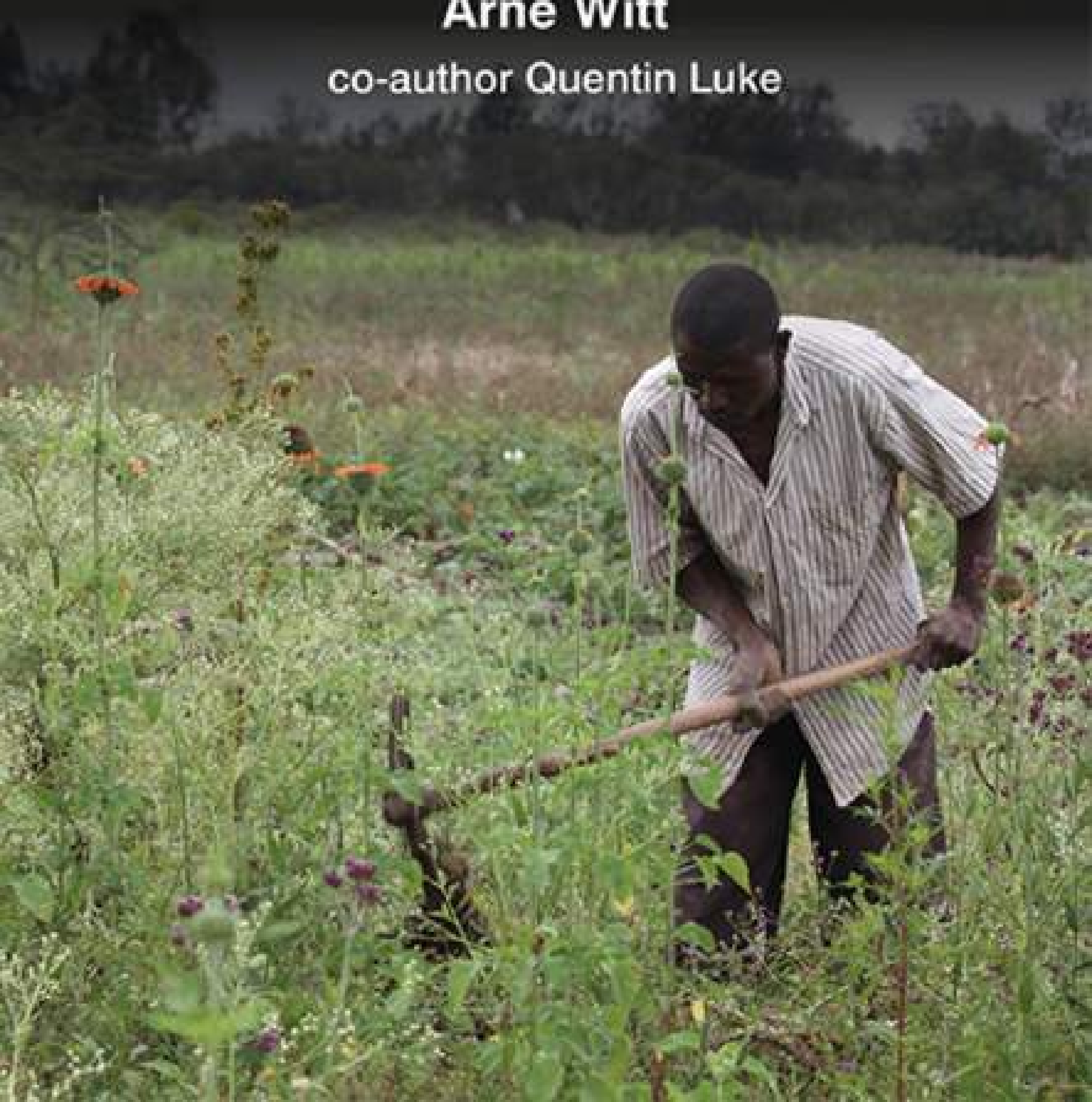
GUIDE TO THE NATURALIZED AND INVASIVE PLANTS OF

EASTERN AFRICA

Arne Witt

co-author Quentin Luke



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Arne Witt is currently the Regional (Africa and Asia) Coordinator for Invasive Species for CABI, based in Nairobi, Kenya. He has fulfilled the roles of International Project Coordinator and/or Technical Advisor for a number of regional UNEP-GEF IAS Projects in Africa, Asia and the Caribbean, dealing with issues pertaining to policy development, capacity building, awareness creation, and development and implementation of best management practices. He continues to develop and implement IAS projects in these regions.

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Foreword

East Africa is home to some of the world's most important biodiversity resources. These resources include the Eastern Arc Mountains and Coastal Forests, which collectively make up a Global Biodiversity Hotspot, boasting no fewer than 1,750 endemic plant species. This hotspot alone is known to harbour 333 species of threatened plants, birds, amphibians, reptiles, and mammals. In East Africa, there are also a number of biodiversity-rich World Natural Heritage Sites, such as the Serengeti, Mount Kenya, Kilimanjaro, and Bwindi Impenetrable Forest National Parks. In Ethiopia, there are more than 7,000 higher plant species, of which about 12% are considered to be endemic. In terms of crop diversity, moreover, eastern Africa is regarded as one of the richest genetic resource centres in the world. Yet this extraordinary biodiversity is threatened by, among other factors, the uncontrolled spread of invasive alien species (IAS).

IAS are exotic, non-native, non-indigenous or foreign plant or animal species that have been introduced by people, either intentionally or unintentionally, into habitats outside of their natural range and beyond the reach of their natural dispersal potential. In their new environments, they establish and proliferate, to the detriment of native biodiversity and local livelihoods and economic activities. Indeed, for the negative impacts they have on biodiversity, IAS are ranked second only in severity to habitat destruction. A 2001 study revealed that IAS are costing the global economy more than US$ 1.4 trillion per annum. These grim economic impacts will go on being exacerbated by increased global trade, travel and transport, and by climate change.

East Africa and Ethiopia have not escaped the onslaught of IAS. The impacts of introduced insect pests and diseases are well known. Familiar examples include the larger grain borer (*Prostephanus truncatus* Horn; Bostrichidae); the Asian fruitfly (*Bactrocera invadens* Drew, Tsura & White; Tephritidae); the tomato leafminer (*Tuta absoluta* Meyrick; Gelechiidae), the diamond-backed moth (*Plutella xylostella* L.; Plutellidae); the spotted stem borer (*Chilo partellus* Swinhoe; Crambidae), and Maize Lethal Necrosis Disease (MLND). By contrast, information relating to which invasive alien plant species are present, and where in the region they are found, and what their impacts are, is generally much less well understood, although there are a few exceptions. The negative impacts of mesquite (*Prosopis juliflora* L.; Fabaceae); famine weed (*Parthenium hysterophorus* L; Asteraceae), and water hyacinth [*Eichhornia crassipes* (Mart.) Solms Pontederiaceae], for example, are now quite widely familiar. Yet little to nothing is known about the many scores of other exotic plant species that have become naturalized and invasive in East Africa and Ethiopia.

Unlike crop pests, most invasive plant species have cross-cutting impacts. Famine weed, for example, has an impact on crop and pasture production, on human and animal health, and on biodiversity. And yet, despite these wide-ranging impacts, very little is being done to manage invasive plant species at a national or regional level. This may be due largely to the fact that countries within the region have no baseline data with regard to which introduced plant species have escaped cultivation and are proliferating, to the detriment of natural resources.

To overcome this impediment or barrier, CAB International has, with support from the JRS Biodiversity Foundation, produced this Guide to the naturalized and invasive plant species of eastern Africa. The Guide, which covers 200 species, includes detailed species descriptions, complete with line drawings, colour images and distribution maps, as well as information on impacts and on methods of control, all of which will significantly enhance our understanding of, and ability to manage, invasive alien plants in the region.

By managing invasive plants more effectively, we shall be contributing, not only to biodiversity conservation, but also to improving the lives and livelihoods of millions of people. This will help us to meet our obligations under various international agreements and treaties, such as the Convention on Biological Diversity (CBD). Improved management of invasive plants will also help the countries of eastern Africa to meet their Sustainable Development Goals.

The authors of this Guide are to be congratulated for having compiled such a thorough and detailed Guide to what has become one of the most pressing challenges of our age. The Guide will contribute significantly to enhancing livelihoods and bolstering biodiversity conservation in East Africa and Ethiopia.

Mrs Tumusiime Rhoda Peace, Commissioner for Rural Economy and Agriculture, African Union Commission

Executive Summary

Both in Ethiopia and in the countries of East Africa, the continuing proliferation and spread of invasive alien species (IAS) is now recognized as a serious problem, which needs to be addressed. Yet the management of invasive species in the region, and of invasive alien plant species in particular, has long been constrained by a number of factors. Common constraints have included weak policy and weak institutional mechanisms; lack of awareness and of access to critical information; inedaquate provision for prevention and control, and a general lack of capacity.

While this situation has improved dramatically over the past 10 years, further progress has been hampered by the absence, hitherto, of a comprehensive IAS database for the region. Countries in the region have repeatedly expressed the need for such a database, as a tool to assist in the identification of naturalized and invasive alien plant species, and in understanding their impacts, both existing and potential, while also providing pointers on what can be done to manage such species.

This information is seen as essential, not only in enabling countries to develop effective IAS management strategies, but also in helping them to meet their obligations under various international agreements and treaties, including Article 8 (h) of the Convention on Biological Diversity (CBD) and Target 9 of the 2020 Aichi Biodiversity Targets. Without effective IAS management, many of the goals agreed to under these and other protocols, such as the 2030 Sustainable Development Goals, will remain elusive.

In providing such a database, this Guide is intended to give the countries of eastern Africa the information they require, in order to be able to develop effective strategies for combating the growing menace posed by invasive alien plants. It is further hoped that this Guide will foster increased regional collaboration, in responding to the challenges of managing shared invasive plant species.

The Guide is based on the findings of extensive roadside surveys, carried out throughout the region, and on a review of the literature pertaining to naturalization and/or invasiveness among alien plants in eastern Africa. By this means, scores of exotic plant species were found to have escaped from cultivation, and to have established populations in the 'wild', to the detriment of natural resources and the millions of people in the region who depend on these resources.

Included in the Guide are descriptions of roughly 200 exotic plant species which are either invasive already or which are deemed to have the potential to become invasive in the region. The profiled species include aquatic invasive plants or waterweeds (seven species); vines, creepers or climbers (20 species); terrestrial herbs, shrubs, and succulents (more than 30 species of each), and trees (more than 60 species). This selection is undoubtedly an underestimate, given that many parts of the region were not surveyed. At the very least, though, we are confident that all the most widespread and abundant invasive plant species present in the region are covered in the Guide.

Of all the invasive plant species that occur in East Africa and in Ethiopia, there is no doubt that the worst ‘offenders’ are famine weed (*Parthenium hysterophorus* L; Asteraceae); mesquite or ‘mathenge’ [*Prosopis juliflora* (Sw.) DC.; Fabaceae]; lantana (*Lantana camara* L.; Verbenaceae); devil weed [*Chromolaena odorata* (L.) King & H.E. Robins; Asteraceae]; water hyacinth [*Eichhornia crassipes* (Mart.) Solms; Pontederiaceae]; neem (*Azadirachta indica* A. Juss; Meliaceae); leucaena (*Leucaena leucocephala* (Lam.) de Wit; Fabaceae); Mexican sunflower (*Tithonia diversifolia* (Hemsl.) A.Gray; Asteraceae); giant sensitive plant (*Mimosa pigra* L.; Fabaceae); creeping sensitive plant (*M. diplotricha* C. Wright; Fabaceae); guava (*Psidium guajava* L.; Myrtaceae); some Australian acacia species (*Acacia* spp.; Fabaceae); various cactus species (*Opuntia* spp.; Cactaceae), and a number of species in the genus *Senna* (Fabaceae). Other widespread and abundant species include goatweed (*Ageratum conyzoides* L.; Asteraceae); species in the genus *Datura* (Solanaceae) and large cocklebur (*Xanthium strumarium* L.; Asteraceae).

Also profiled in this Guide are many exotic plant species which, although their current distribution in the region may still be relatively localized, nevertheless have the potential to become considerably more widespread and problematic. Such species include tree dahlia (*Dahlia imperialis* Roezl ex Ortgies; Asteraceae); yellow bells [*Tecoma stans* (L.) Juss. ex Kunth; Bignoniaceae]; Madeira vine [*Anredera cordifolia*; (Ten.) Steenis; Basselaceae]; balloon vine (*Cardiospermum grandiflorum* Sw.; Sapindaceae); pereskia (*Pereskia aculeata* Mill.; Cactaceae); coral creeper (*Antigonon leptopus* Hook. & Arn.; Polygonaceae); various *Cestrum* (Solanaceae) and *Ipomoea* (Convolvulaceae) species, and four o’clock flower (*Mirabilis jalapa* L.; Nyctaginaceae), among others. In the Guide, the impacts of invasions elsewhere in the world, by these and by other plants, are described in detail, as similar impacts, if not evident already in Ethiopia or in East Africa, can be expected in the future.

As it is, large parts of the arid and semi-arid landscapes of eastern and southern Ethiopia and of northern and northeastern Kenya have been invaded by introduced trees, such as mesquite, as well as by various succulents, including Australian pest pear [*Opuntia stricta* (Haw.) Haw. Cactaceae] and sweet prickly pear [*O. ficus-indica* (L.) Mill.; Cactaceae]. Many *Agave* species (Agavaceae) are well adapted to growing in these areas, as are species in the family Crassulaceae, mainly *Bryophyllum* species, which were introduced as ornamentals but which have subsequently escaped cultivation. *Calotropis* species (Apocynaceae) are also well adapted to survive and to spread in these semi-arid environments.

The East African highlands, especially those in Kenya and Tanzania, have largely been invaded by introduced Australian acacias such as black wattle (*Acacia mearnsii* De Wild.; Fabaceae) and blackwood (*A. melanoxylon* R.Br.; Fabaceae). *Pinus patula* Schiede ex Schltdl. & Cham. (Pinaceae) has also escaped from cultivation in these areas, along with shrubs such as various *Rubus* (Rosaceae) species and Mauritius thorn [*Caesalpinia decapetala* (Roth) Alston; Fabaceae]. African bush daisy [*Euryops chrysanthemoides* (DC.) B. Nord. Asteraceae] also tends to favour higher-lying areas, establishing dense stands. Many of the invasive species profiled in the Guide have been recorded as naturalized or invasive only in the East Usambaras, as escapes from the Amani Botanical Gardens. This area has been well studied, so there are good records of the presence of exotic species that have escaped cultivation, but which have not yet been recorded as being problematic elsewhere in the region, such as *Maesopsis eminii* Engl. (Rhamnaceae), *Hura crepitans* L. (Euphorbiaceae), *Hevea brasiliensis* (Willd. ex A.Juss.) Müll. Arg. (Euphorbiaceae), *Arenga pinnata* (Wurmb) Merr. (Arecaceae), *Castilla elastica* Cerv. (Moraceae), *Cordia alliodora* (Ruiz & Pav.) Oken (Boraginaceae), *Piper aduncum* L. (Piperaceae) and others.

Some exotic species, such as neem and leucaena, seem to favour coastal habitats, and are particularly invasive there, along with species such as coral creeper (*Antigonon leptopus* Hook. & Arn.; Polygonaceae). Mesquite is also invasive along the northeastern coast of Kenya. Species such as devil weed seem to favour savannah habitats, while other species, such as famine weed, lantana, goatweed [*Ageratum conyzoides* (L.) L.; Asteraceae], and common thorn apple (*Datura stramonium* L.; Solanaceae), are adapted to survive and to proliferate across a wider range of habitats, wherever there is sufficient rainfall or soil moisture. Semi-aquatic species, such as giant sensitive plant (*Mimosa pigra* L.; Fabaceae), thrive on floodplains and around the edges of swamps and waterbodies. Other species, such as *Brugmansia suaveolens* (Humb. & Bonpl. ex Willd.) Bercht. & J. Presl (Solanaceae) are generally invasive only along streams and on riverbanks in highland areas, while spectacular cassia [*Senna spectabilis* F (DC.) H.S. Irwin & Barneby; Fabaceae] and yellow cestrum (*Cestrum aurantiacum* Lindl.; Solanaceae) are often problematic in forests and in woodlands. Many introduced vines or 'climbers', such as Madeira vine [*Anredera cordifolia* (Ten.) Steenis; Basselaceae], balloon vine (*Cardiospermum grandiflorum* Sw.; Sapindaceae) and pereskia (*Pereskia aculeata* Mill.; Cactaceae), which are only now starting to escape from gardens, may soon pose a significant threat to forest diversity.

The wide range of habitats and climatic conditions found within Ethiopia and across East Africa make the region as a whole particularly prone to invasions by a host of introduced plant species. Such invasions are being facilitated by increased land degradation, especially through overgrazing and deforestation, and also by climate change.

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Introduction

The main aim of this Field Guide is to enable people to identify some of the alien plant species that are invasive, potentially invasive, or naturalized in East Africa (Burundi, Kenya, Rwanda, Tanzania and Uganda) and Ethiopia (see Figures 1 and 2), and to enable them to learn more about the impacts of these species and about possible options for managing and controlling such plants.

The status of introduced plant species profiled in this Guide was determined through roadside surveys and through a review of the existing literature, both published and unpublished. Covering only 200 species, this is by no means a comprehensive Guide. Indeed, it is a very conservative selection, considering that many localities could not be surveyed, and given too that some species, even in surveyed areas, may have been overlooked. Other species may have escaped attention simply because they are not recorded in the literature as being naturalized or invasive in the region.

Grasses, for example, which can be very difficult to identify during roadside surveys, were not assessed. Many *Eucalyptus* (Myrtaceae) and *Pinus* (Pinaceae) species have been introduced into the region and cultivated, in some cases becoming naturalized or even locally abundant, but these too can be hard to identify, and as such were not assessed at the level of individual species, with a few exceptions. Many other species, of vines for example, especially those in the genus *Ipomoea* (Convolvulaceae), are difficult to identify when not in flower. Some species are obscure and difficult to spot, while others are hard to tell apart from native plant species of similar appearance. So, where a plant species is not recorded as being present in a particular area, this does not necessarily mean that the species does not occur there, only that it was just not seen there during our surveys.

In addition, this Guide includes only species deemed to be having a negative impact, or as having the potential to impact negatively, on biodiversity or rangeland production (including through toxicity to livestock), even though many of the species may also have impacts on crop production and on other productive sectors. In other words, introduced plant species that, in our view, impact only on crop production are not included. This is not because such plants are considered to be less important, only that we have chosen to focus on species that are contributing, or which may contribute, to biodiversity loss and reduced pasture production in the region, now and in the future.

In our view, all the species profiled in this Guide are either naturalized already, or invasive, in East Africa and/or in Ethiopia, or else have the potential to become invasive in the region in the future. While it is obvious that some species, including famine weed (*Parthenium hysterophorus* L; Asteraceae), mesquite [*Prosopis juliflora* (Sw.) DC.; Fabaceae], lantana (*Lantana camara* L.; Verbenaceae) and water hyacinth [*Eichhornia crassipes* (Mart.) Solms; Pontederiaceae] are invasive, we cannot be entirely certain that other species we have “labelled” as potentially invasive or naturalized, will necessarily become problematic.

The decision to include such species is based on observations in the field and on the ecology and the biology of species and/or of closely related congeners which, elsewhere in the world, are known to have become problematic, threatening biodiversity and livelihoods. So, while some of the listed species may never become problematic, it is better to be 'safe than sorry', and so avoid growing or disseminating exotic plant species that could damage our environment and/or economy in the future. This is what is known as the Precautionary Principle. As the sayings go, 'a stitch in time saves nine', and 'forewarned is fore-armed'.

We have included some species, such as *Ipomoea hildebrandtii* Vatke (Convolvulaceae) and peanut butter cassia [*Senna didymobotrya* (Fresen.) H.S. Irwin & Barneby; Fabaceae], which, although they are native to some parts of the region, are behaving, elsewhere in the region, like invasive plants, mainly as the result of poor land-use practices, which are allowing them to proliferate. Climate change may be another contributing factor. Even within the region, some plants, because they have been moved outside of their natural ranges, may now be considered to be invasive alien species. For example, *Maesopsis eminii* Engl. (Rhamnaceae) which is considered to be native to parts of Uganda, has been introduced to the East Usambaras, Tanzania, where it has become problematic, while *Brillantaisia lamium* (Nees) Benth. (Acanthaceae), also native to Uganda, has been introduced to Kenya and is now invasive in Nairobi and environs.

This Guide is sub-divided into seven major sections: Aquatics; Climbers (including vines and creepers); Herbs (including spreading or flat-growing plants); Palms; Shrubs; Succulents, and Trees. Some species may be regarded as both shrubs and small trees, or as both small and large trees, or as both shrubs and climbers, but have been included in only one of the sections or categories in order to avoid duplication. The species appear in alphabetical order within each section, based on their scientific names.

The text gives the scientific name for each species, along with its English common name, or names, and the local or vernacular names that are most frequently used in countries within the region. While it has not been possible to get vernacular names for all of the species, we hope to be able to rectify this in subsequent editions. There is a brief description of each species, complete with line drawings and colour photographs, as well as information on its origin, the reasons for its introduction, the habitats it invades, and its impacts.

The information on impacts has been obtained from multiple sources, often from studies undertaken outside of East Africa and Ethiopia. This can be instructive in that impacts, for most invasive species, tend to be generic, i.e. similar, irrespective of where a particular invasive species is adventive. In some cases, the impacts of introduced plant species within eastern Africa are not well documented in the literature. It is hoped that the case studies cited in this Guide will lead to a more thorough assessment of impacts within the region.

The distribution maps presented in this Guide are based on roadside surveys, including surveys of towns, villages and gardens in Ethiopia and in all the countries in East Africa with the exception of Burundi, which could not be surveyed, owing to security concerns. Insecurity and poor road access in some other areas, in both East Africa and Ethiopia, also prevented surveys from being undertaken. Additional records were obtained from published and unpublished sources, covering the entire region, including Burundi.

Surveyed areas (see Figure 3) and the distribution of naturalized and invasive species are represented by 1/2-degree grid squares (~ 55 x 55 km). In the species distribution maps grey grid squares represent the areas that were surveyed but where no naturalized, invasive or potentially invasive plant species were seen. Orange grid squares represent areas where a plant species was found to be present and/or naturalized, and red grid squares represent areas where a species was considered to be invasive. It is impossible to survey all of a grid square and as such the maps are only an indication that a given species was absent, present, naturalized or invasive within a part of that particular grid square; the part that could be surveyed. Yellow grid squares represent distribution data obtained from other sources with no reference being made to plant densities or invasiveness. Additional information on the distribution of some of the species in the various districts in Ethiopia (see Figure 4) and East Africa have been included in the narrative. (see page 42 for map key)

Any species found to be widespread and abundant, or even localized but abundant, was recorded as being invasive. The assumption is made that all the invasive species present in Ethiopia and in the countries of East Africa (except Burundi) have been recorded, although some naturalized and (as of now) range-limited species may have been missed. The information on best management practices, and on herbicide applications, has been adapted mainly from sources in Australia and South Africa.

Figure 1. Map showing the location of the countries surveyed within Africa

Figure 2. Detailed map showing the countries that were surveyed in eastern Africa (Burundi was not surveyed)

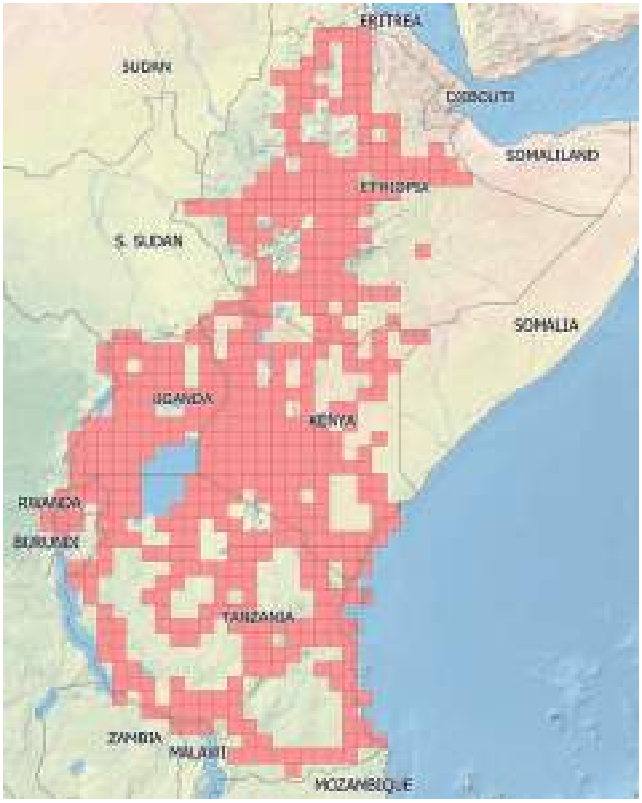


Figure 3. Map showing (in 1/2-degree grid squares) the areas surveyed in eastern Africa

Figure 4. Map showing the various regions in Ethiopia referred to in the Guide

What is an alien plant?

An alien plant is an exotic, non-native, non-indigenous or foreign plant species that has been introduced by people, either intentionally or unintentionally, outside of its natural range and outside of its natural dispersal potential. Plants that have been introduced into an area without the help of people, from an area in which they are already exotic, are also regarded as alien. In other words, a species which does not belong to the native flora is alien. This includes most of our crops (wheat, maize, rice, potatoes, etc.) and many of our ornamental plants.

What is an invasive alien plant?

An invasive alien plant is a species of plant that is both alien, as described above, and destructive to the environment in which it grows. As such, invasive plants can have negative impacts on biodiversity and/or livelihoods. It should be noted that most alien species are useful and do not become invasive. In the context of this Guide, destructive alien species that were found to be widespread and abundant, or even localized but nevertheless abundant, were recorded as being invasive within a particular locality. The same criteria were used in recording the status of native species that we consider to be invasive.

What is a naturalized plant?

In the context of this Guide, a naturalized plant is an alien plant that has established self-perpetuating populations without any human intervention, but which is not yet considered to be invasive, in terms of being either widespread and/or abundant or destructive in the areas where it is found. Most plants that are considered to be naturalized go on to become invasive, but in some cases they do not. The same applies to those exotic species profiled in this Guide that are not naturalized or invasive at present, but which have all of the characteristics or attributes of invasive species; some of these species may never become problematic, but we need to be conscious of their presence in the region.

What is a weed?

A weed is a plant that is out of place and which has not been sown intentionally, or it is a plant growing where it is not wanted. A weed has a negative impact on crop or pasture production, human or animal health, or other aspects of economic activity and development, and may be either native or introduced. Yet while some native weeds may be problematic, in crop production systems for example those very same species, often referred to as pioneers, may also play an important role in plant successions, say, in degraded forests. Pioneers, because they do not persist, allow natural succession to take place, unlike invasive alien species (IAS), which do persist and inhibit or prevent natural succession processes. The definition of a weed is therefore context-dependent, but in the final analysis, while all invasive alien plant species are weeds, not all weeds are invasive alien plants, because many of them are native to the countries or regions where they occur.

Attributes that enable alien plants to become invasive:

- have no natural enemies in areas into which they have been introduced. In other words, there are no diseases or herbivores which have the ability to attack them, and so reduce their growth rate, reproductive capacity and competitive ability;
- are adaptable in that they are capable of growing in a wide range of habitats and soil types and under various climatic conditions;
- are often plants that have the ability to spread vegetatively (through cladodes, tubers, bulbs, etc.) as well as by seed;
- may be plants that are popular as ornamentals or which are used in agro-forestry, as these plants are more likely to be moved around and are grown in large numbers, contributing to increased propagule pressure;
- are often hardy, having the ability to withstand adverse growing conditions;
- have the ability to grow rapidly and to regenerate quickly after being damaged;
- establish easily, often in nutrient-poor or water-limited environments;
- can make very efficient use of limited resources such as water, nutrients and light;
- mature very rapidly and so produce seeds early, often in large quantities;
- possess efficient and effective modes of dispersal;
- do not require specialized pollinators, having flowers that are easily pollinated by any number of different insects, birds and other organisms, and
- have seeds that can remain dormant for long periods, allowing the plants to persist during periods which are not suitable for active growth.

Invasive alien plants may:

- interfere with crop and pasture production and native plants through competition for available light, water and nutrients;
- physically interfere with the growth of a crop or native plant species;
- displace crops, pasture and native plant species through the production of toxins that inhibit the growth of other plants (allelopathy);
- permanently alter natural ecosystems and the services and benefits they provide in nature and to people;
- impact on soil nutrient cycling (e.g. nitrogen-fixing plants);
- contaminate harvested crops with their seeds or by tainting (e.g. the seeds of some weeds are toxic, and may result in poisoning if consumed);
- act as secondary hosts for crop pests (i.e. harbour insects, pests or diseases which attack crops);
- provide suitable habitats for organisms that may pose a threat to human or animal health (e.g. waterweeds provide ideal habitats for vectors of human and animal diseases);

- increase shading (in the case of invasive shrubs or trees), which can alter soil temperatures, affecting the growth, reproduction and/or survival of organisms residing in the soil;
- have a negative impact on human and animal health (e.g. pollen from invasive plants may contribute to respiratory ailments in people);
- interfere with the harvesting of crops or forage (e.g. thorny or woody weeds can make it difficult to harvest crops);
- lead to the need for additional cleaning and processing (e.g. weeds with burs may lodge in sheep's wool);
- reduce the amount of available pasture (i.e. weeds may displace valuable pasture species or prevent access to valuable forage);
- be poisonous to people, livestock or wildlife;
- cause physical injuries to people, livestock or wildlife (e.g. weeds with spines, such as cactus species, can cause serious injuries);
- reduce the quality of animal products such as meat, milk, fleeces or hides (e.g. consumption of some weeds, such as parthenium, by livestock, may render their milk and meat unpalatable);
- invade water bodies, affecting water quality and quantity (e.g. waterweeds can dramatically increase water loss through evapotranspiration);
- inhibit water transport (e.g. waterweeds can inhibit or prevent the movement of boats);
- inhibit or prevent hydroelectricity generation (e.g. waterweeds may block turbines);
- block water courses, including irrigation canals (e.g. aquatic or semi-aquatic weeds), leading to flooding;
- inhibit the ability of people to catch fish (e.g. waterweeds, such as water hyacinth, which by covering entire water surfaces can make fishing impossible);
- alter river flows and contribute to riverbank erosion (e.g. semi-aquatic weeds, such as giant sensitive plant, which can reduce water flow rates);
- contribute to erosion of sand from beaches (i.e. weeds used to stabilize coastal dunes can alter soil movement dynamics, reducing sand deposition on beaches);
- interfere with the recreational use of certain areas, especially water bodies;
- reduce tourism potential (i.e. unpalatable weeds can reduce the abundance of wildlife);
- increase the frequency and intensity of fires (e.g. weeds, such as chromolaena, which are highly flammable);
- provide cover for dangerous animals and in many instances for poachers as well;
- prevent access to natural resources (i.e. weeds forming dense impenetrable thickets can prevent access to water and grazing);

- encroach on roads, paths and villages;
- contribute to the abandonment of homes and villages (i.e. a reduction in crop yields and pasture production may force people to move elsewhere);
- are drivers of human conflict (i.e. invasive plants, by eroding the natural resource base on which millions of people depend, may spark conflict, especially over access to water and grazing); and
- reduce visibility along transport corridors.

It has been estimated that weeds in general are causing crop-yield losses of about 10% in less developed countries, and of about 25% in least developed countries (Akobundu, 1987). In the USA, weeds are reducing potential crop yields by 12%, which equates to a monetary loss of about US$ 33 billion annually (USBC, 1998). Roughly US$ 27.9 billion of this lost crop-production revenue is attributed to exotic weeds (Pimentel *et al.*, 2001). In parts of the USA where infestations of field bindweed (*Convolvulus arvensis* L; Convolvulaceae) are dense, crop yields have been reduced by as much as 50–60% (Callihan *et al.*, 1990). Annual crops, such as cereals and grain legumes, are especially badly affected by bindweed infestations, and yield reductions of 20–80% have been recorded (Phillips and Timmons, 1954; Black *et al.*, 1994). Bindweed is also a problematic weed in vineyards. In 1998 alone, losses caused by bindweed in the USA were estimated at more than US$ 377 million (Berca, 2004).

In India, weeds are responsible for an estimated 30% loss in potential crop production, and are thought to be depriving the country of yields worth about US$ 90 billion per year (Singh, 1996). In India, yield losses of 86%, 67%, 48%, 27%, 25% and 18% have been recorded in niger seed, greengram, sesamum, soybean, black gram, pigeon pea and groundnut respectively, as a result of dodder (*Cuscuta campestris* Yunck.; Convolvulaceae) infestations (Mishra *et al.*, 2007). In the lowlands of Ethiopia, *Parthenium hysterophorus* L. (Asteraceae) is considered by the overwhelming majority of farmers to be the most damaging weed in both croplands and grazing areas (Tamado and Millberg, 2000).

Invasive plant species can also have a dramatic impact on livestock production. About 45% of the weeds in US pastures are alien species, which are together responsible for losses in pasture production worth about US$ 1 billion per year (Pimentel *et al.*, 2001). In Australia, infestations of rubbervine (*Cryptostegia grandiflora* Roxb. ex R. Br; Asclepiadaceae) have reduced the carrying capacities of some pastures by 100%. Economic losses incurred by rubbervine infestations, resulting in reduced cattle-carrying capacities and in increased management costs, have been estimated at A$ 18 million annually to the beef industry of north Queensland, Australia, alone (Agriculture and Resource Management, 2001).

In South Africa, infestations of *Chromolaena odorata* have reduced the carrying capacities of pastures from about six hectares per livestock unit (LSU) to more than 15 ha/LSU (Goodall and Morley, 1995). A recent study has shown that natural grazing capacity in South Africa, without management of invasive plants, would be reduced by 71% (van Wilgen *et al.*, 2008).

In Australia, infestations of thistle [*Cirsium vulgare* (Savi) Ten.; Asteraceae] have caused losses to the wool industry amounting to an estimated US$ 15 million a year (Davidson, 1990). Most pasturelands in India have been invaded to some extent by *Lantana camara* L., (Verbenaceae), resulting in productivity losses worth almost US$ 1 billion per year (Pimentel *et al.*, 2001). It is estimated that introduced weeds in crops and pastures in South Africa, the USA, the UK, India and Brazil result in economic losses of almost US$ 95 billion per annum (Pimentel *et al.*, 2001).

Invasive plants can also have a dramatic impact on water resources. In South Africa, invasive alien plants have reduced surface water run-off by about 3,300 million m^3, which is about 7% of the national total (Le Maitre *et al.*, 2000). Declines in water run-off in South Africa, attributed to infestations of *A. mearnsii* De Wild. (Fabaceae) alone, amount to an estimated 577 million m^3 annually (Versfeld *et al.*, 1998). Introduced pines (*Pinus* spp.) which have escaped from cultivation in South Africa have had a dramatic impact on water resources. On the Drakensberg in Kwazulu-Natal, pine plantations have reduced stream-flows by 82% (Bosch, 1979), while in the Western Cape stream-flows from invaded fynbos water catchments have declined by 55%. If the terrestrial invasive plants now present in South Africa were left to expand their distribution and to occupy their full potential ranges, water losses would increase to about 56% of the national total (van Wilgen *et al.*, 2008).

Infestations of water hyacinth [*Eichhornia crassipes* (Mart.) Solms; Pontederiaceae] and of other waterweeds can also dramatically increase water losses, impacting on a host of other sectors. In southern Benin, an infestation of water hyacinth was found to have reduced the annual income of 200,000 people by about US$ 84 million (de Groote *et al.*, 2003). Water hyacinth infestations are costing seven African countries US$ 20–50 million per year in impact and management costs (Joffe and Cook, 1997).

Invasive plants have negative impacts on human and animal health. For example, famine weed (*Parthenium hysterophorus*) can cause severe allergenic reactions in people who regularly come into contact with the plant (McFadyen, 1995). In Ethiopia, symptoms recorded in people who have come into contact with the weed on a regular basis include general illness, asthma, irritation of skin and pustules on the hands, stretching and cracking of the skin, and stomach pains (Wiesner *et al.*, 2007). Paper mulberry [*Broussonetia papyrifera* (L.) L'Hér. ex Vent.; Moraceae], a tree that is invasive in Ghana, Uganda, Pakistan and elsewhere, produces vast quantities of allergenic pollen, which has been shown to exacerbate asthma in sufferers. In Islamabad, Pakistan, paper mulberry sometimes accounts for as much as 75% of the total pollen count, contributing to ill health or even death in the old and infirm.

In Queensland, Australia, pastoral losses resulting from *L. camara* infestations were in 1985 estimated at US$ 7.7 million, inclusive of lost revenues associated with 1,500 animal deaths, and with reduced productivity and lost pasture production, as well as the costs of control (van Oosterhout, 2004). Invasive *Bryophyllum* species, including *B. delagoense* (Eckl. & Zeyh.) Schinz

(Crassulaceae), caused 41 recorded poisoning incidents, affecting 379 cattle in Queensland, Australia, between 1960 and 1984 (McKenzie and Dunster, 1986). In 1997, 125 cattle died after eating this species on a travelling stock reserve near Moree in New South Wales, Australia (McKenzie *et al.*, 1987). In the Sudan, the ingestion by livestock of *Calotropis procera* (Aiton) Dryand. (Apocynaceae) is a suspected cause of ill-health and sometimes even death in sheep and goats (Mahmoud *et al.*, 1979).

Biodiversity is also dramatically reduced by the presence of invasive plants. Indeed, many consider invasive alien species to pose the second biggest threat to biodiversity, after direct habitat destruction. In Australia, lantana alone is threatening the survival of 275 native plant species and 24 native animal species (Turner and Downey, 2010). On Ascension Island, *Nicotiana glauca* Graham (Solanaceae) is displacing endemic species such as *Euphorbia origanoides* L. (Euphorbiaceae), a critically endangered species, and *Anogramma ascensionis* (Hook.) Dielsby (Pteridaceae), through dominating sites and altering ecological conditions (Gray *et al.*, 2005). *Passiflora suberosa* L. (Passifloraceae) along with invasive plants of other species, is threatening *Platydesma cornuta* Hillebr. var. *decurrens* B. C. Stone (Rutaceae), a rare shrub that is endemic to Oahu, Hawaii, and of which only about 200 individual plants remain (Richardson, 2007). In Australia, herpetologists looking for reptiles in a habitat invaded by rubbervine (*C. grandiflora*) could find only a single lizard, compared with 131 lizards in nearby native vegetation (Valentine, 2006).

In South Africa, infestations of *Chromolaena odorata* (L.) R.M. King & H. Rob (Asteraceae) are having a negative impact on the breeding biology of the Nile crocodile (Leslie and Spotila, 2001), while in Cameroon chromolaena is displacing native species in the family Zingiberaceae, a major food source for the endangered western lowland gorilla (van der Hoeven and Prins, 2007). In Lochinvar National Park, Zambia, infestations of *Mimosa pigra* L. (Fabaceae) have reduced bird diversity by almost 50% and bird abundance by more than 95% (Shanungu, 2009). In South Africa, *Prosopis* spp. infestations have reduced bird species diversity in some guilds by more than 50% (Dean *et al.*, 2002). In Ethiopia, *P. juliflora* (Sw.) DC (Fabaceae) has reduced understorey basal cover for perennial grasses from 68% to 2% and the number of grass species from seven to two (Kebede and Coppock, 2015). Transformation of this habitat and the reduction in pasture species is threatening the survival of Grévy's zebra (*Equus grevyi* Oustalet; Equidae) in invaded areas (Kebede and Coppock, 2015).

Introduced plants that become invasive, unlike many other, perhaps more familiar invasive species, such as insect crop pests, generally have a cross-cutting impact, affecting multiple sectors, ranging from biodiversity to agriculture and pastoralism, and from water resources to human and animal health. Once an invasive plant has become established, and is widespread and abundant, it is virtually impossible to eradicate, with the result that its impacts on natural or human-made ecosystems will be permanent, unless ameliorated through ongoing, judicious management. This is why invasive alien plants pose such a menacing threat to livelihoods and economic progress, especially in the developing world, where most people are dependent on natural resources for their survival. It is therefore critical that we pool our efforts to manage this scourge, at the local, national, regional, and global levels.

Types of invasive plants

Invasive plants come in various growth forms, shapes and sizes. As mentioned in the Introduction, invasive plants in the context of this Field Guide have been grouped into Aquatics, Palms, Climbers, Herbs, Shrubs, Succulents, and Trees. While many of the invasive plants included in this Guide can be regarded as benign, others, if consumed by wildlife, livestock or people, are extremely toxic. The symbols used in this Guide provide users with a quick reference to the various growth forms – and to toxicity.

Toxic: These plants are poisonous and can have a negative impact on human or animal health and may even result in death, if consumed. Species which are toxic include famine weed (*Parthenium hysterophorus* L.; Asteraceae), lantana (*Lantana camara* L.; Verbenaceae) and common thorn apple (*Datura stramonium* L.; Solanaceae), among others.

Aquatics: Plants capable of growing in aquatic or semi-aquatic environments. These include species such as water hyacinth [*Eichhornia crassipes* (Mart.) Solms; Pontederiaceae] and water lettuce (*Pistia stratiotes* L.; Araceae). Some shrubs or small trees, such as giant sensitive plant (*Mimosa* pigra L.; Fabaceae), may also be regarded as semi-aquatic, although they have been included under the 'Tree' section in this Guide.

Palms: Plants with a straight unbranched stem with clearly visible old leaf scars, and long feathered or fan-shaped leaves, arranged in a spiral at the top of the trunk. A few have multiple stems and some are even creeping vines. Palm species included in this Guide are the African oil palm (*Elaeis guineensis* Jacq.; Arecaceae), sugar palm [*Arenga pinnata* (Wurmb) Merr.] and betel nut (*Areca catechu* L.).

Climber/Vine/Creeper: Plants which can grow over and smother other vegetation. These include species such as Madeira vine [*Anredera cordifolia* (Ten.) Steenis; Basellaceae] and balloon vine (*Cardiospermum grandiflorum* Sw.; Sapindaceae). It should be noted that some large shrubs such as Mauritius thorn [*Caesalpinia decapetala* (Roth) Alston; Fabaceae], devil weed [*Chromolaena odorata* (L.) R.M. King & H. Rob] and even lantana (*Lantana camara* L.; Verbenaceae) may also be considered to be climbers as they have the ability to grow over other vegetation and 'climb' into trees. However, in this Guide the latter species are included under the 'Shrub' section, with the exception of Mauritius thorn, which is considered to be predominantly a climber.

Herbs: Small non-woody plants, usually no more than about 1 m tall, with generally green, soft, often single stems. These include species such as common thorn apple (*Datura stramonium* L.; Solanaceae); Mexican poppies (*Argemone* spp. L.; Papaveraceae); spear thistle [*Cirsium vulgare* (Savi) Ten.; Asteraceae], and famine weed (*Parthenium hysterophorus* L.; Asteraceae). Species such as *Catharanthus roseus* (L.) Don (Apocynaceae) and *Mirabilis jalapa* L. (Nyctaginaceae) are often considered to be herbs or shrubs, but in this Guide they are included under the 'Shrub' section.

Spreading or flat-growing herbs or ground covers: Plants with green, soft and horizontal stems that root wherever they come into contact with the ground. Examples include species such as Singapore daisy [*Sphagneticola trilobata* (L.) Pruski; Asteraceae] and creeping sensitive plant (*Mimosa pudica* L.; Fabaceae). The latter is sometimes also considered to be a small shrub.

Small shrubs: Woody plants that are smaller than large shrubs and trees, as described below. Often multi-stemmed and reaching heights of 1 m or less, these include species such as crofton weed [*Ageratina adenophora* (Spreng.) King & Rob.; Asteraceae] and Koster's curse [*Clidemia hirta* L. (Don.); Melastomataceae].

Large shrubs: Woody plants that are smaller than trees and often multi-stemmed, reaching heights of 2 m or more, and which can form dense stands. Examples include lantana (*Lantana camara* L.; Verbenaceae), devil weed [*Chromolaena odorata* (L.) R.M. King & H. Rob], and C*estrum aurantiacum* (Lindl.) (Solanaceae). Many of these large shrubs have the ability to climb over or into other vegetation, and so may also be regarded as climbers. However, in this Guide they are included under the 'Shrub' section.

Succulents: Plants with thick, fleshy leaves or stems, used for storing water. Usually found in arid or semi-arid regions, these include species in the genus *Opuntia*. Many of these species, such as sweet prickly pear [*Opuntia ficus-indica* (L.) Mill.; Cactaceae], may also be considered to be shrubs or even small trees. Some succulents, such as *Bryophyllum fedtschenkoi* (Raym.-Hamet & H. Perrier) Lauz.-March, may be considered to be ground-covers, herbs or even small shrubs, but in this Guide they are included under the 'Succulent' section.

Small trees: Woody plants that are larger than shrubs and which usually have only one erect perennial stem or trunk. Generally reaching heights of a few metres (less tall than 'large trees' as decribed below), these plants have wide crowns and in many cases form dense thickets. Examples include calliandra [C*alliandra houstoniana* (Mill.) Standl. var. *calothyrsus* (Meisn.) Barneby] and pigeon berry (*Duranta erecta* L.; Verbenaceae), although some may consider the latter to be a large shrub.

Large trees: Woody plants that are larger than shrubs and which usually have only one erect perennial stem or trunk, supporting a wide crown, but which (unlike small trees) may reach heights of several metres. Examples include black wattle (A*cacia mearnsii* De Wild; Fabaceae) and 'mathenge' [*Prosopis juliflora* (Sw.) DC; Fabaceae], although the latter is sometimes regarded as a large shrub.

What can we do to manage invasive alien plants?

In order to be effective, all invasive alien plant management strategies need to consider activities related to: (i) prevention; (ii) early detection and rapid response (EDRR); and (iii) control.

Prevention: As most of the invasive plants present in eastern Africa were intentionally introduced, the most effective way to prevent further introductions is to prevent their introduction in the first place. To that end it is important to evaluate the potential of an introduced plant to become invasive prior to introduction. This can largely be determined by undertaking a Risk Assessment (RA) which, amongst other factors, considers the biology of the species, characteristics of the environment to which it is being introduced and if it has been recorded as being invasive elsewhere. Undertaking RA on exotic species which are already present should also be encouraged, so that those plant species which show a high risk of becoming invasive in the future can be eradicated, if possible. It should be noted that climate change, increased disturbance and propagule pressure are all factors that may drive an exotic species, which may appear to be benign now, to become invasive in the future. Prevention is the most cost-effective activity within a holistic invasive species management strategy. As the saying goes 'an ounce of prevention is worth a pound of cure'.

Early detection and rapid response (EDRR): If authorities, competent bodies or even landowners have failed to prevent the introduction of an invasive or potentially invasive species, and it has established in the field, it is critical that it be detected early and eradicated, before it becomes widespread and abundant. To that end it is important that a surveillance strategy be developed and implemented. If an invasive or potentially invasive species is detected, but it is already abundant and widespread, a containment strategy needs to be implemented to prevent its further spread and action taken to mitigate its negative impacts.

Control: If surveillance did not result in the early detection of a potentially problematic plant, and eradication is no longer feasible because it is already widespread and abundant, it is essential to implement a control strategy. A control strategy could include the use of cultural, physical or chemical methods or a combination of some or all of these measures, followed by rehabilitation or restoration. However, before any control is implemented it may be wise to consider these points:

- If possible, undertake a socio-economic survey among communities and/or other target groups to determine the impacts of the invasive plant species on livelihoods or other economic sectors. If there is disagreement among the community as to the costs and benefits of the target species, it is recommended that a cost–benefit analysis (CBA) be undertaken. To acquire sufficient information to undertake a CBA it may be necessary to undertake additional field trials/surveys to support or refute the findings of the socio-economic assessment.

- It is critical that action be taken in order to garner support for control of the target species from government officials and local communities. This may take the form of meetings, workshops and/or the development and dissemination of awareness material.
- Inform all stakeholders as to the identity of the target species, its impacts and management options. A lack of support from communities will be a major barrier to the long-term success of any management activities.
- Demarcate and map the area targeted for control and calculate the costs associated with any control activities – these should include the costs of equipment, transport, labour, herbicides, nurseries to grow plants for restoration activities, etc. Note should be taken of the presence of other invasive plants which may invade the area once the target species has been removed. Costs associated with their control also need to be included.
- Develop baseline data on the density, distribution and impacts of the target species in order to measure the efficacy of control operations and benefits to local communities.
- Ensure that you have sufficient resources to undertake initial control, for follow-up activities and if required rehabilitation or restoration.
- If best management practices are not known, or there is resistance from the community to the implementation of particular control activities, it is suggested that demonstration trials or similar be established to reassure communities about the efficacy and safety of selected methodologies.
- The most cost-effective way of managing infestations is to initially contain the current infestation and then initiate control of the less dense or isolated populations first before moving onto the densest stands. In other words management strategies should work from 'outside-in', clearing less dense infestations on the periphery of larger and denser infestations first.
- If clearing invasive plants in mountain catchments or similar, it is recommended that invaded areas in higher lying areas be cleared first before moving onto lower lying areas because plant propagules (seeds or vegetative material) are more likely to move 'downhill'. This is especially relevant when controlling invasive plants that have invaded riparian zones because most propagules move downstream along with the water flow.
- Try to remove invasive plants before they flower and produce seeds. This is especially relevant and applicable to new infestations detected during surveillance activities.
- It is not advisable to transport plant parts, especially seeds, rhizomes, tubers, bulbs or other vegetative material (e.g. cactus cladodes) from areas where they have been removed for disposal elsewhere. This will most likely contribute to the further spread of the target species. Ideally, the plants that have been removed should be destroyed and left on site.

Example of control methods

Invasive plants can be controlled using physical (manual or mechanical), chemical or biological means (see below for more detail). Cultural control, which is the use of fire, flooding or grazing to reduce the abundance of invasive plants, can also be used in conjunction with other control methods. Cultural control in crop production systems which can include crop rotation, the use of catch crops, winter ploughing, and irrigation management, can also be helpful in controlling problem plants. Overgrazing often facilitates plant invasions by reducing native plant cover, allowing exotic plants to establish and spread – most invasive species thrive on disturbance. Overgrazing can lead to a reduction in fire frequency and intensity. An absence of fires can facilitate the establishment and proliferation of many invasive plants, especially succulents such as cacti, which are sensitive to fires. Livestock owners should therefore practise rotational grazing and apply the correct stocking rates.

A critical component of invasive species management, which is often not implemented, is that of rehabilitation or restoration. Rehabilitation involves activities which convert a cleared piece of land into land suitable for use in terms of habitation or cultivation. The objective of restoration, on the other hand, is to restore land cleared of invasive species to a situation where it matches, as close as possible, the original condition. The latter may involve activities to restore various ecological processes. Cleared areas are very prone to re-invasion, while restored areas are more resistant to invasive plant regeneration and invasion. Restored areas generally also require fewer follow-up activities to remove emerging seedlings and to clear novel plant invaders, and as such can result in significant long-term cost savings.

In areas where degradation is not severe, restoration can be achieved through accelerated natural regeneration (ANR), which relies largely on activities or actions that facilitate natural processes, such as seed germination of native species from the soil seed bank. Factors such as overgrazing and fire, which may harm the regeneration of native plants, can be limited through judicious management. Livestock may be excluded during the regeneration process, while weeding, along with the application of fertilizers and of mulching around regenerating native plants, coupled with direct seeding and steps that will attract seed dispersers, are encouraged (FORRU, 2006).

ANR can be facilitated by enrichment planting or framework forestry. Enrichment planting simply means planting more trees or shrubs of the existing native species, in order to boost their population densities, or else planting trees and shrubs of other native species, in order to enhance overall species richness. Framework forestry involves planting the minimum number of tree species required to reinstate the natural processes of forest regeneration and biodiversity recovery. Framework species include indigenous, non-domesticated forest trees which, on being planted in cleared areas ‘rapidly re-establish forest structure and ecological functioning’ (Elliott *et al.*, 2003). The principles for grassland or savannah restoration are similar.

The most cost-effective way of controlling invasive plants is by combining two or more of the methods mentioned above – as in, for example, manual control applied in conjunction with chemical and/or biological control. This is commonly known as integrated pest management (IPM) and should be implemented whenever possible in order to reduce costs and improve the efficacy of control across a landscape.

The benefits of weed or invasive alien plant management or control are significant, and are well understood in crop production systems. However, few studies have looked at the costs and benefits of an integrated management strategy across a range of sectors, with the possible exception of biological control, which in almost all cases has shown a positive return on investment. Those few studies that have looked at the benefits of an integrated approach to invasive plant management across a range of sectors, have also found it to be a wise investment:

- Brown and Daigneault (2014) found that an integrated approach to the control of the invasive tree *Spathodea campanulata* Beauv. (Bignoniaceae) in Fiji, derived monetized benefits of US$ 3.7 for each US$ 1 spent even without explicitly considering biodiversity, culture and other non-monetized benefits of control.
- Costs of aquatic weed control in Florida in the late 1960s were estimated to be US$ 6 million annually and benefits were reported as US$ 82 million, with the largest benefits coming from increased land use (due to drainage) and prevented flood damage (Lovell *et al.*, 2006).
- An analysis of the costs and benefits of the invasive Australian tree, *Acacia mearnsii,* in South Africa, suggest that a 'do nothing' scenario (with no attempts being made to control the spread of the species beyond the limits of plantations) is not sustainable, as the cost:benefit ratio is around 0.4 (de Wit *et al.*, 2001). The most attractive control option will be a combination of biological control of the whole plant (flowers, seed pods, leaves and stems) and physical clearing, assuming commercial growers can protect plantations at a low cost (cost:benefit ratio of 7.5) (de Wit *et al.*, 2001).
- Based on current values, if the invasive tree *Miconia calvescens* DC. (Melastomataceae) is allowed to expand and reach its full distribution in Hawaii, its impacts on forest ecosystems will amount to US$ 3.08 and US$ 4.6 billion on Oahu and Maui, respectively (Burnett *et al.*, 2007). To retain the current population into perpetuity will cost US$ 10.5 and US$ 73.5 million for Oahu and Maui, respectively. However, if Oahu switches to the optimal policy of population reduction, instead of spending US$ 321,000 per year from today into the future, a present value benefit of US$ 6.5 million can be realized. If Maui switches to an optimal policy of population reduction, a net present value benefit of US$ 34.5 million is possible (Burnett *et al.*, 2007).
- Under a dynamic simulation of an ecological-economic model of alien plant control, in a mountain fynbos ecosystem in South Africa, it was found that the cost of proactive clearing would range from 0.6% to 4.76% of the economic value of ecosystem services, but increases the value of these services between 138% and 149%, depending on the assumptions of the model (Higgins *et al.*, 1997).

- De Lange and van Wilgen (2010) estimated the value of ecosystem services in South Africa at ZAR 152 billion (presently, about US$ 19.7 billion) annually of which an estimated ZAR 6.5 billion was lost every year due to invasive alien plants. However, the loss would have been an estimated additional ZAR 41.7 billion had no invasive plant control been carried out. Between 5% and 75% of this protection was due to biological control.

Cultural control

Cultural control of invasive plants can include the use of grazing, flooding, and fire. Grazing can either promote or reduce weed abundance at a particular site. Increased disturbance as a result of the presence of livestock or other grazers can actually facilitate densification and the spread of some invasive plant species. However, if grazing treatments can be combined with other control techniques, such as herbicides or biocontrol, severe infestations can be reduced. Flooding can also be effective in controlling some invasive plant species, but is very difficult to implement in natural environments, and as such rarely used. Fire is more widely used to control unwanted plants in the natural environment and when combined with other control methodologies can be effective.

Fire can be a very cheap and effective way of controlling specific invasive plant species but its efficacy largely depends on the target species, the ecosystem in which it occurs, the intensity of the fire and the amount of times (frequency) it can be applied. For example, fires may actually stimulate seed germination of some plant species and as a result contribute to their densification, while species, which are usually susceptible to fires, may actually benefit from a controlled burn if it is implemented at the wrong time of the year. For susceptible species, the efficacy of a controlled burn can be further enhanced if used in combination with other control techniques, such as herbicides and biocontrol.

Fire: Especially effective for controlling succulents such as species in the Cactaceae and Crassulaceae. Can also be used to reduce the abundance of young seedlings or saplings of other invasive plants and can be used to control invasive grasses. Control efficacy is enhanced if used in combination with herbicides. For example, the significant biomass of clump grasses can be reduced using fire, and herbicide can then be applied to the emerging shoots, reducing the amount of herbicide that would normally have to be used in the absence of fire. However, before using fire it is critical to understand the ecology and phenology of the target species, when it is most susceptible to fire, and if there is sufficient combustible material in the system to carry an “effective” fire. Precautions should also be taken to prevent the fire from spreading to areas outside of the target area.

Physical control

Manual and mechanical: Manual control involves the direct removal of the above-ground parts of a plant with an axe or a slasher, or the uprooting of plants using a hoe, a garden fork or a spade, or by hand pulling. It may also include ring- and strip-barking. Mechanical control may involve the use of machinery or equipment (e.g. bulldozers or tractors and can, among others, involve pushing, stick-raking, blade ploughing and/or chaining of larger plants or medium density infestations). Mechanical control is often used to remove dense stands of woody weeds but can be expensive and may leave soils bare and so susceptible to erosion and re-invasion by invasive plants of the same species or of other species. Soil disturbance associated with manual control may stimulate the germination of weed seeds in the soil seed bank.

1. Uprooting: Physically removing a weed from the ground using tools such as hand-hoes, picks, garden forks, mattocks or even the "tree popper". Suitable for most weeds, especially when in the seedling stage. Not suitable for weeds with deep root systems or which produce suckers. All below-ground plant parts, which can result in the re-establishment of the target species, need to be removed and disposed of in a safe and effective manner.

2. Hand pulling: Similar to uprooting and widely used to remove seedlings and young plants of most invasive plant species; works best when the soil is moist. Take hold of the stem at ground level and pull out vertically. Try to remove plants when they are not fruiting in order to limit the spread of seeds. All below-ground parts of target species, which have rhizomes, tubers or other regenerating vegetative structures, need to be removed and disposed of to prevent their re-establishment.

3. Slashing or felling: A mower, slasher, machete, axe, saw or other tool is used to cut down a plant just above the soil surface. Only suitable for use against weeds that do not coppice or regrow from the rootstock (e.g. *Pinus* species). However, some species, such as *Acacia mearnsii*, will coppice readily from cut stems less than 10 cm in diameter, but larger trees will not do so. Felling can also be used in combination with foliar herbicide application for species that coppice or regrow. For example, large shrubs can be cut down at ground level and herbicide applied to the coppice or regrowth.

4. Ring barking: Removing a 30 cm band or strip around the stem or trunk of a shrub or tree at a height of about 50 cm. It is important to remove all of the bark and cambium. Not suitable for use on multi-stemmed plants, or on plants that coppice or produce root suckers. Hardwood species generally die after ringbarking, whereas most softwood species can survive ringbarking.

5. Strip barking: Stripping all of the bark from the stem or trunk from about 75 cm to below the soil surface using an axe or similar tool. Only suitable for species with bark that strips easily (e.g. Australian *Acacia* species).

6. Mechanical control: The use of heavy machinery, such as tractors or bulldozers, in conjunction with ploughs or similar equipment. For example, blade ploughing, grubbing and chaining are utilized in Australia to control invasive *Prosopis* species. Ploughing can also be used to control herbaceous plants, although this is largely limited to crop production systems. Aquatic weeds can also be removed mechanically from water bodies using 'harvesters'.

Advantages of manual control

- In most cases, little training or supervision is required.
- Tools are simple, cheap and easily obtainable in all countries – and with hand pulling no tools are required.
- In most cases, little or no harm is caused to the environment – desirable vegetation is not damaged by the hand pulling or uprooting of weeds.
- It can be used in countries where no herbicides are registered for use against a particular weed species.

Disadvantages of manual control

- Procedures are labour intensive, and can be expensive in countries with high labour costs.
- It is physically demanding and slow, and it usually requires repeated follow-up operations.
- Where machinery is used, manual control can be expensive – incurring fuel and maintenance costs.
- Soil disturbance may stimulate seed germination among weeds, and on steep slopes or on riverbanks this may also exacerbate soil erosion.
- In dense infestations, native species are often inadvertently damaged or removed.

Chemical control (adapted from Bromilow, 2001)
Chemical control is the use of herbicides, applied alone or in combination with other methods. A herbicide is a naturally occurring or man-made substance that alters the metabolic processes of a plant, so the plant is either killed or suppressed, or its growth habit altered. Herbicides can be divided into groups according to their modes of action. Non-selective herbicides will affect any plant they come into contact with, whereas selective herbicides can, for example, be used in crop production systems to kill weeds without impacting on the crop itself. However, it is important to recognize that non-selective herbicides can be applied selectively. For example, tree stumps can be treated with little risk to other plants growing nearby. Non-selective herbicides can also be injected into target species without affecting nearby plants.

Contact herbicides affect only the plant tissue they come into contact with, whereas systemic herbicides are translocated or moved throughout the plant from the initial point of application. So, for example, a chemical applied to the stem can be translocated to the roots and leaves, eventually killing the whole plant. Translocated herbicides may move either through the phloem (the living tissue which transports carbohydrates from the leaves or storage organs) or the xylem (non-living tissue that moves water and minerals from the roots to the shoots). Translocated herbicides can be selective or non-selective.

Pre-emergence herbicides, applied to the soil before weeds emerge, are often used in crop production systems, but are rarely used to control invasive plants in natural environments. Post-emergence herbicides, applied to weeds after they have emerged, are most frequently used to control environmental weeds.

It is important, in many cases, that herbicides are applied together with an adjuvant or adjuvants. Adjuvants are substances added to spray mixtures to enhance the efficacy of herbicide applications or application characteristics. They may include buffers and acidifiers, compatibility agents, de-foaming agents, deposition aids, dyes, stickers and surfactants. In some cases, the addition of an adjuvant is recommended, but in others it is important they are not used. Surfactants are the most important adjuvants because they facilitate the movement of the active ingredient into the plant. They include 'surface-active' chemicals such as penetrators, wetters, stickers and spreaders. These chemicals change the surface tension of the spray droplets, enhancing the spreading of droplets and their adherence to leaf surfaces.

- **Wetters** reduce the surface tension of spray droplets, facilitating their spread over the leaf surface. This also makes it easier for spray droplets to adhere to a waxy or hairy leaf surface. Many of these products are based on soaps or detergents.
- **Stickers** improve the retention of spray droplets on the plant once good wetting and coverage have been achieved.
- **Penetrants**, as the name implies, increase the penetration potential of the applied chemical into the plant.
- **Carriers** are used to dilute or suspend a herbicide formulation during its application – water and diesel are the most commonly used. Diesel can also assist in penetration.
- **Anti-foam agents** prevent the formation of foam in the spray tank, preventing the loss of active ingredients in the foam.
- **Anti-evaporants** are added to slow the evaporation of droplets of volatile herbicides, giving the herbicide more time to penetrate the target plant.
- **Emulsifiers** promote the suspension of one liquid in another, allowing the product to mix with water or oils such as diesel.
- **Solvents** are used in liquid formulations to disperse the active ingredient uniformly in the medium.
- **Stabilizers**, already present in most herbicide formulations, promote and maintain a uniform distribution of active ingredient throughout the spray tank, while prolonging the shelf life of the active ingredient(s). Products are available which can be added to enhance the effect described.

- **Buffers** maintain the desired pH (acid or alkaline) of spray mixtures in the tank.
- **Drift control agents** control the size of spray droplets.
- **Dyes** are substances that stain areas where the herbicide has already been applied in order to show visually which plants have already been sprayed or treated and which have not.

A herbicide formulation will therefore include:

- the active ingredient(s);
- additives that enhance herbicide effectiveness, stability or ease of application, such as surfactants and adjuvants; and
- other additives such as solvents, carriers or dyes.

Factors that influence the efficacy of herbicides

- Seedlings are very sensitive to foliar applied herbicides – those of the contact type especially. On the other hand, systemic herbicides require both a large leaf area and active plant growth for efficient translocation.
- Stressed plants cannot absorb or translocate a herbicide efficiently.
- Rainfall or irrigation immediately after application can wash a chemical off the plant before it has been absorbed.
- Sometimes, if a mixture of products is used, one of the products may interfere with the action of another, reducing the overall efficacy of the application. Conversely, some chemicals can complement or enhance the efficacy of others.
- Insufficient coverage, resulting from the use of incorrect equipment, may reduce the efficacy of the application.
- Sediments, in the form of fine organic matter or clays in dirty water, may block spray nozzles. Active ingredients may bind with suspended solids and reduce their efficacy.

Advantages of chemical control

- In many cases, there are no other effective options.
- In most cases, chemical control is more cost-effective than other methods, especially manual control.
- Results are quicker than with manual control, especially when compared with ring-barking or stripping.
- Use of the correct herbicides, applied according to label recommendations, has little to no negative impacts on the environment.

Disadvantages of chemical control

- The purchase of specialized equipment and the training of applicators are essential, and can add to costs.

- Herbicides can be expensive – incorrect formulations can result in poor control, requiring repeated applications, which can add to costs.
- Target species must be ‘healthy’, and weather conditions suitable, at the time of a herbicide’s application.
- Foliar application can affect non-target species.
- Herbicide misuse may cause environmental damage.
- Manual control of plants may be necessary before herbicide application (e.g. in cut-stump treatments) or in the spraying of re-growing or coppicing plants that were too tall to spray initially.

IMPORTANT NOTES

- Always read the product label and follow all instructions relating to safe and proper use of the product.
- Always wear protective/safety gear when applying herbicides.
- Only apply herbicides that are registered for use against a particular target species in your country.

1. Foliar applications:

Foliar spraying is the use of a herbicide, diluted with water, sprayed over the foliage (leaves and stems) of seedlings, shrubs, grasses or dense vine infestations to the 'point of runoff' (until every leaf is wet). Some herbicides will require the addition of stickers and wetters in order to improve efficacy. With plants that have been slashed or cut down, the coppice or regrowth should ideally have reached a height of 50–100 cm before spraying, if effective control is to be achieved. This method of control should generally be considered only for large and dense infestations where risks to non-target species are minimal. Efficacy may be influenced by: (i) the available surface area of the leaves; (ii) the position of the leaves; (iii) hair density on the leaves; and (iv) the thickness of the waxy layer on the leaves.

NB: Poor water quality may reduce a plant's herbicide uptake. Soil particles in water may also block spray nozzles. Active ingredients may bind with clay particles in the water, further reducing efficacy. As such, river water should not be used.

Advantages of foliar application

- Easy to apply.
- Large areas can be sprayed in a relatively short period of time.
- Small areas, or even individual plants, can be targeted.
- Ideal for follow-up work to kill seedlings or coppicing plants.
- Herbicides can be applied at lower concentrations than are needed for basal bark or cut-stump treatments.
- Minimal soil disturbance.
- Relatively cheap.
- Not labour intensive.

Disadvantages of foliar application

- Cost of spray equipment.
- Inconsistent or inadequate application rates, influenced by factors such as difficult terrain (steep slopes, rocky outcrops, etc.) and high plant densities, or by laxness on the part of operators.
- A herbicide's efficacy, as determined by its rate of uptake by targeted plants, may be affected by a host of environmental factors, as well as by the condition of the plants. For example, rainfall shortly after application will wash off the herbicide. Uptake will also be reduced in plants that are covered in dust, or that are stressed (through high temperatures, drought, water-logging or leaf damage caused by diseases or by insect attack).
- Can be undertaken only during the growing season of the plants.
- Cannot be applied in windy areas, while the wind is blowing.
- Potential spray drift may result in off-target damage.
- Large quantities of clean water are required at a spray site.

2. Stem applications:

No pre-treatment of the targeted plant is required. Herbicide is applied directly to the stem of the growing plant.

a. Basal stem application: Usually applied to thin-barked woody weeds, tree saplings, regrowth and multi-stemmed shrubs and trees with basal diameters of no more than 20 cm. The entire circumference of the trunk or stem from ground level to a height of 30–100 cm is sprayed or painted. To help bark penetration, an oil-soluble herbicide is mixed in diesel/kerosene/mineral turpentine/penetrating oil/mineral oil or in other formulated oil blends. The full circumference of every stem or trunk rising from the ground needs to be saturated with the herbicide solution. Trees with old or rough bark may require increased coverage. Application may be made at any time. Bark should not be cut or removed before a basal stem application. Herbicide uptake will be reduced in plants with trunks that have been scorched by previous fires.

b. Total frill: Using a hand-axe, a panga or machete, make horizontal cuts into the sapwood tissue of the stems or trunks of trees, vines or woody weeds, and then insert herbicide into the cuts. Cuts are made at waist height around the circumference of the trunk. While still in the cut, the axe or tomahawk is leaned out to make a downward angled pocket, to which 1–4 ml of herbicide solution is IMMEDIATELY applied (within 15 seconds of making the cut), using a syringe or hand-held sprayer. A partial frill requires a few large cuts on all sides of the tree (5–10 cm apart), while a total frill requires a complete ring of level downward slanting cuts near the base of the stem. DO NOT ringbark the tree, as this will decrease herbicide uptake into the plant.

c. Stem injection: Also called drill-and-frill. Using a battery-powered drill or similar tool, make holes (at a 45° downward angle) in the stems or trunks of trees, cacti, vines or woody weeds, and IMMEDIATELY (within 15 seconds of drilling the hole) apply herbicide in the drill hole, using a squeeze bottle or plastic syringe. This technique targets the sapwood (cambium growth) layer just under the bark, which will transport the chemical throughout the plant. Do not drill too deeply or you will get into the heartwood, which will not take up the herbicide. Drill four holes for smaller plants, and a maximum of 12 holes for large plants. Stem injection relies on the active uptake and growth of the plant to move the chemical through its tissues, so plants that are already stressed may not be killed.

Similar to this is the **tree spearing** method whereby a specifically designed tree spear is thrust into the base of the tree at an angle of 30–40° from vertical. A herbicide solution is applied IMMEDIATELY to the holes/cuts, which are spaced approximately 5 cm apart.

Advantages of stem applications

- Most procedures are simple and require little preparation or training.
- The ability to kill large standing trees in locations where felling might damage native vegetation.
- Minimal disturbance is caused to surrounding vegetation, and no soil disturbance.
- It is less labour intensive than felling trees (using cut-stump applications).
- It is target specific, with little or no potential for herbicide drift (hence minimal non-target impacts).
- It is ideal for controlling weeds that can be difficult to kill using other methods.
- Can be applied at any time of the year.

Disadvantages of stem applications

- The need for some training, in the case of certain procedures.
- Diesel, used as a carrier, can be expensive, and is usually more toxic to people than the herbicide itself.
- Dense infestations may require large quantities of diesel, which may contaminate the soil and/or water.
- Large standing trees that have been treated, and which are dying, may fall suddenly or drop branches, and as such may be dangerous. They also pose an increased fire hazard.
- The woody biomass within large trees cannot be utilized to offset control costs.
- Frill and stem injection techniques can be slow.

3. Stump applications:

These include procedures that involve cutting down a plant at the base of the stem, and then immediately applying herbicide to the stump.

a. Cut stump: Sometimes also referred to as "cut and spray" or "lopping/pruning". Sever the plant completely at its base (no higher than 15 cm above the ground), preferably horizontally using a chainsaw, brush-cutter, machete or even secateurs or pruning loppers (tool selection will depend on ease of cut, as determined by the thickness of the stem/trunk), and IMMEDIATELY apply herbicide (with a paint brush, a squeeze bottle, a sponge-tipped bottle or a spray bottle). Application delays of more than 15 seconds for water-based herbicides and 1 minute for diesel-soluble herbicides, from cutting to chemical application, will give poor results. For trees with trunks of large circumference, the herbicide solution should be applied only around the edges of the stump, targeting only the cambium layer. Apply to the point of wetting, but not to the point of runoff. Treatments can be applied at any time of the year.

b. Total stump: Sever the plant completely at its base (no higher than 15 cm above the ground) using a chainsaw, axe, brush-cutter or machete. Once cut, the herbicide solution can be sprayed or painted on to the exposed cut surface and to the sides of the stump down to the root collar area, using a knapsack sprayer, a paint brush, a drench gun or a hand-held spray bottle. This method is generally used on trees with stems of small circumference. For vines with aerial tubers (e.g. *Anredera cordifolia*), both cut ends have to be treated with herbicide. Hold cut stems in a container of herbicide solution for 15 seconds after cutting, so that maximum translocation will occur.

Advantages of stump applications

- They are target specific, with negligible potential for herbicide drift (hence minimal non-target impacts).
- Tall foliage can be treated.
- They are relatively cost-effective in that only small amounts of herbicide are used.
- One application is usually enough to kill the target plant.
- Can be done in winter – outside of the growing season.
- There is no soil disturbance.

Disadvantages of stump applications

- Cutting down trees or shrubs is labour intensive.
- Can be time-consuming when dealing with large infestations.
- May require some training.

- Felling large trees can damage native vegetation.
- Sudden removal of the canopy can stimulate seed germination among weeds, and expose the soil to erosion.
- Diesel, often used as the carrier, can be expensive, and is more toxic to people than the herbicide itself.
- Some herbicides are long-acting and may be absorbed by non-target plant species growing nearby.

4. Scrape and paint:

Scrape a very thin layer of bark, using a sharp knife, from a 10–30 cm section of stem (taking care not to cut through the vine), and IMMEDIATELY apply the herbicide to the exposed green underlying soft tissue (before the plant can seal). Removing a small portion of the bark will allow the herbicide to penetrate into the plant's sapwood. For large shrubs and vines, several scrapes, placed approximately 7.5 cm apart, may be required.

Advantages of scrape and paint

- It is effective because herbicide is placed directly on to the target plant, with the result that non-target impacts are negligible.
- It is relatively cost-effective in that only small amounts of herbicide are used.
- One application is usually enough to kill the target plant.
- Gradual defoliation of a target plant will allow plants of native species growing nearby to recover over time, while also preventing sudden exposure of the soil to erosion.
- There is no soil disturbance.

Disadvantages of scrape and paint

- It may require some training.
- Large standing trees that have been treated, and are dying, may fall suddenly or drop branches, and as such may be dangerous. They also pose an increased fire hazard.
- It is labour intensive.

NB: The herbicides and the modes of application recommended for controlling most (for some of the plants we could not find any relevant information pertaining to herbicide use) of the species included in this Field Guide are those that are used in Australia and/or South Africa (see **Appendices C, D and E**). The recommended herbicides may not be available or registered for use against the target species in your respective countries. If legislation in your country prohibits the use of these herbicides, or they have not been registered for use against a particular target species, it is illegal to use them, unless temporary authorization for experimental trials has been granted by a competent authority. It should also be noted that the information contained in this book is a guideline only and that all herbicide-users read and strictly follow all label instructions when using a particular pesticide. The author of this Field Guide encourages those that choose to use herbicides to:

- purchase products that are registered and fit for purpose;
- obtain the correct advice from accredited advisers;
- ensure correct handling, transportation and storage of products;
- always use protective gear when applying herbicides;
- always read the product labels and follow all instructions relating to the safe and proper use of the product;
- always use the recommended product mixtures;
- always use the recommended equipment;
- take all necessary precautions to avoid non-target impacts; and
- dispose of all containers in a safe manner ensuring that they will not be used for other purposes subsequent to disposal or have a negative impact on the environment.

Biological control

The use of host-specific natural enemies (pathogens, mites and insects) to control invasive plants has been practised for many decades by a host of countries, especially the USA, Australia, South Africa, Canada and New Zealand. The main aims of biological control are to:

- suppress plant vigour;
- reduce seed production;
- slow plant growth; and
- reduce the density of the weed infestation.

Biological control agents include: (i) gall-forming insects; (ii) defoliators (e.g. leaf-feeding beetles); (iii) leafminers; (iv) sap-suckers such as insects and mites with piercing and sucking mouthparts; (v) flower-, bud- and seed-feeders; (vi) stem-borers; (vii) crown-feeders; (viii) root-feeders; and (ix) disease-causing microorganisms such as bacteria, viruses, fungi and nematodes. In some cases, only one introduced biocontrol agent has been needed for success in controlling an invasive plant infestation. In most cases, however, effective suppression of a target plant species has been achieved through the release of multiple biocontrol agents, which attack different parts of the plant.

Over a period of 150 years, until the end of 1996, more than 350 species of invertebrates and pathogens were deliberately released in 75 countries for the control of at least 133 weed species (Julien and Griffiths, 1998). It was estimated (Winston *et al.*, 2014) that by the end of 2012, there were 1555 separate and intentional releases of 469 species of weed biological control agents against 175 species of non-native target weeds (when related taxa of unidentified plant species, such as some *Opuntia* species, are counted as single target weeds). These so-called 'classical' biocontrol projects have been conducted in a total of 90 countries (Winston *et al.*, 2014). At a national level, biocontrol programmes have achieved success rates of 83%, 80%, 61%, 51% and 50%, respectively, in New Zealand (Fowler, 2000), Mauritius (Fowler *et al.*, 2000), South Africa (Zimmermann *et al.*, 2004), Australia (McFadyen, 2000) and Hawaii (Markin *et al.*, 1992).

The main benefits of biocontrol (Greathead, 1995)

- Agents establish self-perpetuating populations, often throughout the range of a target weed, including areas that are not accessible using chemical or mechanical control methods.
- The control of a target weed is permanent.
- There are no negative impacts on the environment.
- The cost of biocontrol programmes is low, relative to other approaches, and requires only a one-off investment.
- Benefits can be reaped by many stakeholders, irrespective of their financial status or of whether they contributed to the initial research process.

An analysis of some biocontrol research programmes in South Africa found that benefit:cost ratios ranged from 34:1 for *Lantana camara* to 4,331:1 for golden wattle, *Acacia pycnantha* Benth. (van Wilgen *et al.*, 2004). It is also estimated that biocontrol agents present in South Africa have reduced the financial costs of mechanical and chemical control by more than 19.8%, or ZAR 1.38 billion (Versfeld *et al.*, 1998). It is further estimated that biocontrol programmes, if fully implemented in the future, may reduce control costs by an additional 41.4%, or ZAR 2.89 billion (Versfeld *et al.*, 1998). These findings are supported by studies in Australia which have found that every dollar invested in the weed biocontrol effort yielded a return of A$ 23.10 (Page and Lacey, 2006). There, the benefit:cost ratio for agriculture alone (in terms of both cost savings on control and increased production) was 17.4. If current annual expenditures on biocontrol research continue into the future, it is expected that weed biocontrol projects in Australia may provide, on average, an annual net benefit of A$ 95.3 million, of which A$ 71.8 million is expected to flow into the agriculture sector (Page and Lacey, 2006).

In southern Benin, the reduction of water hyacinth as a result of biocontrol has been credited with an increase in income of US$ 30.5 million per year to a community of about 200,000 people (de Groote *et al.*, 2003). If one assumes that the benefits stay constant over the next 20 years, the accumulated present value would be US$ 260 million – a benefit:cost ratio of 124:1 (de Groote *et al.*, 2003).

The invasive plants which have been described in this Guide, and for which biological control agents are available, are listed in **Appendix B**. All of the agents listed have established in the identified countries as indicated, although a number have proved largely ineffective, owing to a range of factors.

Summary guidelines for managing Invasive Alien Plants

When developing and implementing an invasive alien plant management strategy it is recommended that the following steps be followed:

- Inspect the area/property which has been identified for management;
- Record/map the location of all target species in the designated area, the habitats in which they are growing, and the possible presence of biological control agents;
- Identify all available control options and determine associated costs and benefits, including those for follow-up operations, being aware of the fact that physical and chemical control operations may have a negative impact on any biological control agents that may be present;
- Ensure that sufficient resources are available to reduce and maintain infestations to levels which have been pre-determined and agreed upon by all stakeholders;
- Undertake Environmental Impact Assessment's for management options, if required;
- Design, document and implement the management strategy based on inputs from all interested and affected parties;
- Regularly monitor effectiveness, including costs, of the control strategy;
- Record and share the results of the strategy in order to evaluate success and provide lessons learnt;
- Design, document and implement a long-term programme to prevent re-establishment or re-invasion of the cleared area. Ideally this should also include restoration.

Acknowledgements

This Field Guide could not have been compiled without the generous support of many individual people and organizations. There is not space enough, here, to acknowledge the contributions made by each and every individual or organization, but you can rest assured that we are deeply grateful to everyone who has contributed, whether by attending country workshops and providing useful information, or by assisting with the gathering of field data.

The idea of this Field Guide arose from the realization that one of the biggest impediments to effective invasive plant management in the region has been the lack of information relating to which species are present, their distribution, their impacts, and how best to manage them. Community members, protected area managers and rangers, farmers, researchers and others have at one time or another all expressed the need for a Guide, to help them to identify and to monitor invasive plant species in the field. Based on this need, we approached the JRS Biodiversity Foundation, which provided the support that enabled us to undertake the surveys which have culminated in the production of this Guide, as one of the main outputs of a broader project, known as *East Africa datasets and identification toolkit for invasive plant species.*

Of the many people who have contributed to the making of this Guide, one of the biggest supporters has been Don Doering, the Executive Director of the JRS Biodiversity Foundation, who has been a constant pillar of support throughout the Project. Others who have contributed include Beatrice Pallangyo (Ministry of Agriculture, Livestock and Fisheries, Tanzania), John Richard Mbwambo (Tanzania Forest Research Institute), Jean Leonard Seburanga (Rwanda), Mary Namaganda (Makerere University, Uganda), Winnifred Aool (National Agricultural Research Laboratories, Uganda), Emily Wabuyele (National Museums of Kenya), Agnes Lusweti (National Museums of Kenya), Sospeter Kiambi (Kenya Wildlife Service), Lekishon Kenana (Kenya Wildlife Service), John Weller (Ol Jogi Conservancy, Laikipia, County, Kenya), Rezene Fessehaie (Ethiopian Institute of Agricultural Research), Taye Tessema (Ethiopian Institute of Agricultural Research), Gadi Gumisiriza (Uganda), Peter Beine (Uganda), Peter Goodman (Grumeti Fund, Tanzania), Matt Perry (Grumeti Fund, Tanzania), Philemon Mneney (Grumeti Fund, Tanzania) and Geoffrey Howard (IUCN). Patrick Maundu, Andrew McConnachie and Nick Trent provided additional locality data for *Prosopis juliflora*, *Parthenium hysterophorus* and *Opuntia stricta*, respectively. Additional locality data for a number of invasive plants was provided by Amare Fufa, Hussein Serata, Hada Beyene, and Serawit Handisso, all from Ethiopia. I am extremely grateful to these contributors for their support and assistance.

I am also grateful to my colleague Winnie Nunda, for her assistance with surveys, entering data and the sourcing of information. Thanks also to Morris Akiri, CABI Regional Director, and Dennis Rangi, CABI Director General for International Development, for their support in this initiative. I am especially grateful to Sarah Hilliar (CABI) who did the layout for this Field Guide and who in the end brought it all together – your patience and support is always appreciated. Joe Vitelli from Biosecurity Queensland, Department of Agriculture and Fisheries, Australia, and Debbie Sharpe (Natural Resource Management: Department of Environmental Affairs, South Africa) kindly provided information on herbicide use, while Rachel Winston provided additional information for incorporation in the biological control table. Elijah Ngoroge produced all the line drawings, for which I am extremely grateful, as I am to those who contributed images; many thanks, you are all acknowledged where your images appear. Gordon Boy kindly reviewed previous drafts of the Guide at very short notice, and for that too I am grateful.

A number of references and source materials were used to glean information on various species and on their impacts and their management. I have unashamedly used a format similar to that used by the Kwazulu-Natal Branch of the Wildlife and Environment Society of South Africa in their Guide entitled *Invasive Alien Plants in Kwazulu-Natal – Management and Control* (2008), as this was deemed to be the most popular format among potential users. The following additional sources of information were widely used, so I would like to acknowledge all of them:

- *Flora of Tropical East Africa*, by various authors, was used to acquire additional information on species descriptions and on the status and distribution of exotic plant species.
- *Flora of Ethiopia and Eritrea*, by various authors, was used for the same purposes as described above.
- The field guide *Alien Weeds and Invasive Plants* (2001) by Lesley Henderson was used to acquire additional information on the identification of some invasive plants.
- The guide, *Problem Plants of South Africa* (2001) by Clive Bromilow, was used largely to glean additional information on herbicide use;
- Another guide, *Naturalised and invasive succulents of southern Africa* by Walters *et al.* (2011) was useful for the descriptions it provides of succulent species.
- Additional information on invasive plant species in East Africa was sourced from the BioNET-EAFRINET keys and factsheet website for invasive plants (**http://keys.lucidcentral.org/keys/v3/eafrinet/plants.htm**).
- Sheldon Navie and Steve Adkins allowed me to use much of the information contained in the website *Environmental Weeds of Australia* (**http://keyserver.lucidcentral.org/weeds/data/media/Html/index.htm#A**).
- Information on some agroforestry species, known to be invasive, was obtained from the World Agroforestry Centre website (**http://www.agroforestry.org**).
- Additional information on invasive plants came from the Global Invasive Species Database (**http://www.iucngisd.org/gisd/**).
- Information of invasive plant impacts in the Pacific was obtained largely from the Pacific Island Ecosystems at Risk (PIER) website (**http://www.hear.org/pier/**).

- Comprehensive information on the origin, descriptions and impacts of invasive plants was obtained from CABI's Invasive Species Compendium (**http://www.cabi.org/isc/**).
- Other source material is listed in the references.

Ultimately, none of this would have been possible without the financial support of the JRS Biodiversity Foundation, which has contributed massively, not only to the development of this Guide, but also to the *East Africa datasets and identification toolkit for invasive plant species* Project as a whole. Last, but definitely not least, I would like to thank Imelda and Rudolf. Both not only assisted with the recording of data during surveys, but also had to endure many holidays monopolised by my constant desire to record the presence of naturalized and invasive plant species.

Key to distribution maps

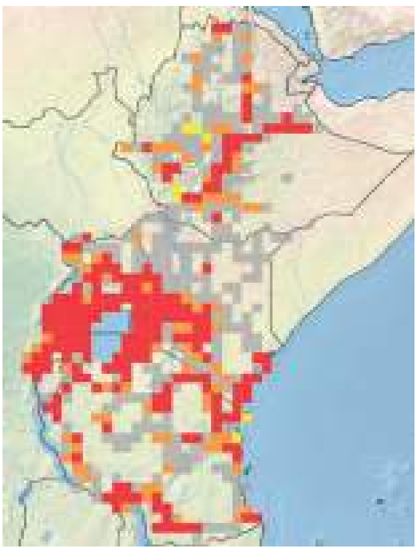
Surveyed areas and the distribution of naturalized and invasive species are represented by 1/2-degree grid squares (~ 55 x 55 km).

Areas that were surveyed but where no naturalized, invasive, or potentially invasive plant species were seen.

Orange grid squares represent areas where a plant species was found to be present and/or naturalized.

Red grid squares represent areas where a plant species was considered to be invasive.

Locality data obtained from other sources with no reference being made to plant densities or invasiveness.



Sample map

AQUATICS

PAGE 45

Aquatic plants are plants that have adapted to living in aquatic (Water) environments, e.g. *Eichhornia crassipes* (water hyacinth).

CLIMBERS

PAGE 61

Weak-stemmed plants that derive their support from climbing, twining, or creeping along a surface, e.g. *Ipomoea indica* (morning glory).

HERBS

PAGE 109

Seed-bearing plants which do not have a woody stem, e.g. *Ageratum conyzoides* (ageratum).

PALMS

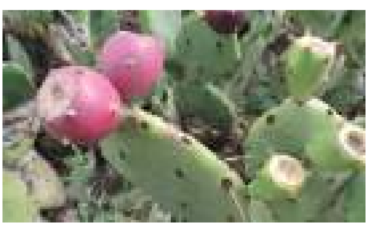
PAGE 187

Stems with clearly visible old leaf scars, and long feathered or fan-shaped leaves, arranged in a spiral at the top of trunks e.g. *Elaeis guineensis* (African oil palm).

SHRUBS

page 195

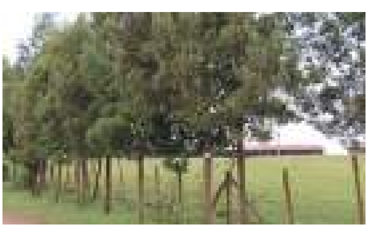
Woody plants which are smaller than trees with several main stems arising at or near the ground,e.g. *Lantana camara* (lantana).



SUCCULENTS

PAGE 271

Plants having some parts that are more than normally thickened and fleshy, usually to retain water in arid climates or in dry soil conditions, e.g. *Opuntia stricta* (erect prickly pear).



TREES

PAGE 345

Woody plants, typically having a single stem or trunk growing to a considerable height and bearing branches at some distance from the ground, e.g. *Acacia melanoxylon* (blackwood).

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University of Florida/IFAS Center for Aquatic and Invasive Plants


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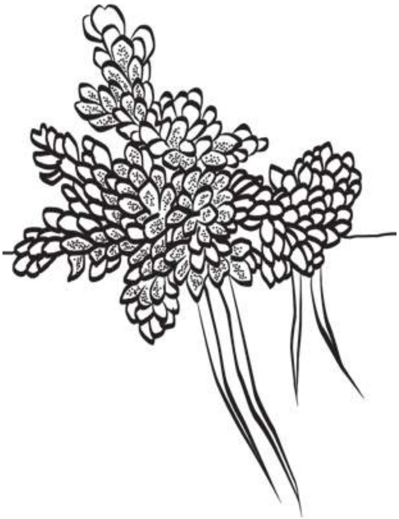
AQUATICS

Azolla filiculoides Lam.



FERN FAMILY
Azollaceae

COMMON NAMES

English: azolla, large mosquito fern, red azolla, red water fern

DESCRIPTION
Evergreen, free-floating, aquatic fern with horizontal stems (to 25–35 mm long); branching pattern loosely alternate; the roots hang into the water and have fine laterals with 1-3 roots per node.

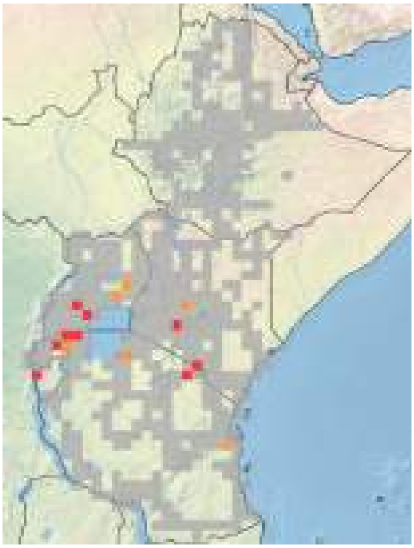
Leaves: Silvery-green turning reddish-brown or purplish in winter, broadly egg-shaped to almost circular (1–1.5 mm long), alternate and overlapping.

Fruiting bodies: Minute, in the axils of the leaves; reproduction also by detached plant fragments.

ORIGIN
Argentina, Brazil, Uruguay and Peru.

REASON FOR INTRODUCTION
Green manure, aquaria and ornament.

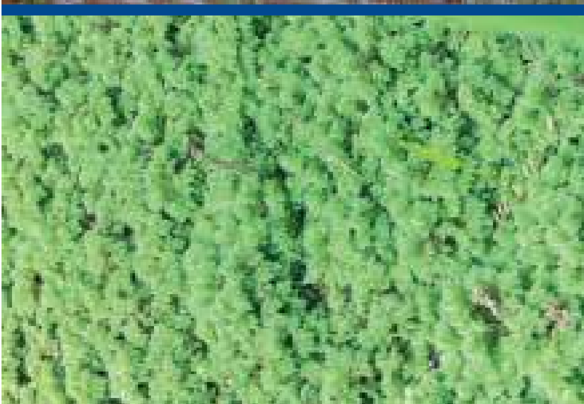
INVADES
Ponds, dams, floodplains, swamps, wetlands, lakes and slow-moving rivers.



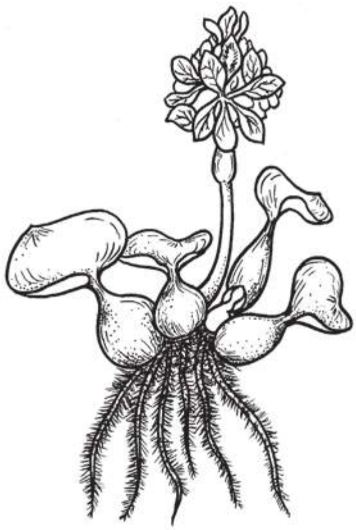
IMPACTS

Can grow in water that is low in nitrogen content. Mats, sometimes 30 cm thick, reduce water quality, impoverish biodiversity and increase siltation. Below the mats, which prevent light from penetrating, decaying root and leaf matter creates anaerobic conditions that are detrimental to aquatic organisms. One endangered fish species, the Eastern Cape rocky (*Sandelia bainsii* Castelnau; Anabantidae), is faced with extinction as the result of *A. filiculoides* infestations. Such infestations may also render water unpalatable to people, livestock and wildlife (Hill, 1997). Thick mats, mistaken for solid ground, result in the drowning of animals. Infestations increase water loss through evapotranspiration, while also providing habitats for vectors of disease. Impact costs in South Africa run to an estimated US$ 589 per hectare per year (McConnachie *et al*., 2003).

Notes: According to Verdcourt (1999), the only two *Azolla* species in East Africa are *A. nilotica* Mett. and *A. pinnata* (R.Br). *A. nilotica* has numerous (five or more) roots per node with aerial parts that extend upwards from the floating parts; larger than *A. filiculoides. A. pinnata* has 2-3 roots per node, but the plant is more pinnate and is never reddish. Surveys have indicated that *A. filiculoides* is widespread and abundant on many water bodies in Kenya, Tanzania and Uganda, including protected areas such as Amboseli National Park and conservancies in Laikipia County, in Kenya. However, recent evidence from South Africa indicates that *A. filiculoides* is predominantly invasive in colder areas, while *A. cristata* Kaulf. dominates in more tropical regions (L. Henderson, *pers*. *comm*.) *A. cristata* has prominent root caps, while *A. filiculoides* often has curled root tips and less conspicuous root caps (L. Henderson, *pers*. *comm*.). Additional research is required to confirm if *A. cristata* is also present in eastern Africa or if *A. filiculoides* has been incorrectly identified.



Eichhornia crassipes (Mart.) Solms



PICKEREL WEED FAMILY
Pontederiaceae

COMMON NAMES
English: lilac devil, Nile lily, pickerelweed, water hyacinth, water orchid
Rwanda: irebe

DESCRIPTION
Evergreen free-floating aquatic plant [usually 10–20 (–100) cm high] that may become anchored in shallow water; roots long and feathery, producing runners (10 cm long) across the water surface that give rise to new plants.

Leaves: Dark green, shiny, hairless, oval to egg-shaped to almost rounded (2–25 cm long and 2–15 cm wide) with swollen bladder-like leaf stalks (30 cm long).

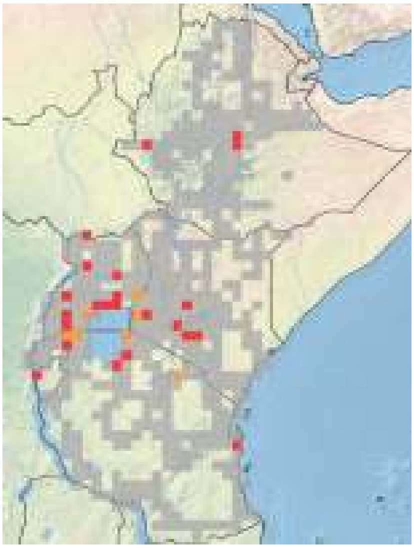
Flowers: Pale violet or blue (4–6 cm long and 3.5–5 cm wide), upper petal of each flower has a prominent yellow-centred patch; flowers in clusters of 8–10.

Fruits: Capsules (dry fruits that open at maturity) (10–15 mm long), containing very fine seeds.

ORIGIN
Brazil, French Guiana, Guyana, Surinam and Venezuela.

REASON FOR INTRODUCTION
Ornament.

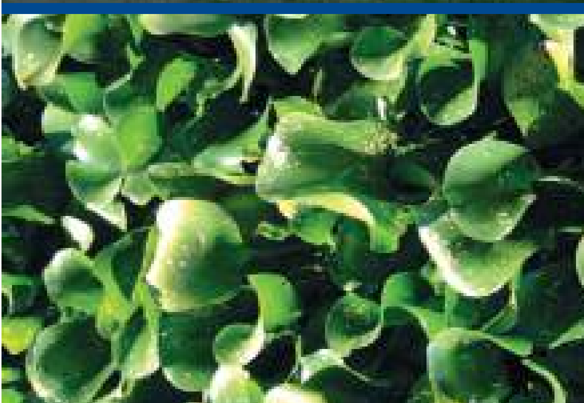
INVADES
Irrigation channels, dams, ponds, floodplains, swamps, wetlands, lakes and slow-flowing rivers.



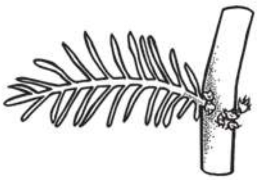
IMPACTS

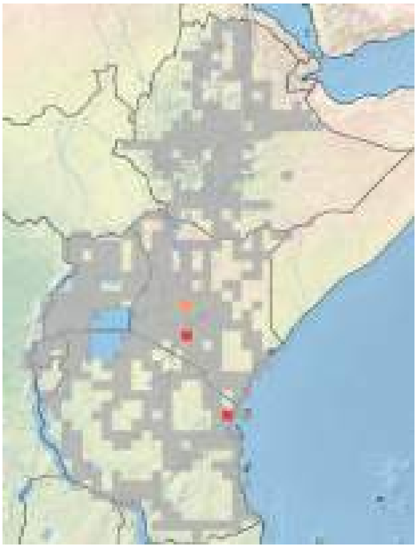
This aquatic weed has the ability to form thick mats which hamper water transport; inhibit or even prevent fishing-related activities; block waterways and canals, and hamper hydroelectricity generation; while also providing breeding sites for vectors of human and animal diseases, increasing the incidence of malaria, encephalitis, schistosomiasis, filariasis, river blindness and possibly cholera (Burton, 1960; Spira *et al*., 1981; Gopal and Sharma, 1981; Viswam *et al*., 1989). The thick mats reduce light penetration into the water, causing declines in phytoplankton concentrations which support the zooplankton–fish food chain. Extensive mats of water hyacinth increase water loss through evapotranspiration, and impact rice production (Waterhouse, 1993). In southern Benin, an infestation of water hyacinth was found to have reduced the annual income of 200,000 people by about US$ 84 million (de Groote *et al*., 2003). For men, the lost revenues were mostly fishing-related, while women experienced lost revenues in trade, primarily of food crops and fish.

Notes: In Ethiopia, it has become "very troublesome locally, covering water surfaces, choking water courses, disrupting hydro-electric installations, and sheltering disease vectors" (Aweke, 1997). It is problematic at Koka Dam along the Awash River, and in Gambela along the Baro, Gilo, Pibor and Sobate Rivers (Aweke, 1997). It was first recorded on garden ponds in Nairobi and Mombasa in 1957 (Njuguna, 1992). It is widespread and abundant on a number of water bodies in East Africa, including Lake Victoria and Lake Naivasha.



Myriophyllum aquaticum (Vell.) Verdc.





WATERMILFOIL FAMILY
Haloragaceae

COMMON NAMES

English: Brazilian watermilfoil, parrot's feather, water feather

DESCRIPTION

Evergreen aquatic plant; rooted, with terminal, leafy shoots rising 20–50 cm above the water surface; stems yellowish green (2–5 m long and 5 mm thick), with roots forming at the joints.

Leaves: Pale green or bluish green, feather-like, finely divided, elongated or oval with deeply divided margins (30–45 mm long and 15 mm wide), arranged in groups of 4–6 at the tips of the stems.

Flowers: Creamy, inconspicuous (1.2 mm long), solitary, in the axis of the leaves.

Fruits: None, spreads vegetatively.

ORIGIN

Argentina, Brazil, Bolivia, Chile, Ecuador, Paraguay and Peru.

REASON FOR INTRODUCTION

Ornament

INVADES

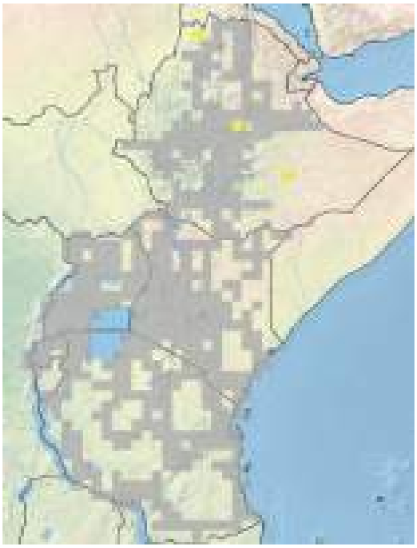
Drainage ditches, irrigation channels, dams, ponds, swamps, wetlands, lakes and slow-moving rivers or streams.

IMPACTS

Dense infestations exclude native plants and have multiple negative impacts on water transport, fisheries and recreation, while potentially increasing the abundance of mosquitoes. High parrot feather density has been correlated with higher mosquito larval abundance (Orr and Resh, 1992). This aquatic plant rapidly colonizes wetlands and other water bodies, forming dense stands that exclude native water plants (Weber, 2003). In Belgian lakes native species richness was 57% lower in heavily invaded, compared to uninvaded sites (Stiers *et al*., 2011). Some rare and vulnerable native plant species were also absent in heavily invaded sites compared to semi-invaded sites. Infestations also shade out algae in the water column that form the basis of the food web, affecting a myriad of organisms (Washington State Department of Ecology, 2011). High tannin content also means that fish do not eat the plant; fish survival is also compromised by a reduction in the oxygen content of the water (Hussner, 2008). Infestations in Germany contributed to a reduction in native macrophyte diversity (Hussner, 2008). In Washington, the Longview Diking District, estimates that it spends US$ 50,000 a year on parrot feather control in drainage canals (Washington State Department of Ecology, 2011), while in California, control of this weed over a two-year period cost US$ 215,000 (Anderson, 1993). Also recorded as invasive in South Africa, Zambia, USA, UK, Australia and New Zealand (CABI, 2016).

Notes: Not as widespread in the region as many other waterweeds, it is present and locally abundant in and around Nairobi, Kenya, and elsewhere. Specimens have also been collected in the Lushoto District, Tanzania

Myriophyllum spicatum L.



WATERMILFOIL FAMILY
Haloragaceae

COMMON NAMES

English: spiked watermilfoil

DESCRIPTION
Evergreen aquatic plant, usually total submerged below the water surface except for the leafless flowering shoots; stems thin, green and branched, becoming brown or pinkish white [0.5–2.5 (–3) m long].

Leaves: Bright green, feather-like, finely divided, elongated or oval with deeply divided margins, in whorls of (3–) 4 (–5) around the stems.

Flowers: Creamy to yellow, small (1.6–1.8 mm long), in whorls of four on long emergent spikes (7–25 cm long).

Fruits: Schizocarps (dry fruits that split into one-seeded segments at maturity) consisting of four small, almost round ‘seeds’ or nutlets (2–3 mm across).

ORIGIN
Europe, Asia and North Africa (Algeria and Egypt). Van der Meijden and Caspers (1971) are of the opinion that it is also native to East and southern Africa.

REASON FOR INTRODUCTION
Ornament

INVADES
Drainage ditches, irrigation channels, dams, ponds, swamps, wetlands, lakes and slow-moving rivers or streams.

IMPACTS

Dense mats shade out other species and alter the temperature profile of water bodies. Infestations interfere with irrigation flows, and hamper water transport, hydro-electric generation, fisheries and recreation, while increasing the risk of flooding (O'Hare *et al*., 2007). *M. spicatum* impacts on the abundance of waterfowl and other animals that depend on native aquatic species as a source of food. In Ontario, USA, watermilfoil infestations reduced the abundance and diversity of aquatic insects and the abundance of fish (Keast, 1984). Although dense infestations contribute to an increased survival of young fish, larger fish find it more difficult to obtain prey (Lillie and Budd, 1992). *M. spicatum* also has a serious impact on recreational activities such as boating, fishing, swimming, and/or waterfowl hunting. Negative impacts, on the recreational value of the Lake Tahoe watershed of California/Nevada alone, have been estimated at US$ 0.5 million per annum (Eiswerth *et al*., 2000).

Notes: In Ethiopia, it is present in the regions of Eritrea West, Shewa and Bale, where it can "become a bad weed in water channels, reducing water flow and blocking channels" (Verdcourt, 2000). It has been recorded in the Lower Sondu Miriu wetland of Lake Victoria, Kenya (Gichuki *et al*., 2001), but was not seen in East Africa during our surveys.

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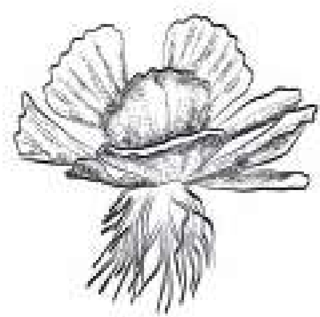
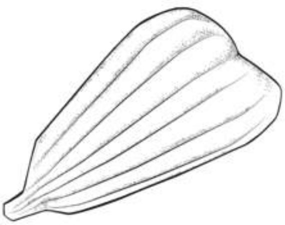
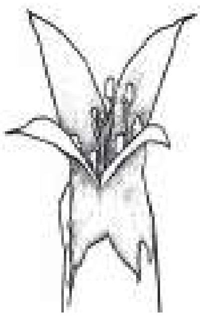
Pistia stratiotes L.







ARUM FAMILY
Araceae

COMMON NAMES

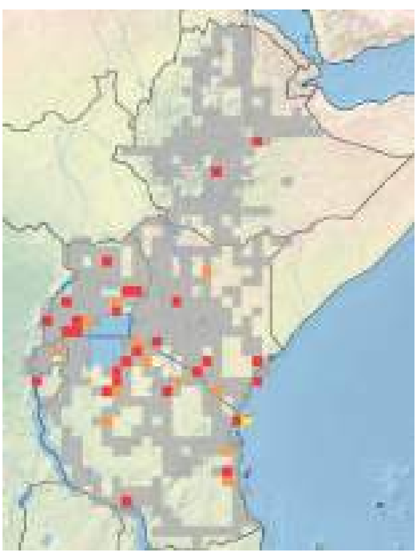
English: Nile cabbage, tropical duckweed, water cabbage, water lettuce
Ethiopia: mechaaraa
Kenya: yungi
Rwanda: irebe
Tanzania: chantende, gugufa, ileve, kakomakoma, maleve, nyamayingiya, yumbe
Uganda: ebor, kitengejja, kiyonga

DESCRIPTION
Evergreen aquatic plant forming extensive mats, usually free-floating; consists of a rosette of leaves [15–20 (–30) cm across] with a tuft of long, feathery roots beneath (to 80 cm long); plants develop runners (to 60 cm long); resembles floating lettuce.

Leaves: Pale yellow-green or greyish-green, spongy, narrow at the base and rounded at the tips (2.5–15 cm long and 2–8 cm wide), margins with a series of curved projections, leaves ribbed with 6–15 longitudinal veins radiating from the base; soft white, velvety hairs on the tops and bottoms of the leaves repel water.

Flowers: Pale green or white, inconspicuous, arising from the leaf forks.

Fruits: Berries (fleshy fruits that do not open at maturity), small, green, egg-shaped or oval (5–10 mm long); containing 4–15 seeds (0.2 cm long and 0.1 cm wide).



ORIGIN
Considered by some to be native to Africa, with a very ancient origin (possibly in the Tethus region), while others maintain that it is native to Brazil.

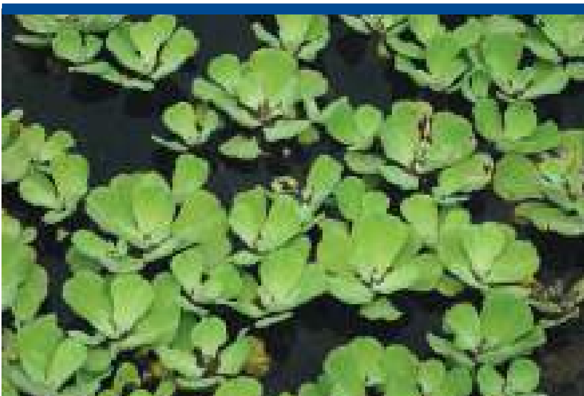
REASON FOR INTRODUCTION
Ornament

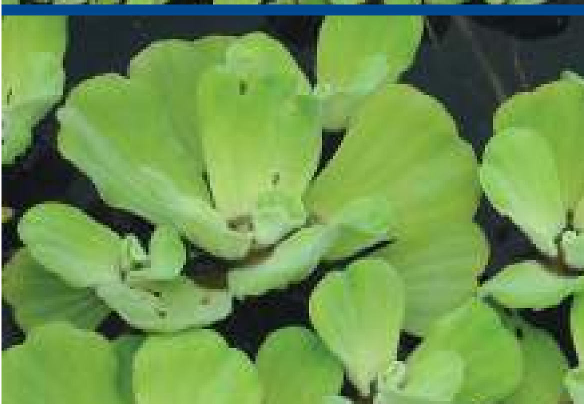
INVADES
Irrigation channels, dams, ponds, floodplains, swamps, wetlands, lakes and slow-moving rivers.

IMPACTS

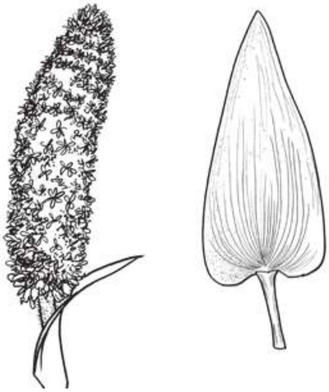
Water lettuce infestations contribute to "increased rates of siltation, the slowing of water flow rates, the degradation of fish nesting sites, increased nutrient loading, thermal stratification, increased alkalinity and mortality among fish and macro-invertebrates" (Dray and Center, 2002). Mats of water lettuce block waterways, making navigation difficult. Dense mats also hamper fishing activities, interfere with hydroelectricity generation and hinder flood-control efforts.They also provide habitats for vectors of disease, and can interfere with rice production (Holm *et al*., 1977; Waterhouse, 1993). It is considered to be a weed in Africa, Asia, parts of Australia and North America, the Caribbean and the Pacific (Holm *et al*., 1991).

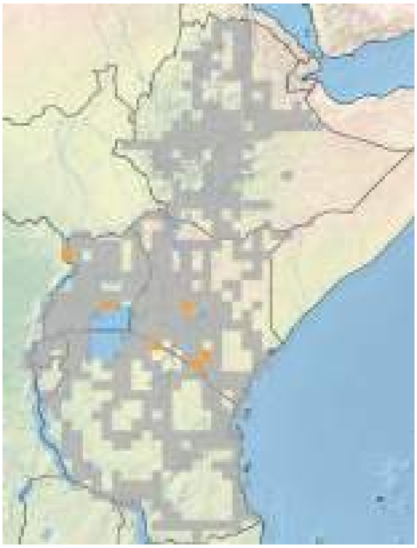
Notes: Widespread throughout the region (Mayo, 1985), it is present in the Ethiopian regions of Shewa, Ilubabor, Gamo Gofa and Sidamo (Riedl, 1997). In Kenya it has been recorded on Lake Naivasha, Lake Victoria, Lake Baringo, Tana River Delta and on waterbodies in the Marsabit Forest and Shimba Hills (Njuguna, 1992). Invasive on many other slow-moving water bodies in Ethiopia and East Africa.





Pontederia cordata L.





FAMILY
Pontederiaceae

COMMON NAMES

English: blue-flag, pickerel weed, pontederia

DESCRIPTION
Evergreen aquatic plant (1–2 m high), rooted with erect emergent stems and horizontal rhizomes, forming dense stands on the edges of water bodies.

Leaves: Yellowish-green, glossy, heart-shaped (6–22 cm long and to 12 cm wide), margins entire with pointed tips, long leaf stalks (to 60 cm long) which clasp the stems.

Flowers: Usually blue but sometimes mauve or white with a prominent yellow-centred patch on upper petal, small (1–2 cm long), arranged in spikes (2–15 cm long).

Fruits: Capsules (dry fruits that open at maturity), small (4–10 mm long), hidden in old flower parts; apparently sterile in Africa with no fruits seen, and as such probably spreads vegetatively.

ORIGIN
Argentina, Belize, Canada, Cuba, Brazil, Colombia, Paraguay, Uruguay and USA.

REASON FOR INTRODUCTION
Ornament

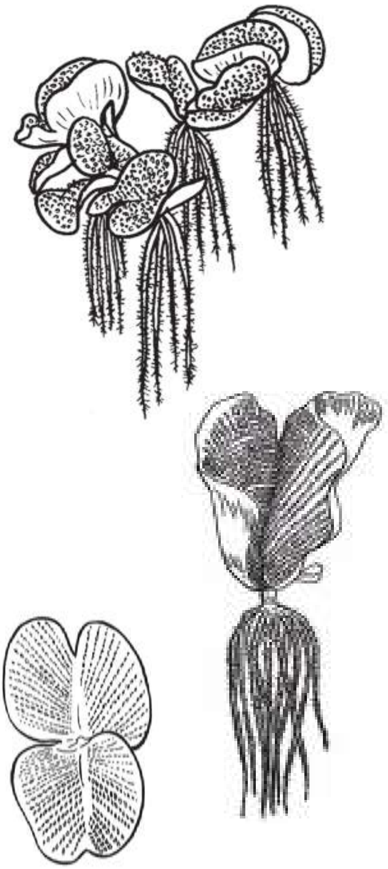
INVADES
Still or slow-moving water, including riverbanks and drainage lines.

IMPACTS

Forms dense stands which can have a negative impact on native plant and animal species. Clumps can block drainage canals, interfere with crops in irrigated fields, and obstruct access to water bodies (ISSA, 2016). Present in several European countries, the species has formed large stands in vulnerable natural habitats in Belgium (National Botanic Garden of Belgium, 2015). In Victoria, Australia, *P. cordata* is regarded as an environmental weed. In other regions of Australia, *P. cordata* is regarded as an emerging new threat (Technigro Australia, 2011).

Notes: Not recorded as being present in Ethiopia (Aweke, 1997), and not seen there during our surveys. Grown as an ornamental in ponds, it has escaped cultivation in and around Nairobi, Kenya, and possibly also elsewhere.

Salvinia molesta D.S. Mitch



WATERMOSS FAMILY
Salviniaceae

SYNONYM
Salvinia adnata Desv.

COMMON NAMES

English: aquarium water-moss, Australian azolla, butterfly fern, giant salvinia, kariba-weed, salvinia, velvet weed

DESCRIPTION
Evergreen aquatic free-floating fern, forming extensive mats, with branching horizontal stems (6–25 cm long and 1.2 cm thick) and submerged feathery roots.

'Leaves': Green or yellowish-green fronds, in pairs, oval (2–6 cm long and 10–15 mm wide); almost impossible to wet due to a covering of fine egg-beater-shaped hairs (cage-like structures) (1–3 mm long) on upper surface; undersides covered with matted brown hairs.

Flowers: None.

Fruits: None, spreads vegetatively from detached fragments.

ORIGIN
Brazil.

REASON FOR INTRODUCTION
Ornament

INVADES
Drainage ditches, irrigation channels, dams, ponds, swamps, wetlands, lakes and slow-moving rivers.

IMPACTS

Thick mats reduce light penetration into water bodies, impacting negatively on submerged aquatic plants. By out-competing rooted underwater native plants, infestations often reduce plant diversity (Sculthorpe, 1985). The benthic fauna is usually also reduced (Coates, 1982), while fish may be impacted by changes in oxygen concentrations as *S. molesta* plants die and rot within water bodies (Sculthorpe, 1985). It is also a pest of rice paddies in India. Dense mats provide habitats for human disease vectors such as *Mansonia* spp. mosquitoes, which are vectors of West Nile virus, St. Louis encephalitis, Venezuelan equine encephalitis and rural elephantiasis (Pancho and Soerjani, 1978; Chow *et al.*, 1955; Ramachandran, 1960; Lounibos *et al.,* 1990). Mats also harbour snails that transmit schistosomiasis (Holm *et al.,* 1977). Infestations impact negatively on water transport and fishing. Along the Sepik River in Papua New Guinea, infestations of *S. molesta* have led to the abandonment of some entire villages, which had depended on water transport for "access to education, food and healthcare" (Gewertz, 1983).

Notes: No records from Ethiopia. It was already being cultivated in garden ponds and aquaria in Nairobi by 1936 (Gaudet, 1976). Present in Nairobi River, Lake Ol Bolosatt, Ewaso Ngiro (north) River, Ewaso Narok River, Masinga Dam and Ramisi River (Njuguna, 1992). Also present on Lake Naivasha, Kenya. It is now "an aggressive weed found near lakes, in areas with *Cyperus papyrus* shade" (Verdcourt, 2000). More widespread than indicated on the distribution map.

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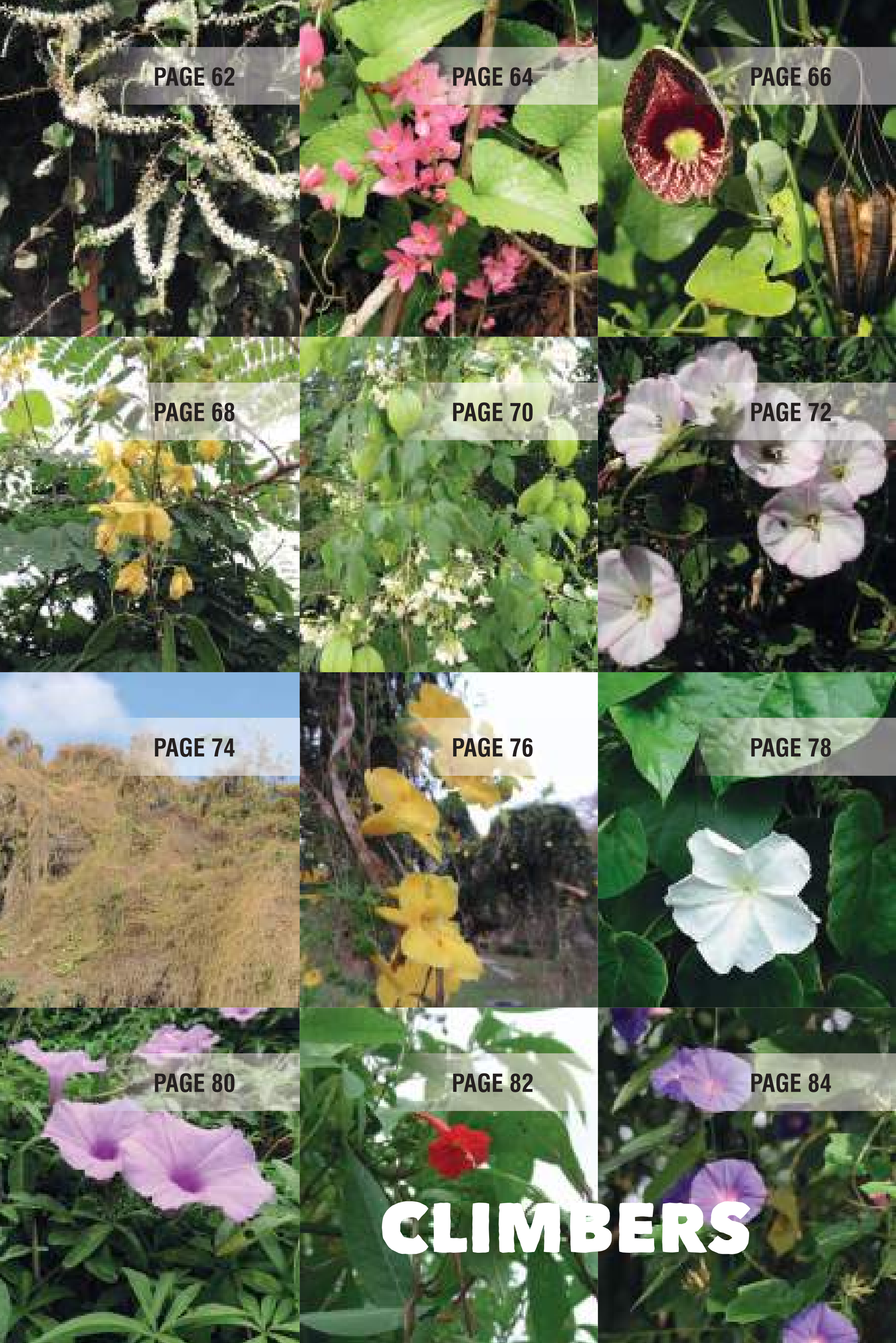
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CLIMBERS


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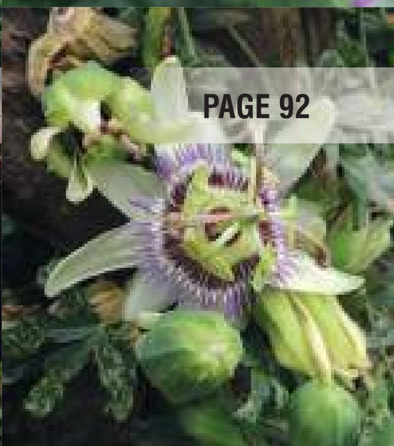
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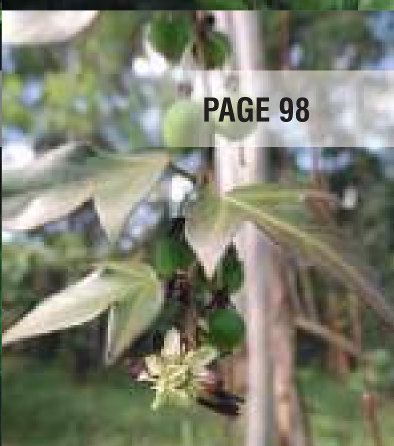
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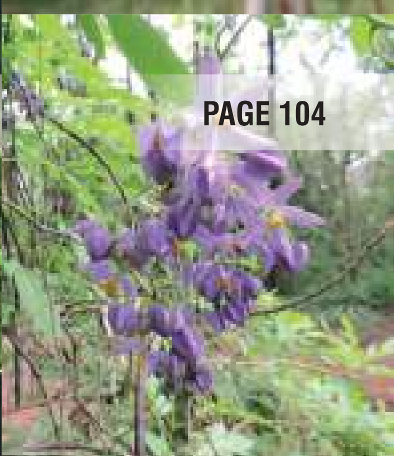
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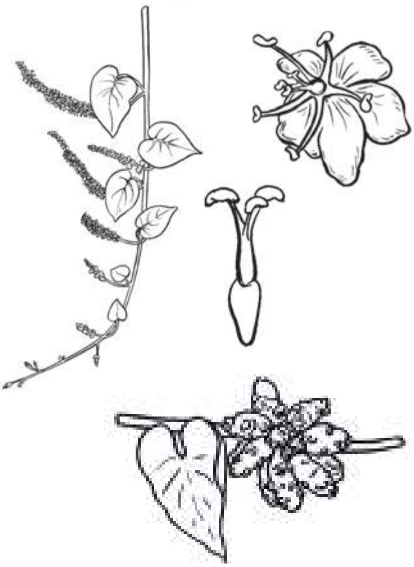
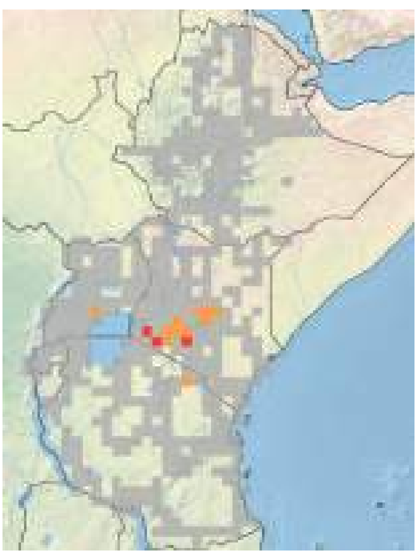
Anredera cordifolia (Ten.) Steenis





FAMILY

Basellaceae

COMMON NAMES

English: bridal wreath, lamb's tail, Madeira vine, potato vine

DESCRIPTION

Evergreen semi-succulent twining vine or creeper that can grow to over 30 m in height; young stems (to 6 m long) are hairless, green or reddish turning grey-brown and becoming rope-like in appearance.

Leaves: Bright green, glossy and slightly fleshy, heart-shaped (2–15 cm long and 1.5–10 cm wide), held alternately on stems, well-spaced.

Flowers: White, showy (5 mm across), held in long unbranched inflorescences or spikes (6–30 cm long), short flower stalks (0.5–3.5 mm long), fragrant.

Fruits: Usually not present; reproduces from warty aerial tubers (2–3 cm long) that grow at the junctions of the stems and leaves and which drop to the ground.

ORIGIN

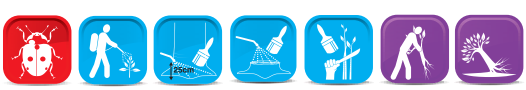
Argentina, Bolivia, Brazil, Columbia, Ecuador, Paraguay, Peru and Uruguay.

REASON FOR INTRODUCTION

Edible roots, barrier/hedge and ornament

INVADES

Roadsides, disturbed areas, urban open spaces, gardens, plantations, forests, forest edge/gaps, woodlands, woodland edge/gaps and riparian vegetation.

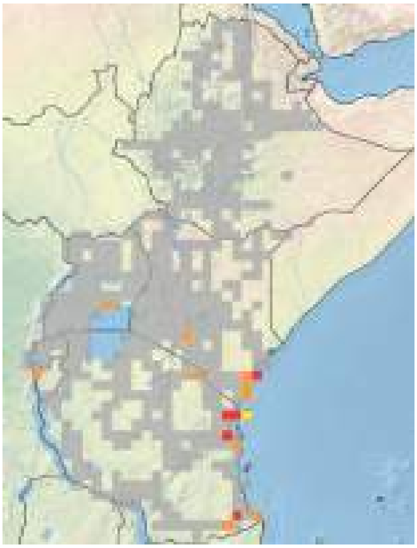


IMPACTS

It has the ability to cover the ground and to smother native vegetation, including trees, causing canopy collapse. Such is the weight of this creeper, it is capable of breaking off tree branches, "potentially causing collapse of the rainforest canopy" (LCC, 2001). Growth rates of stems in suitable climates can exceed one metre per week and up to six metres in a growing season (Neal, 1965). The aerial tubers, through which it reproduces can, after dropping to the ground, remain viable for up to two years, making this an exceptionally difficult plant to manage. As many as 1,500 tubers per m^2 have been reported from under dense infestations (LCC, 2001). It is considered to be one of the worst weeds in Australia and New Zealand. In Queensland and New South Wales, Australia, it is regarded as the most serious threat to rainforest and coastal remnants (LCC, 2001). Invasions threaten the endangered Illawarra socketwood (*Daphnandra* sp. C 'Illawarra'; Monimiaceae) and the endangered Coxen's fig-parrot [*Cyclopsitta diophthalma coxeni* (Hombron and Jacquinot); Psittaculidae] by degrading the latter species' feeding and nesting habitat. It is toxic to pigs, sheep and possibly cattle and goats as well. Poisoning of stock is thought to occur via drinking water, causing diarrhoea and convulsions (Simmonds, 2008).

Notes: At a distance it could be confused with *Basella alba* L. (Basellaceae), which is widely grown as a hedge and green vegetable in East Africa. Unlike *A. cordifolia* it has no aerial tubers. According to Verdcourt (2000), *A. cordifolia* it is present in Asmara and Tepi and probably also in Addis Ababa and other towns in Ethiopia. It has escaped cultivation and has established on forest edges and in urban open spaces, especially in and around Nairobi but also in other towns and villages in Kenya, including some on the border of Meru National Park. Probably far more widespread than indicated in the distribution map.

Antigonon leptopus Hook. & Arn.



FAMILY
Polygonaceae

COMMON NAMES

English: bride's tears, chain of love, coral bells, coral creeper, love vine

DESCRIPTION
Evergreen climber or vine with tendrils (slender, usually twisting, structures on the stems or leaves that aid in 'climbing'), on angular stems [6–10 (–15) m long]; hairless or with young shoots covered with brownish or reddish hairs; older stems brown and woody near base; underground tubers.

Leaves: Light green on upper surface, pale green below, membranous, conspicuous network of veins, heart-shaped or triangular (2.5–15 cm long and 2–10 cm wide), margins entire, wavy or bluntly toothed with pointed tips, leaf stalks 1–5 cm long, slightly winged.

Flowers: Bright pink, sometimes white, in clusters (4–20 cm long) at the tips of branches, tips of clusters ending in a short tendril.

Fruits: Achenes (small, dry, one-seeded fruits that do not open at maturity), brown, cone-shaped or three-angled (8–12 mm long and 4–7 mm wide), covered by the papery remains of the flower 'petals'.

ORIGIN
Mexico

REASON FOR INTRODUCTION
Ornament

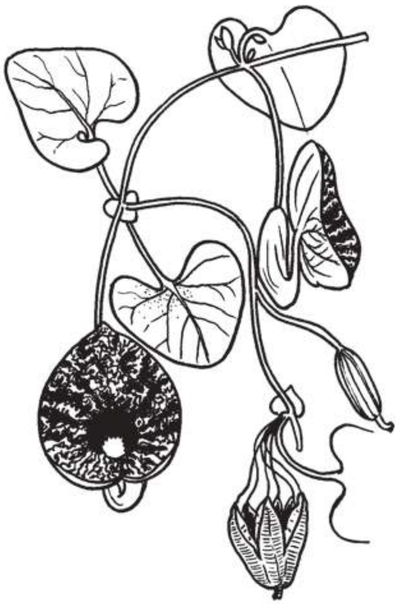
INVADES
Roadsides, disturbed areas, wastelands, urban open spaces, forest edges/gaps, riparian vegetation and coastal sand dunes.

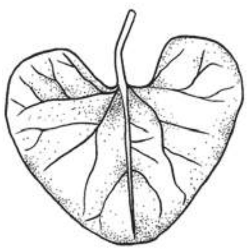
IMPACTS

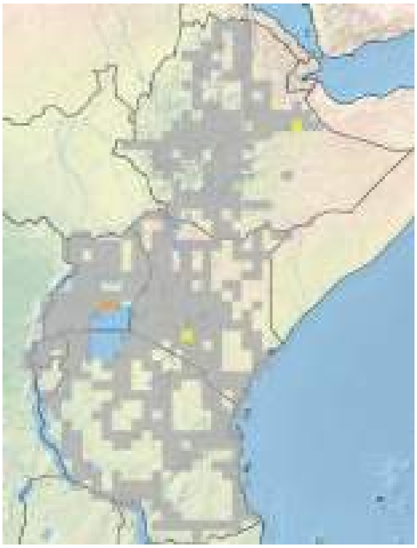
Has the ability to grow in almost any soil type, including poor soils, and is relatively drought tolerant (Gilman, 2007). Smothers native trees, out-competes understorey plants, and alters fire regimes (Langeland *et al*., 2008; USDA-NRCS, 2011). In a study in Saipan (Northern Mariana Islands), *A. leptopus* decreased the "abundance, richness and diversity of flora across all habitat types" (Garrett and Meneses, undated). Plant abundance was significantly lower in native limestone, secondary forest, and tangantangan plots invaded by coral creeper, and *Coccinea grandis* (L.) Voigt (Cucurbitaceae), compared to uninvaded plots. Diversity of flora was also significantly reduced in native limestone and secondary forest (Garrett and Meneses, undated). On Christmas Island (Indian Ocean), it is "rampant on sea and inland cliffs and in previously mined areas … where it may be hampering the annual migration of crabs and interfering with natural regeneration" (Swarbrick and Hart, 2000). It has been found to cover an estimated 20% of the island of St Eustatius (Caribbean) (Ernst and Ketner, 2007). In Australia it is a "weed of waterways and riparian areas, monsoon vine thickets, rainforest margins, coastal sand dunes, mangrove vegetation, roadsides, disturbed sites, waste areas and old gardens in the wetter tropical and sub-tropical regions of Australia" (Environmental Weeds of Australia, 2016). Once established, it is difficult to control because it has many tuberous roots, allowing it to propagate vegetatively.

Notes: According to Hedberg (2000), it has "occasionally escaped" in the Afar region of Ethiopia. Already abundant along parts of the coasts of Kenya and Tanzania more than 50 years ago, especially near villages and towns, its continued proliferation as a local "escape from cultivation" (Graham, 1958), was confirmed during our surveys. Becoming increasingly invasive along the Kenyan coast especially in urban open spaces and coastal forests.

Aristolochia littoralis D. Parodi







BIRTHWORT FAMILY
Aristolochiaceae

SYNONYM
Aristolochia elegans Mast.

COMMON NAMES

English: calico flower, Dutchman's pipe
Ethiopia: boro, hurguma, kerid bari, jukum
Tanzania: lunkulwe, unkulwe
Uganda: kasero, masanda, mukumya, nakasero

DESCRIPTION
Evergreen, hairless, twining climber [2–3 (–7) m high], with slender, pendulous flowering branches.

Leaves: Bright green above and greyish below, hairless, heart- to kidney-shaped or slightly triangular (3–10 cm long and 3–12 cm wide), margins entire, 5–7 veins from the base, leaves held alternately on the stems, on leaf stalks (15–50 mm long) with a small ear-shaped leafy structure at the base of each stalk; unpleasant smell.

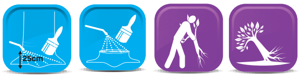
Flowers: Maroon with white marbling and a yellow throat, tubular with broad heart-shaped opening (7.5 cm long and 10 cm across), held on drooping stalks (7 cm long).

Fruits: Capsules (dry fruits that open at maturity), green turning brown as they mature, sausage-shaped, (4–6 cm long and about 2.5 cm wide), hang like baskets after seed dissemination.

ORIGIN
Argentina, Bolivia, Brazil, Colombia, Ecuador and Paraguay.

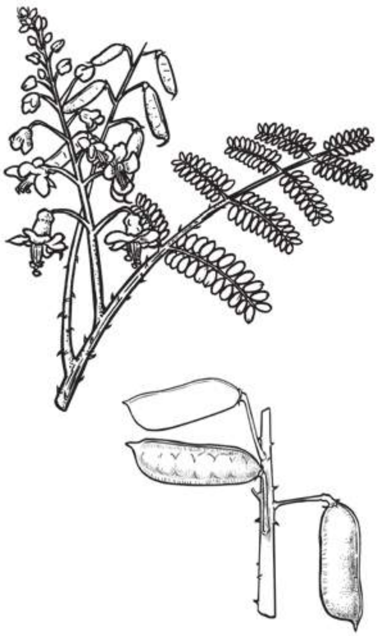
REASON FOR INTRODUCTION
Ornament

INVADES
Roadsides, disturbed areas, urban open spaces, plantations, forest edges/gaps and riparian vegetation.



IMPACTS
Climbs into and over vegetation, smothering plants, reducing diversity and abundance. In Australia, it readily invades dry rainforests, lowland rainforests and riparian vegetation, replacing native vines and preventing the growth and regeneration of native plants. In southeastern Queensland, *A. littoralis* was recently ranked among the top 50 worst invasive plants. In Australia, it is contributing to the decline of the native birdwing vine (*Pararistolochia praevenosa* (Muell.) Parsons; Aristolochiaceae), the only food plant of the Richmond birdwing butterfly [*Ornithoptera richmondia* (Gray); Papilionidae]. Due to the scarcity of its native food plant, the adult female butterflies inadvertently lay eggs on *A. littoralis*, which is toxic to their larvae. The larvae of other native butterflies, such as the big greasy (*Cressida cressida* Fabricius; Papilionidae) and the red-bodied swallowtail (*Pachlopta polydorus* L.; Papilionidae) also perish after feeding on this invasive plant (Environmental Weeds of Australia, 2016). In eastern Uganda, plantations of *Eucalyptus* species are also threatened by *A. littoralis*, which climbs up young trees, "covering their crowns and stunting or killing them" (Mclean, 1971).

Notes: Cultivated plants have "gone wild in [Kenya's] Central Highlands (in plantation and riverine forest)" (Beentje, 1994). In Uganda, it has been found in plantations and riverine forest (Verdcourt, 1986). It is also present in Ethiopia, having been seen on the Alemaya University Campus, Hararge Region (Verdcourt, 2000). Not actively recorded during surveys but probably more widespread and abundant than indicated.



PEA FAMILY
Fabaceae; sub-family: Caesalpiniaceae

SYNONYM
Biancaea scandens Tod.; *Caesalpinia sepiaria* Roxb.

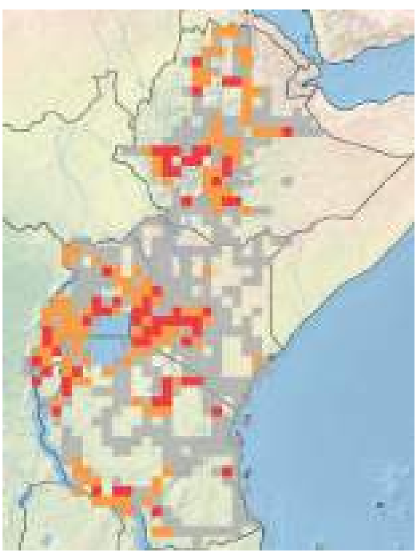
COMMON NAMES
English: cat's claw, Mauritius thorn, mysore thorn, shoofly, wait-a-while; Ethiopia: gharengei, yeferenj-ktktta; Kenya: chepkomon, ekenangwa, ktandambo, luavari, lunani, matata, mburuga, mkomwe, mubagi, mutate, okwato, olunani, oiti orok; Rwanda: umufatangwe; Tanzania: olmashinga, mshawa, msoo-wa-mbuugha, urushu

DESCRIPTION
Robust, thorny, evergreen shrub or climber [2–4 (–10) m high]; often forms dense thickets; stems have very fine golden hairs and numerous straight to hooked thorns, not in regular rows or confined to nodes.

Leaves: Dark green above, paler below, twice-divided (to 30 cm long); 4–10 pairs of leaflet branchlets, each branchlet with 8–12 pairs of leaflets which are egg-shaped or somewhat elongated with almost parallel sides (7–20 mm long and 2–8 mm wide), rounded at the ends.

Flowers: Pale yellow (25–30 mm wide), in elongated, erect clusters or spikes (10–40 cm long).

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning brown as they mature (6–10 cm long and 25 mm wide), flattened, unsegmented and smooth with a sharp beak at the distal end; held stiffly erect on woody stalks; flattened black seeds (8–12 mm long and 6–8 mm wide).



ORIGIN
Bhutan, China, India, Indonesia, Japan, Korea, Laos, Malaysia, Myanmar, Philippines, Sri Lanka, Thailand and Vietnam.

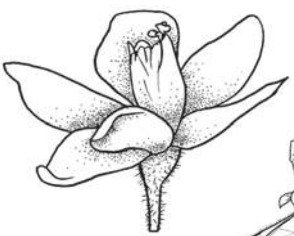
REASON FOR INTRODUCTION
Bee forage, hedge/barrier and ornament.

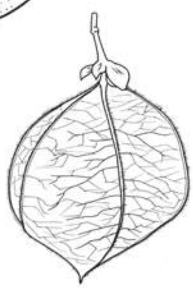
INVADES
Roadsides, disturbed land, wasteland, gardens, plantations, drainage ditches, forest, forest edges/gaps, woodlands, woodland edges/gaps, savannah, riparian vegetation, lowlands and gullies.

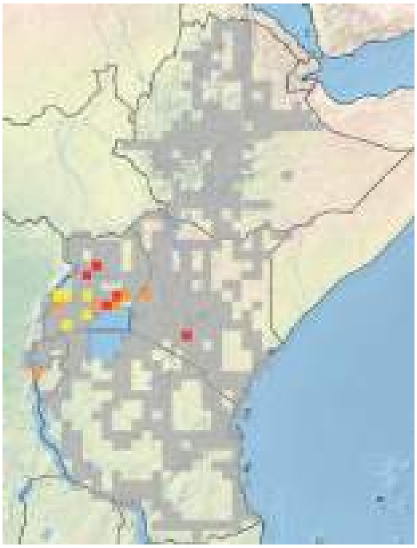
IMPACTS

Climbs over vegetation, forming tangled, impenetrable thickets, detrimental to fauna and to other flora. Has the ability to grow into forest and woodland canopies, causing canopy collapse. Also grows on to man-made structures, causing infrastructural damage. Mauritius thorn impedes operations in managed forestry plantations and is a fire hazard (Geldenhuys *et al*., 1986). In Hawaii, *C. decapetala* has invaded pastures, reducing their livestock carrying capacities and inhibiting the movement of livestock and people (Starr *et al*., 2003). The large spines on the stems can cause injuries to wildlife, livestock and people.

Notes: Present in wooded grassland and upland evergreen bushland and "frequently established on dry hillsides and valley slopes" in the Ethiopian regions of Welo, Shewa, Arsi, Harerge and Kefa, where it is "becoming naturalized" (Thulin, 1989). In Kenya, it has "gone wild" (Beentje, 1994) and is "widely naturalized and spread over much of Kenya at altitudes of up to 2,000 m" (Birnie and Noad, 2011). KHS (1995) states that "it romps all over the place, becoming a weed, and is not easily removed." In Uganda, it is "going wild" in many places (Katende *et al*., 1995). These observations were confirmed by our surveys, which found it to be naturalized and abundant in many parts of East Africa and Ethiopia, especially in riparian vegetation and forest edges and gaps. Its congener, *C. pulcherrima* (L.) Sw., is "naturalized, most often as a relic from cultivation" (Beentje, 1994), and "naturalized both at the coast and in Machakos District" in Kenya (Birnie and Noad, 2011), although its naturalization could not be confirmed during surveys.







Cardiospermum grandiflorum Sw.

SOAPBERRY FAMILY
Sapindaceae

SYNONYM
Cardiospermum hirsutum Willd.; *Cardiospermum hispidum* Kunth; *Cardiospermum macrophyllum* Kunth

COMMON NAMES
English: balloon vine, heart seed vine, large balloon creeper
Ethiopia: immi, semeg, shaqwre
Kenya: burili
Uganda: akazibira, binyino, olunyereketo, oruzibira

DESCRIPTION
Evergreen, slightly woody climber [2–5 (–10) m in height] with tendrils (slender, usually twisting structures on the stems or leaves which aid 'climbing'), often smothering trees; stems ribbed and covered with bristly yellowish or reddish hairs especially when young.

Leaves: Bright green, compound (6–16 cm long), leaflets (2–8 cm long and 1–5 cm wide) arranged in three groups of three; margins with forward-pointing sharp projections or teeth and pointed tips.

Flowers: White or yellow, in clusters (about 35 mm long) with two tendrils at the base of each cluster, sweet smelling.

Fruits: Capsules (dry fruits that open at maturity), inflated and balloon-like, green turning brown as they mature, membranous or papery, pointed, much longer than broad (45–65 mm long and 30–45 mm wide), with three compartments; seeds round, black, with an elongated white spot, sides almost parallel.

ORIGIN
Argentina and Brazil.

REASON FOR INTRODUCTION
Ornament

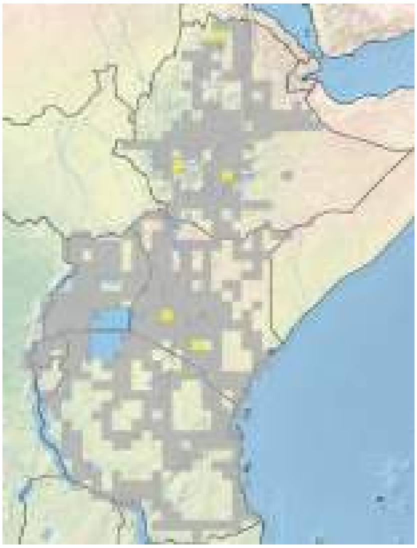
INVADES
Roadsides, disturbed areas, wastelands, urban open spaces, gardens, forest edges/gaps and riparian vegetation.

IMPACTS

Climbs on to trees and shrubs causing canopy collapse, especially along forest edges and watercourses, and in urban open spaces in sub-tropical areas (WESSA, 2006). It forms dense but localised infestations, growing to enormous lengths, capable of smothering trees up to 10 m tall. Infestations alter light penetration, which suppresses the regeneration of native species. Dense thickets can also restrict the movement of native fauna, preventing access to forage and water sources. *Cardiospermum* spp. invasions have had significant economic impacts on sugarcane and soybean production (Johnston *et al*., 1979; Jolley *et al*., 1983; Voll *et al*., 2004, Subramanyam *et al*., 2007; Murty and Venkaiah, 2011). For example, in Brazil, *C. halicacabum* has reduced soybean crop yields by up to 26% (Dempsey, 2011; Brighenti *et al*., 2003). Control of *Cardiospermum* spp. infestations in soybean crops is aggravated by the difficulty of mechanically excluding their seeds, which are similar in size and shape to those of soy (Brighenti *et al*., 2003).

Notes: While it has not been reported as present in Ethiopia, its congener, *C. halicacabum*, which is considered to be indigenous, is widespread as a weed of cultivation (Vollesen, 1989). According to Davies and Verdcourt (1998), *C. grandiflorum* is present in riverine forest and thicket, grassland patches within forests and roadsides in Kenya, Tanzania and Uganda. It is also occasionally present on rocky ground in upland forest edges in Kenya (Agnew and Agnew, 1994). It is very abundant in some urban centres in Kenya, especially Nairobi, and in forest and woodlands in Uganda. Possibly more widespread and abundant than indicated, this climber poses a significant threat to forests in the region.

Convolvulus arvensis L.



MORNING GLORY FAMILY
Convolvulaceae

SYNONYM
Convolvulus chinensis Ker Gawl.

COMMON NAMES

English: Annual bindweed, bindweed, common bindweed, field bindweed, wild morning glory
Ethiopia: balersf, filatut, gama-harestei, gashanekaye, ja-gurberi-gammi, wanta bukusi

DESCRIPTION
Evergreen herb growing from a deep tap-root or rhizome (5 cm–2.6 m long), shoots developing from adventitious buds on the roots at depths of down to 1 m; stems slender (to 3 m long), hairless, trail or climb by twining.

Leaves: Dull green with visible veins, hairless or slightly hairy, variable in shape but with distinct arrow-shaped bases (1.2–5 cm long), pointed at the terminal end, margins entire, held alternately on the stems; leaf stalks are flattened and grooved on the upper side.

Flowers: White or pale pink, sometimes with red stripes, funnel-shaped (10–25 mm long and 10–25 mm across), solitary on long stalks.

Fruits: Capsules (dry fruits than open at maturity), brown, round to egg-shaped (8 mm wide), splitting into four valves, each containing one seed (0.5–1.2 cm long).

ORIGIN
Afghanistan, Albania, Algeria, Armenia, Austria, Azerbaijan, Belarus, Belgium, Bulgaria, China, Cyprus, the former Czechoslovakia, Denmark, Egypt, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Italy, Iran, Ireland, Israel, Jordan, Kazakhstan, Kyrgyzstan, Latvia, Lebanon, Libya, Lithuania, Moldova, Mongolia, Morocco, Nepal, Netherlands, Norway, Pakistan, Poland, Portugal, Romania, Russia, Spain. Sweden, Switzerland, Syria, Tajikistan, Tunisia, Turkey, Turkmenistan, the UK, Ukraine, Uzbekistan and the former Yugoslavia.

REASON FOR INTRODUCTION
Accidentally as a contaminant.

INVADES
Roadsides, disturbed areas, urban open spaces, fallow lands, croplands, grassland and savannah.

IMPACTS

Listed as one of the world's worst weeds (Holm *et al*., 1977), bindweed produces copious quantities of seeds (50,000 to 20 million per hectare in pure stands), and has the ability to form dense tangled mats, to the detriment of other plant species. Through competition for soil moisture, nutrients and sunlight, bindweed can contribute to a reduction in plant diversity and available forage for native species (Swan, 1980). Field bindweed is also allelopathic, inhibiting the germination of other plants. It threatens bunchgrass/forb-dominated habitats by decreasing biodiversity, and is a direct threat to several native species in parts of the USA (Lyons, 2001). In crop production systems, bindweed significantly reduces available soil moisture, contributing to reduced crop yields (Wiese *et al*., 1996). Crop yields can be reduced by 50–60% where infestations are dense (Callihan *et al*., 1990). Annual crops such as cereals and grain legumes are badly affected by bindweed infestations, and yield reductions of 20–80% have been recorded (Phillips and Timmons, 1954; Black *et al*., 1994). It is also considered to be a problematic weed in vineyards. Losses caused by this weed in the USA were estimated at more than US$ 377 million in 1998 alone (Berca, 2004). It also considered being mildly toxic to livestock, causing distress in pigs that feed on it (Callihan *et al*., 1990).

Notes: On the Kenya highlands, it was considered, more than 50 years ago, to be a weed of cultivation on black cotton and other soils (Verdcourt, 1963). It is also a weed of cultivated areas in the Ethiopian regions of Eritrea East, Tigray, Sidamo and Shewa (Demissew, 2006). Invasive but not actively recorded during surveys so likely to be considerably more abundant than indicated.

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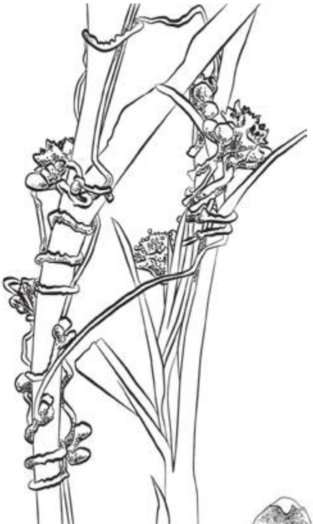
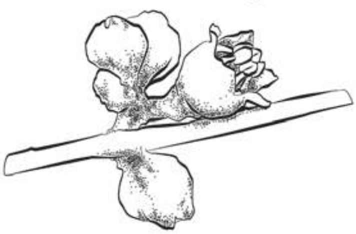
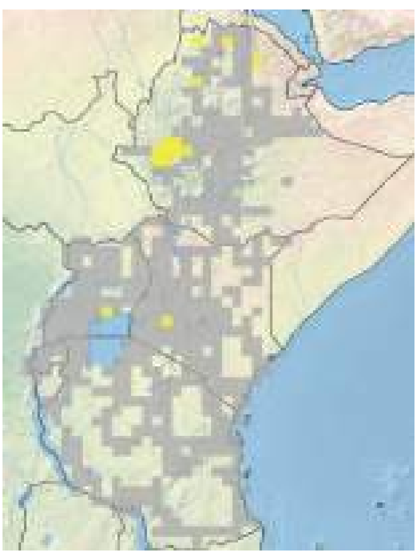
Cuscuta campestris Yunck.







MORNING GLORY FAMILY
Convolvulaceae

SYNONYM
Cuscuta arvensis Beyr. ex Engelm.

COMMON NAMES

English: common dodder, dodder, field dodder, golden dodder
Ethiopia: yenoug anbessa
Rwanda: ingurukira

DESCRIPTION
Parasitic herb, very distinctive, consisting mainly of leafless, hairless, yellow or pale orange stems (0.3 mm in diameter), with coil-forming tendrils (slender, usually twisting, structures found on the stems or leaves of some plants and which serve as 'climbing' aids) and with specialized root-like suckers called haustoria that penetrate the host plant from which it then obtains water and nutrients.

Leaves: Tiny, inconspicuous scales in the place of leaves.

Flowers: White or greenish (1.5–3 mm long and 2 mm across), in compact round clusters (1–2 cm across) of 3–8 flowers.

Fruits: Capsules (dry fruits that open at maturity) (2–3 mm across), light brown, containing 2–4 seeds (1 mm across); remain on plant long after maturity.

ORIGIN
Bahamas, Canada, Cuba, Guadeloupe, Jamaica, Martinique, Mexico and USA.

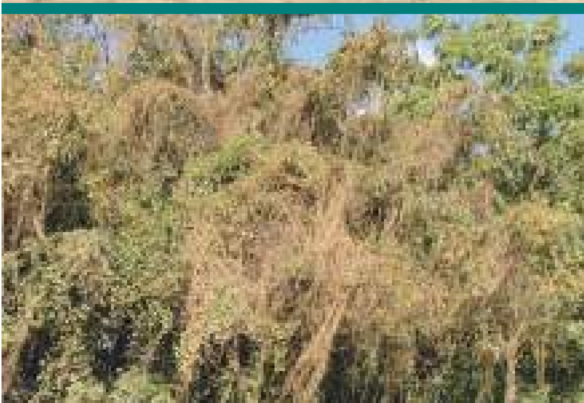
REASON FOR INTRODUCTION
Accidentally as a contaminant.

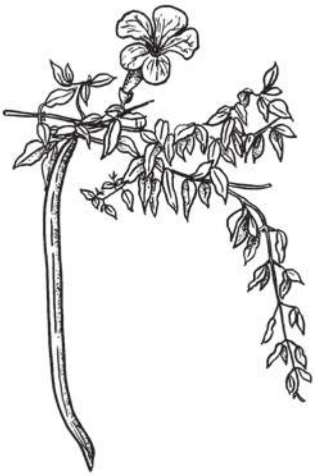
INVADES
Roadsides, disturbed land, urban open spaces, croplands and riverbanks.

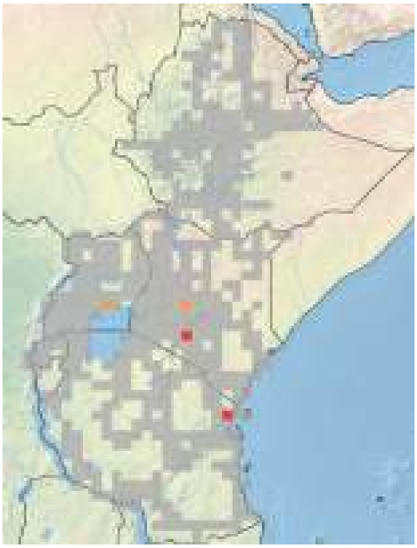
IMPACTS

Has the ability to climb into and over other plants, smothering them. It has a major impact on many crops, often leading to total crop loss. Crops most seriously affected include: lucerne in North America, the former Yugoslavia and many other countries; niger seed in India and Ethiopia; sugarbeet in the former Yugoslavia, Italy and eastern Europe; and chrysanthemum in Australia, the Canary Islands and Ethiopia (Parker and Riches, 1993). It is also a major pest of tomatoes in Spain and Israel (Tei *et al*., 2003). Over a two-year period, dodder has been found to reduce lucerne yields by 57% and the amount of sugar in beet by 3.5–4 tons per hectare (Parker and Riches, 1993). In India, yield losses of 86%, 67%, 48%, 27%, 25% and 18% have been recorded in niger seed, greengram, sesamum, soybean, black gram, pigeon pea and groundnut, respectively (Mishra *et al*., 2007). Farah and Al-Abdulsalam (2004) recorded yield losses of greater than 50% in hyacinth bean, lentil, chickpea, faba bean, lucerne and fodder pea, and losses of 10–50% in fenugreek, Egyptian clover, lupin and garden pea, as a result of bindweed infestations. Additional losses and costs are incurred when exported crops are rejected or have to be cleaned to remove bindweed seeds.

Notes: This species has long been present in eastern Africa with the first specimen collected in the Nakuru District, Kenya, in 1931. Subsequently specimens were collected in Nairobi National Park, Kenya; Moshi District, Tanzania; and in Mabira Forest, Uganda. Early records indicate that it has the ability to spread into forest undergrowth (Verdcourt, 1963). According to Agnew and Agnew (1994), it is found on a wide variety of hosts in Kenya in "bushy and waste places." Across most of Ethiopia, it is "parasitic on a wide range of species in cultivated areas" (Aweke and Edwards, 2006), notably in the Western, Central and Chercher Highlands, and in the Northeast, and the Tana Basin (Stroud and Parker, 1989). Not actively recorded but known to be invasive and becoming increasingly problematic in Kenya, it is much more widespread and abundant than indicated.







JACARANDA FAMILY
Bignoniaceae

SYNONYM
Macfadyena unguis-cati (L.) A.H. Gentry

COMMON NAMES

English: cat's claw creeper, cat's claw trumpet, cat's claw vine, funnel creeper

DESCRIPTION
Evergreen climber (to 9 m or higher) with tendrils (slender, usually twisting, structures on the stems or leaves that serve as 'climbing' aids); younger stems green and hairless, often with reddish-brown or bronze tips, older stems (to 15 cm thick) woody, light brown or greyish; extensive tuberous root system.

Leaves: Bright green, compound, with two leaflets and a terminal, three-parted, claw-like tendril; leaflets hairless, oval to slightly elongated (10–80 mm long and 4–30 mm wide), margins entire to slightly wavy with pointed tips, held opposite each other on stems on long leaf stalks (10–25 mm long).

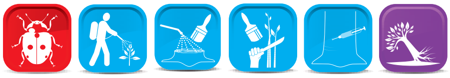
Flowers: Bright yellow, trumpet-shaped or tubular (4–10 cm long and 10 cm wide), in the angle between leaf stalk and stem, solitary or in clusters of two or three.

Fruits: Capsules (dry fruits that open at maturity), green turning brown as they mature, leathery, long, flattened (15–50 cm long and 8–12 mm wide), splitting open to release many papery-winged seeds (10–40 mm long and 4–10 mm wide).

ORIGIN
Argentina, Belize, Bolivia, Brazil, Colombia, Costa Rica, Ecuador, Guatemala, French Guiana, Guyana, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Surinam, Venezuela and the Caribbean.

REASON FOR INTRODUCTION
Ornament

INVADES
Roadsides, urban open spaces, gardens, forests, forest edges/gaps, woodlands and woodland edges/gaps.

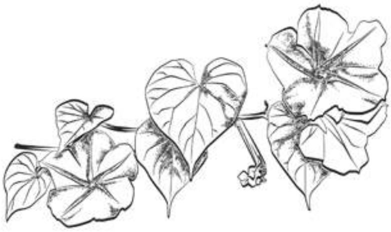


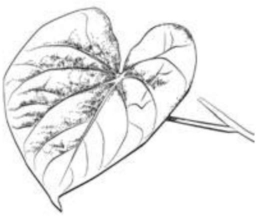
IMPACTS

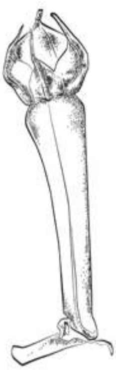
Has the ability to climb into trees and forest canopies, smothering plants and causing canopy collapse, often leaving only dead tree trunks (Grice and Setter, 2003). It can also form a thick carpet of leaves and stems on the forest floor, displacing native plants and preventing their regeneration. Widely considered to be "one of the most destructive exotic vines" (McClymont, 1996), its infestations have been described as "troublesome", "obnoxious" (FLEPPC, 2015), and "serious" (PIER, 1999). Ranked as the fourth most invasive alien plant species in southeastern Queensland, Australia, it is now regarded as a priority environmental weed in five Natural Resource Management regions in Australia. Out of 340 invasive environmental weeds in New South Wales, Australia, *D. unguis-cati* was ranked 11th for its threat to biodiversity (Downey *et al*., 2010). Also considered to be an agricultural weed (Groves *et al*., 2005; Randall, 2007), it is a "significant invader" of plantations and orchards (King *et al*., 2011). It is invasive in South Africa and naturalized within and around the cities of Harare and Mutare in Zimbabwe, while having also escaped around Lusaka, Zambia.

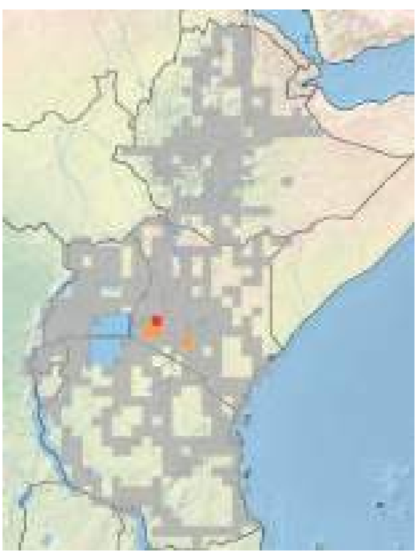
Notes: It has been recorded as invasive in the Amani Nature Reserve, East Usambaras, Tanzania (Dawson *et al*., 2008), but there are no records from Ethiopia (Bidgood, 2006). Present in the Mengo District in Uganda; in Nairobi, and in the Kisumu–Londiani and Kwale Districts in Kenya; and in Lushoto District in Tanzania; it is considered to be naturalized in some of these areas (Bidgood *et al*., 2006). An escape from gardens in Nairobi and Kampala it is now smothering trees and shrubs along roadsides and in urban open spaces.

Ipomoea alba L.









MORNING GLORY FAMILY
Convolvulaceae

COMMON NAMES
English: evening glory, moonflower, moon vine, tropical white morning glory, white morning glory

DESCRIPTION
Annual or evergreen vine with hairless stems (to 5 m long); aerial climbing stems sometimes have numerous small prickly projections; milky latex.

Leaves: Bright green, thick, sometimes slightly fleshy, heart-shaped or sometimes lobed (5–20 cm long and 4–20 cm wide) with pointed tips, held alternately on the stems, on stalks (5–18 cm long).

Flowers: White, large, tubular or trumpet-shaped with a long and narrow greenish-white floral tube (7–15 cm long) and five large, spreading lobes (10–15 cm wide), held in clusters or sometimes singly in the leaf forks; open at night.

Fruits: Capsules (dry fruits that open at maturity), green to dark brown or black as they mature, small (2–3 cm long) with a pointed tip containing four hairless seeds (about 10 mm long).

ORIGIN
Argentina, Bahamas, Belize, Bolivia, Brazil, Colombia, Costa Rica, Cuba, Dominican Republic, French Guiana, Guatemala, Guyana, Haiti, Honduras, Mexico, Nicaragua, Panama, Surinam, USA and Venezuela.

REASON FOR INTRODUCTION
Ornament

INVADES
Roadsides, disturbed areas, wasteland, urban open spaces, forest edges/gaps, woodlands, savannah and riparian vegetation.

IMPACTS

Has the ability to climb into trees and over other vegetation, smothering native plants, to the detriment of biodiversity. Naturalized in parts of Australia, it has the potential to become a serious weed of rainforest gaps and margins, wet sclerophyll forests and riparian areas throughout the coastal districts of Queensland and northern New South Wales. It is also listed among the "exotic vines and scramblers" whose invasion of native vegetation is regarded as a "key threatening process" in New South Wales (Environmental Weeds of Australia, 2016). It has also naturalized in scattered localities in Florida (Floridata, 2015), and in Hawaii it is "naturalized in usually moist areas" (Wagner *et al*., 1999). In Fiji, it is found in dense forest and thickets (Smith, 1991), while on the Galápagos Islands it is present in the arid lowlands and moist uplands (McMullen, 1999).

Notes: In the Harerge Region of Ethiopia, it has "escaped and established in waste places near streams and rivers" (Demissew, 2006). Widespread in East Africa on "waste places and rubbish heaps," it is also "locally established in upland and riverine forests" (Verdcourt, 1963). Congeners such as *I. lobata* (Cerv.) Thell. (Syn.: *Mina lobata* Cerv.), *I. tricolor* Cav., and *I. turbinata* Lag. are considered to be naturalized in Ethiopia (Demissew, 2006). Not often recorded during surveys.

Ipomoea cairica (L.) Sweet

MORNING GLORY FAMILY
Convolvulaceae

COMMON NAMES
English: Cairo morning glory, five-fingered morning glory, ivy-leaved morning glory, mile-a-minute vine, morning glory
Ethiopia: ayit-harege, jilijili, kelala, mandecho, maran, mecharia harege, meracha

DESCRIPTION
Evergreen climbing plant with hairless stems, sometimes producing roots from the joints where these come into contact with the ground.

Leaves: Green, hairless, divided into 5–7 lobes, like the fingers of a hand (3–10 cm long and 3–10 cm wide), arranged alternately on the stem, on stalks (2–6 cm long).

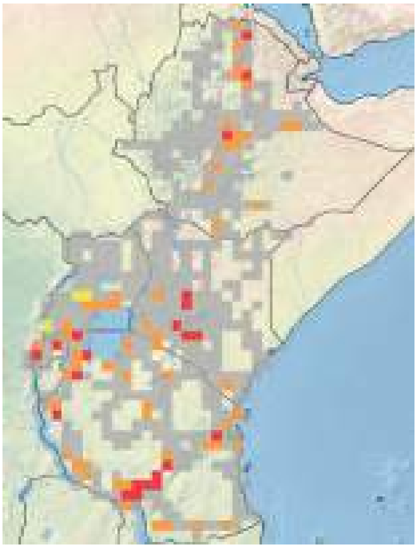
Flowers: Purple to pinkish-purple or completely white with a deeper coloured throat or centre, funnel-shaped (4–6 cm long and 5–8 cm across), held singly or in small clusters.

Fruits: Capsules (dry fruits that open at maturity), green turning brown as they mature, round (10–12 mm across), containing four brown seeds (6 mm across) partly covered with long, silky hairs.

ORIGIN
Unclear, but probably tropical Africa and parts of Asia.

REASON FOR INTRODUCTION
Ornament (probably native to the region).

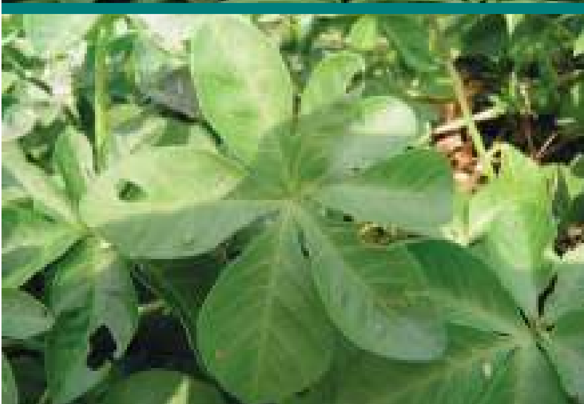
INVADES
Roadsides, disturbed areas, gardens, urban open spaces, woodlands, forest edges, savannah, lowlands, swamps, wetlands, riparian areas and coastal sand dunes.



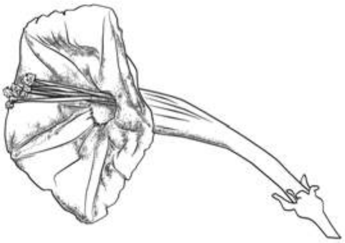
IMPACTS

Climbs into and over trees and shrubs, smothering them, to the detriment of native flora and fauna. In a field study in Guangdon Province, China, *I. cairica* was found to have significantly decreased plant richness and diversity (Hui and Tao, 2012). In China, three invasive liana species, *Mikania micrantha* Kunth (Asteraceae), *Dolichandra unguis-cati* and *I. cairica*, have smothered entire habitats, "killing trees in gardens, plantations and forests" (Huang *et al*., 2009). *I. cairica* is listed as one of the most invasive species in southern China, where it has invaded bare land, wasteland, forests and their edges, and protected areas (Hu and Wang, 2001). Recently, it was even found invading salt marshes between terrestrial and marine ecosystems (Liu *et al*., 2015). In Australia, it has invaded conservation areas, and in southeastern Queensland it is ranked as one of the top 30 worst weeds, while in New South Wales it is listed as a "key threatening process" (Environmental Weeds of Australia, 2016). Remnant communities of endangered plants in New South Wales, Australia, are thought to be under threat from *I. cairica*, while on Lord Howe Island, it is reportedly threatening the habitats of the critically endangered Lord Howe Island phasmid [*Dryococelus australis* (Montrouzier) (Phasmatidae)]. *I. cairica* is considered to be allelopathic, having leaf extracts that negatively affect the germination, early development and morphology of a number of plant species including *Ipomoea grandifolia* (Dammer) O'Donel (Convolvulaceae) (Takao *et al.,* 2011).

Notes: In Ethiopia, it is widespread in scrub grassland, woodland, along roads and forest margins and near streams, rivers and lakes (Demissew, 2006). In East Africa, it is common in similar habitats, on roadsides, in urban open spaces, in swamps, wetlands, riparian vegetation and forest edges. Although considered to be native it is becoming more widespread and locally abundant in many of these habitats, smothering native vegetation. Research has shown that it benefits significantly from increased carbon dioxide levels, which may be largely driving its proliferation.



Ipomoea hederifolia L.



MORNING GLORY FAMILY
Convolvulaceae

COMMON NAMES

English: ivy-leaf morning glory, red convolvulus, redstar, scarlet morning glory, star ipomoea, star morning glory

DESCRIPTION
Annual twining vine with long stems (3–5 m long) that climb into and over other vegetation, hairless.

Leaves: Green, hairless, variable in shape, roughly triangular and often three-lobed with heart-shaped base and pointed apex; leaf stalk 2–9 (–12) cm long.

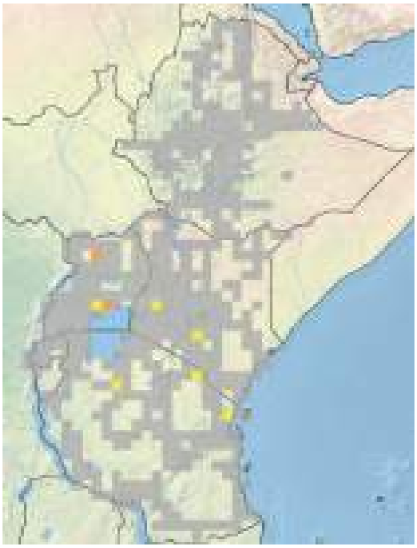
Flowers: Scarlet to red with an orange throat, hairless, trumpet-shaped with tube slightly curved (3–4 cm long), sepals (outer whorl of flower, often green and leaf-like in appearance) 2–3 mm long, with a long awn or horn-like appendage (2–4 mm long); single or in groups.

Fruits: Capsules (dry fruits that open at maturity), usually hairless, round (6–7 mm across), splitting into four valves; seeds (3.5–5 mm long), dark brown or black, hairy.

ORIGIN
Brazil, Bolivia, Colombia, Costa Rica, Dominican Republic, Ecuador, Guatemala, Guyana, Haiti, Jamaica, Mexico, Nicaragua, Panama, Peru, Paraguay, southern USA.

REASON FOR INTRODUCTION
Ornament

INVADES
Roadsides, disturbed areas, gardens and forest edges/ gaps.

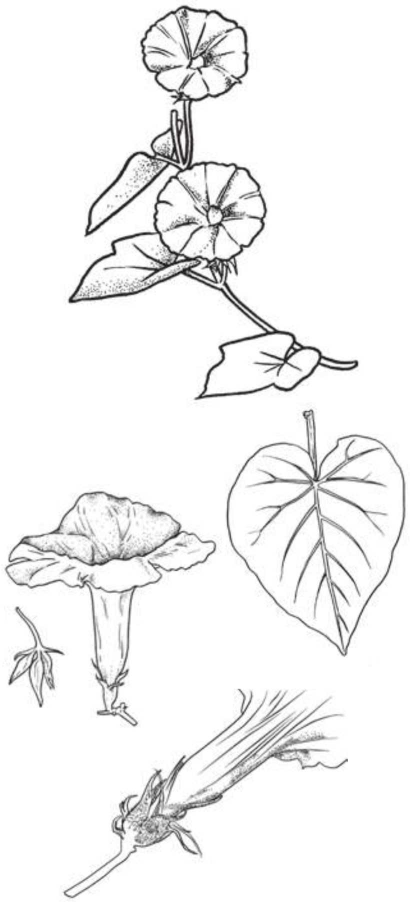


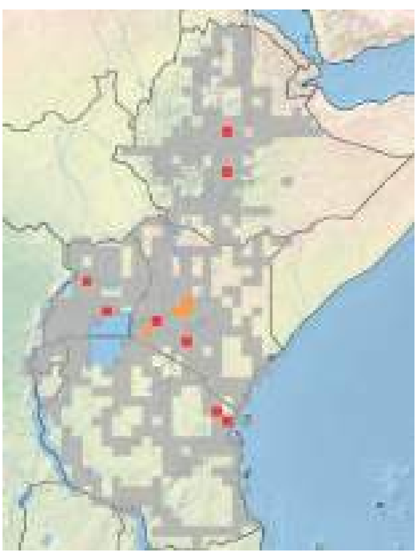
IMPACTS

Impacts for most invasive *Ipomoea* species with a climbing habit are similar; they can cause direct population declines in indigenous species by out-competing them for nutrients, water, and sunlight, in habitats ranging from bushland and riparian woodlands, to wetlands and coastal habitats. Several species in the genus are allelopathic, suppressing the growth of other plants (Bah and Pereda-Miranda, 1997). In Australia, *I. hederifolia* has escaped cultivation and is an occasional weed of bushland and riparian areas, as well as sugarcane plantations, roadsides, gardens, disturbed sites and waste areas (Environmental Weeds of Australia, 2016). According to Simpson (2016) it can be invasive in "canefields, cotton crops, and potato fields" and unless treated early, before it reaches the climbing stage on crops, it can be very difficult to control. On some Pacific islands it is a weed in canefields, young plantations, gardens and roadsides (PIER, 2006), being well established in a few lowland areas in New Guinea and common in roadside thickets and waste areas in Tonga (PIER, 2006). It is also present in Malawi, Mozambique, Zimbabwe and Zambia.

Notes: In East Africa, *I. hederifolia*, is "naturalized in waste places, in thickets and on cliffs, and is locally established in riverine forest" (Verdcourt, 1963). It has not been recorded as present in Ethiopia (Demissew, 2006), and was not recorded during surveys in East Africa although it is obviously present, but may have been overlooked.

Ipomoea indica (Burm.) Merr.





MORNING GLORY FAMILY
Convolvulaceae

SYNONYM
I. acuminata (Vahl) Roem. & Schult.

COMMON NAMES
English: blue morning glory, morning glory, ocean-blue morning glory

DESCRIPTION
Evergreen twiner or scrambling plant with hairy stems [3–6 (–15) m long], exuding milky sap when damaged.

Leaves: Bright green, sparsely hairy, egg-shaped and flat, entire or three-lobed (5–18 cm long and 3.5–16 cm wide), heart-shaped at base with pointed tips, leaf stalks 2–18 cm long.

Flowers: Purplish-blue, reddish, magenta, or white, sometimes with contrasting stripes, funnel-shaped (5–10 cm long and 7–10 cm across), in clusters of 2–12 in the leaf forks; five sepals (outer whorl of a flower, often green and leaf-like in appearance), long, narrow and uniformly tapering (14–22 mm long), with flattened soft hairs at the base, unlike *I. purpurea* where the sepals are pointed but not long and tapering (10–15 mm long) and have a bristly base.

Fruits: Capsules (dry fruits that open at maturity), rounded (10 mm across).

ORIGIN
Unclear, but possibly West Indies and elsewhere in tropical America.

REASON FOR INTRODUCTION
Ornament

INVADES
Roadsides, disturbed areas, wasteland, urban open spaces, gardens, plantations, woodland, forest edges/gaps, lowlands and riparian vegetation.

IMPACTS

Morning glory climbs into and over trees and shrubs, causing canopy collapse, to the detriment of native flora and fauna. It is considered to be invasive in New Zealand, Australia, South Africa, California and Portugal. In Hawaii, it is common at low-elevation sites (Wagner *et al*., 1999), and in Fiji it is found in "forests and forest edges, in thickets, on reeds in open places, and in plantations and waste places" (Smith, 1991). It is also toxic, and can, if consumed by livestock, result in chronic limb weakness, frequent urination and muscle twitches.

Notes: In parts of East Africa, it is "locally naturalized in waste places" (Verdcourt, 1963). It is widely cultivated in the Ethiopian regions of Shewa, Eritrea West and Sidamo, where it has "escaped and naturalized" (Demissew, 2006). In most areas of East Africa and Ethiopia where it has been planted, it has escaped cultivation, and in some areas it is considered to be invasive. Has established in high-rainfall areas where it smothers vegetation on roadsides, in urban open spaces, on forest edges and in riparian vegetation. Easily missed during surveys when not in flower, it is probably much more widespread than indicated in the distribution map.

Ipomoea nil (L.) Roth

MORNING GLORY FAMILY
Convolvulaceae

SYNONYM
Ipomoea hederacea (L.) Jacq.

COMMON NAMES

English: blue morning glory, Japanese morning glory, white-edge morning glory
Ethiopia: omok

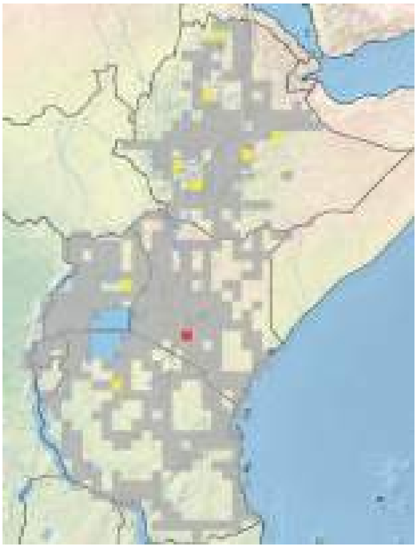
DESCRIPTION
Annual twiner covered with long, coarse hairs.

Leaves: Green, hairy, egg-shaped to almost circular (5–12 cm long and 4.5–11 cm wide), three-lobed, sometimes five-lobed, rarely entire, base heart-shaped, apex pointed, held alternately on stems; leaf stalk up to 7 cm long.

Flowers: Bluish-white with a white throat, trumpet- or funnel-shaped (3–5 cm long and 4–5 cm wide); five sepals (outer whorl of flower, often green and leaf-like in appearance) long, slender, sword-shaped (23–28 mm long) with end portion conspicuously narrow with a scattered covering of long soft hairs, bristly at the base, unlike *I. indica* where the sepals are shorter (14–22 mm long), with flattened soft hairs at the base.

Fruits: Capsules (dry fruits that open at maturity), almost round (8–12 mm across).

ORIGIN
Tropical America



REASON FOR INTRODUCTION
Ornament

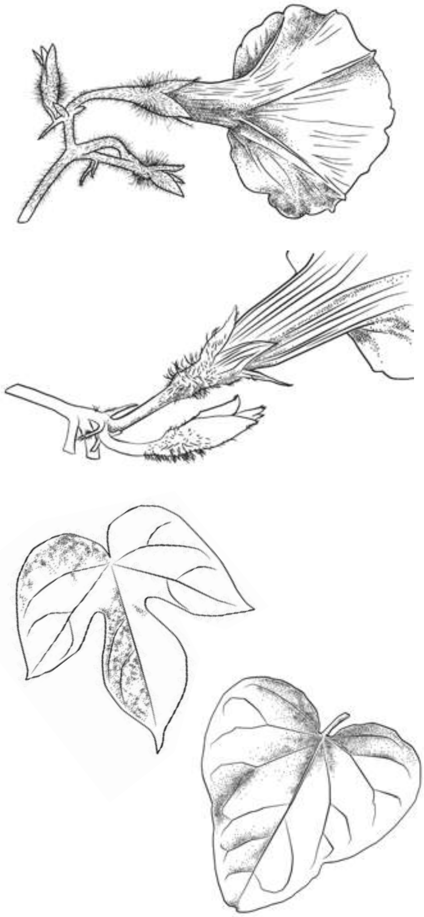
INVADES
Roadsides, disturbed land, urban open spaces, cropland and forest edges/gaps.

IMPACTS

Has escaped cultivation in some areas, smothering vegetation, to the detriment of native flora and fauna. It is considered to be invasive in in Botucatu and Jaboticabal, São Paulo, in southeastern Brazil (Maimoni-Rodella and Yanagizawa, 2007). Considered by some to have been introduced and to be invasive in the eastern United States (Wunderlin, 1982), on the edges of agricultural fields and in roadside ditches. It can be a problem in cotton growing areas, smothering plants.

Notes: *I. nil* is "established on waste ground and secondary thickets" in East Africa (Verdcourt, 1963). Supporting this view, Oyen (2013) states that it is naturalized in Kenya, Uganda and Tanzania. It also considered to be naturalized in Ethiopia (Demissew, 2006). Occasionally seen in Nairobi, Kenya, but probably more widespread and locally abundant than indicated.

Ipomoea purpurea (L.) Roth



MORNING GLORY FAMILY
Convolvulaceae

SYNONYM
Ipomoea glandulifera Ruiz & Pav.

COMMON NAMES

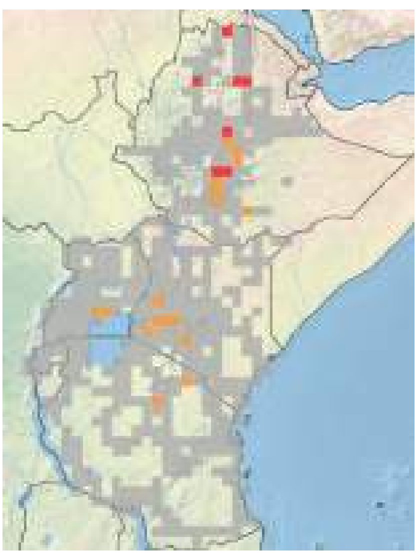
English: common morning glory, purple morning glory, tall morning glory
Ethiopia: dun

DESCRIPTION
Annual twiner with hairy stems (to 3 m long).

Leaves: Bright green, sparsely hairy, egg-shaped and flat, entire or three-lobed (4–15 cm long), heart-shaped at base with pointed tips, leaf stalks 2–18 cm long.

Flowers: Purplish-blue, reddish, magenta or white, sometimes with contrasting stripes, funnel-shaped (up to 85 mm long); five sepals (outer whorl of a flower, often green and leaf-like in appearance), pointed but not long and tapering (10–15 mm long), bristly at base, unlike *I. indica*, which has long, tapering sepals (14–22 mm long) with flattened hairs at base.

Fruits: Capsules (dry fruits that open at maturity), rounded (10 mm across).



ORIGIN
Argentina, Brazil, Colombia, Costa Rica, Ecuador, El Salvador, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru and Venezuela.

REASON FOR INTRODUCTION
Ornament

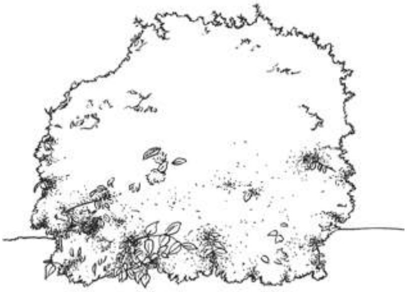
INVADES
Roadsides, disturbed areas, wasteland, urban open spaces, gardens, plantations, woodland, forest edges/ gaps, lowlands and riparian vegetation.

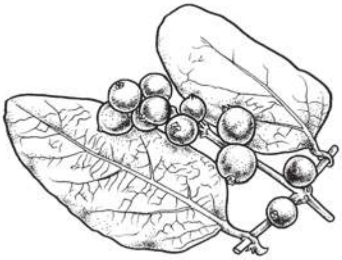
IMPACTS

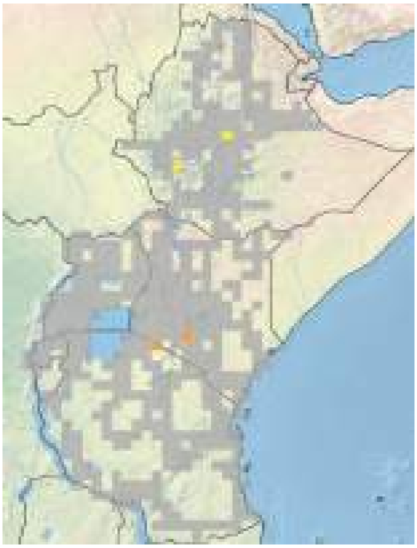
Like *I. indica*, this creeper smothers trees and shrubs, causing them to collapse, to the detriment of native plants and their associated organisms. *I. purpurea* out-competes native species for nutrients, water and sunlight (Halvorson, 2003; Oviedo Prieto *et al*., 2012). A common weed of agricultural areas, its infestations result in stunted crop growth and reduced yields, while causing difficulties during harvesting (Defelice, 2001). Its invasive nature is often reported in the social media with comments such as "this vine is a very invasive pest to get rid of, especially if you put it in a garden of perennials and eventually don't want it there any longer. You will end up doing alot of weeding for the next few years, in order to get rid of this crafty vine" or "the flowers are seductively beautiful, but self-sown seedlings are a real hazard; many are set, and seemingly every one germinates" (Daves's Garden, 2016b). Parts of this plant, including the seeds, are poisonous if ingested, so the plant is rarely used by vertebrate wildlife as a source of food. If consumed by livestock symptoms can include depression, frequent urination and muscle twitches, associated with chronic weight loss.

Notes: Established in East Africa on "waste and cultivated ground" (Verdcourt, 1963), it has also "escaped and established on waste ground" in Ethiopia (Demissew, 2006). Widely grown as an ornamental, it has often escaped and is considered to be naturalized and invasive in many urban areas on roadsides, urban open spaces, forest edges and riparian vegetation. Easily missed during surveys when not in flower, it is probably much more widespread than indicated in the distribution map.

Lonicera japonica Thunb.







HONEYSUCKLE FAMILY
Caprifoliaceae

COMMON NAMES

English: Chinese honeysuckle, Japanese honeysuckle, woodbine

DESCRIPTION
Semi-evergreen or evergreen climber or scrambling plant (to 9 m high); young stems greenish or reddish and covered with hairs; older stems thick and woody.

Leaves: Dark green and hairless above, pale and slightly downy below, oblong or egg-shaped (2.5–8 cm long and 1–4 cm wide), rounded at the base, tips pointed, margins entire, held opposite each other on stems, on leaf stalks 3–10 mm long.

Flowers: White becoming yellow, sometimes tinged with red (4–5 cm long), held in pairs on stems, fragrant.

Fruits: Berries (fleshy fruits that do not open at maturity), black, egg-shaped to round (5–10 mm long).

ORIGIN
China, Japan and Korea.

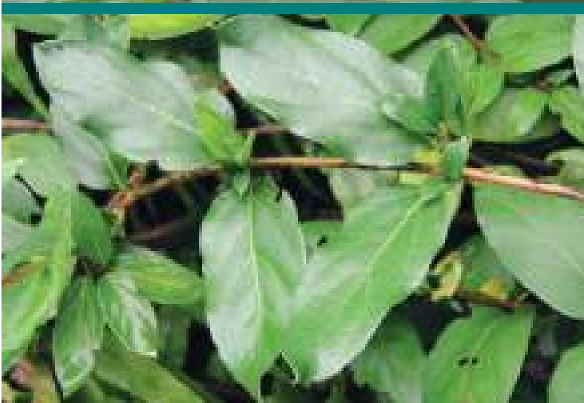
REASON FOR INTRODUCTION
Hedge/barrier and ornament.

INVADES
Disturbed areas, urban open spaces, woodlands and riparian vegetation.

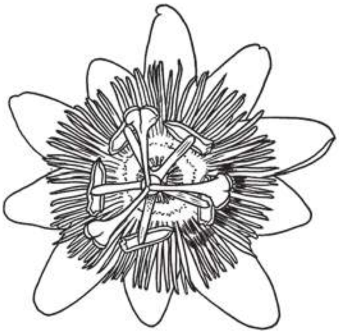
IMPACTS

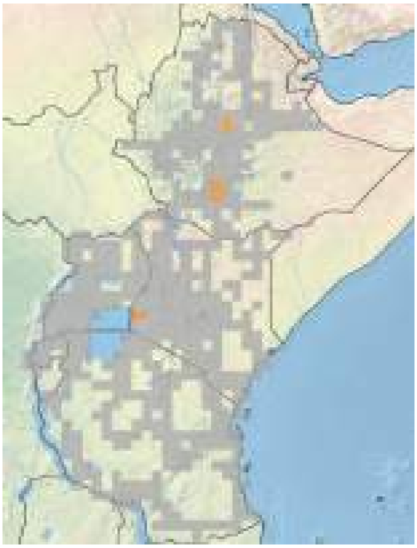
Competing with native plants for light and nutrients, *L. japonica* spreads rapidly, covering and smothering shrubs and small trees. Its stems twine around the stems and trunks of native trees and shrubs, cutting water flows and effectively 'strangling' native plants. In North America, it is especially problematic in wetland and riparian margins (Williams and Timmins, 1990, 1998). In forest ecosystems, it prevents the germination and establishment of native plant seedlings resulting in simplified forest structures of "greatly reduced floristic diversity" (GISD, 2016). It is also a serious weed in Virginia apple orchards, where it inhibits cultivation, dries soil, and provides habitats for mice (King, 1966, in CABI, 2016). In New Zealand, it grows in a wide range of habitats such as roadsides and wastelands, wetland margins, and areas with some woody cover (Williams and Timmins, 1998). In parts of New Zealand, shrublands, 4-6 m tall, may be completely covered by Japanese honeysuckle (Williams and Timmins, 1998). It is also regarded as invasive in Hawaii (Cronk and Fuller, 1995); the southern parts of Australia where it poses a very serious threat to native vegetation (Carr *et al*., 1992); and in southern Chile (Williams and Timmins, 1998). A host of other *Lonicera* species are also known to be invasive outside of eastern Africa, including *L. maackii* (Rupr.) Maxim., *L. morrowii* Gray and *L. tatarica* L. (Weber, 2003).

Notes: Cultivated as an ornamental in the regions of Eritrea West and Shewa in Ethiopia (Kelbessa, 2003), it is also widely grown as an ornamental in East Africa. Blundell (1992) found it to be invasive in Kenya, but our surveys, which found no naturalized or invasive populations, contradict this view. Additional surveys will need to be undertaken to confirm if it is indeed invasive in Kenya. Probably considerably more widespread, as an ornamental, than indicated on the distribution map.



Passiflora caerulea L.





PASSION FRUIT FAMILY
Passifloraceae

COMMON NAMES

English: blue crown passion flower, blue passion flower, passion flower
Rwanda: itunda

DESCRIPTION

Woody evergreen climber (to 25 m high, depending on height of supporting tree) with tendrils (slender, usually twisting structures on the stems or leaves that aid in 'climbing'); stems short and angular but not winged, hairless.

Leaves: Greyish or bluish-green leaves (10–18 cm long and wide) with (3–) 5 (–7) elongated lobes with sharp tips (resembling the fingers of a hand), margins entire; leaf stalks 1.5–4 cm long; base of each leaf has a twining tendril (5–10 cm long).

Flowers: White or pale pink (6–10 cm across), with white and blue corona threads (middle of flower).

Fruits: Berries (fleshy fruits that do not open at maturity), orange-yellow, oval (6 cm long and 4 cm wide), containing many seeds.

ORIGIN

Argentina, Brazil, Paraguay and Uruguay.

REASON FOR INTRODUCTION

Edible fruit, barrier/hedge and ornament.

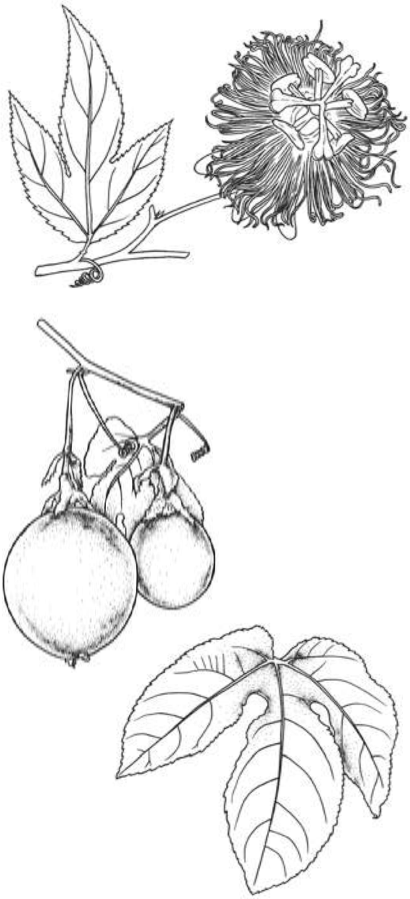
INVADES

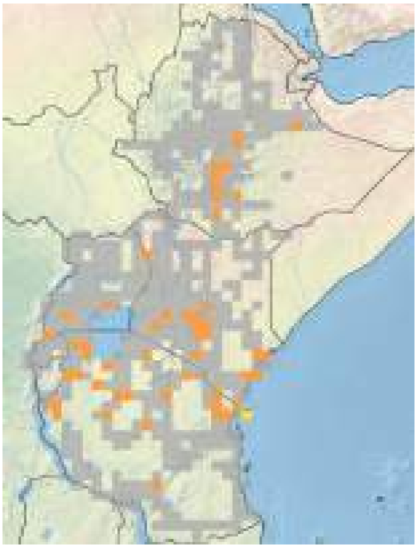
Riparian vegetation, wetlands and coastal areas.

IMPACTS

P. caerulea climbs into and over plants of other species, smothering them and preventing the emergence and survival of new native seedlings (Weedbusters New Zealand, 2014). Similar impacts have been noted in South Africa (ISSA, 2016) and in Australia (Environmental Weeds of Australia, 2016). It has invaded some wetland areas in southern California, and has established in Hawaii. It can tolerate full sun or partial shade, and as such can readily invade and establish in forest gaps and edges. It may also be toxic (ISSA, 2016).

Notes: In East Africa, several species in the genus *Passiflora* have been introduced, some as ornamentals, such as *P. caerulea* L.; *P. mixta* L.f.; and *P. mollissima* (Kunth) Bailey; others for their edible fruits, such as *P. edulis* Sims; *P. laurifolia* L., and *P. quadrangularis* L. (de Wilde, 1975). *P. quadrangularis* has "quite often escaped" in East Africa (de Wilde, 1975). *Passiflora mollissima* (Kunth) Baily, *P. edulis* Sims, and *P. caerulea* L. have also been recorded in Ethiopia, where *P. caerulea* is present in the regions of Eritea West and Shewa (de Wilde and Gilbert, 1995). *P. caerulea* has also been recorded in Kakamega Forest, Kenya (Fischer *et al*., 2010), and is occasionally naturalized on roadsides and riparian vegetation.





PASSION FRUIT FAMILY
Passifloraceae

COMMON NAMES
English: granadilla, black passion fruit, common passion fruit, purple passion fruit
Kenya: grandadilla
Rwanda: itunda
Tanzania: grandadilla, mkuluko

DESCRIPTION
Evergreen climber with tendrils (slender, usually twisting, structures on the stems or leaves that aid in 'climbing'), (to 10 cm long); stems sometimes angular (to 15 m high).

Leaves: Glossy dark-green or yellow-green above, paler and duller green below, slightly leathery (5–25 cm long and 15 cm wide), deeply three-lobed, lobes oval, elongated, apex pointed, margins finely toothed, on leaf stalks (1.5–5 cm long).

Flowers: Petals white, except for base of corona (middle of flower) which is purple, (50–75 mm across).

Fruits: Berries (fleshy fruits that do not open at maturity), greenish-yellow turning deep purple as they mature, round, hairless (5–6 cm long and 4–5 cm wide); pulp is sweet and edible.

ORIGIN
Argentina, Brazil and Paraguay.

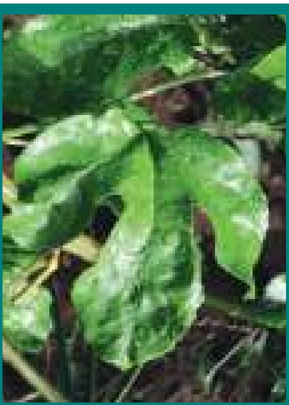
REASON FOR INTRODUCTION
Edible fruits and ornament.

INVADES
Disturbed areas, urban open spaces, gardens, forest edges/gaps and riparian vegetation.

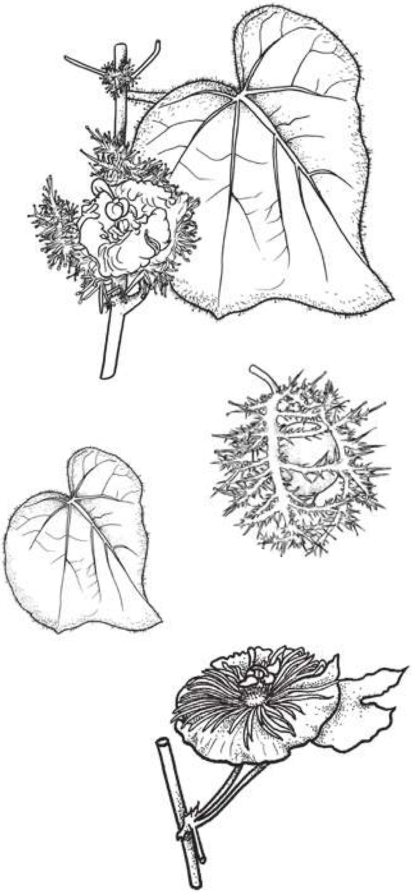
IMPACTS

Climbs into and over trees and shrubs, smothering them, to the possible detriment of biodiversity. According to Weber (2003) invaded forests are species poor. Large trees are killed by the heavy weight of the vines and dense infestations prevent seedling establishment and as a result forest regeneration. *P. edulis* is invasive in the Galápagos, Hawaii, Raoul and other tropical oceanic islands. In Zimbabwe it is "naturalized, often somewhat invasive weed along the margins of forest and scrub, often in wet or high-rainfall areas" (Flora of Zimbabwe, 2016). It naturalizes and spreads in most areas where it has been introduced.

Notes: In East Africa, it has established in "forest edges, thicket and disturbed places" (de Wilde, 1975) while in Ethiopia, it has "often escaped in disturbed places" in the regions of Shewa, Ilubabor, Kefa and Harerge (de Wilde and Gilbert, 1995). In Uganda it is widely grown in Mubende, Fort Portal, Kasese, Bushenyi, Rukungiri, Kabale, Mbale and Kapchorwa Districts, where it has "become naturalized" (Katende *et al*., 1995). Based on observations by others we consider *P. edulis* to be naturalized in the region.



Passiflora foetida L.



PASSION FLOWER FAMILY
Passifloraceae

COMMON NAMES
English: foetid passion flower, passion flower, stinking passion fruit, wild passionfruit
Rwanda: itunda

DESCRIPTION
Evergreen climber with tendrils (slender, usually twisting structures on the stems or leaves that aid in 'climbing'); stems sometimes angular (to 15 m high); tendril at the base of each leaf stalk together with a stipule (thread-like appendage) covered with sticky glands; stems have an unpleasant odour.

Leaves: Glossy dark-green above, simple, deeply three-lobed, but sometimes entire or five-lobed (3–10.5 cm long and 3–10 cm wide), margins with forward-pointing sharp projections or teeth; leaves held alternately along stems and borne on stalks (1–6 cm long).

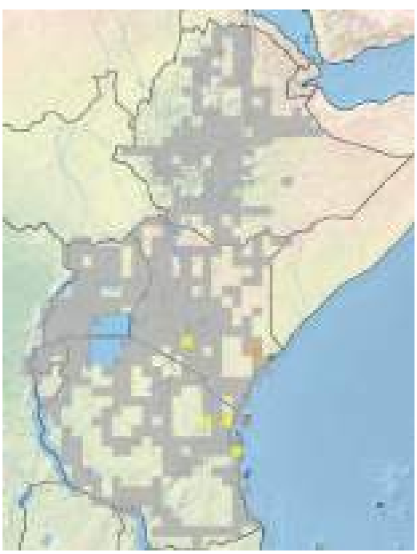
Flowers: White or purplish (3–5 cm across), borne singly on stalks (2–4.5 cm long) arising from the leaf forks.

Fruits: Berries (fleshy fruits that do not open at maturity), greenish-yellow turning yellow/orange as they mature, round, dry, large (1.5–4 cm long), hairless, partially enclosed by the sticky bracts.

ORIGIN
Argentina, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, El Salvador, French Guiana, Guatemala, Guyana, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Surinam, Uruguay, USA and Venezuela.

REASON FOR INTRODUCTION
Medicine, ground cover and ornament.

INVADES
Roadsides, disturbed areas, crops, plantations, forest edges/gaps, savannahs and riparian zones.

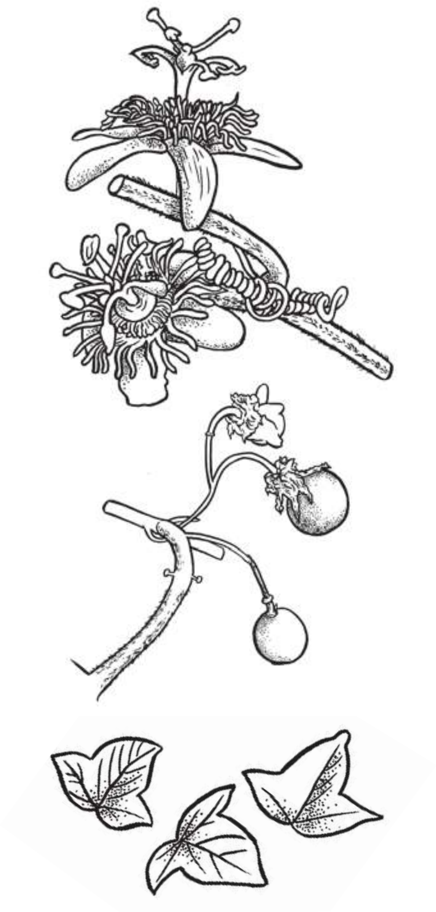


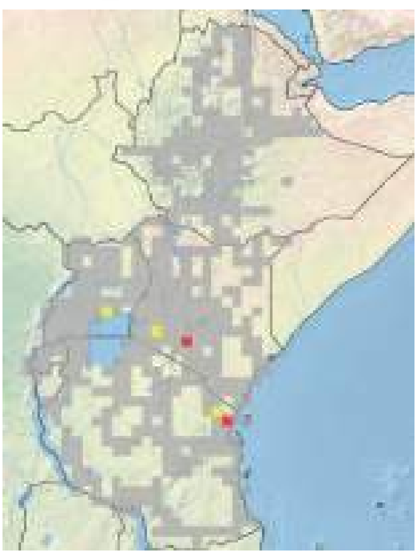
IMPACTS

In parts of Malaysia, it is a serious weed of maize and rubber. It also impacts negatively on coconut production in the Pacific; on maize, sugarcane and cotton in Thailand; on oil palm in Indonesia; on taro in Samoa; and on various other crops in Sarawak (Holm *et al*., 1997). It is an alternate host for the vectors of a number of diseases affecting cultivated passion fruit. *P. foetida* leaves contain cyanide, which if consumed by goats, mainly during the dry season, result in poisoning with symptoms such as "apathy, tachycardia, tachypnea, jugular venous pulse, incoordination, bellowing, mydriasis, and sternal recumbence followed by lateral recumbence" (Carvalho *et al*., 2011).

Notes: Has not been recorded as present in Ethiopia (de Wilde and Gilbert, 1995). In East Africa, it is "sometimes cultivated and often escaped, now common in disturbed places, on coastal sands" (De Wilde, 1975). Only occasionally seen during surveys but probably more common than indicated.

Passiflora suberosa L.





PASSION FLOWER FAMILY

Passifloraceae

COMMON NAMES

English: cork passion flower, small passion fruit, wild passionfruit
Rwanda: itunda

DESCRIPTION

Evergreen slender vine/climber or creeper with stems (to 6 m in length) that produce tendrils (slender, usually twisting structures on the stems or leaves that aid in 'climbing') in the leaf forks; young stems rounded, sometimes angular, becoming corky at the base with age.

Leaves: Dark green, simple (3–11 cm long and 4–12 cm wide), with three lobes; lobes triangular to sword-shaped and tapering to a point, margins entire; leaves held alternately on the stems, on stalks 0.5–4 cm long.

Flowers: White to pale green, small (15–25 mm wide), on stalks (1.5–2.5 cm long) arising from the leaf forks.

Fruits: Berries (fleshy fruits that do not open at maturity), green turning bluish-black or purplish-black as they mature, hairless, round (1–1.5 cm across), containing numerous wrinkled seeds (3–4 mm long).

ORIGIN

Argentina, Belize, Bolivia, Brazil, Colombia, Costa Rica, Ecuador, El Salvador, French Guiana, Guatemala, Guyana, Honduras, Mexico, Panama, Paraguay, Peru, Surinam, Uruguay, USA and Venezuela.

REASON FOR INTRODUCTION

Ground cover and ornament.

INVADES

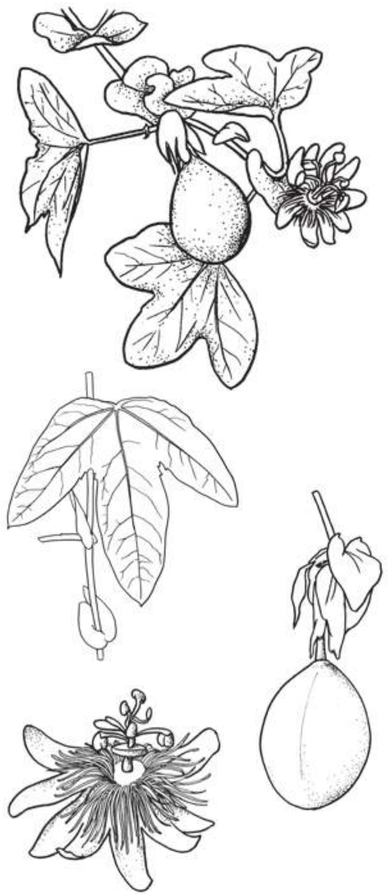
Roadsides, disturbed land, wasteland, plantations, forest edges/gaps, woodland edges/gaps, lowlands and riparian vegetation.

IMPACTS

Smothers native vegetation, reducing biodiversity. This climber, along with other invasive plant species, is threatening *Platydesma cornuta* Hillebr. var. *decurrens* B. C. Stone (Rutaceae), a rare shrub that is endemic to Oahu, and of which only about 200 individual plants remain (Richardson, 2007). It has also invaded sugarcane and *Eucalyptus* spp. plantations in Mauritius (Seeruttun *et al*., 2005). Areas covered with dead and dying native plants become a fire hazard, while also increasing the potential for erosion (Garrison *et al*., 2002). It is apparently toxic to cattle and ducks (Everist, 1974).

Notes: In East Africa, it has "escaped from gardens" and is established on "roadsides and disturbed shady places" (de Wilde, 1975), an observation supported by our surveys. It is also abundant on the edges of plantations and forests, especially in Nairobi, Kenya. Not recorded as being present in Ethiopia (de Wilde and Gilbert, 1995).

Passiflora subpeltata Ortega



PASSION FRUIT FAMILY
Passifloraceae

COMMON NAMES

English: passion flower, passion fruit, white granadilla
Rwanda: itunda

DESCRIPTION
Evergreen climber with tendrils (slender, usually twisting structures on the stems or leaves that aid in 'climbing'); stems cylindrical (to 5 m long), hairless, slightly blue-green, with a two-lobed structure (1–4 cm long) where the leaf stalks join the stem.

Leaves: Pale green above and bluish or greyish-green below (3–10 cm long and 4–11 cm wide), shallowly three-lobed, lobes oval to elongated with round or pointed tips (to 5 cm long), margins entire, leaf stalks 3–6 cm long.

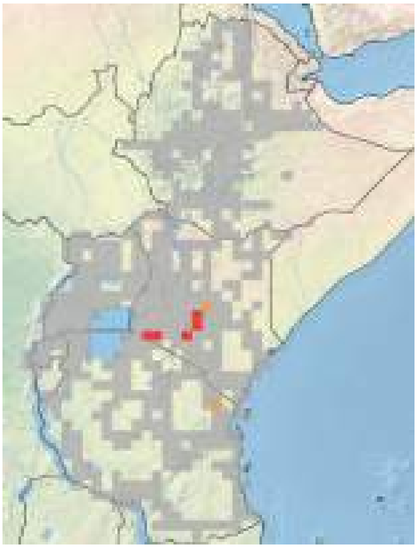
Flowers: Pure white (4–5.5 cm across), borne singly on stalks.

Fruits: Berries (fleshy fruits that do not open at maturity), pale green turning bluish-green then yellowish as they mature, egg-shaped to almost round (about 4 cm long).

ORIGIN
Colombia, Guatemala, Mexico, Panama and Venezuela.

REASON FOR INTRODUCTION
Ornament

INVADES
Roadsides, disturbed areas, urban open spaces, gardens, plantations, forest edges/gaps, woodlands and riparian vegetation.



IMPACTS

Climbs into and over vegetation, smothering native plants and reducing plant diversity. In Australia, it is regarded as an environmental weed in Queensland and New South Wales. In Hawaii, it is naturalized in dry to mesic disturbed sites (Wagner *et al*., 1999), and in Tonga it occurs in disturbed vegetation (Whistler, 1988). White passion-flower contains cyanic acid, and is thought to be poisonous to humans and livestock if eaten in sufficient quantities. The fruit is not edible.

Notes: According to de Wilde (1975), it is "freely escaped in abandoned plantations and on forest edges" in East Africa. The most widespread and abundant *Passiflora* species in the region, it is now present on roadsides, in urban open spaces and in forest gaps and edges. It is likely to be present in Ethiopia, but has not yet been recorded there (de Wilde and Gilbert, 1995).

Passiflora tarminiana Coppens & V.E. Barney

PASSION FRUIT FAMILY
Passifloraceae

COMMON NAMES

English: banana passionfruit; banana poka

DESCRIPTION
Evergreen climber (to 20 m high), hairy to very hairy.

Leaves: Upper surfaces dark green, hairless and smooth, undersides light green with fine hairs; sub-orbicular (15 cm long and 20 cm wide), three-lobed (each lobe up to 6 cm long), margins toothed.

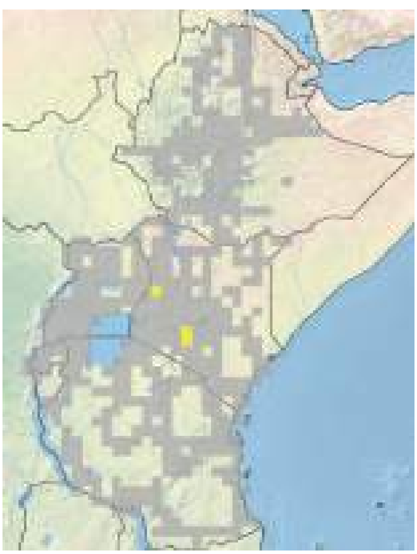
Flowers: Light pink to pinkish-white (5–10 cm in diameter), often with a white-centred stripe, 10 petals (each 3–6 cm long).

Fruits: Berries (fleshy fruits that do not open at maturity), light green turning yellowish-orange as they mature, elongated (8–15 cm long and 4 cm wide), resembling a banana fruit that contains approximately 180 small seeds (5 mm wide).

Origin
Bolivia, Colombia and Venezuela.

Reason for introduction
Ornament.

INVADES
Roadsides, wastelands and forest edges/gaps.

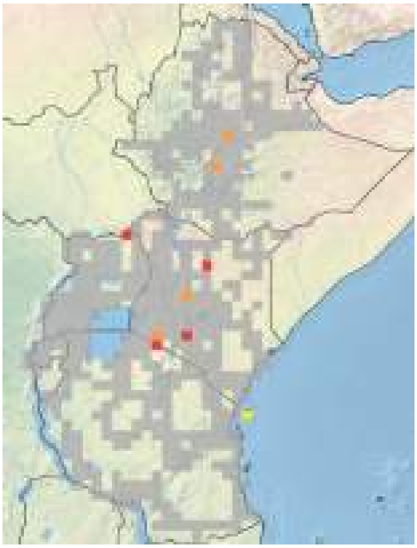


IMPACTS

Has escaped cultivation, smothering other vegetation, to the detriment of biodiversity. Native species can be shaded out, or even toppled by the weight of infestations. Forest gaps are rapidly invaded, preventing the regeneration of native species. In Hawaii, feral pigs attracted to the fallen fruit, exacerbate the problem by dispersing the seeds, and by disturbing soils and surrounding native plants with their rooting (Warshauer *et al.*, 1983). By altering the composition and structure of forests, *P. tarminiana* is further threatening already endangered forest-dwelling native birds and animals. In Hawaii, the species is regarded as one of the most agressive and destructive invaders, especially in mesic *Acacia koa–Metrosideros polymorpha* forests (Warshauer *et al.*, 1983). About 50,000 ha of forest has been invaded and seriously damaged as a result (Warshauer *et al.*, 1983; La Rosa, 1984). In Australia and New Zealand, *P. tarminiana* has had a negative impact on ecosystems services.

Notes: *P. tarminiana* is a newly described species, so older references to *P. mollissima* [now *Passiflora tripartita* var. *mollissima* (Kunth) Holm Nielsen & Jørgensen] may in fact be referring to *P. tarminiana*. Specimens from Kenya, previously described as *P. mollissima*, should now possibly be treated as *P. tarminiana*; will need to be confirmed by a study of herbarium specimens. According to de Wilde (1975), *P. mollissima* is “cultivated as an ornamental” and has “often escaped, growing on forest edges, in clearings and elsewhere”, an observation supported by Beentje (1994), who found that it “has gone wild in central and north-west Kenya, on forest edges”. It has been recorded at only one locality in Ethiopia (de Wilde and Gilbert, 1995). Rarely seen during surveys in East Africa.

Solanum seaforthianum Andrews



TOMATO FAMILY
Solanaceae

COMMON NAMES
English: Brazilian nightshade, climbing nightshade, potato creeper, vining solanum

DESCRIPTION
Slender herbaceous or softly woody climber or scrambling vine [2–3 (–5) m high]; stems green, hairless but with a few sticky hairs on the flowering branches.

Leaves: Bright green, hairless, simple (4–13 cm long and 3–11 cm wide) with 3–9 deep lobes (3.5–4.5 cm long and 1–2 cm wide), margins entire, often undulate, with rounded or pointed tips; held alternately on the stems, on stalks 0.5–6 cm long.

Flowers: Blue to purple, star-shaped (2–3 cm across), in drooping clusters of 10–50 flowers.

Fruits: Berries (fleshy fruits that do not open at maturity), shiny green turning red as they mature, round, small (8–12 mm across), in pendulous or hanging bunches, containing many brown to black seeds (2–3 mm long).

ORIGIN
Belize, Colombia, Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Trinidad and Tobago, USA and Venezuela.

REASON FOR INTRODUCTION
Ornament

INVADES
Disturbed areas, urban open space, gardens, woodlands, forest gaps/edges and riparian vegetation.

IMPACTS

Has the ability to form dense stands which may out-compete native species by crowding, or by shading them out (GISD, 2016; Environmental Weeds of Australia, 2016; PIER, 2016). In forest understoreys, a predominance of *S. seaforthianum* can prevent the germination and establishment of native plant species, reducing biodiversity and simplifying forest structure. The species is also toxic, and consumption of the fruits has resulted in cases of poisoning among chickens, as well as in children. Cattle, pigs and sheep have also been poisoned after consuming this plant in mixed fodder (Queensland Department of Primary Industries and Fisheries, 2011).

Notes: Now a "common and often naturalized escape" in Kenya, Tanzania and Uganda, *S. seaforthianum* "is found in semi-deciduous forests, ground-water forests, grasslands, farmlands, plantations and gardens" (Edmonds, 2012). According to Bukenya and Carasco (1995), it is an "introduced decorative climber, seemingly naturalized" in Uganda. Invasive in forest gaps and edges it is probably significantly more widespread than indicated.




Thunbergia grandiflora (Rottl.) Roxb.

ACANTHUS FAMILY
Acanthaceae

SYNONYM
Flemingia grandiflora Roxb. ex Rottl.; *Thunbergia adenophora* W.W. Sm

COMMON NAMES

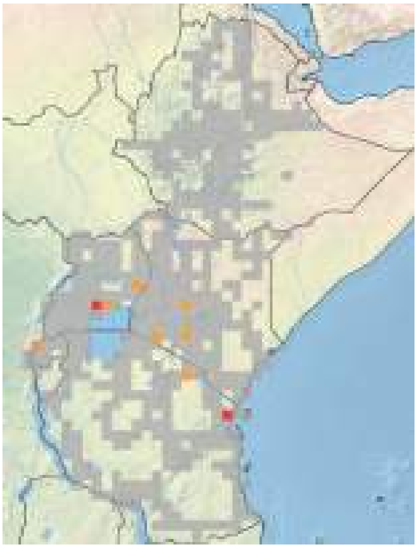
English: Bengal trumpet vine, blue thunbergia, blue trumpet vine, Indian sky flower
Kenya: umarere

DESCRIPTION
Vigorous evergreen climber with rope-like stems (to 15 m in height) with tuberous roots; young stems green, hairy, square in cross-section, becoming brown and more rounded with age.

Leaves: Dark green, somewhat hairy; simple, triangular or heart- to egg-shaped with broad end at base (8–22 cm long and 3–15 cm wide); margins entire to irregularly toothed or with irregular pointed lobes; held opposite each other on the stems.

Flowers: Pale-blue, violet or mauve with a pale yellow or whitish throat; trumpet-shaped (3–8 cm long and 6–8 cm across), in elongated clusters with each flower on a stalk (4.5 cm long).

Fruits: Capsules (dry fruits that open at maturity) with a rounded base (18 mm long and 13 mm wide) and a long tapered beak (2–5 cm long and about 7 mm wide); seeds 8–12 mm in diameter.



ORIGIN
Bhutan, China, India, Myanmar and Nepal.

REASON FOR INTRODUCTION
Ornament

INVADES
Plantations, forests, forest edges/gaps, woodlands, woodland edges/gaps and riparian vegetation.

IMPACTS

This climber smothers established plants of other species and prevents the regeneration of native species in invaded areas (Starr *et al*., 2003). It is fast growing and can smother all vegetation up to 12 m aboveground, especially along rivers (Weber, 2003). Its heavy and extensive tuberous root system, with some tubers reaching 50 cm in diameter and 3 m in length (Weber, 2003), can destabilize riverbanks, and damage fences and building foundations (Motooka *et al*., 2003). In Queensland, Australia, *T. grandiflora* is having a negative impact on threatened lowland tropical rainforests that have been fragmented by agricultural and urban development (BQ, 2016). It also 'climbs' on to power lines, causing power outages.

Notes: Has been recorded as naturalized in the Amani Nature Reserve, Tanzania (Dawson *et al*., 2008), where recent surveys have shown that it is proliferating rapidly and can now be regarded as invasive. It has not been recorded in Ethiopia (Kelbessa, 2006). The closely related species, *T. laurifolia* Lindl. [Syn.: *T. grandiflora* (Rottl.) Roxb. var *laurifolia* (Lindl.) Benoist.], which has ovate-elliptic leaves, 3–5 veined from the base, either without or with 1 or 2 basal teeth, "is widely cultivated in East Africa, occasionally becoming naturalized" (Vollesen, 2008).

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HERBS


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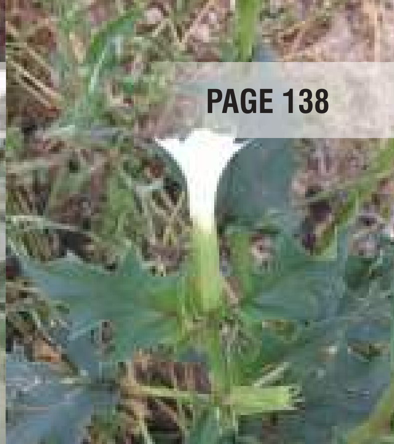
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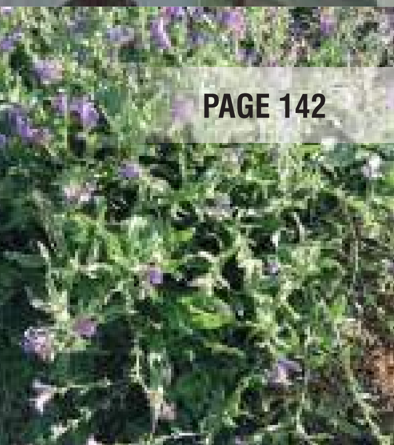
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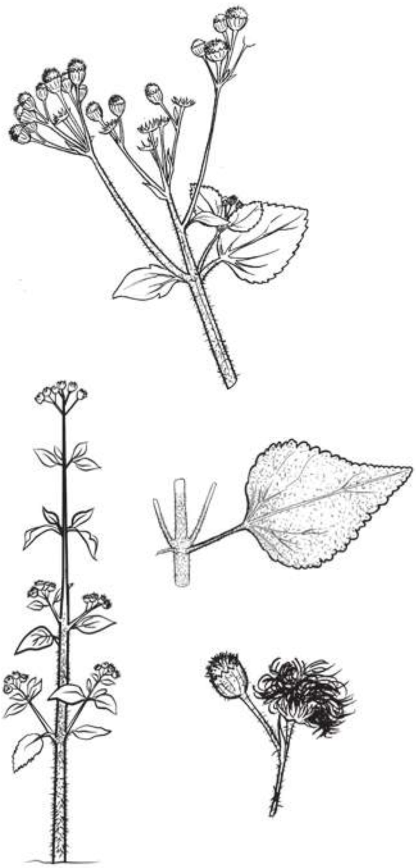
HERBS

Ageratum conyzoides L.



DAISY FAMILY
Asteraceae

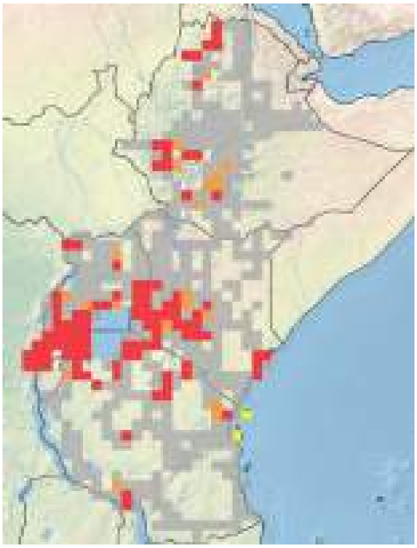
COMMON NAMES
English: goatweed, invading ageratum, Mexican ageratum
Ethiopia: adda, erema, gunyato, shawadir, tefo
Kenya: adwolo, atiraja, chelelmetiet, cheptakar, gathenge, ilusa, kimavi-cha-kuku, kundambara, mososoyiah, mutumbaku, oluoro-chieng, omonyaitira, tellok
Tanzania: beenge, bukabuka, matawana, mgeresa, mguyama, namurembe, mutumbaku, naikaranenka, ruchago, sifufumila
Uganda: adwolo, atiraja, butabuta, katabe, otikidiel, liganigani, munyaniwenkanda, mwigaa, namirembe
Rwanda: inkuruba

DESCRIPTION
Annual herb [0.3–1 (–1.5) m tall] with fluffy flowerheads and green, purplish or reddish stems covered with short white hairs on young parts and nodes; shallow fibrous roots.

Leaves: Bright green, sparsely hairy, rough with prominent veins, triangular to egg-shaped (20–100 mm long and 5–50 mm wide), margins bluntly toothed with blunt or pointed tips, held in opposite pairs on stems, hairy leaf stalks (5–75 mm); characteristic odour when crushed, likened to the smell of a male goat.

Flowers: Blue to lavender, sometimes with a white head, in compact terminal flowerheads bearing 4–18 flowers (4–5 mm across and 4–6 mm long), with slender, hardly exserted styles (as opposed to its congener *A. houstonianum*, which has longer, thicker exserted styles in heads about 6–9 mm across); slightly aromatic.

Fruits: Achenes (small, dry, one-seeded fruits that do not open at maturity), brown to black, ribbed.



ORIGIN
Central and South America and West Indies.

REASON FOR INTRODUCTION
Accidentally as a contaminant and ornament.

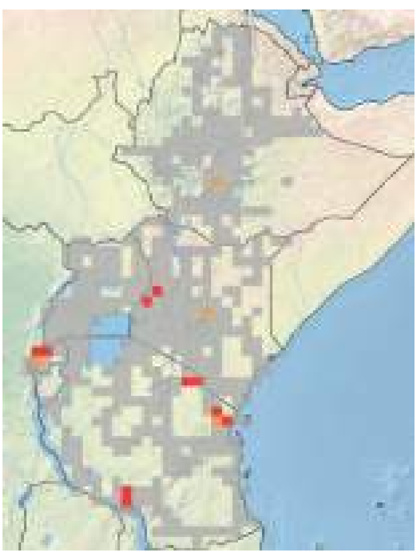
INVADES
Roadsides, railways, disturbed land, wasteland, urban open spaces, fallow land, croplands, plantations, managed pasture, drainage ditches, forest edges/gaps, grasslands, natural pasture, riparian areas, lowlands, wetlands and coastal dunes.

IMPACTS

This weed is allelopathic and so readily displaces native plant species. It excludes native grasses and medicinally important plants, reduces native plant abundance, and creates homogenous monospecific stands (Dogra *et al*., 2009). In Hawaii, it threatens the survival of native species, including *Brighamia insignis* A. Gray (Campanulaceae) (Centre for Plant Conservation, 2004, in CABI, 2016). It also reduces crop yields (Kohli *et al*., 2006), while serving as an alternate host for a number of economically destructive crop pathogens and nematodes. In cultivated lands in the lower Shivalik range of the Himalayas, infestations are so severe that farmers may have to abandon their fields (Kohli and Batish, 1996). According to Manandhar *et al*. (2007) infestations can reduce rice yields by 25% to 47%. It is a human allergenic and a health hazard (Sankaran and Suresh, 2013). In Tigray, northern Ethiopia, accidental consumption of the seeds with sorghum has been implicated in the deaths, from liver disease, of 27 people and numerous livestock (Desta *et al*., 2014).

Notes: In East Africa, it is a "weedy escape in cultivation and post-cultivation" and often a pioneer in disturbed grassland and acacia woodland habitats (Beentje *et al*., 2005), with a wide distribution (Agnew and Agnew, 1994). It is also a "weed of cultivated fields, roadsides and gardens" in the Shewa and Welega regions of Ethiopia (Tadesse, 2004). Stroud and Parker (1989) found it to be present in the Western Highlands, Southern Rift Valley, Gorge Areas, and Central Highlands of East Africa, as well as in northeastern Ethiopia. It is probably far more widespread and abundant in East Africa and Ethiopia than indicated in the distribution map. Can often be mistaken for *A. houstonianum* (see next page).

Ageratum houstonianum Mill.



DAISY FAMILY
Asteraceae

COMMON NAMES

English: goatweed, invading ageratum, Mexican ageratum
Ethiopia: gunyato, arema
Kenya: adwolo, atiraja, gathenge, ilusa, kimavi cha kuku, kundambara, mososoyiah, oluoro-chieng, omonyaitira
Tanzania: beenge, bukabuka, matawana
Uganda: adwolo, atiraja, butabuta, munyaniwenkanda, namirembe, otikidiel
Rwanda: inkuruba

DESCRIPTION
Annual herb [0.3–1 (–1.5) m tall] with fluffy flowerheads; stems green, purplish or reddish softly hairy.

Leaves: Bright green, sparsely hairy, rough with prominent veins, triangular to egg-shaped or oval (2–7 cm long and 1.5–6 cm wide), broader at the base and tapering towards the end, margins bluntly toothed with blunt or pointed tips, in opposite pairs on stalks (0.5–3 cm long); in *A. houstonianum* leaf base is heart-shaped or appears to end abruptly as if cut off squarely but this is never so in *A. conyzoides*.

Flowers: Blue to mauve, slightly aromatic, in compact terminal flowerheads (5–8 mm across), showing longer, thicker exserted styles (the elongated, slender female part of a flower connecting the ovary to the stigma).

Fruits: Achenes (small, dry, one-seeded fruits that do not open at maturity), black or brown (2 mm long).

ORIGIN
Central and South America and West Indies.

REASON FOR INTRODUCTION
Accidentally as a contaminant and ornament.

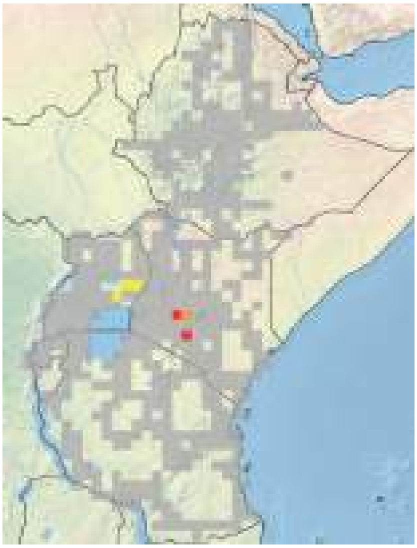
INVADES
Roadsides, railway lines, disturbed land, fallow land, cropland, plantations, gardens, drainage ditches, forest edges/gaps, woodlands, woodland edges/gaps, grasslands, wetlands and lowlands.

IMPACTS

Similar to those of *A. conyzoides*, but more pronounced in higher-lying and cooler areas in eastern Africa, where it is most abundant and widespread especially along roadsides, in the understorey of forestry plantations, croplands and urban open space. In Australia it invades natural vegetation "resulting in substantial changes in native plant communities" displacing native plants and animals (Environmental Weeds of Australia, 2016). *A. houstonianum* has invaded "relatively intact open forest vegetation within Brisbane Forest Park" and is locally abundant on coastal hind-dunes and headlands in New South Wales, including conservation areas (Environmental Weeds of Australia, 2016). In South Africa it has invaded a range of habitat types displacing other plant species. In Hawaii it is common in disturbed habitats, especially along trails and roadsides (Wagner *et al*., 1999). It is naturalized on Fiji, especially "along roadsides, on river banks, and on cleared upland slopes and crests" (Smith, 1991). In Zimbabwe it occurs on disturbed sites and along streams and rivers (Flora of Zimbabwe, 2016). Like its congener, the plant contains "an alkaloid, pyrrolizidine, which causes liver lesions and tumours if ingested by grazing animals" (Sankaran and Suresh, 2013).

Notes: Invasive in many highland areas of East Africa, where it is regarded as a "weedy escape of streambanks and moist waste ground" (Beentje *et al*., 2005). In Ethiopia, it is also present, probably as "an escape", notably in the regions of Shewa, Kefa and Harerge (Tadesse, 2004). As with *A. conyzoides*, it is probably far more abundant and widespread in East Africa and Ethiopia than indicated.

Allium neapolitanum Cirillo



ONION FAMILY
Alliaceae

SYNONYM
Nothoscordum inodorum (Aiton) G. Nicholson

COMMON NAMES

English: false onion weed, fragrant false garlic, sweet garlic, wild onion

DESCRIPTION
A long-lived or evergreen onion-like plant with upright stems [15–60 (–100) cm tall]; underground bulbs white, egg-shaped (15–25 mm long).

Leaves: Green, hairless, narrow and flattened (15–60 cm long and 4–10 mm wide), margins entire with rounded tips, papery sheaths (clasping tubular structures) at bases of leaves, clustered together in groups of 2–10 at base of plant; faint onion-like smell when damaged.

Flowers: White with pale green to pinkish or brownish central markings (1–1.5 cm long), in clusters of 8–20 at the end of the long upright stalk (40–100 cm long).

Fruits: Capsules (dry fruits that open at maturity), green turning pale brown as they mature, egg-shaped, small (5–8 mm long) with three chambers each containing 4–12 black seeds.

ORIGIN
Argentina, Brazil, Chile, Costa Rica, Guatemala, Honduras, Mexico, Panama, Paraguay, Peru and Uruguay.

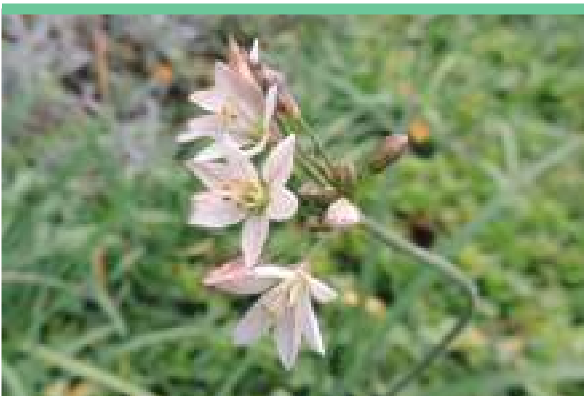
REASON FOR INTRODUCTION
Ornament and accidentally as a contaminant..

INVADES
Roadsides, disturbed areas, wastelands, urban open spaces, gardens, croplands, plantations, wetlands and riversides.

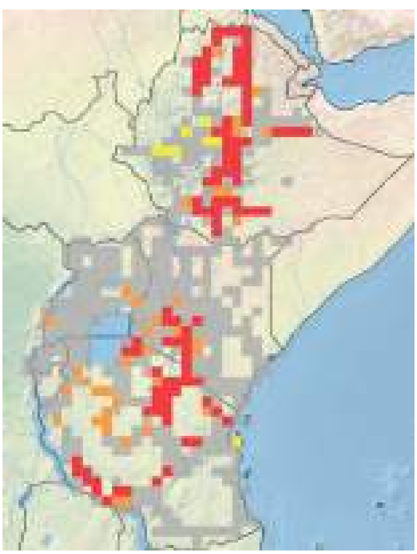
IMPACTS

Forms dense stands, to the possible detriment of native flora and fauna. In temperate regions of Australia, it is considered to be an environmental weed in coastal districts, and has been recorded in many conservation areas. Regarded as an agricultural weed in parts of the USA, it often dominates in croplands (Fragman-Sapir, 2003). When harvested with crops *A. neapolitanum* often imparts an undesirable garlic or onion flavour to contaminated food products, reducing quality and often resulting in produce being rejected for sale or export (CDFA, 2009). To avoid potential losses at market considerable effort, often at great cost, is required to remove onion weed plant parts from harvested crops. Infestations in croplands often increase pest loads as both edible and ornamental *Allium* species share the same pests and diseases such as onion fly [*Delia antiqua* (Meigen); Anthomyiidae], stem eelworm [*Ditylenchus dipsaci* Kuhn; Anguinidae], rust (*Puccinia allii* DC.; Pucciniaceae) and onion white rot (Page and Olds, 1998).

Notes: Widespread throughout East Africa, especially along roadsides, in disturbed areas and in urban open spaces and gardens. According to Smith and Stansbie (2003), it "has become weedy in East Africa through being able, from around the bases of parent bulbs, to produce many loosely attached bulbils, making it difficult to control." It has spread "from nurseries, gardens and parks, along roads, often near houses" (Smith and Stansbie, 2003). "Once spread, they are almost impossible to eradicate" (KHS, 1995). Not actively recorded so probably far more widespread throughout the region than indicated on the distribution map.



Argemone mexicana L.



POPPY FAMILY
Papaveraceae

COMMON NAMES

English: Mexican poppy, Mexican thistle, prickly poppy
Ethiopia: dandaro, hadalafa, kosheshila, lebash, medafee, nech lebasse, shoqat, yeahya suf
Kenya: mbaruti
Tanzania: mkumajalaga
Rwanda: mtiwa
Uganda: ekijembajembe

DESCRIPTION
Annual, very spiny herb (to 0.9 m high); stems exude a yellow sap when damaged.

Leaves: Bluish-green with prominent white veins and a yellow mid-vein (5–22 cm long and 3–7 cm wide), 7–12 deep lobes, margins spiny/prickly; leaves of *A. ochroleuca* are a lighter or greyer shade of green.

Flowers: Bright yellow (2.5–5 cm across), as opposed to pale yellow or creamy white in *A. ochroleuca*.

Fruits: Capsules (dry fruits that open at maturity), spiny, green turning brown as they mature, egg-shaped (2.5–4 cm long), splitting into (3–) 5 (–6) lobes, releasing small black seeds (1.5 mm across).

ORIGIN
Belize, Bolivia, Brazil, Colombia, Costa Rica, Ecuador, El Salvador, Florida (USA), Guatemala, Guyana, Honduras, Mexico, Nicaragua, Panama, Paraguay, Uruguay, Venezuela and the Caribbean.

REASON FOR INTRODUCTION
Accidentally as a contaminant.

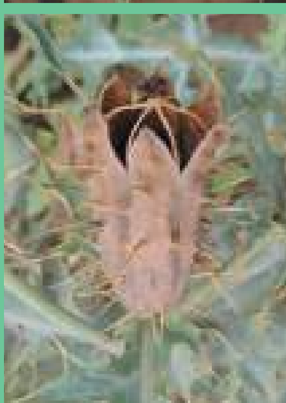
INVADES
Roadsides, railway lines, disturbed land, wasteland, urban open spaces, fallow land, cropland, managed pasture, riparian areas, gullies and dry river courses.

IMPACTS

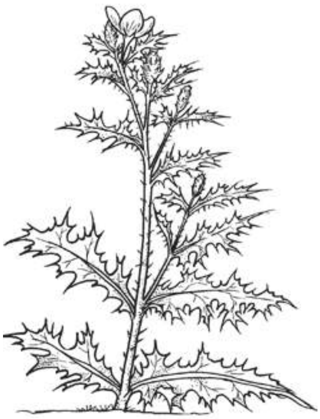
Reduces plant diversity and has an inhibitory effect on germination and seedling growth in vegetables (Hazarika and Sannigrahi, 2001). Weed residues may also affect the growth and development of bambara groundnut and sorghum (Karikari *et al*., 2000). Ingestion of seeds by poultry can result in death. Grazing animals can be poisoned if they consume the weed in hay or chaff. Harvesting of crops infested with this weed can also result in injuries. Edible vegetable oil either accidentally contaminated with *A. mexicana* or intentionally adulterated by unscrupulous traders has resulted in epidemic dropsy in India. An epidemic also occurred in South Africa following the contamination of wheat flour (Sharma *et al*., 1999). *A. mexicana* has been identified as a serious allergen in India (Singh and Kumar, 2004).

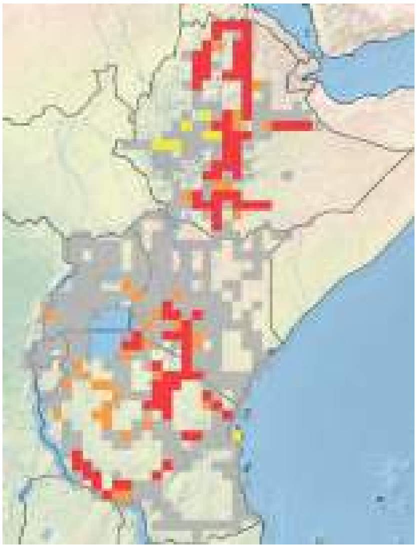
Notes: According to Lucas (1962), it grows on "wasteland, roadsides and abandoned cultivated ground" in East Africa. Widespread throughout Ethiopia, it is considered to be an "opportunistic plant, often growing in almost pure stands" (Demissew, 2000) in the Central Highlands, Northeast, Northern Highlands, Southern Rift Valley and Arsi/Bale Highlands (Stroud and Parker, 1989). It is difficult, during roadside surveys, to differentiate between *A. mexicana* and *A. ochroleuca*, so their distributions are grouped together. Both species are common on roadsides, disturbed areas, cropland and overgrazed pasture and are probably significantly more widespread and abundant in East Africa and Ethiopia than indicated in the distribution map.




Argemone ochroleuca Sweet





POPPY FAMILY
Papaveraceae

COMMON NAMES

English: Mexican poppy, prickly poppy, Mexican thistle, yellow poppy
Ethiopia: dandaro, hadalafa, kosheshila, lebash, medafee, nech lebasse, shoqat, yeahya suf
Kenya: mbaruti
Tanzania: mkumajalaga
Rwanda: mtiwa
Uganda: ekijembajembe

DESCRIPTION
Annual, very spiny or prickly herb (30–100 cm tall); stems covered with stiff yellowish prickles which exude a yellow sap when damaged.

Leaves: Grey-green with prominent white veins and a yellow mid-vein (7–15 cm long and 2–6 cm wide), 7–12 lobes, margins spiny/prickly; leaves of *A. mexicana* are a darker shade of green.

Flowers: Pale yellow or creamy white (3–7 cm across), as opposed to bright yellow in *A. mexicana*.

Fruits: Capsules (dry fruits that open at maturity), initially green turning brown as they mature, spiny, elongated with almost parallel sides (25–45 mm long and 12–18 mm wide), splitting into 5 lobes or compartments, releasing small black seeds.

ORIGIN
Mexico and West Indies.

REASON FOR INTRODUCTION
Accidentally as a contaminant..

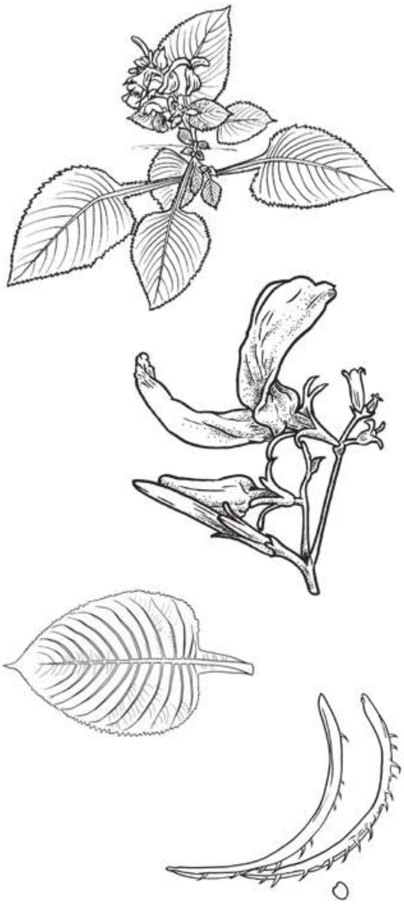
INVADES
Roadsides, railway lines, wasteland, disturbed land, urban open spaces, fallow land, cropland, managed pasture, savannah and dry river courses.

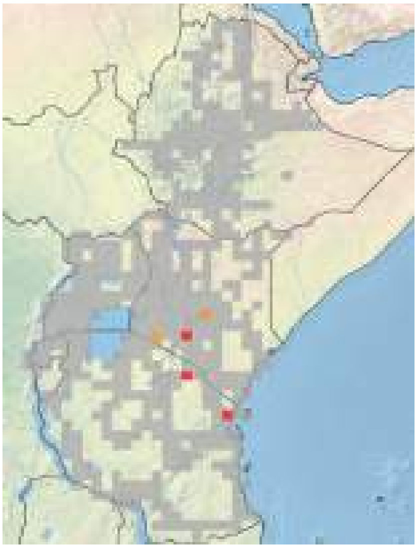
IMPACTS

Forms large and dense infestations, especially in disturbed areas, where it crowds out other species. It alters the structure, not only of native plant communities, but also of their associated fauna (Moussa and Muneera, 2012). In Australia, it is found in seasonal creeks, stream beds, drainage lines and disturbed areas, where it competes with native species and restricts the movement of animals, often causing injury (Smith, 2002; Weber, 2003). It is a major weed of crop fields (Holm *et al*., 1977), reducing yields of cereals such as wheat (Rawson and Bath, 1981). However, in Australia, both *A. ochroleuca* and *A. mexicana* are not considered to be particularly aggressive competitors of crops or established pastures, persisting only until the crop, or perennial species, become established, then gradually disappearing (Parsons and Cuthbertson, 1992). Similar to its congener, *A. mexicana*, it is also highly toxic to humans and has contributed to many deaths, especially when consumed in contaminated mustard oil (Babu *et al*., 2007). The plant is unpalatable and as such rarely consumed by livestock, but plant material, including seeds, mixed with hay or grain may poison animals if consumed (Holm *et al*., 1977). Other impacts are assumed to be similar as those recorded for *A. mexicana*.

Notes: It is difficult, during roadside surveys, to differentiate between *A. mexicana* and *A. ochroleuca*, so their distributions are grouped together. Both species are invasive and probably considerably more abundant and widespread than indicated on the distribution map.

Brillantaisia lamium (Nees) Benth.





ACANTHUS FAMILY
Acanthaceae

SYNONYM
Brillantaisia eminii Lindau

COMMON NAMES

English: brillantaisia, tropical giant salvia

DESCRIPTION
Erect shrubby herb [0.5–1.5 (–2 m) high]; stems hairy, green or purplish, four-angled (square), branched.

Leaves: Dark green, long soft hairs on both surfaces, heart-shaped [(6–) 10–17 cm long and (3.5–) 5–10.5 cm wide]; margins entire or with fine forward-pointing teeth.

Flowers: Purple or violet (20–30 mm long), in clusters at the tips of the stems.

Fruits: Capsules (dry fruits that open at maturity), green turning brown as they mature, cylindrical or cigar-shaped (25–45 mm long), with about 20 seeds (1.5–2 mm long) in each half.

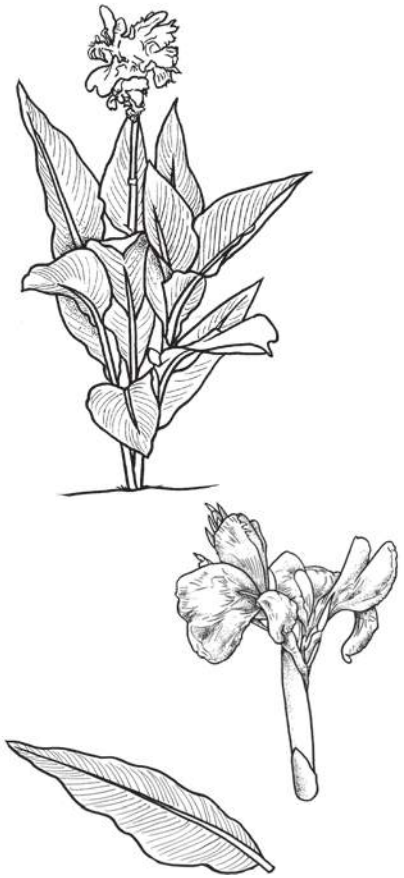
ORIGIN
West and Central Africa including Uganda.

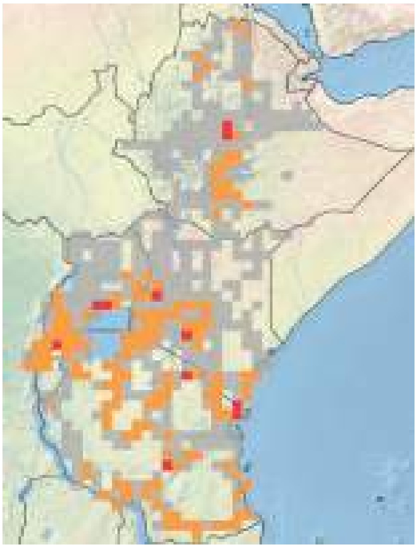
REASON FOR INTRODUCTION
Ornament.

INVADES
Road culverts, disturbed land, urban open spaces, water courses, swamps and wetlands.

IMPACTS
Native to West Africa and extending its range into northwest Tanzania, parts of Uganda and southwest Ethiopia, this species has been introduced to Kenya, where it rapidly colonizes lowlands, from seeds and stem fragments, forming large monospecific stands, to the detriment of native species. In Australia, it has negative impacts in riparian and other habitats in coastal areas, where it out-competes the native vegetation and deprives wildlife of food sources and shelter (Environmental Weeds of Australia, 2016). It is also considered to be problematic in orchards, nurseries, and along drainage ditches around sugarcane plantations in Australia (Australian Weeds Committee, 2015). Even in West Africa, where it is native, it can form a dense understorey within plantation crops such as oil palms, cocoa, coffee and bananas, impacting on yields.

Notes: In Ethiopia, it has been found in the Welega Region alongside a forest stream (Kelbessa, 2006). Most plants in Kenya have "escaped" and have "become naturalized from original garden plantings of Uganda material" (Vollesen, 2008). The species is regarded as being "quite common in swamps around Nairobi" (Vollesen, 2008) and on "marshy stream banks" (Agnew and Agnew, 1994). These observations were corroborated by surveys, which found similar infestations elsewhere in the region.





CANNA FAMILY
Cannaceae

COMMON NAMES

English: canna, canna lily, common garden canna, Indian shot
Rwanda: ikana
Tanzania: mitasbihi, mtasbihi, sitabihi

DESCRIPTION
Robust, evergreen herb (1–2 m high) with a thick, branching, underground rhizome (horizontal root-like stem).

Leaves: Purple-bronze, blue-grey, blue-green, striped or green, hairless, simple, elongated or oval (20–60 cm long and 10–30 cm wide), tapering to a point, margins entire; leaf stalks slender, forming a sheath (tubular structure that clasps the stem); similar to *C. indica* L., which has green leaves.

Flowers: Yellow, red, orange, white, or in other colours, five false 'petals', broad (15–55 mm wide), arranged in larger, branched clusters of 6–20 flowers at the ends of flowering stems.

Fruits: Capsules (dry fruits that open at maturity), green turning brown as they mature, spiny, three-valved, containing hard black seeds (0.5 cm wide).

ORIGIN
Ornamental cultivar with origins in Argentina, Belize, Brazil, Colombia, Costa Rica, Ecuador, El Salvador, French Guiana, Guatemala, Guyana, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Surinam, Uruguay, Venezuela and the Caribbean.

REASON FOR INTRODUCTION
Ornament.

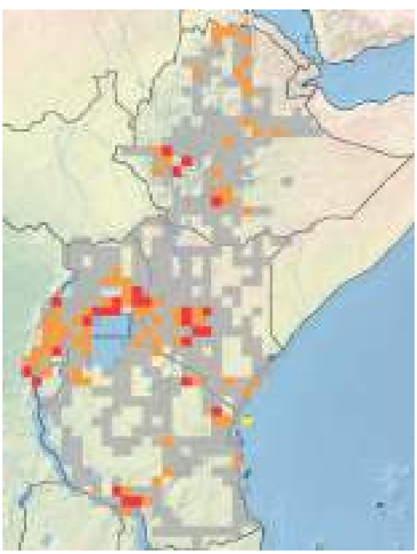
INVADES
Disturbed areas, urban open spaces, gardens, drainage ditches, irrigation channels, dam edges, forest edges/gaps, lowlands, wetlands and watercourses.

IMPACTS

Like *C. indica*, this *Canna* hybrid has the ability to form dense stands in moist lowland areas, displacing native plant species and the organisms associated with them. Other impacts are assumed to be similar to those recorded for *C. indica*.

Notes: Commonly grown as an ornamental in Ethiopia, it has "sometimes escaped on roadsides" in the regions of Shewa, Kefa and Sidamo (Lye, 1997). Also widely grown in East Africa, it is an occasional escape in low-lying areas especially along streams, rivers and swamps in urban areas.

Canna indica L.



CANNA FAMILY

Cannaceae

COMMON NAMES

English: African arrowroot, canna lily, edible canna, Indian shot, purple arrowroot
Ethiopia: siet akuri
Rwanda: ikana
Tanzania: mtasbihi, mitasbihi, sitabihi
Uganda: malaanga

DESCRIPTION

Robust evergreen herb (1–2 m high) with a thick, branching, underground rhizome; leaves taper into slender leaf stalks that form a sheath (clasping tubular structure) around the main stem.

Leaves: Green, hairless, simple, elongated or oval (20–60 cm long and 10–30 cm wide), tapering to a point, margins entire, stem-clasping sheath similar to *C.* × *generalis* Bailey, which has purple-bronze, blue-grey, blue-green, striped or green leaves.

Flowers: Red or orange, usually yellow below, five false 'petals', narrow (40–50 mm long), held singly or in pairs, arranged in larger branched clusters of 6–20 flowers at the ends of flowering stems; in *Canna* × *generalis*, flowers are yellow, red, orange, white or in other colours, broad (80–90 mm wide).

Fruits: Capsules (dry fruits that open at maturity), green turning brown as they mature, spiny, three-valved, containing hard black seeds (0.5 cm wide).

ORIGIN

Argentina, Belize, Brazil, Colombia, Costa Rica, Ecuador, El Salvador, French Guiana, Guatemala, Guyana, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Surinam, Uruguay, Venezuela and the Caribbean.

REASON FOR INTRODUCTION

Ornament.

INVADES

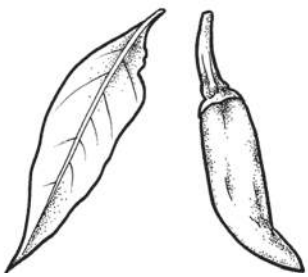
Disturbed areas, urban open spaces, gardens, plantations, drainage ditches, irrigation channels, forest edges/gaps, dam/lake/river edges, ponds, lowlands, floodplains, swamps and wetlands.

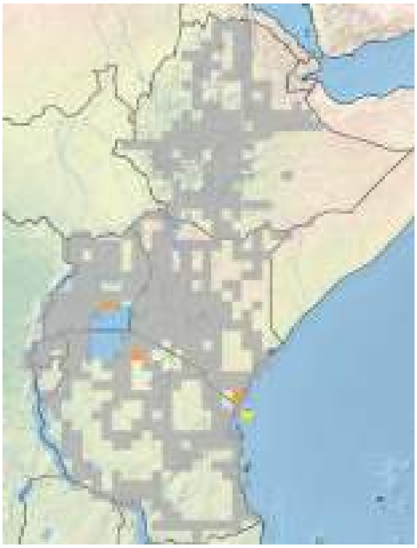
IMPACTS

Forms dense clumps, out-competing native plant species. It also restricts the flow of water, contributing to increased sedimentation and flooding. Dense stands can also restrict access to water. In Hawaii, USA, it has become naturalized mainly in disturbed mesic to wet forest, and in Fiji it is naturalized in coconut plantations, in clearings, and near streams in forests (Smith, 1979). In Australia it is considered to be an environmental weed forming “large dense clumps, particularly along waterways” where it “replaces native aquatic and wetland species” (BCC, 2016). According to Binggeli (1997), it is one of the main invasive species on Pitcairn Island where it forms large monotypic stands. It is an alternative host of a number of crop pests, including banana bunchy top virus, cucumber mosaic virus and tomato spotted wilt virus, and a range of other pests that cause pathogenic diseases. Chemical extracts have a negative impact on snail species (Tripathi and Singh, 2000).

Notes: “Widely naturalized” throughout East Africa (Lock, 1993), it is also grown in gardens in Ethiopia, where it is “found as an escape on roadsides” in the regions of Shewa, Ilubabor and Kefa (Lye, 1997). It is especially abundant along roadsides in drainage channels, in urban open spaces, and along streams, rivers and dams in towns and villages throughout East Africa, especially in Nairobi. Also widespread and abundant along the edges of water bodies throughout Uganda.

Capsicum annuum L.





TOMATO FAMILY
Solanaceae

SYNONYM
Capsicum frutescens L.

COMMON NAMES

English: chilli pepper, bell pepper, paprika, cayenne, halapenos, chitlepin, Christmas pepper
Ethiopia: berberie
Rwanda: urusenda
Tanzania: pipii, pilipili
Uganda: kamulali

DESCRIPTION
Evergreen herb (to 1 m tall), stem erect, soft-wooded, densely branched.

Leaves: Green, hairless, simple, egg-shaped (12 cm long and 5 cm wide), margins entire, leaf stalk 1–4 cm long.

Flowers: White or yellow, inconspicuous, generally solitary.

Fruits: Berries (fleshy fruits that do not open at maturity), green, yellow or red when ripe, rounded or ovoid to oblong-conical (12–25 mm long and 5–10 mm wide); seeds yellow (3–4 mm long).

ORIGIN
Bolivia and Brazil.

REASON FOR INTRODUCTION
Food, flavouring and ornament.

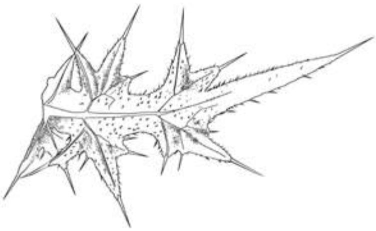
INVADES
Disturbed areas, forest edges/gaps and woodlands.

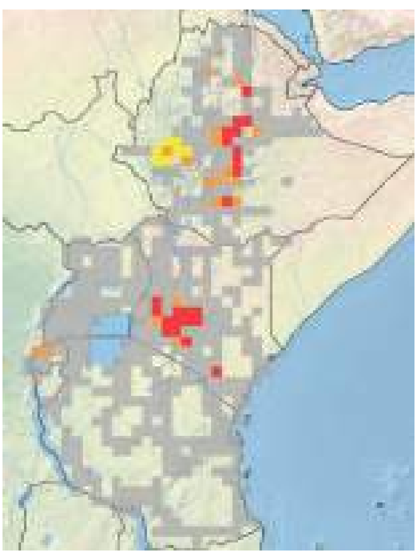
IMPACTS

It has escaped cultivation and has established populations in the wild, with potential negative impacts on native plant species. In Australia, it is found on forest edges and in regenerating forest. *C. annuum* is also allelopathic. In wheat (*Triticum aestivum* L., Poaceae), aqueous extracts of red pepper significantly reduce root, shoot and seedling growth and seedling dry weight (Iqbal *et al*., 2015). In Hawaii, *C. frutescens*, which some consider to be a separate species, or a synonym of *C. annuum* (see below), is "naturalized in dry to mesic, disturbed areas" (Wagner *et al*., 1999). Has also escaped cultivation in Fiji and is now "naturalized in coconut plantations, cultivated fields, and clearings, and along rocky coasts, and on open hillsides" (Smith, 1991). Also considered to be invasive on a large number of other Pacific Islands, including Galápagos (PIER, 2011).

Notes: It should be noted that *C. annuum* can be difficult to separate from the cultivated *C. chinense* and *C. frutescens*; their morphological features often overlap. They share the same ancestral gene pool and are sometimes called the 'annuum-chinense-frutescens complex'. *C. annuum* is widely cultivated in eastern Africa and considered to be an "escape" in Uganda, Kenya and Tanzania (Edmonds, 2012). Naturalized populations of *C. annuum* were found during surveys in the region. Luke (2005) found *C. frutescens*, which is considered to be a synonym of *C. annuum* by some, to be naturalized in the Shimba Hills, Kenya. Probably more widespread than indicated.

Cirsium vulgare (Savi) Ten.





DAISY FAMILY
Asteraceae

SYNONYM
Cirsium dubium Lojac.; *Cirsium lanceolatum* (L.) Scop.

COMMON NAMES

English: black thistle, boar thistle, common thistle, green thistle, spear thistle

DESCRIPTION
Spiny herbaceous plant living for more than one year but for less than two, forming a large, flat rosette of leaves with much-branched stems (30–300 cm high), stems have spiny wings; deep tap-root.

Leaves: Dark green above with stiff hairs, white and woolly beneath; oval to somewhat elongated (4–30 cm long), deeply lobed, lobes ending in sharp spines; young leaves entire, stalkless.

Flowers: Pink to mauve, in heads (to 5 cm long and 5 cm wide) surrounded by spiny bracts (small leaf-like structures underlying or directly beneath the flowers).

Fruits: Achenes (small, dry, one-seeded fruits that do not open at maturity), 20 mm long, tufted with silky hairs.

ORIGIN
Afghanistan, Albania, Algeria, Armenia, Austria, the former Czechoslovakia, Azerbaijan, Belarus, Bulgaria, China, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Iran, Iraq, Ireland, Italy, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Moldova, Morocco, Netherlands, Norway, Pakistan, Poland, Portugal, Romania, western Russia, Spain, Sweden, Switzerland, Tunisia, Turkey, Turkmenistan, Ukraine, the former Yugoslavia, and the UK.

REASON FOR INTRODUCTION
Bee forage and accidentally as a contaminant.

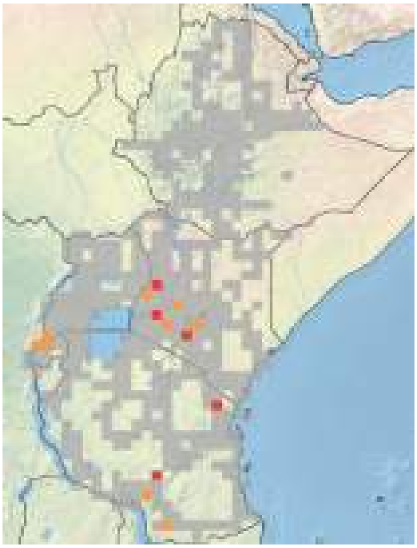
INVADES
Roadsides, disturbed land, wasteland, fallow land, managed pasture, drainage ditches, woodland, woodland gaps/edges, grasslands, savannah, lowlands and gullies.

IMPACTS

Can form dense stands which displace native plant species, reducing biodiversity. *C. vulgare* can also inhibit the growth of other plants (Holm *et al*., 1997). It has been found to reduce growth rates of seedlings of the ponderosa pine, *Pinus ponderosa* Douglas ex C. Lawson (Pinaceae) (Randall and Rejmánek, 1993), and to reduce fruit yields in orange groves in California, USA (Jordan, 1981). It reduces available forage in pastures, inhibits livestock movement, reduces wool quality and causes injury to animals (Auld *et al*., 1978; Forcella and Wood, 1986), and has little nutritional value for livestock (Holm *et al*., 1997). In Australia, the thistle has caused losses to the wool industry amounting to an estimated US$ 15 million a year (Davidson, 1990). In New Zealand, a negative correlation has been found between live-weight gain in sheep and densities of *C. vulgare* (Hartley, 1983). The species is also an alternative host for the cucumber mosaic virus (Fletcher, 1989), the tobacco etch virus (Weinbaum and Milbrath, 1976), and the tomato spotted wilt virus (Bitterlich and MacDonald, 1993). Its spiny leaves and bracts are responsible for transmitting viral diseases, including myxomatosis and scabby mouth, among animals (Parsons and Cuthbertson, 1992). Contact with the plant can cause physical injury and/or contact dermatitis (Dawe *et al*., 1996).

Notes: Present in most regions in Ethiopia (Tadesse, 2004), where it is a "cereal crop weed", it is also present in "disturbed grassland on lakeshores" in East Africa (Beentje, 2000). A widespread roadside weed in East Africa and Ethiopia, it can become abundant in disturbed areas such as fallow lands and overgrazed pasture.

Dahlia imperialis Roezl ex Ortgies



DAISY FAMILY
Asteraceae

COMMON NAMES
English: bell tree dahlia, candelabra dahlia, giant dahlia, imperial dahlia, tree dahlia
Rwanda: daliya
Uganda: daliya

DESCRIPTION
Evergreen fast-growing herb (2–6 m tall); stems erect, 4-angled, brittle and woody (8 cm wide), usually branched from the base with swollen nodes and with underground tubers (a swollen underground stem that functions as a food storage organ or as a means of vegetative production).

Leaves: Bright green, veins on upper surfaces covered with short fine hairs, with a scattering of long, soft hairs below, large, twice-divided (35 cm long); leaflets are egg-shaped with broader, rounded bases tapering towards the end, margins with forward-pointing sharp projections or teeth, leaves held opposite each other on the stems.

Flowers: Pink or purple with a yellow core, large (75–150 mm wide), pendulous, solitary or paired in the axils of the upper leaves, showy.

Fruits: Achenes (small, dry, one-seeded fruits that do not open at maturity) (13–17 mm long).

ORIGIN
Mexico and possibly Colombia and Guatemala and elsewhere in Central and South America.

REASON FOR INTRODUCTION
Ornament.

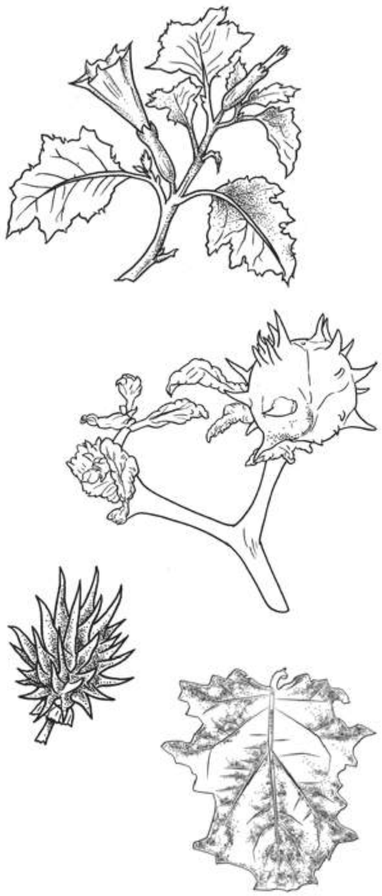
INVADES
Roadsides, disturbed areas, wastelands, urban open spaces, gardens, plantations and forest gaps/edges.

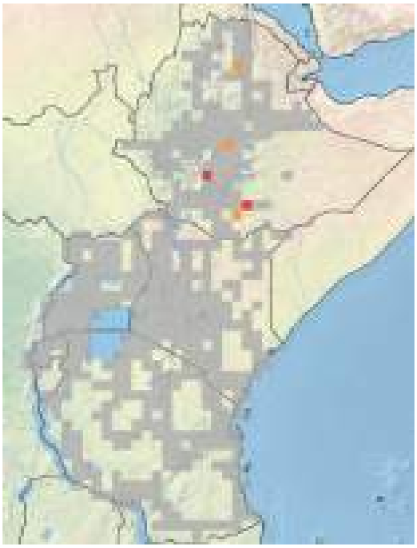
IMPACTS

Forms dense stands which may displace native fauna and flora. Parts of the plant are considered to be toxic.

Notes: According to Tadesse (2004), it is not present in Ethiopia. On record as being present more than 10 years ago in the Iringa Region of Tanzania (Beentje *et al*., 2005), it is now reported to be extremely invasive in pine and gum plantations there. It has also been found to be locally abundant at a number of localities in Kenya.

Datura ferox L.





TOMATO FAMILY
Solanaceae

COMMON NAMES
English: angel's trumpet, Chinese thorn apple, fierce thorn apple, large thorn apple, long-spine thorn apple
Tanzania: msiafu

DESCRIPTION
Erect annual herb or sub-shrub (to 1.5 m high), stems sparsely hairy to hairless, branches repeatedly forked, green or purplish near base.

Leaves: Dark green above and paler below, veins conspicuous; egg-shaped (8–14 cm long and 6–16 cm wide), margins coarsely or irregularly toothed or deeply wavy; long leaf stalks; unpleasant odour when crushed.

Flowers: White, solitary, narrowly funnel-shaped (to 65 mm long).

Fruits: Capsules (dry fruits that open at maturity), green turning brown as they mature, hardened, egg-shaped (2–4 cm long and 2–3 cm wide), covered with 40–60 stout, spreading spines [10–15 (–30) mm long]; held erect on the plant.

ORIGIN
Mexico and USA and possibly also elsewhere in Central and South America.

REASON FOR INTRODUCTION
Accidentally as a contaminant.

INVADES
Roadsides, disturbed land, wasteland, fallow lands, riverbanks and dry riverbeds.

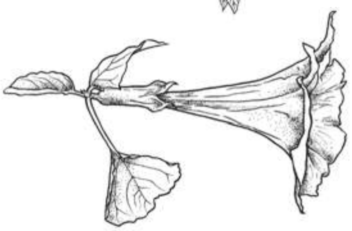
IMPACTS

A single plant can produce up to 30,000 long-lived seeds, resulting in the establishment of dense stands, which displace native plants and crops, with impacts similar to those as recorded for other *Datura* spp. Economic damage caused by *D. ferox* includes crop yield losses due to weed infestations, and livestock poisoning. Although the plant is generally not consumed, because of its bitter taste, problems may occur if it is accidentally consumed in contaminated hay or in meal fed to poultry, because the seeds are difficult to separate from seeds of grain sorghum due to their similarity in size, shape and density (Parsons and Cuthbertson, 2001). Meal containing 1% of thorn apple seed is the upper limit which can be tolerated by young chickens (Parsons and Cuthbertson, 2001). *D. ferox* intoxication has been reported in cattle, pigs, dogs, sheep, goats, poultry and horses (Binev *et al*., 2006), and mortality in pigs and poultry has been recorded in Argentina (Gallo, 1987). In South Africa, contamination of grain with *D. ferox* seed has been responsible for fatal intoxication in horses (Schulman and Bolton, 1998). Signs and symptoms of poisoning include excessive thirst, depressed breathing, convulsions, paralysis, coma, and death.

Notes: Considered to be an escape from cultivation in Kenya, Tanzania, and Uganda (Edmonds, 2012), it was not seen during our surveys in East Africa. There are no herbarium records indicating its presence in Ethiopia (Friis, 2006), even though it was collected in the Afar region of Ethiopia in 2014. Invasive and probably more widespread than indicated in the distribution map.

©Kay Montgomery

Datura innoxia Mill.



TOMATO FAMILY
Solanaceae

SYNONYM
Datura meteloides DC. ex Dunal

COMMON NAMES
English: downy thorn apple, Indian-apple, moonflower, pricklyburr, recurved thorn-apple
Ethiopia: astenager, qabooc, qamadaari
Tanzania: msiafu

DESCRIPTION
Annual trailing or bushy herb (to 2 m high), softly grey-velvety on all parts; glandular hairs cover the stems and leaves, making it clammy to the touch.

Leaves: Grey-velvety turning dark green and less velvety, veins prominent; oval (to 20 cm long), margins entire to shallowly toothed, held alternately on stem on long leaf stalks; bad-smelling when crushed or bruised.

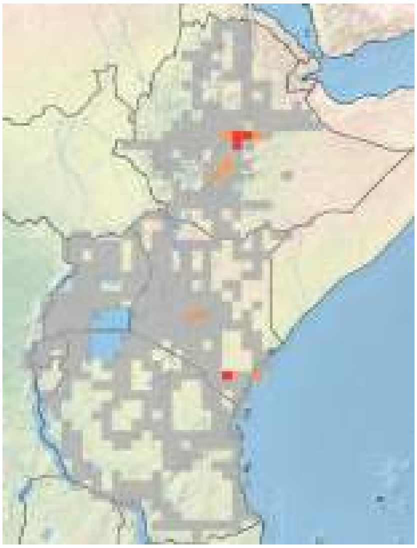
Flowers: White, solitary, tubular or trumpet-like, large (20 cm long and 12 cm wide), green veins.

Fruits: Capsules (dry fruits that open at maturity), brown, hardened, round (30–50 mm long), densely covered with slender spines about 1 cm long, hanging downwards from the plant; brown seeds (4–5 mm long).

ORIGIN
Belize, Guatemala, Mexico, USA and possibly elsewhere in tropical America.

REASON FOR INTRODUCTION
Ornament.

INVADES
Roadsides, wasteland, disturbed land, fallow land, lowlands, gullies and dry riverbeds.



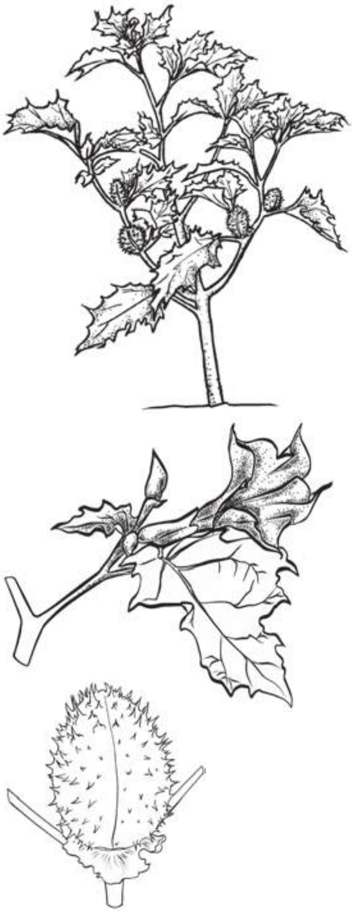
IMPACTS

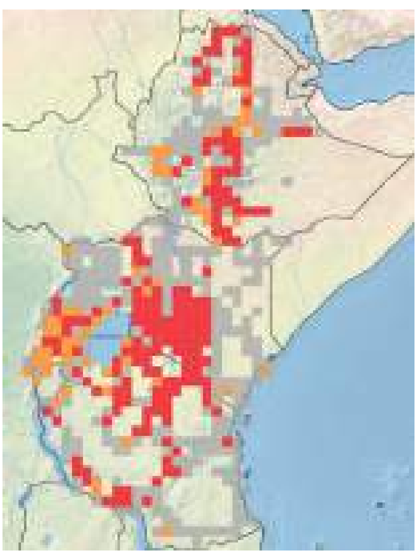
It readily escapes from gardens, where it has been grown as an ornamental, forming large stands to the possible detriment of native plant species. It also competes strongly with crop plants (Parsons and Cuthbertson, 1992). In Windhoek, Namibia, *D. innoxia* "is widely distributed along riverbanks, disturbed areas and around human settlements" (Joyce, 2008). As with other *Datura* species, it is toxic and may be fatal if ingested by humans and other animals, including livestock and pets (Parsons and Cuthbertson, 1992). Other impacts are assumed to be similar to those recorded for other *Datura* species.

Notes: In Kenya and Tanzania, it is found "along rivers and occasionally on disturbed soil in ruderal sites" (Edmonds, 2012). In Ethiopia, it is widespread and is regarded as a "weedy plant that occurs frequently in waste places" (Friis, 2006). Because it can be confused, from a distance, with other *Datura* species, it is probably more widespread than indicated on the distribution map.




Datura stramonium L.





TOMATO FAMILY
Solanaceae

SYNONYM
Datura hybrida Ten.; *Datura inermis* Juss. ex Jacq.

COMMON NAMES

English: common thorn apple, datura, devil's trumpet, jimson weed, moonflower, thorn apple; Ethiopia: astenager, asangirra, atafaris, manji, maserba, msiafu, stanagert, thrifra; Kenya: athumba, barutu, chemogong, koth kiyombi, mranaa, muana, mwalola, ngwata, obala-ndagwa, omonyaitira, silulu; Tanzania: msiafu, ouling'weki, rweziringa, silulu; Uganda: amaduudu, amaruuru, nyarweziringa, rweziringa

DESCRIPTION

Annual herb (0.5–2 m tall); stems green, purple or brown, hairy to hairless; single stem divides into two branches, both of which again divide into two branches as they grow, and so on.

Leaves: Dark green or purple, paler below, hairless, veins prominent; egg-shaped, bases broad, rounded to broadly triangular (5–25 cm long and 4–25 cm wide), margins coarsely and irregularly toothed or lobed; alternate on stems on long leaf stalks (to 10 cm); bad-smelling when crushed or bruised.

Flowers: White, mauve or purplish, funnel-shaped (to 100 mm long), at each fork of the stem.

Fruits: Capsules (dry fruits that open at maturity), initially green turning brown as they mature, egg-shaped (3–7 cm long and 2–3.5 cm wide), covered with slender spines (to 10 mm long), held erect on the plant; seeds dark brown to black (3–4 mm long and 2–3 mm wide).

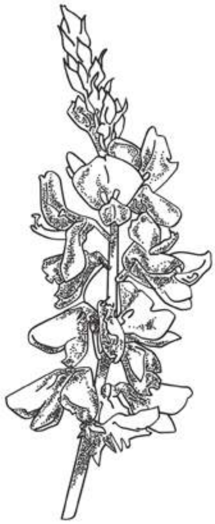
ORIGIN
Unclear, but probably tropical America.

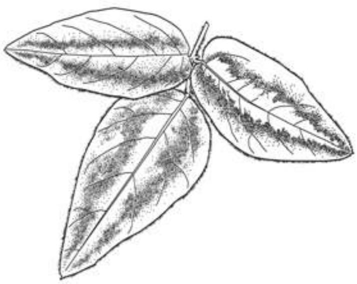
REASON FOR INTRODUCTION
Ornament and accidentally as a contaminant..

INVADES
Roadsides, railways, disturbed land, wasteland, fallow land, crops, managed pasture, drainage ditches, woodland edges/gaps, lowlands, gullies and dry riverbeds.

IMPACTS
Competes aggressively with native plants and crops, forming dense monospecific stands. Infestations in the USA have resulted in a 56% yield loss in cotton (Oliver *et al*., 1991). Yields of soybean plants growing within a distance of 1.2 m from a thorn apple plant are significantly reduced (Henry and Bauman, 1991), demonstrating the allelopathic impacts of this weed. In Spain, competition from thorn apple in irrigated maize has reduced yields by 56% (Torner *et al*., 1995). At densities of 3–11 plants per m^2, yields of tomatoes may be reduced by 26–71% (Monaco *et al*., 1981). *D. stramonium* is also an alternative host for several pests and pathogens of solanaceous crops. Toxic to people, horses, cattle, sheep, pigs and chickens (Watt and Breyer-Brandwijk, 1962), thorn apple has gained notoriety as a plant that is used by people to commit suicide. Between 1950 and 1965, 2,775 human deaths have been attributed to ingestion of this weed (Freye, 2010).

Notes: Present "along rivers and occasionally on disturbed soil in ruderal sites" in Kenya and Tanzania (Edmonds, 2012). In Ethiopia, it is also considered to be a weed in "disturbed areas" (Friis, 2006) of the Chercher, Central, Arsi/Bale, Western and Northern Highlands and Northeast and Southern Rift Valley regions (Stroud and Parker, 1989). Surveys found it to be widespread and locally abundant throughout the region, especially along roadsides, disturbed areas, wastelands, croplands, gullies and overgrazed pasture.





PEA FAMILY

Fabaceae; sub-family: Papilionaceae

COMMON NAMES

English: desmodium, silverleaf desmodium; Spanish clover, Spanish tick-clover, velcro plant, velcro vine

DESCRIPTION

Evergreen legume with long cylindrical or angular stems covered with short, hooked hairs that stick to body hair or to clothing; rooting at the nodes; strong tap-root.

Leaves: Dark green above with an irregular pear-shaped silver pattern along the mid-rib or main vein; undersides lighter green and uniform with no pattern, both sides covered with whitish hairs; trifoliate with three pointed egg-shaped leaflets [7–8 (–10) cm long and 2.5–3 (–5) cm wide]; leaf stalks 2–7 cm long.

Flowers: Pale lilac to pink to bluish when mature (0.8–1 cm long), in pairs along the terminal ends of long flowering stems (to 50 cm long).

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning brown as they mature, constricted between seeds, curved (5–7 cm long), covered with short, hooked hairs; breaking into 4–8 segments when mature; seeds light brown with olive-green to cream mottling, kidney-shaped.

ORIGIN

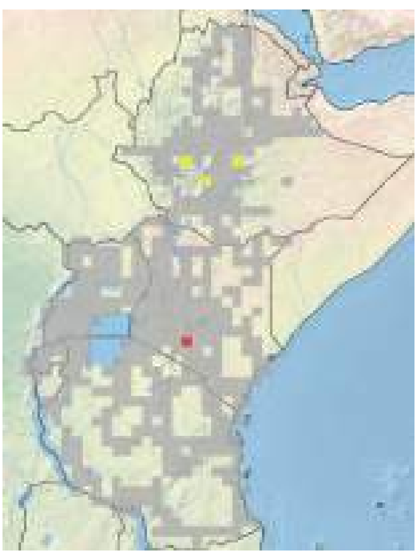
Argentina, Bolivia, Brazil, Colombia, Ecuador, El Salvador, Nicaragua, Paraguay, Peru, Uruguay and Venezuela.

REASON FOR INTRODUCTION

Nitrogen-fixation, fodder and ground cover.

INVADES

Roadsides, disturbed areas, urban open spaces, forest edges/gaps, open woodlands and riparian vegetation.

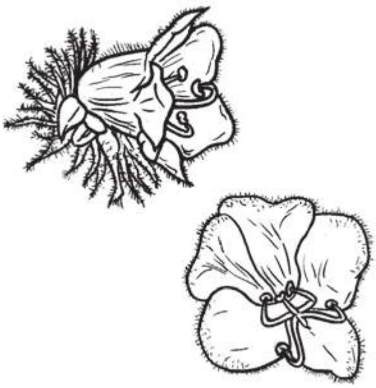


IMPACTS

Has the ability to climb into and over vegetation, smothering plants, to the detriment of native fauna and flora. In parts of Australia, it is a weed of creek banks, roadsides, fence lines, forest margins, disturbed sites, waste areas and even plantation crops such as sugarcane (Environmental Weeds of Australia, 2016). It is ranked as one of the top 100 most invasive plant species in some regions of Australia (Batianoff and Butler, 2003). There, it has reportedly "trapped" and killed native wildlife, including small frogs, birds, lizards and micro-bats, which easily become stuck in its stems and fruit. By fixing nitrogen it may also alter natural nutrient cycling processes. It is now locally naturalized in many tropical and sub-tropical parts of Africa and Southeast Asia (FAO, undated; Kretschmer *et al*., 2001).

Notes: It is cultivated for forage and as a cover crop in the Asela, Soddo and Jimma areas of Ethiopia (Thulin, 1989). Introduced to Kenya, via CSIRO, Australia, it is now widely promoted in eastern Africa for forage. It has subsequently escaped cultivation, and is probably far more widespread, particularly in areas of higher rainfall, than our surveys indicate. Abundant along roadsides, in urban open spaces and along streams in parts of Nairobi and probably also invasive elsewhere.

Echium plantagineum L.



FORGET-ME-NOT FAMILY
Boraginaceae

COMMON NAMES
English: blue weed, Paterson's curse, purple bugloss, salvation Jane

DESCRIPTION
An erect herb [30–80 (–150) cm tall] with several stems arising from the base; leaves and stems covered with coarse, white hairs which have bulbous or enlarged bases; living for longer than one year but for less than two.

Leaves: Those around the upper stem are small, narrow, stalkless, with pointed tips, while those around the basal rosette are large (5–25 cm long and 1.5–10 cm wide), on stalks up to 6 cm long, with prominent lateral veins.

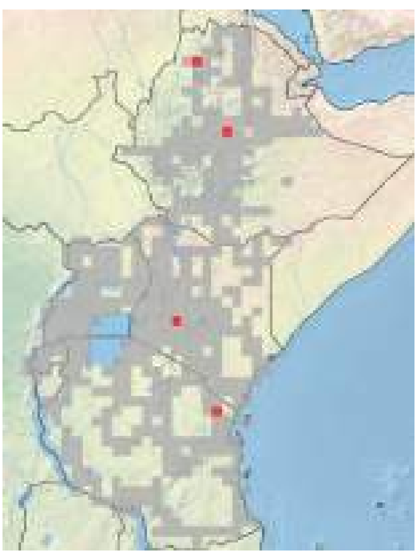
Flowers: Blue or purple, tubular (20–30 mm long), in one-sided unbranched inflorescences.

Fruits: Schizocarps (dry fruits that split into one-seeded segments at maturity) of 4 'seeds' or nutlets, surrounded by bristly bracts; 'seeds' brown, grey or black (2–3 mm long).

ORIGIN
Albania, Algeria, Azores, Bulgaria, Canary Islands, Cyprus, France, Egypt, Georgia, Greece, Israel, Italy, Jordan, Lebanon, Libya, Madeira Islands, Morocco, Portugal, Spain, Syria, Tunisia, Turkey, the UK, Ukraine and the former Yugoslavia.

REASON FOR INTRODUCTION
Bee forage and ornament.

INVADES
Forest edges and gaps, plantations, savanna, water courses, roadsides, urban open space.

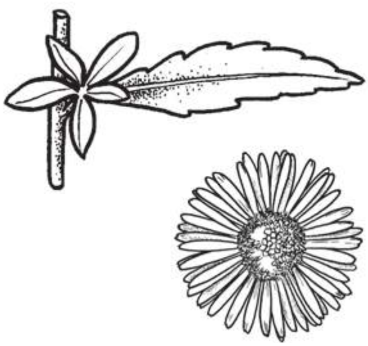


IMPACTS

E. plantagineum has the ability to form dense stands, out-competing native plants and valuable forage species. In Australia, it occurs in various natural habitats, including grasslands, open woodlands and heathlands, where it can form very dense stands, displacing smaller native plants and inhibiting the regeneration of others. It is common in South Australia, where it is considered to be one of the top three most commonly occurring environmental weeds (Environmental Weeds of Australia, 2016). In Australia, Paterson's curse covers roughly 33 million ha of land and is costing the agricultural industry as much as A$ 300 million each year (CSIRO, 2006). By displacing valuable forage species, Paterson's curse impacts negatively on livestock production costing Australian livestock farmers about A$ 30 million every year in lost production and control costs (Industries Assistance Commission, 1985). *E. plantagineum* is also toxic to livestock (Culvenor, 1956). Eaten in substantial amounts over long periods, it can cause chronic liver damage and animal mortality. It has been implicated in the poisoning of horses in Australia (Seaman, 1978; Dellow and Seaman, 1985) and of cattle in Brazil (Schild *et al*., 2004). It has been the cause of sheep deaths in Australia (Seaman, 1987), while having been implicated in several cases of mortality in horses and occasionally young pigs (Bull *et al*., 1968), and even among caged canaries (Hurst, 1942). It has been associated with human allergy problems and with other risks to human health, often through contaminated foodstuffs. This has led to bans on cereal exports from affected areas.

Notes: Present in the Ethiopian regions of Gonder and Shewa (Riedl and Edwards, 2006), it is locally abundant in some areas. In East Africa, it is "naturalized along roads and in meadows" in the Nakuru (Kenya) and Lushoto Districts (Tanzania) (Verdcourt, 1991). Our surveys found it to be abundant in some parts of Ethiopia, especially on roadsides and in croplands, but less so in East Africa. It is probably more widespread than indicated on the distribution map.

Erigeron karvinskianus DC. (unresolved)



DAISY FAMILY

Asteraceae

COMMON NAMES

English: bony-tip fleabane, coastal daisy, erigeron, Mexican daisy, wall daisy
Rwanda: akanayu

DESCRIPTION

Evergreen erect herb (50–100 cm tall) of spreading habit; woody at the base; stems greenish purple, with white hairs.

Leaves: Dark green, simple, oval-shaped (1–5 cm long and 1 cm wide), margins entire, in varying shapes along the stem.

Flowers: White or pink, with yellow centres, daisy-like (7–10 mm across).

Fruits: Achenes (small, dry, one-seeded fruits that do not open at maturity) (1 mm long), tipped with hair to aid in wind dispersal.

ORIGIN

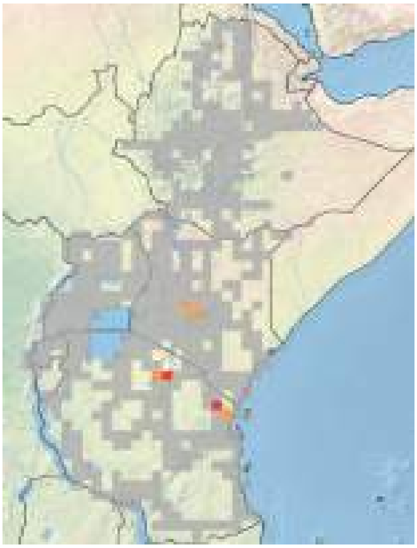
Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua and Venezuela.

REASON FOR INTRODUCTION

Ornament.

INVADES

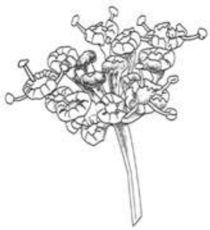
Roadsides, disturbed areas, urban open spaces, gardens and forest edges/gaps.

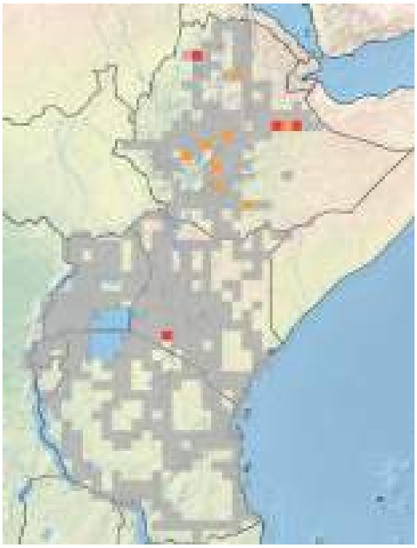


IMPACTS

Fleabane has the ability to form extensive mats, displacing native plant and animal species. *E. karvinskianus* invades and dominates vegetation on tropical islands such as Réunion (Triolo, 2005); Ngazidja in the Comoros (Leuschner, 1996); and the Hawaiian Islands (Lorence and Wagner, 1995), where it is considered to be one of the worst invasive species. In Hawaii, it forms mats on forest floors, smothering low-growing native plant species (Motooka *et al*., 2003), while also overrunning cliff habitats (Lorence and Wagner, 1995). In Japan, it threatens many native grasses (NIES, 2010). It is regarded as an environmental weed in New South Wales, Victoria, Tasmania and South Australia (Environmental Weeds of Australia, 2016). In South Australia, it is listed as an invasive garden plant in the Greater Adelaide region, and is also present in some conservation areas.

Notes: In East Africa, it is found “along roadsides, in clearings, on cultivated lands, but usually within the montane forest zone” (Beentje, 2002). There are no records of this species in Ethiopia or Eritrea (Tadesse, 2004). Widely grown in gardens throughout East Africa, it has escaped cultivation in some areas, establishing on roadsides and in urban open spaces, and may be considered to be invasive.





CARROT FAMILY
Apiaceae

SYNONYM
Foeniculum dulce Mill.; *Foeniculum officinale* All.

COMMON NAMES

English: false aniseed, fennel, wild fennel

DESCRIPTION
Erect herb [150–200 (–300) cm tall] with branched hairless stems, green or bluish-green and filled with a white spongy pith.

Leaves: Bright green, fern-like, hairless (30–50 cm long and 40 cm wide), finely divided into linear or thread-like segments (1–4 cm long and 0.5 mm wide), held alternately along stems; leaf stalks 3–10 cm long.

Flowers: Yellow, tiny (1–3 mm across), in large clusters (7–15 cm across) at the ends of the branches.

Fruits: Schizocarps (dry fruits that split into one-seeded segments at maturity), green turning grey, brown or yellowish-brown, egg-shaped (4–10 mm long); having two 'seeds' (3–6 mm long and 1.5–2 mm wide) which separate from each other at maturity.

ORIGIN
Algeria, Afghanistan, Albania, Algeria, Azores, Bulgaria, Canary Islands, Egypt, France, Greece, Iran, Israel, Italy, Jordan, Lebanon, Libya, Madeira Islands, Morocco, Portugal, Spain, Syria, Tunisia, Turkey, Pakistan and the former Yugoslavia.

REASON FOR INTRODUCTION
Herb and medicine.

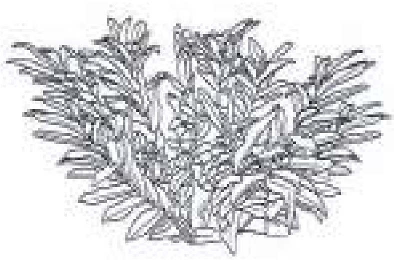
INVADES
Roadsides, disturbed lands, urban open spaces, gardens, lowlands and savannah.

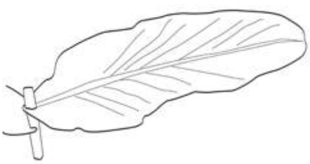
IMPACTS

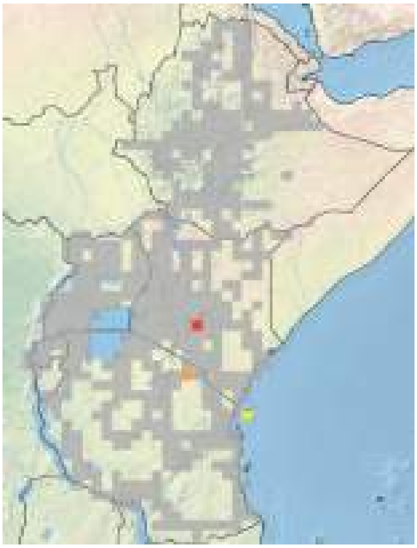
Fennel has escaped cultivation, and is now established in many areas, impacting negatively on other plant species. In California, *F. vulgare* is regarded as one of the "most aggressive invasive plants", having displaced native species and disrupted natural habitats (CAL-IPC, 2005). It alters fire regimes, and has increased both the frequency and the intensity of fires in California and New Zealand (Esler, 1988). In California, it invades mainly gaps in coastal scrub, where it "shades out the understorey herbaceous layer" (CAL-IPC, 2005). In parts of Australia, *F. vulgare* is regarded as "a significant and widespread environmental weed" (Environmental Weeds of Australia, 2016) because of its ability to out-compete small native understorey shrubs and ground-cover plants, and because it may also reduce the amount of useful habitat available to native animals. It has invaded many conservation areas in southeastern Australia, and poses a significant threat to the last remaining population of the critically endangered sunshine diuris (*Diuris fragrantissima* D.L. Jones & M.A. Clem.; Orchidaceae) (Environmental Weeds of Australia, 2016). *F. vulgare* is also reported to be allelopathic, impacting negatively on the growth of tomatoes and beans (Parsons and Cuthbertson, 1992). Fennel is known to cause dermatitis in people, exposed to sunlight, after handling or touching the plants (Connor, 1977).

Notes: Grown across most of Ethiopia, fennel is considered to be "naturalized in disturbed places" (Hedberg and Hedberg, 2003). In East Africa, where it has established small populations, particularly on roadsides, it has been described as "an introduction, naturalized in disturbed places" (Townsend, 1989). Considered to be occasionally invasive in eastern Africa.

Hedychium coronarium J. Koenig







GINGER FAMILY
Zingiberaceae

COMMON NAMES

English: butterfly ginger, garland flower, garland lily, ginger lily, white butterfly ginger lily, white ginger, white ginger-lily, wild ginger

DESCRIPTION
Evergreen herbaceous plant (1–2.5 m tall) producing a thick mat of creeping underground stems (2.5–5 cm across) close to the soil surface; stems reddish at base, covered by leaf sheaths (tubular structures that clasp stem).

Leaves: Green, glossy upper surface smooth and hairless, lower surface with some hairs (downy), somewhat elongated or sword-shaped (50–60 cm long and 10–15 cm wide), base pointed, apex tapering gradually to a sharp point, margins entire with prominent mid-vein; held alternately on stems with a long base sheathing or surrounding the stem.

Flowers: White, tubular, with three narrow and three broad petal-like lobes, held in egg-shaped clusters or spikes (up to 300 mm long) at the tip of each unbranched stem; showy, fragrant.

Fruits: Capsules (dry fruits that open at maturity), orange-yellow, dry, smooth, somewhat elongated with almost parallel sides (2.5–3.5 cm long), containing many seeds (6 mm long and 4 mm wide).

ORIGIN
China, India, Myanmar, Nepal and Taiwan.

REASON FOR INTRODUCTION
Ornament.

INVADES
Roadsides, disturbed areas, plantations, drainage ditches, irrigation channels, dam edges, ponds, forests, forest edges/gaps, riparian vegetation, lowlands, floodplains, swamps, wetlands, lake and river sides.

IMPACTS

Forms extensive thickets that disrupt water flow in channels and displace and suppress the regeneration of native wetland plants. In Brazil, dense infestations have caused the localized extinction of *Peripatus acacioi* Marcus and Marcus (Onychophora), a rare invertebrate, in a nature reserve that had been established to protect it (Soares and Barreto, 2008). On Hawaii's Maui Nui group of islands, white ginger is a threat to two endemic plant species, *Clermontia samuelii* F.B. Forbes (Campunalaceae) and *Labordia tinifolia* A. Gray var. *lanaiensis* Sherff. (Loganiaceae) (USFWS, 1999). In Saint Lucia, it may be replacing the rare indigenous orchid *Habenaria monorrhiza* [Sw.] Rchb.f (Orchidaceae) (Krauss, 2012). The plant is also toxic.

Notes: Not recorded as being present in Ethiopia (Lock, 1997). Grown as an ornamental in Kenya and elsewhere in East Africa, but only one infestation, on the edges of a dam at Kakuzi, near Thika, Kenya, was seen during surveys, indicating that it has the potential to become problematic along the edges of water bodies.

GINGER FAMILY
Zingiberaceae

COMMON NAMES

English: cream garland lily, cream ginger, cream ginger lily, wild ginger, yellow ginger

DESCRIPTION
Evergreen herbaceous plant (1.5–2 m tall) that produces a mat of large, creeping underground stems or branching rhizomes (3.5 cm wide, to 1 m thick); stems covered by hairless leaf sheaths (tubular structure that clasps stem).

Leaves: Green upper surface hairless, lower surface with some hairs (downy), somewhat elongated or sword-shaped [25–45 (–60) cm long and 5–10 (–12.5) cm wide] with a pointed base and apex tapering gradually to a sharp point, margins entire with a prominent mid-vein; held alternately on stems with a long base sheathing or surrounding the stem; not to be confused with *H. flavum*, the leaves of which are less hairy on the undersides.

Flowers: Yellow, tubular, with three narrow and three broad petal-like lobes, darker patch on petals, held in ovoid clusters or spikes (15–20 cm long and 8 cm wide); bracts green, oval to egg-shaped (4–6 cm long and 1.5–3 cm wide); in *H. flavum* deep yellow without darker patch.

Fruits: Capsules (dry fruits that open at maturity), round (1–2 cm wide) with three compartments, rare.

ORIGIN
Eastern India, Myanmar, Nepal, southern China and Thailand.

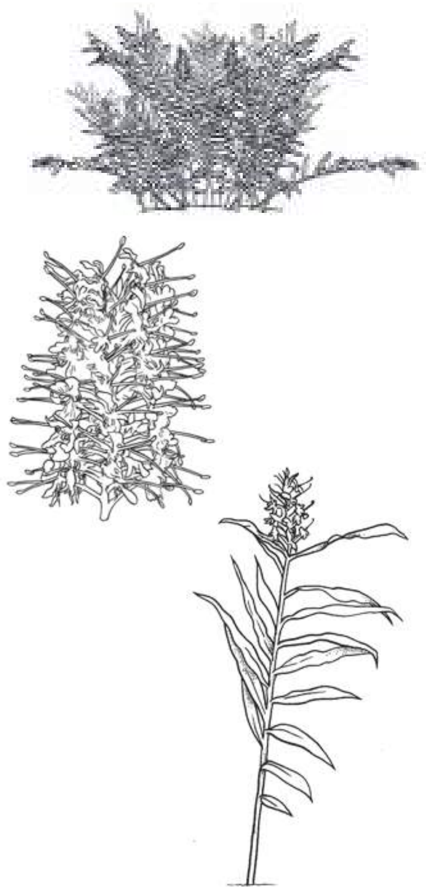
REASON FOR INTRODUCTION
Medicine and ornament.

INVADES
India and Nepal.

IMPACTS

Has the ability to form dense monospecific stands, to the detriment of native flora and fauna. Its thick layer of underground stems and rhizomes prevents the establishment of other plant species. In New Zealand, Hawaii and La Réunion, dense infestations cover large areas, displacing native plants and preventing their regeneration. *H. flavescens* inhibits forest succession by reducing the abundance of native seedlings and saplings in the critical regeneration phase (Williams *et al*., 2003). In New Zealand infestations may result in the permanent displacement of rare plants or specialised plant communities (NZ DOC, undated). Wild ginger also alters nutrient levels and hydrological processes, affecting erosion/deposition (Williams *et al*., 2000). It may also impact on faunal diversity and animal behaviour (Williams *et al*., 2000). Dense infestations may prevent access to invaded areas.

Notes: Although widely grown in some of East Africa's major cities, it was found to have escaped, and to have become abundant, only along the Kandisi River, Ololua Forest, Karen, Nairobi, Kenya, and to be growing wild on the edges of a dam near Hillcrest, Nairobi. Not recorded as being present in Ethiopia (Lock, 1997).



GINGER FAMILY
Zingiberaceae

COMMON NAMES
English: kahili garland lily, kahili ginger, red ginger lily, wild ginger

DESCRIPTION
Robust evergreen herbaceous plant [1–2 (–2.5) m high] with creeping underground stems or rhizomes; branching surface rhizomes can form dense mats (to 1 m thick).

Leaves: Bright green or greyish-green, glossy, upper surface hairless, lower surface sparsely hairy (downy), narrow, tapering (20–45 cm long and 10–15 cm wide) with pointed tips, margins entire; held alternately on stems with a long base sheathing or surrounding the stem.

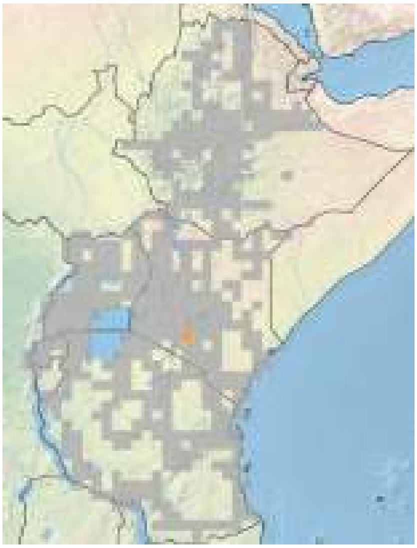
Flowers: Yellow, tubular, with three narrow and three broad petal-like lobes, in large upright clusters or spikes (15–45 cm long and 15–20 cm wide) at tips of stems.

Fruits: Capsules (dry fruits that open at maturity), thin-walled (about 1.5 cm long) with three compartments.

ORIGIN
Bhutan, India and Nepal.

REASON FOR INTRODUCTION
Medicine and ornament.

INVADES
Roadsides, disturbed areas, plantations, forests, forest edges/gaps, riverbanks and damp areas.



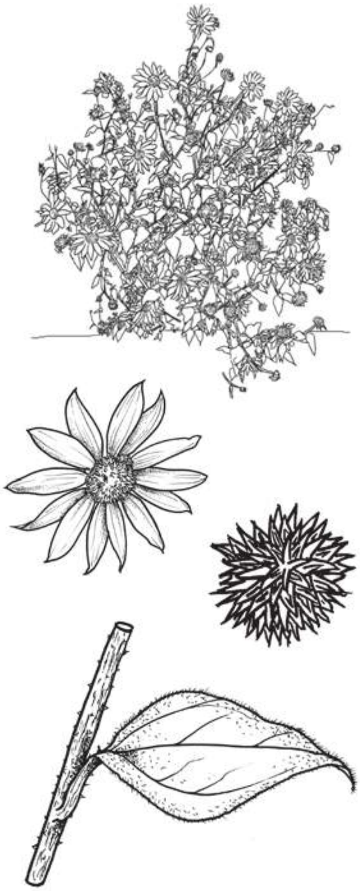
IMPACTS

Forms dense stands, out-competing native species for light, space, nutrients and moisture. Being shade-tolerant, it is able to thrive in closed-canopy forests. Its thick rhizome mats prevent the establishment of other species. Populations are now found on all the islands of Hawaii (Smith, 1985). Its "aggressive growth habit and its shade-tolerance" have enabled it to form dense thickets in the understorey of open- and closed-canopy *Metrosideros polymorpha* Gaud. (Myrtaceae) rainforest, as well as in open habitats and forest edges around the Volcanoes National Park (Anderson and Gardner, 1999). It threatens primary forest remnants in La Réunion. Its continued expansion in the Azores may endanger endemic lichens, vascular plants, molluscs and arthropods. Infestations on Sao Miguel Island also threaten the Azores bullfinch (*Pyrrhula murina* Godman; Fringillidae). During rains, large infestations on steep slopes become heavy with absorbed water, and often slip down slopes, contributing to erosion and gully formation.

Notes: Not recorded as being present in Ethiopia (Lock, 1997). Grown as an ornamental in East Africa, there are no records, to date, of its having escaped from cultivation, although it has the potential to become problematic based on its biology/ecology and the fact that other *Hedychium* species in East Africa are already naturalized or invasive.




Helianthus annuus L.



DAISY FAMILY
Asteraceae

SYNONYM
Helianthus tubaeformis Nutt.

COMMON NAMES

English: annual sunflower, common sunflower, sunflower, wild sunflower
Ethiopia: jabar-suf, nuugi-adi, yeferenj suf

DESCRIPTION

An annual plant [(25–) 50–300 (–450) cm tall] with erect, usually rough to hairy stems and a relatively deep tap-root; this weedy variety is highly variable, hybridizing with several other cultivated forms.

Leaves: Green, simple, rough with minute hairs, egg-shaped to triangular (7–40 cm long and 3–35 cm wide), margins entire or irregularly toothed, usually tapering to a sharp-pointed tip, mostly held alternately on stems; leaf stalks long (2–20 cm).

Flowers: Bright yellow [10–30 mm long and (15–) 20–50 mm in diameter]; longer and much wider in cultivated forms, at ends of branches; one plant can produce 500 flowers.

Fruits: Achenes (small dry, one-seeded fruits that do not open at maturity), black to grey, brown, or with white stripes or mottling, narrowly wedge- to egg-shaped (3–7 mm long), flattened but usually more or less 4-angled in cross-section.

ORIGIN
Mexico and USA.

REASON FOR INTRODUCTION
Accidentally as a contaminant.

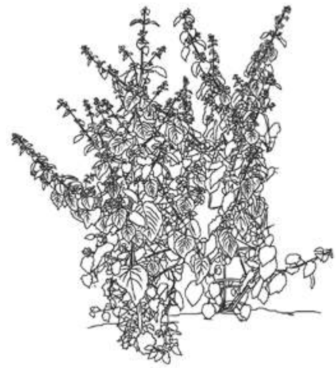
INVADES
Roadsides, disturbed areas, wastelands, urban open spaces, fallow land and croplands.

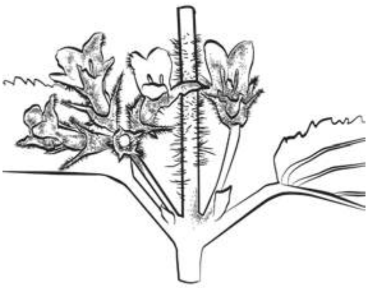
IMPACTS

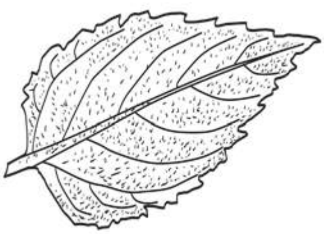
Establishes readily in disturbed areas, displacing plants of other species. In parts of the USA, it is widespread along roadsides and railroads, disturbed sites, pastures, meadows, plains and foothills. Wild *H. annuus* is also established in central Argentina (Poverene *et al*., 2008), Australia (Seiler *et al*., 2008), and in France and Spain (Muller *et al*., 2009), where it is found in crop fields and in uncultivated places (Poverene and Cantamutto, 2010). Wild sunflower is the most common and most problematic weed species in sorghum crops in northern Tamaulipas, Mexico (Rosales-Robles *et al*., 2005). It is highly competitive, owing to its vigour in the early phases of development, and on account of its height and foliar area (Geier *et al*., 1996). Competition from wild sunflower has been shown, in field trials conducted four weeks after sorghum germination, to reduce sorghum growth by 20%, 60%, and 26%, in 2001, 2002 and 2003, respectively. Damage in 2002 was exacerbated by scarce precipitation during the first growth stages of the sorghum (Rosales-Robles *et al*., 2005).

Notes: Should be recognised that the wild form is significantly different, especially from a morphological perspective, to the cultivated form. Found to be abundant on roadsides and disturbed areas in Athi River and surrounding areas in Kenya. It may also be present elsewhere in the region.

Hyptis suaveolens (L.) Poit.







MINT FAMILY
Lamiaceae

SYNONYM
Mesosphaerum suaveolens (L.) Kuntze

COMMON NAMES

English: Chinese mint, horehound, hyptis, mint weed, mintweed, pignut, wild spikenard
Tanzania: mkamasi

DESCRIPTION

Annual or short-lived evergreen, upright and branched herb [1–1.5 (–3) m tall]; stems green or reddish-green, hairy, square in cross-section, woody towards the base; leaves emit a strong minty smell when crushed.

Leaves: Green, hairy, egg-shaped, oval or slightly heart-shaped (2–10 cm long and 1–7 cm wide), bases round to heart-shaped with pointed tips, margins shallowly toothed; held opposite each other on the stems, on leaf stalks 5–40 mm long.

Flowers: Pinkish, bluish-purple or lavender, tubular (5–7 mm long) with two 'lips', the upper lip has two lobes and the lower lip three; held in clusters of 1–5 flowers in the upper leaf forks.

Fruits: Schizocarps (dry fruits that split into one-seeded segments at maturity); splitting into two dark brown to black 'seeds' (nutlets or mericarps) (3–4 mm long and 2.5–3 mm wide).

ORGIN
Central and tropical South America.

REASON FOR INTRODUCTION
Medicine and accidentally as a contaminant.

INVADES
Roadsides, disturbed areas, crop and fallow land, rangelands, savannahs, open woodlands, floodplains and riverbanks.

IMPACTS

Can form dense stands, to the detriment of native fauna and flora. *H. suaveolens* now has an almost pan-tropical distribution, and is regarded as one of the world's most noxious weeds. It is believed to be allelopathic, impeding the germination of other plant species, and as such it threatens natural succession processes (Padalia *et al.,* 2014). It also physically competes for space and nutrients in grain crops and peanuts (Parsons and Cuthbertson, 2001). Near Materi, Kenya, farmers are alarmed by the rapid rate at which it is spreading, and by the impacts it is having on crop and pasture production. Widely naturalized in the savannahs of northern Australia, it is there considered to pose the greatest threat to "rangeland biodiversity". It is also unpalatable to livestock and wildlife. It is also becoming increasingly invasive in India, and is naturalized in Papua New Guinea and on several Pacific islands.

Notes: Abundant in parts of East Africa, especially in areas to the east of Mount Kenya, where it was first identified as problematic in about 2010. Here, near Materi, Kenya, it has "formed thickets, almost waist-high in places, on roadsides and in ditches, on abandoned farmlands and in shambas and grazing pastures" (Andrew Botta, *pers*. *comm*.). It is also abundant along parts of the Kenyan coastline, but assumed to be far more widespread and abundant elsewhere in the region than indicated. No concerted efforts were made to actively record its presence during our surveys, but based on the evidence of its impacts, it is a species which needs to be controlled.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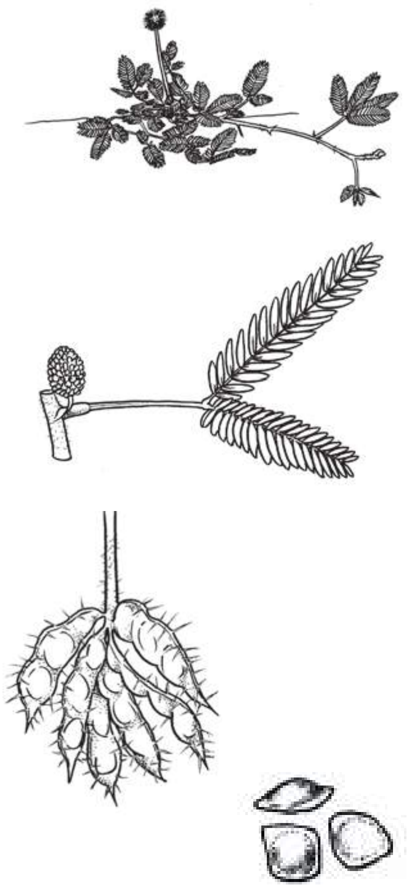
Mimosa pudica L.



PEA FAMILY
Fabaceae; sub-family: Mimosaceae

COMMON NAMES

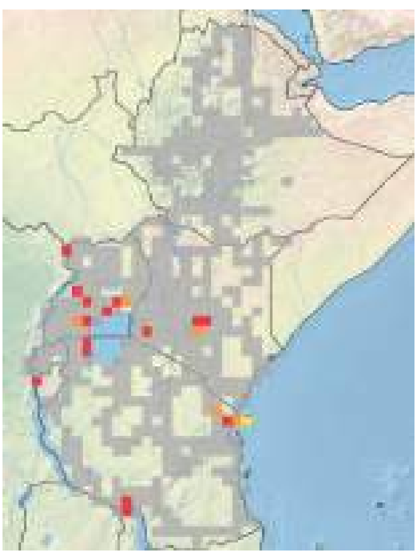
English: common sensitive plant, shame plant, sleeping grass, touch-me-not
Kenya: mbodzembodze
Tanzania: kifyauwongo, mgama, mgambu, mntobwe, msesi, mseziluguru, ndulu, ngambo, nguvurukundu
Uganda: kafansonyi

DESCRIPTION
Evergreen prickly herbaceous plant or small shrub [15–50 (–100) cm high] with a creeping or sprawling habit; stems reddish-brown to purplish, rounded, with sparse prickles (2–2.5 mm long).

Leaves: Yellowish-green, sparsely hairy, twice-divided, 1–2 pairs of leaflet branchlets (2.5–8 cm long) each bearing 10–25 pairs of elongated leaflets with almost parallel sides (6–15 mm long and 1–3 mm wide), margins entire, borne on stalks (1.5–6 cm long), leaves fold together at night or when touched.

Flowers: Lilac or pink in fluffy round heads or clusters (9–15 mm across) held on bristly stalks (1–4 cm long).

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning brown as they mature, elongated with almost parallel sides, flattened (1–2.5 cm long and 3–6 mm wide), held in clusters covered with bristles, and with prickles along their margins, break transversely into segments; seeds light brown, flattened (2.5–3 mm long).



ORIGIN
Barbados, Belize, Bolivia, Brazil, Colombia, Costa Rica, Cuba, Dominican Republic, El Salvador, French Guiana, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Puerto Rico, Trinidad and Tobago, Surinam and Venezuela.

REASON FOR INTRODUCTION
Medicine, tannins, bee forage, ground cover and ornament.

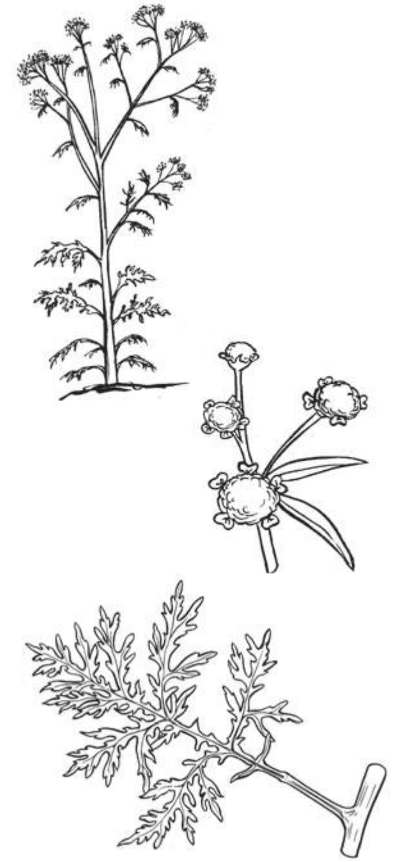
INVADES
Roadsides, railway lines, disturbed land, wasteland, urban open spaces, gardens, fallow land, crops, plantations, managed pasture, drainage ditches, savannahs, lowlands, wetlands and gullies.

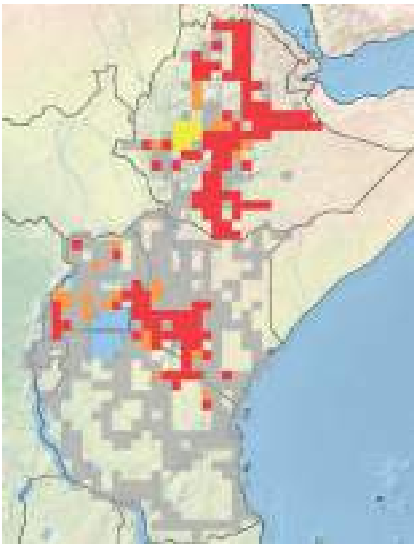
IMPACTS

On record as posing a significant threat to native flora in some parts of the world, *M. pudica* is also a known fire hazard. It is considered to be a serious pest of crops and pastures throughout the tropics (Holm *et al*., 1979). In Kerala, India, infestations have reduced upland rice yields by 10–70% (Joseph and Bridgit, 1993). In other infested upland rice-producing regions of the world, similar losses have been reported. It is considered to be a serious weed of sugarcane in Mexico and Taiwan (Holm *et al*., 1977); of sorghum and maize in Malaysia and Indonesia (Holm *et al*., 1977); and of soybeans in the Philippines (Holm *et al*., 1977); as well as of tomatoes, pineapples and cotton (Lee Soo Ann, 1976; Waterhouse and Norris, 1987). Mimosa is also a serious weed of plantation crops such as rubber, tea, coffee, coconuts, oil palms, bananas, mangoes, papaya, citrus and even *Acacia mangium* Willd. (Fabaceae) plantations in Indonesia (Nazif, 1993). Mimosa invades pastures and can be toxic to livestock, due to the high levels of mimosine it contains. It is suspected of poisoning cattle in Papua New Guinea (Henty and Pritchard, 1973), and has caused stunted growth in chickens in Indonesia (Kostermans *et al*., 1987).

Notes: It has been recorded in Uganda, Tanzania and Zanzibar (Brenan, 1959), and is naturalized in the Amani Nature Reserve, East Usambaras, Tanzania (Dawson *et al*., 2008). Infestations elsewhere in the region, along roadsides especially, are often unobtrusive and may have been overlooked; so it is probably far more widespread and abundant than indicated on the distribution map.

Parthenium hysterophorus L.





DAISY FAMILY
Asteraceae

COMMON NAMES

English: carrot weed, carrot grass, congress weed, famine weed, ragweed, white top
Ethiopia: faramsiisa, harama dhimbi, kalignole, qinche arem

DESCRIPTION
Annual erect herb, much branched [0.5–1.5 (–2) m high], forms a basal rosette of leaves when young, green stems are longitudinally grooved or ribbed and covered with short hairs.

Leaves: Pale green, covered with short, stiff hairs; rosette and lower stem leaves are deeply divided and large (3–30 cm long and 2–12 cm wide); upper stem leaves are shorter and less divided.

Flowers: White (about 5 mm across), in small compact heads clustered at the tips of branches, each flowerhead has five distinctive petals.

Fruits: Small (1.5–2.5 mm long), dry, each containing one black seed, five in each flowerhead.

ORIGIN
Argentina, Bahamas, Barbados, Belize, Bolivia, Cuba, Dominica, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Martinique, Mexico, Paraguay, Puerto Rico, St. Vincent and the Grenadines, Trinidad and Tobago, Uruguay, Venezuela and Virgin Islands.

REASON FOR INTRODUCTION
Medicine, ornament and accidentally as a contaminant.

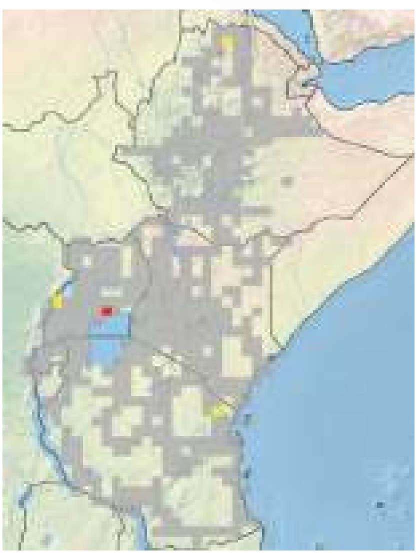
INVADES
Roadsides, railways, wasteland, disturbed land, fallow land, crops, plantations, managed pasture, gardens drainage ditches, forest edges/gaps, woodland edges/gaps, grassland, savannahs, riversides, lowlands and gullies.

IMPACTS

Parthenium disrupts the ecology of grasslands, invades woodlands, and generally disturbs native vegetation through aggressive competition (Evans, 1997). Being allelopathic, it inhibits the germination and growth of other plants, reducing crop yields and displacing palatable species in natural and improved pastures. *P. hysterophorus* is now considered, by 90% of the farmers in the lowlands of Ethiopia, to be the most serious weed of croplands and grazing areas (Tamado and Millberg, 2000). There, in experimental fields infested with high densities of *P. hysterophorus*, sorghum yields were reduced by 97% (Tamado *et al*., 2002). In India, parthenium infestations have resulted in yield losses of up to 40% in several crops (Khosla and Sobti, 1979). Parthenium is also a secondary host for a range of crop pests. In terms of pasture production, this noxious weed has been found to reduce livestock carrying capacities by as much as 90% (Jayachandra, 1971). It poses serious health hazards to livestock, and can cause severe allergenic reactions in people who regularly come into contact with the weed.

Notes: The first record of this plant in the region is from Ruiru, Kenya, in 1973 (Beentje *et al*., 2005). It was then regarded as a weed of coffee plantations. The first infestations in Uganda were found in November 2008, and in Tanzania in 2010. It was probably introduced to Ethiopia in the 1970s. In Ethiopia, it has been described as a "notorious weed" which is "spreading throughout the region" (Tadesse, 2004). In both Ethiopia and East Africa, it is one of the fastest spreading invasive plants, occupying millions of hectares.

Rivina humilis L.



POKEWEED FAMILY
Phytolaccaceae

COMMON NAMES
English: coralberry, inkberry, pigeon berry, blood berry

DESCRIPTION
Evergreen herb (0.6–1 m tall), sometimes woody at the base with spreading branches; younger stems greenish, mostly hairless.

Leaves: Light green, thin, almost hairless, simple, somewhat elongated or narrowly egg-shaped (3–13 cm long and 1–5 cm wide), margins entire with pointed tips, held alternately on long slender stalks (1–5 cm long).

Flowers: White or greenish to rosy, small (2–4 mm across), in elongated clusters (4–8 cm long) in the forks of the upper leaves.

Fruits: Berries (fleshy fruits that do not open at maturity), green turning bright red as they mature (3–4 mm across), each containing one hairy seed.

ORIGIN
Argentina, Belize, Bolivia, Brazil, Colombia, Costa Rica, Ecuador, El Salvador, French Guiana Guatemala, Honduras, Mexico, Nicaragua, Panama, Peru, Guyana, Paraguay, Peru, Surinam, USA, Venezuela and the Caribbean.

REASON FOR INTRODUCTION
Ornament.

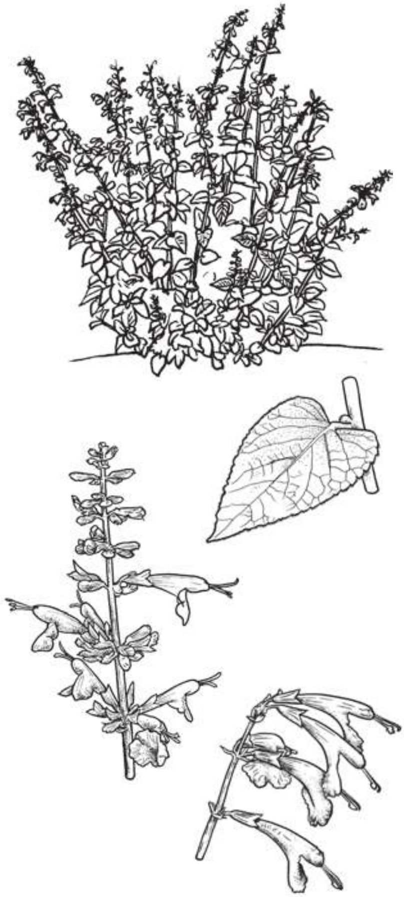
INVADES
Roadsides, disturbed areas, urban open space, forest edges/gaps, woodlands and riverbanks.

IMPACTS

R. humilis grows very rapidly, forming dense, persistant stands, to the detriment of native vegetation. It has the ability to establish and proliferate in shade, which means that it can invade closed forests (Motooka *et al*., 2003). In Australia, it establishes readily on rainforest edges and in gaps and other shaded places on the coastal belt (Kleinschmidt and Johnson, 1987, cited in Csurhes and Edwards, 1998). *R. humilis* is one of several introduced weeds seen to be threatening the endangered shrub *Corchorus cunninghamii* Muell. (Malvaceae) in Australia (Saunders, 2001). There, dense stands are preventing native birds, such as the rare black-breasted button-quail (*Turnix melanogaster* Gould; Turnicidae) from foraging on the forest floor (Queensland Government, 2013). In Hawaii, *R. humilis* has been found, along with other introduced plants, to be a threat to the endangered plants *Nototrichium humile* Hillebr. (Amaranthaceae) and *Phyllostegia parviflora* (Gaudich.) Benth. (Lamiaceae) (USFWS, 2008b). In South Africa, dense stands are inhibiting, or in some cases preventing, the regeneration of native forest species (SANBI, 2013). *R. humilis* has also been recorded as a weed of coffee in Cuba (Caro *et al*., 1985) and as an ‘important’ weed of oil palm in Indonesia (SAMEO BIOTROP, 2013).

Notes: It is grown as an ornamental, and has become “naturalized in riverine vegetation at lower altitudes in Somalia and in East Africa,” but it has not been recorded as present in Ethiopia (Polhill, 2000). Found in riverine forest and grassland in East Africa (Polhill, 1971), it is invasive and probably significantly more widespread in East Africa than indicated on the distribution map.

Salvia coccinea Buc'hoz ex Etl.



MINT FAMILY
Lamiaceae

COMMON NAMES

English: blood sage, crimson sage, red sage, wild salvia
Kenya: mnyokanyoka, mtambaa
Uganda: kaishe-ihaya

DESCRIPTION

Evergreen erect herb (to 1.5 m tall), stems covered with both short and long, spreading hairs.

Leaves: Green, upper surfaces hairless to sparsely haired, densely hairy beneath; egg-shaped to triangular (1.5–6 cm long and 1–5 cm wide), tips pointed to rounded, margins toothed, held in pairs along the stems.

Flowers: Bright red, pink or white, tubular (15–30 mm long), held in elongated clusters at the tips of the stems, in groups of 3–10.

Fruits: Schizocarps (dry fruits that split into one-seeded segments at maturity), splitting into four one-seeded segments or 'seeds' (nutlets) when mature; brown 'seeds' smooth, narrowly egg-shaped (about 3 mm long).

ORIGIN

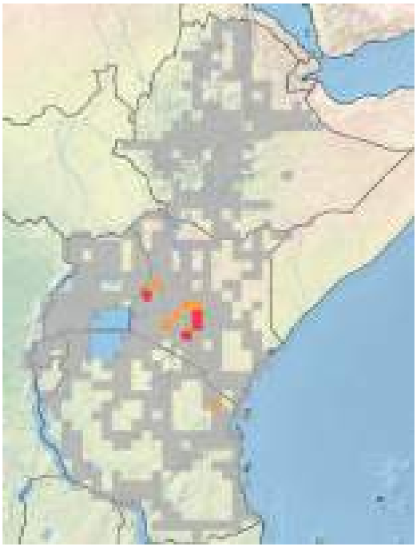
Belize, Brazil, Colombia, El Salvador, Guatemala, Mexico, Peru, southeastern USA, and the Caribbean.

REASON FOR INTRODUCTION

Ornament.

INVADES

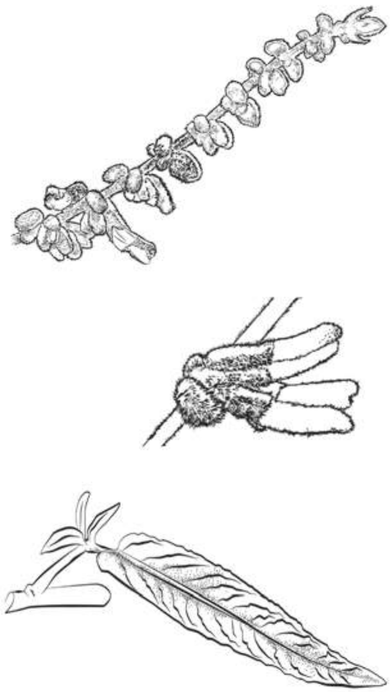
Roadsides, disturbed areas, wastelands, urban open space, gardens, plantations, open woodlands and riparian vegetation.



IMPACTS
Forms dense stands, displacing native plant and animal species. It is naturalized in Fiji (Smith, 1991) and in Hawaii, especially in disturbed habitats (Wagner *et al*., 1999). In Niue, it is common in waste places and plantations (Sykes, 1970), while in Tonga it is widespread only in plantations (Yuncker, 1959). Young plants are toxic to cattle, inducing symptoms such as extreme weakness and uncoordinated movements (Hindmarsh, 1937).

Notes: It is "perhaps naturalized on ruderal ground" in the regions of Welo and Harerge in Ethiopia (Demissew, 2006). In East Africa, it is "an escape in several places" (Paton *et al*., 2009). Widely grown as an ornamental, it has escaped cultivation in many higher lying areas of East Africa and is locally abundant on roadsides and urban open space.

Salvia leucantha Cav.



MINT FAMILY
Lamiaceae

COMMON NAMES

English: Mexican bush sage, Mexican sage, Mexican salvia, midnight Mexican sage, velvet sage, woolly salvia

DESCRIPTION

Bushy evergreen sub-shrub that grows in a loose, spreading mound (0.6–1.2 m tall), about as wide as it is high; stems 4-angled, conspicuously white and woolly.

Leaves: Grey-green, puckered (wrinkled) above, and white-woolly, hairy beneath; willow-like, sword-shaped, (2.5–12.7 cm long), apex pointed and base rounded, held in opposite pairs on the stems, on leaf stalks about 2.5 cm long.

Flowers: White, with velvety purple or lavender-blue bracts (small leaf-like structures underlying flowers), tubular (2.5–5 cm long), in elongated arching clusters (15–30.5 cm long) at the ends of erect, spreading stems, showy.

Fruits: Schizocarps (dry fruits that split into one-seeded segments at maturity), splitting into smooth, ovoid or oblong 'seeds' or nutlets.

ORIGIN

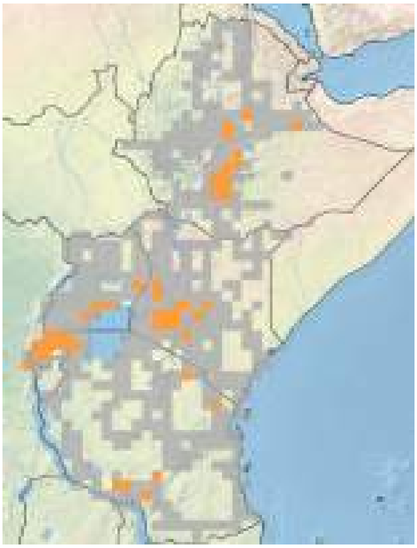
Mexico and possibly elsewhere in Central America.

REASON FOR INTRODUCTION

Ornament.

INVADES

Roadsides, gardens and urban open space.



IMPACTS

It is present in tropical and sub-tropical pine forests across much of central and eastern Mexico. In East Africa, it has escaped cultivation, forming dense stands that in some areas may be having a negative impact on native plants and their associated organisms. It is also an escape from cultivation in California.

Notes: In Ethiopia, it is widely cultivated and often "naturalized in wetter areas" (Demissew, 2006). Widely grown in East Africa, it has "escaped in some places," such as Makerere University Hill and Masaka City Centre in Uganda (Paton *et al*., 2009). Surveys found *S. leucantha* to be naturalized in a few places. A congener, *S. involucrata* Cav, has "escaped locally in the Kenyan highlands", while another, *S. microphylla* Kunth, also has a "tendency to escape" (Paton *et al*., 2009).

Senecio madagascariensis Poir.

DAISY FAMILY
Asteraceae

COMMON NAMES
English: fireweed, Madagascar groundsel, Madagascar ragwort
Kenya: karajing

DESCRIPTION
Upright, relatively short-lived herb [10–50 (–70) cm tall] with a single main stem or with several stems growing from the base of the plant, much-branched towards the top of the plant, with many terminal flower-heads.

Leaves: Bright green, hairless or sparsely hairy, simple, narrow and elongated (2–12 cm long and 3–25 mm wide), margins toothed, either entire or lobed, growing alternately on stems, becoming smaller from the base; no stalks.

Flowers: Yellow, daisy-like (15–20 mm across).

Fruits: Brown, dry, ribbed, one-seeded, cylindrical (1.5–3 mm long and less than 0.5 mm wide); topped with a silky tuft of hairs.

ORIGIN
Madagascar, South Africa and Swaziland.

REASON FOR INTRODUCTION
Accidentally as a contaminant.

INVADES
Disturbed areas, roadsides, urban open space, gardens, pastures, woodlands and grasslands.

IMPACTS

Can form dense stands, displacing valuable forage species. It is also toxic to livestock (Seaman and Walker, 1985; Small *et al*., 1993; Sindel *et al*., 1998), which is why it is considered to be the worst weed in coastal areas of New South Wales, Australia (Sindel and Michael, 1988). Its infestations, by displacing grasses and other low-growing plants (Sindel *et al*., 1998), contribute to increased soil erosion. Although livestock generally avoid the plant, its consumption in hay has resulted in heavy livestock losses in Australia (Culvenor, 1985). Whereas a large intake of the plant may prove fatal relatively quickly, most livestock deaths are the result of cumulative sub-lethal poisoning over months or even years (Bull *et al*., 1968; McLean, 1970; Mattocks, 1986). Annual losses in Australia as the result of fireweed infestations amount to US$ 2 million (Motooka *et al*., 1999). On Hawaii, *S. madagascariensis* has invaded pastureland on the northeastern and western sides of the island, from where it has been expanding its range towards southern areas (Motooka *et al*., 1999).

Notes: While there are no records of this species in Ethiopia, other species in the genus, such as *S. pinnatipartitus* Sch. Bip. ex Oliv. and *S. vulgaris* L., have been recorded there as "weeds" (Tadesse, 2004). In Kenya, *S. madagascariensis* was first recorded on a farm near Gilgil, Naivasha District, in the 1980s (Beentje *et al*., 2005). Since then, however, it has spread to the Aberdares, to Nairobi, and possibly also to Eldoret. Being a relatively obscure plant, it is easily either overlooked or confused with similar-looking species.

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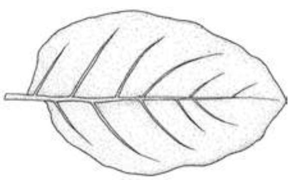
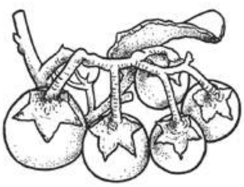
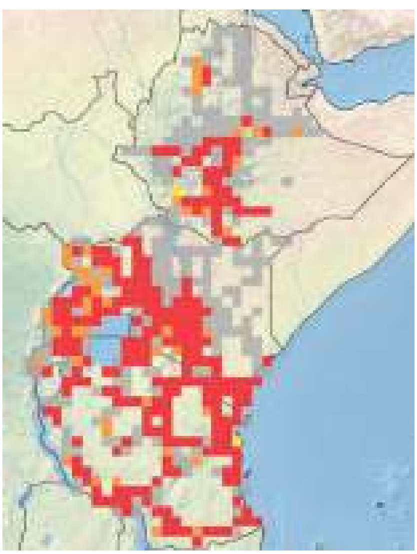
Solanum campylacanthum A. Rich.







TOMATO FAMILY
Solanaceae

SYNONYM
Previously known by the misapplied name *S. incanum* L.

COMMON NAMES
English: bitter apple, poison apple, snake apple, sodom apple, thorn apple
Kenya: etulelo, idi-gaga, lobotwet, mtonda, mtunguja mwilu, mokondu, mutongu, mwilumtunguza-koma, ochok, omotobo
Tanzania: mtua, mtula, ndula
Uganda: ekikokwa, ekitobotobo, entengotengo, etulel, ocokocok, orugusuru

DESCRIPTION
Evergreen herbaceous shrub with an erect stem (0.5–2 m high), and with spines (3–5 mm long) on the leaves, stalks and stems.

Leaves: Upper leaf surface green-grey, lower surface green-white, covered with velvet hairs, egg-shaped with broad end at base, with 2 or 3 shallow-lobed margins, arranged alternately on the stem.

Flowers: Bright purple petals with yellow anthers, held singly or in in pendulous clusters.

Fruits: Berries (fleshy fruits that do not open at maturity), yellow turning black as they mature, round, 1–2 cm in diameter.

ORIGIN
Africa, Middle East and India. In northern Africa, it co-occurs with *S. incanum*.

REASON FOR INTRODUCTION
Considered to be native.

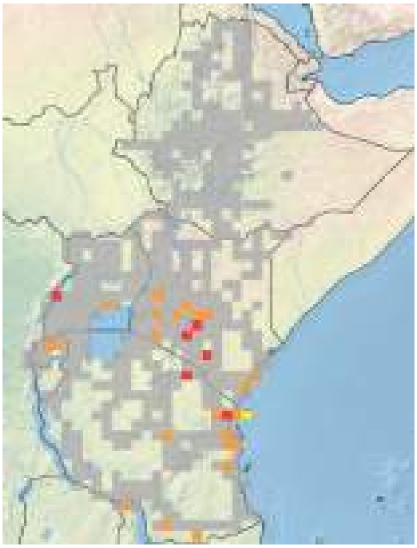
INVADES
Disturbed sites, roadsides, woodlands, riparian areas, forests, open woodlands, pastures, waterways, plantations, crops, gardens and waste areas.

IMPACTS

Can form dense stands, to the detriment of native plants. The unripe fruits are toxic to livestock, although more so to sheep than to goats. Surveys in Ethiopia have shown that it is regarded as one of the most toxic plants (Mekonnen, 1994). In trials, symptoms observed among sheep which had consumed the fruits included bloat, vomiting, hypersalivation, staggering gait, depression and lateral recumbency with leg paddling movements, and death (Thaiyah *et al*., 2011). Symptoms observed in goats included bloat, diarrhoea and shivering (Thaiyah *et al*., 2010).

Notes: It is a common weed of "roadsides, abandoned cultivation, wooded grassland, bushland, dunes and forest edges (Edmonds, 2012). In Ethiopia, it is present in all regions, "along trails in montane forest, evergreen bushland, rarely deciduous bushland, grazed places in montane woodland and grassland and waste places (Friis, 2006). Although considered to be native, *S. campylacanthum* is becoming increasingly widespread and abundant throughout East Africa and Ethiopia.

Sphagneticola trilobata (L.) Pruski



DAISY FAMILY
Asteraceae

COMMON NAMES
English: creeping ox-eye, creeping daisy, creeping wedelia, Singapore daisy

DESCRIPTION
Evergreen creeping, mat-forming herb with a scrambling or climbing habit [15–30 (–70) cm tall]; stems green or reddish (to 2 m long), slightly hairy, rounded, rooting at the joints.

Leaves: Dark green, glossy, almost hairless, fleshy (40–180 mm long and 15–80 mm wide), three-lobed or weakly lobed to entire, sometimes toothed, held opposite each other on the stems, stalkless or on short stalks.

Flowers: Bright yellow to orange, daisy-like (20–35 mm across), borne singly on upright stalks (3–15 cm long).

Fruits: Achenes (small, dry, one-seeded fruits that do not open at maturity), brown, elongated (4–5 mm long).

ORIGIN
Belize, Bolivia, Brazil, Colombia, Costa Rica, Ecuador, French Guiana, Guatemala, Guyana, Honduras, Mexico, Nicaragua, Panama, Peru, Surinam, Venezuela and the Caribbean.

REASON FOR INTRODUCTION
Medicine, erosion control and ornament.

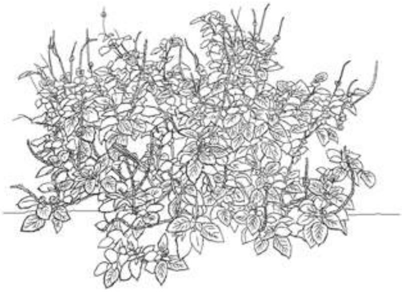
INVADES
Roadsides, disturbed areas, wasteland, drainage ditches, forest edges/gaps, woodland edges/gaps and lowlands.

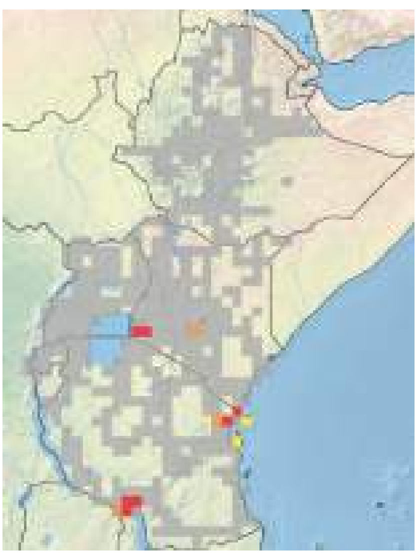
IMPACTS

Forms a dense ground cover, to the detriment of other plant species. Its being allelopathic enhances its competitiveness (Zhang *et al*., 2004). Even low-level infestations have a negative impact on plant diversity. In a study on Hainan Island, China, even a *S. trilobata* cover of 10% was found to have initiated significant declines in the diversity of native plant communities (Qi *et al*., 2014). In South China, the invasive *S. trilobata* co-occurs with a congener *S. calendulacea* (L.) Pruski along riverbanks, coastal areas and other moist habitats but due to its rapid expansion over the last two decades, the distribution and abundance of the native *S. calendulacea* have decreased significantly (Wu *et al*., 2013). In addition, these two species readily hybridize contributing to the further decline of the native species. In southeast Viti Levu and Taveuni Island, Fiji, *S. trilobata* has invaded fields of taro [*Colocasia esculenta* (L.) Schott; Araceae] (Macanawai, 2013). In Florida, USA, *S. trilobata* invades “agricultural areas, along roadsides and trails, along streams, waste places and disturbed sites” (UF/IFAS, 2016). Also recorded as invasive in India, Singapore, Sri Lanka and Taiwan in Asia; Sierra Leone, South Africa and Zimbabwe in Africa; Cuba, Jamaica, Puerto Rico, United States Virgin Islands in the Americas; a large number of Pacific Islands; and Australia (CABI, 2016). Also considered to be invasive in Cambodia and other countries in Southeast Asia (A.B.R. Witt, *pers*. *obs*.).

Notes: Widely grown as an ornamental in East Africa, it has spread from gardens and has established on roadsides and in public open space. According to KHS (1995) “it grows very fast, invasive, rooting where the stems touch the ground. ”In the East Usambaras, Tanzania, it has established on roadsides and is spreading into the forest understorey.

Stachytarpheta jamaicensis (L.) Vahl





VERBENA FAMILY
Verbenaceae

COMMON NAMES

English: blue porter weed, blue snake weed, Brazilian tea, Jamaica snakeweed, porterweed, snake weed
Kenya: mpororo, mupurure

DESCRIPTION

Evergreen shrubby herb (60–120 cm high), young stems green or purplish, mostly hairless and square in cross-section becoming rounded, light brown and woody as they mature; woody rootstock.

Leaves: Green with a bluish or greyish tinge, leathery, hairless or with a few hairs on veins on undersides, simple, leaves egg-shaped, oval or somewhat elongated with almost parallel sides (2–12 cm long and 1–5 cm wide) with rounded tips, margins sharp but finely toothed; leaves opposite each other on stems, on stalks 5–35 mm long.

Flowers: Light blue, blue or mauve, tubular (7–11 mm long and 8 mm across) on long, curved and thick spikes (15–50 cm long and 3–7 mm thick) at the ends of branches.

Fruits: Green turning dark brown, dark purple or black as they mature, small, somewhat elongated with almost parallel sides (3–7 mm long and 1.5–2 mm across).

ORIGIN

Belize, Brazil, Colombia, Costa Rica, Ecuador, El Salvador, French Guiana, Guatemala, Guyana, Honduras, Mexico, Nicaragua, Panama, Surinam, USA, Venezuela and the Caribbean.

REASON FOR INTRODUCTION

Medicine and ornament.

INVADES

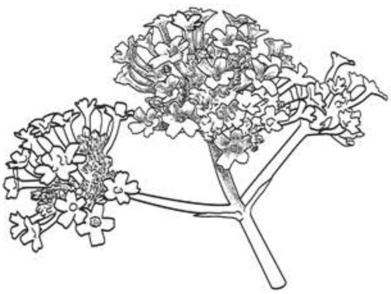
Roadsides, disturbed sites, wastelands, fallow land, plantations, managed pasture, gardens, drainage ditches, savannahs, forest edges/gaps, woodland edges/gaps, lowlands, floodplains and coastal environments.

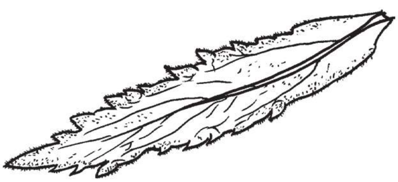
IMPACTS

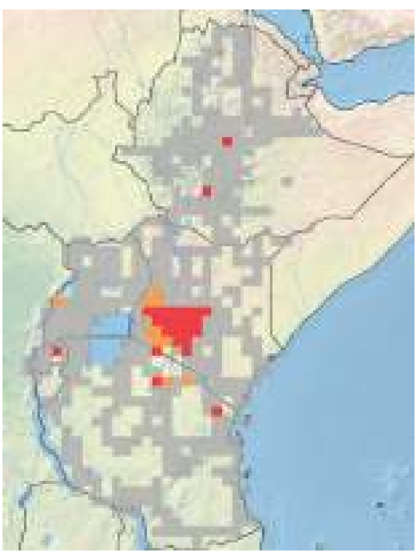
Forms dense stands which can out-compete native plants for water and for nutrients. In Hawaii, it is naturalized in disturbed areas (Wagner *et al*., 1999), and is common along roadsides, in wastelands, and also in pastures in New Guinea (Henty and Pritchard, 1973) and Australia (Holm *et al*., 1997). It is apparently unpalatable to livestock. In India, it is also a probable host for the cucumber mosaic cucumovirus (Mathew and Balakrishnan, 1991).

Notes: Not recorded as being present in Ethiopia (Demissew, 2006). In East Africa, it occurs in seasonally wet grasslands, near villages, and is very common on Zanzibar, occurring in pure stands over large areas (Verdcourt, 1992). A congener, *S. cayennensis* (Rich.) Vahl, is considered to be naturalized in the East Usambaras (Dawson *et al*., 2008), together with *S. urticifolia* (Salisb.) Sims, which is a widespread weed in intact forests (Sheil, 1994). According to PIER (2013), *S. jamaicensis* and *S. cayennensis* readily hybridize, making identification of these two species considerably more difficult. *S. jamaicensis* is invasive and probably far more widespread than indicated.

Verbena bonariensis L.







VERBENA FAMILY
Verbenaceae

COMMON NAMES

English: Argentinian vervain, clustertop vervain, pretty verbena, purple top, tall verbena

DESCRIPTION
Evergreen fast-growing herb (to 2 m high); stems slender, square-shaped in cross-section, rough and hairy; branches spread widely from main stem.

Leaves: Dark green, upper surface coarsely hairy; oval to sword-shaped (7–10 cm long) with pointed tips; margins with forward-pointing sharp projections or teeth; grow opposite each other on the stems.

Flowers: Purple, bluish or lavender-pink, tubular (2.5–3.5 mm long), at the ends of stems, in rounded clusters (5–7 cm wide).

Fruits: Schizocarps (dry fruits that split into one-seeded segments at maturity) (1.3–1.8 mm long), separating into four brown ‘seeds’ when mature.

ORIGIN
Argentina and Brazil.

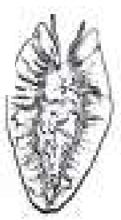
REASON FOR INTRODUCTION
Ornament.

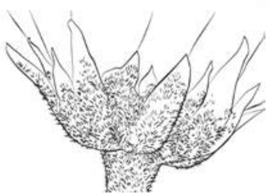
INVADES
Roadsides, disturbed land, drainage ditches, riverbanks, lowlands, forest edges/gaps, woodland edges/gaps and grasslands.

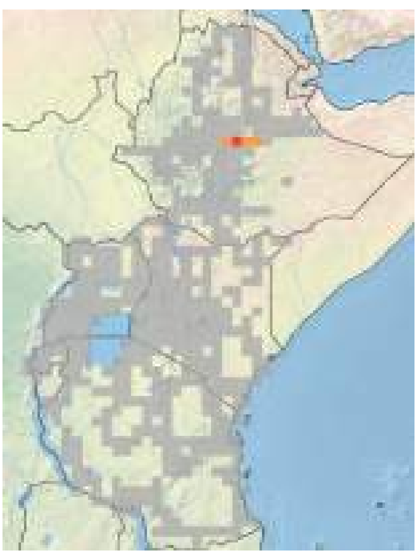
IMPACTS
Can form dense stands which displace native plant and animal species. Once established in disturbed areas, it may persist (Weber, 2003). It reduces the livestock carrying capacities of pastures, and is said to cause abortion and sickness in cattle if consumed. It is naturalized in the southern USA. In Fiji, it is considered to be a weed (Smith, 1991), while in New Guinea it is a weed of wasteland and pastures (Henty and Pritchard, 1973).

Notes: In East Africa, it is a "weed of roadsides, river banks and grasslands with scattered trees" (Verdcourt, 1992). It is cultivated in the Shewa Region of Ethiopia (Demissew, 2006). It is abundant, especially along roadsides and in adjoining grasslands in southern, central and south-western Kenya.

Verbesina encelioides (Cav.) Benth. & Hook. f. ex A. *Gray*







DAISY FAMILY
Asteraceae

COMMON NAMES

English: American dogweed, butter daisy, golden crown daisy, wild sunflower, yellowtop

DESCRIPTION
Annual herbaceous plant (0.3–1.6 m tall), stems covered with fine white hairs.

Leaves: Green, covered with fine white hairs, mainly on the undersides; triangular or egg-shaped with the upper leaves more elongated (4–10 cm long and 1–4 cm wide); margins slightly lobed or sharply toothed; lower leaves held opposite each other on stems, upper leaves held alternately on short stalks.

Flowers: Yellow, resembling small sunflowers (2.5–5 cm across), held singly at the ends of branches, on long stalks (25 cm long).

Fruits: Achenes (small, dry one-seeded fruits that do not open at maturity) (5–8 mm long), brown or greyish-brown, flattened, finely hairy.

ORIGIN
Mexico and USA.

REASON FOR INTRODUCTION
Ornament and accidentally as a contaminant.

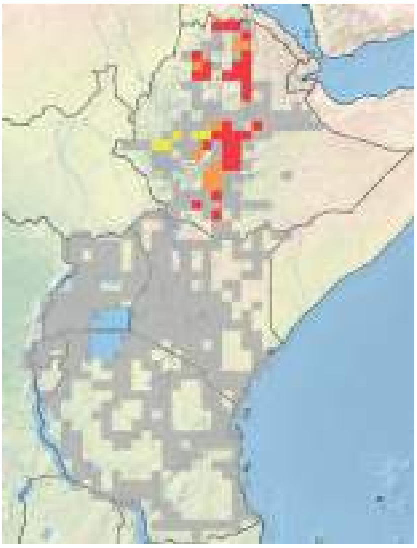
INVADES
Roadsides, disturbed areas, wastelands, urban open space, fallow land, cropland, woodlands, savannahs and grasslands.

IMPACTS

Spreads rapidly, forming dense monospecific stands, to the detriment of biodiversity. In Hawaii, it has reduced habitat quality by shading out native plants and creating a physical barrier to nesting birds (Klavitter, USFWS, *pers. comm*., 2007, in Feenstra and Clements, 2008). There, its aggressive habit is inhibiting the growth of native plants such as *Scaevola taccada* (Gaertn.) Roxb. (Goodenaceae) and *Ipomoea pes-caprae* (L.) R.Br. (Convolvulaceae) (Shluker, 1999; Walther, 2004). On Midway Atoll, *V. encelioides* has “out-competed all 20 extant native plant species, while its infestations have deprived seabirds of nesting habitat” (John Klavitter, USFWS, *pers. comm*., 2007, in Feenstra and Clements, 2008). *V. encelioides* contains the toxic compound galegine, which in Argentina has resulted in the fatal poisoning of livestock (Keeler *et al*., 1992). In the USA, infestations have significantly reduced crop yields, especially of peanuts (Farris and Murray, 2006), while also providing an alternative host for crop pests (Grichar and Sestak, 1998).

Notes: A “recently introduced roadside weed” (Tadesse, 2004), *V. encelioides* can now be found at a number of localities in Ethiopia, where in places it is establishing dense stands. Not seen in East Africa.

Xanthium spinosum L.



DAISY FAMILY
Asteraceae

COMMON NAMES
English: Bathurst burr, burrweed, cocklebur, Spanish thistle
Ethiopia: as sebety, deha, kore buse, kosheshele, torserawit, yeset milas

DESCRIPTION
Annual much-branched herb [30–100 (–120) cm tall]; stems smooth and green or yellowish when young, covered with fine hairs, armed with three-pronged spines (15–50 mm long) at base of each leaf stalk.

Leaves: Upper surfaces blue-green and shiny with prominent whitish veins, lower surfaces pale green and covered with woolly hairs; lower leaves 3- but sometimes 5-lobed; lobes on upper leaves very small or absent, giving the leaves an elongated shape (2–10 cm long and 6–30 cm wide).

Flowers: Yellow-green and rather inconspicuous, in the leaf axils.

Fruits: Burrs, greenish becoming yellowish and brown as they mature, oval-shaped (8–15 mm long and 4–6 mm wide), covered with many small hooked spines (2–3 mm long), stalkless, containing two brown or black seeds.

ORIGIN
Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru and Uruguay.

REASON FOR INTRODUCTION
Accidentally as a contaminant.

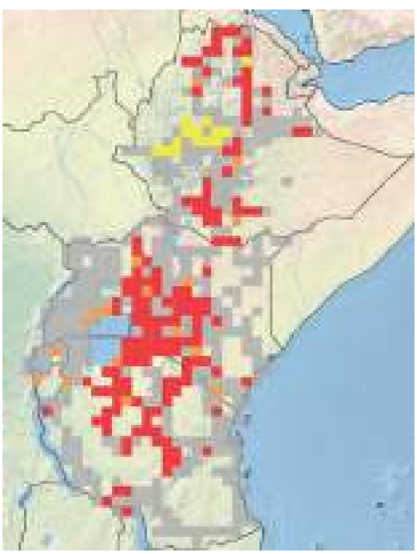
INVADES
Roadsides, disturbed areas, wastelands, fallow land, croplands, plantations, savannahs and riverbanks.

IMPACTS

X. spinosum has the ability to form dense stands, displacing native plant species. It is also considered to be allelopathic. It establishes readily in cultivated land, in pastures and meadows, and on riverbanks, where it may threaten native or endemic wildlife (Pitcher, 1989). Infestations on riverbanks can result in increased soil erosion, affecting water flow and quality. Infestations in croplands have reduced yields of soybeans and cotton (Auld *et al*., 1999), with yield losses of 60–70% reported in the case of soybeans (Mirshekari and Siyami, 2013). In parts of Australia it is common in irrigated crops such as sunflower, soybean, maize and cotton where it also reduces yields through competition (Andrews, 1993), while the spiny fruits lodge in the fleeces of grazing sheep causing significant wool fault. In an attempt to reduce the impacts of Bathurst burr the wool industry spends more than A$ 82 million/year in controlling it (Australian Wool Innovation, 2009). The plant is toxic, especially to pigs and horses (Pitcher, 1989). Severe poisoning can result in convulsions and spasmodic running movements, and death may occur within a few hours or days. People who come into contact with the weed may develop allergic contact dermatitis (Fisher *et al*., 1988). *X. spinosum* is also an important interim host of broomrape [*Orobanche* L. (Lamiales)] (Wilhelm and Benson, 1955), and it can act as a host for a number of fungal diseases of plants, including *Sclerotina minor* Jagger (Sclerotiniaceae).

Notes: Not present in East Africa, but in Ethiopia it is a "weed of irrigated field and roadsides" (Tadesse, 2004) in the Northeast, Northern Highlands, Central Highlands, Southern Rift Valley and Chercher Highlands (Stroud and Parker, 1989). Common in most areas surveyed in Ethiopia.

Xanthium strumarium L.



DAISY FAMILY
Asteraceae

COMMON NAMES
English: large cocklebur, noogoora bur, sheep bur
Ethiopia: adro, attamako, banda, bandoo, gobez, karis-budeexe, nikel, yemoyne fikur

DESCRIPTION
Annual much-branched herb with erect stems (20–150 cm high) without spines; stems stout, green, brownish or reddish-brown, roughly hairy.

Leaves: Green, paler below, hairy on both surfaces; egg-shaped to triangular or broadly three-lobed (2–8 cm long); margins irregularly toothed; held alternately on stems; long leaf stalks [2–8 (–15) cm)].

Flowers: Green, inconspicuous, in the leaf axils.

Fruits: Burrs, green turning yellowish then brown as they mature, cone-shaped (1.5–2.5 cm long), covered with hooked spines (to 20 mm long), with two terminal beaks or horns.

ORIGIN
Uncertain, but probably Central and South America.

REASON FOR INTRODUCTION
Bee forage and accidentally as a contaminant.

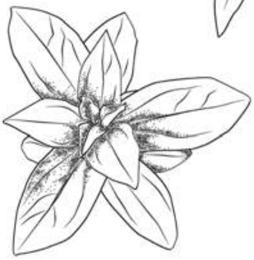
INVADES
Roadsides, wasteland, disturbed land, fallow land, crops, plantations, drainage ditches, savannahs, water courses, lowlands, floodplains and sandy dry riverbeds.

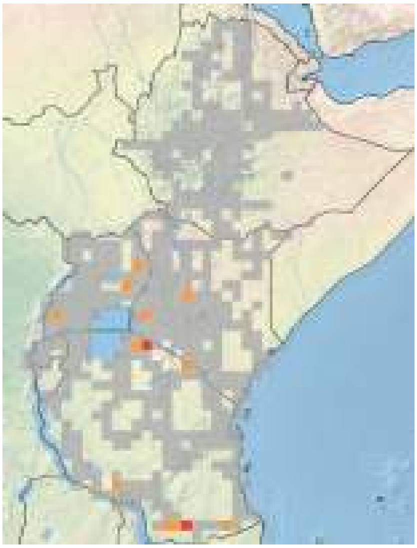
IMPACTS

Rapidly forms large stands, displacing other plant species. *X. strumarium* is a major weed of row crops such as soybeans, cotton, maize and groundnuts in many parts of the world, including North America, southern Europe, the Middle East, South Africa, India and Japan (Webster and Coble, 1997). It also has a damaging impact on rice production in Southeast Asia (Waterhouse, 1993). In the USA, high-density cocklebur infestations have resulted in soybean yield losses of as much as 80 % (Stoller *et al*., 1987; Rushing and Oliver, 1998). Infestations can also decrease soybean seed quality and harvesting efficiency (Ellis *et al*., 1998). Even low-density cocklebur infestations in cotton fields in the USA have contributed to seed yield losses of 60–90 kg per hectare, or roughly 5% (Snipes *et al*., 1982). Cocklebur has also caused yield losses in groundnuts of 31–39% and 88% at low and high densities, respectively, in the southern USA (Royal *et al*., 1997). Cocklebur is also an alternative host for a number of crop pests (Hocking and Liddle, 1986). *X. strumarium* burrs lodge in animal hair and in sheep's wool, reducing the quality and increasing treatment costs (Wapshere, 1974; Hocking and Liddle, 1986). The plants are toxic to livestock and can lead to death if eaten (Weaver and Lechowicz, 1983). In 2007, following a severe food shortage in Bangladesh, a large number of people died after consuming *X. strumarium* (Gurley *et al*., 2010). It can result in allergic contact dermatitis in susceptible humans (Mitchell and Rook, 1979; Weaver and Lechowicz, 1983; Burrows and Tyrl, 1989).

Notes: Common at ruderal sites throughout East Africa (Beentje *et al*., 2005). In Ethiopia, it is a "weed in farmland and along roadside ditches, streams and riverbanks" (Tadesse, 2004) in the Northeast, Northern Highlands, Chercher Highlands, Central Highlands, Southern Rift Valley and Tana Basin (Stroud and Parker, 1989). One of the most widespread and abundant invasive plants in East Africa and Ethiopia.

Zinnia peruviana (L.) L.





DAISY FAMILY
Asteraceae

COMMON NAMES

English: Peruvian zinnia, wild zinnia, zinnia
Ethiopia: cabcabe, gamba-caseeyo

DESCRIPTION
Erect annual herb [20–75 (–90) cm high]; stem green to red-violet, hairless; woody tap-root.

Leaves: Green, rough surface, sword- to egg-shaped (1.5–7 cm long and 5–15 mm wide), margins entire, 3–5 veined at the rounded base; held opposite each other on stems; stalkless or nearly stalkless.

Flowers: Orange to yellow-orange (8–25 mm long and 5–10 mm across), held singly on ends of stems.

Fruits: Achenes (small dry, one-seeded fruits that do not open at maturity), somewhat elongated (10 mm long), crowned with two low tufts of hairs.

ORIGIN
USA, Mexico, Venezuela, Bolivia, Colombia, Ecuador, Peru, Argentina and the Caribbean.

REASON FOR INTRODUCTION
Ornament.

INVADES
Roadsides, disturbed areas, urban open space and savannahs.

IMPACTS

Can spread rapidly, forming extensive stands that may impact on native flora and fauna. It is naturalized in Hawaii (Wagner *et al*., 1999), and invasive in Australia, the Galápagos Islands and French Polynesia (PIER, 2012). It is also naturalized in China, and outside of its natural range in the USA, and regarded as a weed in Ethiopia, Gulf of Guinea Islands, Botswana, Zimbabwe and northern South Africa (Flora of Zimbabwe, 2016). Information on impacts is otherwise limited.

Notes: In Ethiopia, it is present in the regions of Shewa, Bale and Harerge, and is regarded as a "weed in cultivated fields on black cotton soils" (Tadesse, 2004). Invasive but not seen very often in East Africa or Ethiopia during our surveys.

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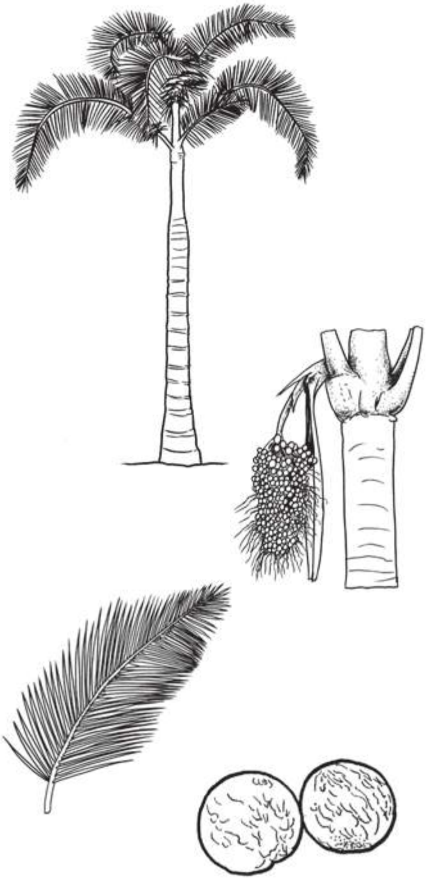
PALMS

Areca catechu L.



PALM FAMILY
Arecaceae

COMMON NAMES
English: areca palm, Betel palm
Kenya: popoo, mpopoo
Tanzania: mpopoo, popoo

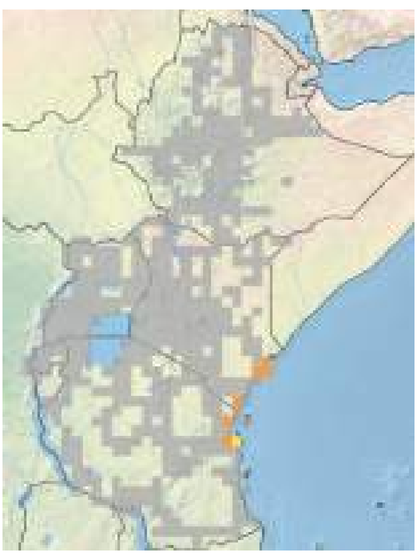
DESCRIPTION
Large palm (to 30 m tall) with a straight trunk (25–40 cm in diameter); crown about 2.5 m wide.

Bark: Green when young, becoming greyish-brown, with conspicuous rings.

Leaves: Green, 8–12 leaves per plant, once-divided (100–150 cm long), each with 30–50 leaflets (30–70 cm long and 3–7 cm wide).

Flowers: Female flowers are green and creamy white (1.2–2 cm long), in a single branched inflorescence, held on the stem just under the crown.

Fruits: Berries (fleshy fruits that do not open at maturity), green turning yellow to orange or scarlet as they mature, smooth, oval to round (5–10 cm long and 3–5 cm wide), containing one seed.



ORIGIN
Indonesia, Malaysia, Myanmar, Philippines, Thailand and Vietnam.

REASON FOR INTRODUCTION
As an ornament, or for its seeds, which are chewed as a narcotic.

INVADES
Disturbed land, forest edges/gaps, forests, watercourses, floodplains and swamps.

IMPACTS
Many palm species are considered to be naturalized, but only 12 palm species are regarded as being invasive in tropical regions and islands (Meyer *et al*., 2008). Of those invasive species, six are grown as ornamentals in East Africa (KHS, 1995). These include species such as the fountain palm (*Livistona chinensis* (Jacq.) R.Br. ex Mart.); California [*Washingtonia filifera* (Linden ex André) H. Wendl. ex de Bary] and Mexican (*W. robusta* H. Wendl.) fan palms; date palm (*Phoenix dactylifera* L.); Cuban royal palm [*Roystonea regia* (Kunth) O.F. Cook]; and Alexander palm, *Archontophoenix alexandrae* (F. Muell.) H. Wendl. & Drude (Meyer *et al*., 2008). Although not present in East Africa (KHS, 1995), the mangrove palm (*Nypa fruticans* Wurmb), which was introduced from Singapore to Nigeria in 1906, is currently displacing the native mangrove vegetation in the Niger delta, and impacting coastal plant communities, causing long-term ecological damage (Sunderland and Morakinyo, 2002). *A. catechu* is shade-tolerant, allowing it to invade undisturbed forest, where it forms large monospecific stands in the understorey, displacing native plants and preventing their regeneration. On the island of Guam, "betel nuts are collected from semi-wild trees in ravine forests", an indication that the species may be naturalized there. It may establish in secondary forests but "never far from cultivation." (Staples and Bevacqua, 2006). In Sri Lanka it forms "naturalized groves" in moist valleys (Staples and Bevacqua, 2006). There are also reports that it is "easily grown" and can withstand extreme temperatures.

Notes: Naturalized in the Amani Nature Reserve, East Usambaras, Tanzania (Dawson *et al*., 2008), and "gone wild" on Lamu and in the Tana River Mouth in Kenya (Beentje, 1994), with one small stand near Gongoni Forest Reserve in Kwale County, Kenya. It is also considered to be invasive in the Jozani Forest on the main island of Zanzibar (Nahonyo *et al*., 2002) where it may be suppressing native vegetation. Also present on Pemba Island (Koenders, 1992).

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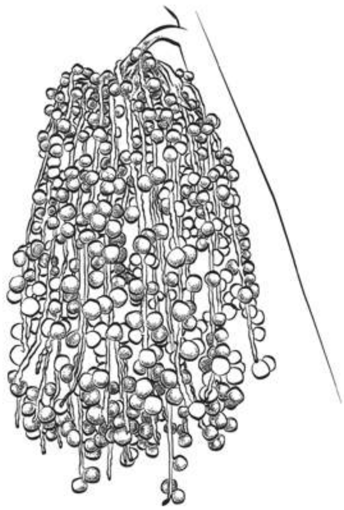
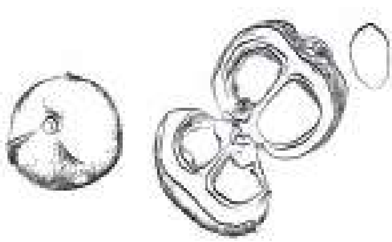
Arenga pinnata (Wurmb) Merr.





PALM FAMILY
Arecaceae

SYNONYM
Arenga saccharifera Labill. ex DC.

COMMON NAMES

English: arenga palm, areng palm, black-fibre palm, gomuti palm, sugar palm
Tanzania: ale, maale

DESCRIPTION
Medium-sized palm [5–20 (–30) m tall] with a straight trunk (30–40 cm in diameter) and a crown about 2.5 m across.

Bark: Green when young becoming greyish-brown, with conspicuous rings and covered with black fibres and spines.

Leaves: Dark green above and whitish beneath, 8–12 leaves per plant, once-divided (6–12 m long and 1.5 m wide), each with 30–50 leaflets (30–70 cm long and 3–7 cm wide).

Flowers: Female flowers are green and creamy white (1.2–2 cm long); in a single branched inflorescence, borne on the trunk, under the crown.

Fruits: Berries (fleshy fruits that do not open at maturity), green turning yellow to orange as they mature, almost round (10 cm long and 5 cm wide), containing 2 or 3 seeds.

ORIGIN
Bangladesh, Brunei, Cambodia, India, Indonesia, Laos, Malaysia, Myanmar, Papua New Guinea, Philippines, Singapore, Sri Lanka, Thailand, Vietnam.

REASON FOR INTRODUCTION
Food, fibre, alcoholic beverage and ornament.

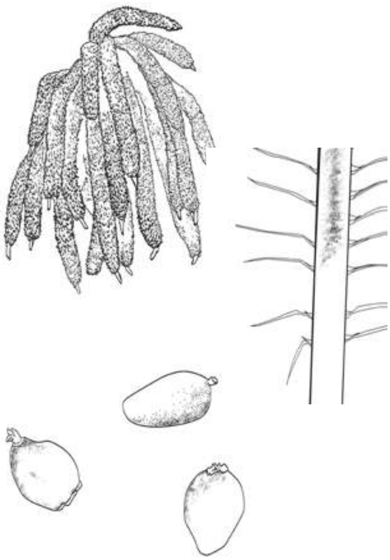
INVADES
Disturbed areas, forests, forest gaps/edges, riparian vegetation and lowlands.

IMPACTS

Has the ability to invade forest gaps and forest understoreys, forming dense stands to the detriment of native plant species. It has invaded secondary floodplain forest in Peninsular Malaysia (Hashim *et al*., 2010). A native congener, *A. obtusifolia* Mart., has invaded about 18,000 hectares of the Ujong Kulon National Park in Indonesia, displacing forage species of value to the endangered Javan rhinoceros (*Rhinoceros sondaicus* Desmarest) (Adhi *et al*., 2012). Removal of *A. obtusifolia* from treatment plots has resulted in a significant increase in the diversity and abundance of food plants, and in increased visitation by rhinos (Adhi *et al*., 2012). In Hawaii, it is naturalized in Lyon Arboretum where it forms dense stands (Daehler and Baker, 2006). It is also considered to be invasive in parts of the Philippines (PIER, 2013).

Notes: It is locally abundant in the Amani Nature Reserve, East Usambaras, Tanzania (Dawson *et al*., 2008). Not found to be naturalized or invasive elsewhere in the region although it may be grown more widely as an ornamental than indicated.

Elaeis guineensis Jacq.



PALM FAMILY
Arecaceae

COMMON NAMES
English: African oil palm, oil palm, macaw-fat
Kenya: mchikichi, mjenga, mchanga, metsengwa, mposi
Rwanda: umukindo
Tanzania: mchikichi, muwese
Uganda: ekingol, enazi, esa, esasa, mba, mubira, munazi, nsasa, omunaasi, tit

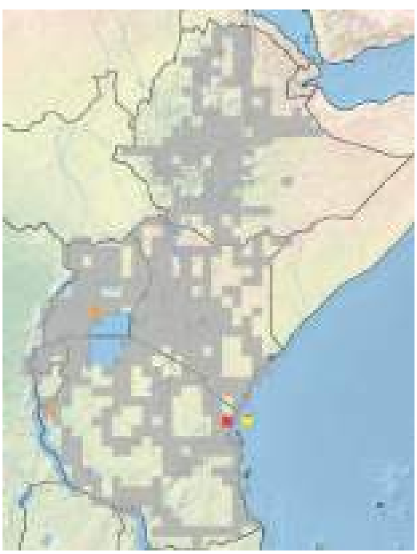
DESCRIPTION
Palm tree (20–30 m tall) with single erect, cylindrical, trunk or stem (22–75 cm in diameter); root system shallow, forming a dense mat in the upper 35 cm of the soil, with only a few deeper roots.

Bark: Spirally arranged leaf bases, no spines, ringed.

Leaves: Green, 40–60 large stalked leaves, once-divided [4–5 (–7.5) m long] with 60–160 pairs of long and linear leaflets (35–65 cm long and 2–4 cm wide), mid-vein prominent, tapering to a point; margins spiny, spirally arranged on the stem; leaf stalk 1–2 m long, clasping the stem at base.

Flowers: Yellow, tiny, in clusters from about every second leaf axil.

Fruits: Drupes (fruits with a stony centre), green turning orange-red as they mature, egg-shaped to elongated (2–5 cm long and 2 cm wide) with pointed ends; held in clusters of 1,000–3,000 fruits, fleshy with oil-producing nuts inside.



ORIGIN
Uncertain, but some consider it to be native to West Africa, along a coastal belt from Liberia to Angola; while others consider East Africa to be part of its natural range.

REASON FOR INTRODUCTION
Palm oil, palm kernel oil, palm wine and ornament.

INVADES
Disturbed land, plantations, forests, forest edges/gaps, swamps and riparian vegetation.

IMPACTS

Has the ability to form dense stands in the understoreys of forests and in forest gaps and edges, to the possible detriment of native plants and associated organisms. It has become very invasive in remnants of the Atlantic Forest in Bahia state, northeast Brazil, where infestations are common in a range of vegetation types, including woodlands and moist, coastal and mangrove forests (Zenni and Ziller, 2011). The African oil palm is naturalized in the Fautaua Valley in Tahiti, and locally naturalized in a wet secondary forest that was once a cultivated area in a deep valley on the island of Raiatea (Society Islands) (PIER, 2013). Also considered to be invasive in Indonesia, Malaysia, the Federated States of Micronesia and French Polynesia (PIER, 2013). Localized invasions have been recorded in Bogor, Indonesia (T. Setyawati, *pers*. *comm*.)

Notes: It was introduced to the Amani Botanical Garden, East Usambaras, Tanzania, where it is now considered to be invasive (Dawson *et al*., 2008). Our surveys confirmed this, along with other documented infestations, on the shores of Lake Victoria in Uganda, which are considered to be adventive.





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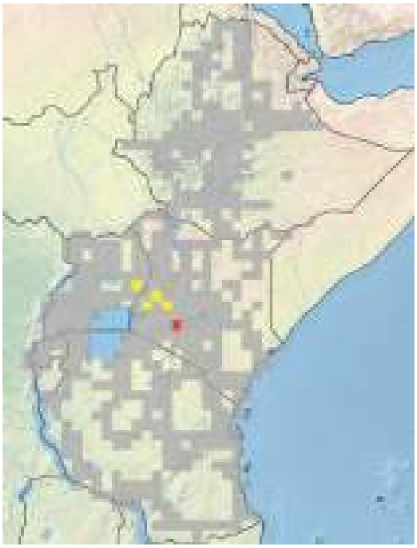
SHRUBS

Ageratina adenophora (Spreng.) R.M. King & H. Rob.



DAISY FAMILY
Asteraceae

SYNONYM
Eupatorium adenophorum Spreng.

COMMON NAMES
English: cat weed, crofton weed, hemp agrimony, Mexican devil

DESCRIPTION
A multi-stemmed evergreen herb or soft shrub [1–2 (–3) m high], young stems green, reddish or purplish covered with sticky hairs, becoming woody and brownish-green or brown when mature.

Leaves: Dark green, diamond-shaped or almost triangular (4–15 cm long and 3–9 cm wide) with toothed margins, three-veined from the base, held opposite each other on stems, on long stalks (about 1–6 cm long), non-aromatic.

Flowers: White flowerheads (5–8 mm across) in terminal clusters at the tips of branches.

Fruits: Achenes (small, dry, one-seeded fruits that do not open at maturity), bristly, (about 2 mm long and 0.3–0.5 mm wide).

ORIGIN
Mexico

REASON FOR INTRODUCTION
Ornament.

INVADES
Roadsides, railway lines, disturbed areas, wastelands, urban open spaces, plantations, forests, forest edges/ gaps, riparian vegetation and lowlands.

IMPACTS

Trailing branches easily root at the nodes on contact with the soil, forming dense, impenetrable stands, resulting in the loss of biodiversity. In Australia, infestations pose a threat to rare and endangered species. It also reduces crop yields, reduces livestock carrying capacities, and restricts movement of livestock and machinery (Sankaran and Suresh, 2013). In Australia, it spread so fast that dairy farmers and banana growers abandoned their land (Auld, 1969, 1970; Holm *et al*., 1991; Parsons and Cuthbertson, 1992). After being introduced to China, there was an initial lag phase of 20 years, after which *A. adenophora* spread rapidly, with an average expansion rate of 20 km/year (Wang and Wang, 2006). It is unpalatable to cattle, and is toxic to horses, which in some cases have readily consumed the plants. *A. adenophora* has been implicated in the death of three horses in Zimbabwe (K. van Laeren, Borrowdale Park Veterinary Hospital, Zimbabwe, *pers*. *comm*. in Botha and Naudé, 2002). After grazing on the flowering plant for a few weeks, horses start to cough frequently followed by "reduced exercise tolerance and signs of chronic emphysema" followed by depression and death (Botha and Naudé, 2002). Wildlife, especially zebras, may also be inclined to feed on this plant with similar consequences, although this has never been demonstrated. It is also a serious weed in many other tropical and sub-tropical regions including Hawaii, West Africa, and South and Southeast Asia (Muniappan *et al*., 2009). In South Africa it invades roadsides, streambanks, forest margins and plantations (Henderson, 2001).

Notes: While present in Kenya and Uganda, it has not become invasive (as it has in southern Africa and elsewhere). As such, it is considered only to be naturalized or nearly invasive within East Africa. Stands have been seen around Mount Elgon and elsewhere in western Kenya, in montane forest, lower bamboo zones, riverine and swamp forest (Beentje *et al*., 2005) and along forest edges (Agnew and Agnew, 1994). A large stand was seen on Crescent Island, Lake Naivasha, Kenya.

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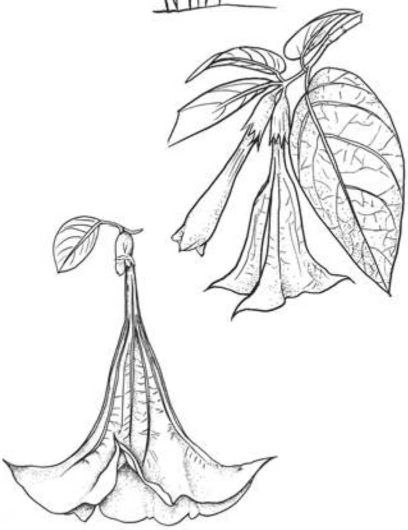


TOMATO FAMILY
Solanaceae

SYNONYM
Datura suaveolens Humb. & Bonpl. ex Willd.

COMMON NAMES

English: moon flower, angel's trumpet
Uganda: maduudu

DESCRIPTION
Shrub or small tree [2–3 (–4.5) m high]; semi-woody with single trunk with many branches.

Bark: Grey-green with prominent small, scattered corky spots or pores and longitudinal streaks.

Leaves: Green, rough surfaces, oval (10–30 cm long and 5–15 cm wide), tips pointed, margins entire or coarsely toothed, held alternately on stem.

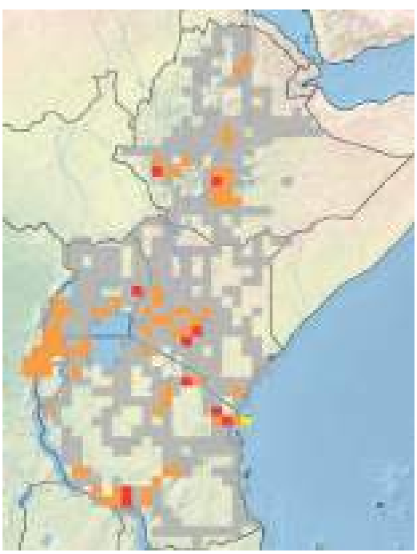
Flowers: White, creamy, yellow and pale orange, sometimes pale pink, trumpet-shaped (20–35 cm long), suspended/pendulous, fragrant and showy.

Fruits: Capsules (dry fruits that open at maturity), green, berry-like, oval to narrow, tapering to a point, spindle-shaped and tapering at each end (9 cm long and 3 cm wide), with four valves or chambers.

ORIGIN
Argentina, Bolivia, Brazil, Ecuador, Paraguay, Peru and Venezuela.

REASON FOR INTRODUCTION
Ornament

INVADES
Road culverts, roadsides, disturbed areas, urban open spaces, plantations, forest edges/gaps and riparian vegetation.

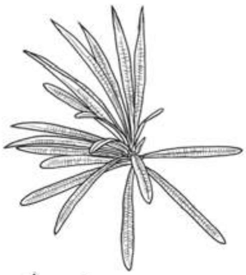


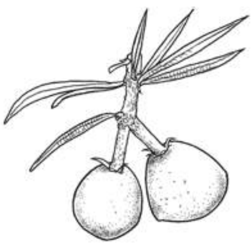
IMPACTS

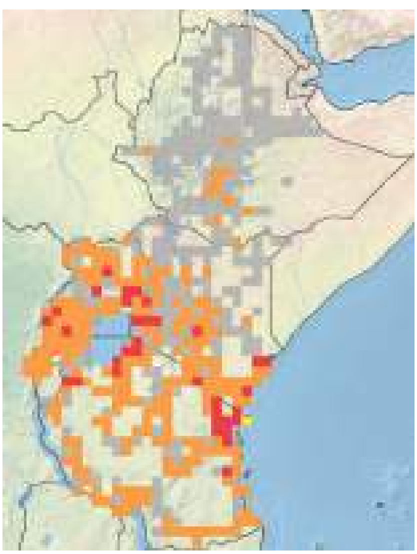
Has the ability to form large monospecific stands in riparian areas, displacing native plant and animal species. In Australia, it can form large colonies that inhibit water flow and impact negatively on native vegetation (Navie, 2012). *B. suaveolens* is also a host for a number of the viruses that cause serious diseases in solanaceous crops such as potato and tomato (Verhoeven *et al*., 2010). The plant is also toxic, with the sap causing vision problems, confusion and elevated heart rates in people who have ingested parts of the plant. In Taiwan, ingestion has been found to cause dizziness, dry mouth, flushed skin, palpitation, nausea, drowsiness, tachycardia, blurred vision and mydriasis (Chang *et al*., 1999). In 1994, 112 teenagers who had ingested *B. suaveolens* in Florida were hospitalized (Roberts and Wink, 1998). The seeds, if consumed by horses, can lead to anorexia, weight loss, thirst, tachycardia, dilated pupils, diarrhoea, excessive urination and death (Pugliese, 2009). Poisoning of pets by *B. suaveolens* has also been reported (Sena Filho *et al*., 2007).

Notes: It is present in the Ethiopian regions of Shewa, Kefa and Sidamo (Friis, 2006). It is considered to be a "successful weed in many East African countries as an escape from cultivation" (Edmonds, 2012). It is most abundant in the high-lying regions of East Africa and Ethiopia, especially in riparian vegetation, where it is often invasive. Probably more widespread and abundant than indicated.

Cascabela thevetia (L.) Lippold







OLEANDER FAMILY
Apocynaceae

SYNONYM
Cascabela peruviana (Pers.) Raf.; *Thevetia peruviana* (Pers.) K. Schum.

COMMON NAMES

English: bestill tree, cook tree, lucky nut, luckynut, Mexican oleander, yellow oleander

DESCRIPTION
Small evergreen shrub or small tree [2–6 (–10) m high], with glossy green, hairless younger stems turning pale brown in older stems; contains milky sap in all parts.

Leaves: Bright green and glossy above, paler below, hairless, long and narrow, sword-shaped (5.5–15 cm long and 4–15 mm wide), mid-vein prominent, and conspicuous, margins downward curving, held spirally on stems, often clustered near the tips of stems, on short leaf stalks (1–4 mm long).

Flowers: Bright yellow or orange, funnel- to trumpet-shaped, spirally twisted (5–7 cm long and 5 cm wide), in clusters at the ends of branches.

Fruits: Drupes (fruits with a stony centre), green and glossy turning black and shrivelling as they mature, triangular with a raised ridge across the middle, slightly fleshy (2–3 cm wide), containing 2–4 flat seeds (35 mm long and 15 mm wide).

ORIGIN
Mexico, Peru and the Caribbean.

REASON FOR INTRODUCTION
Barrier/hedges and ornament.

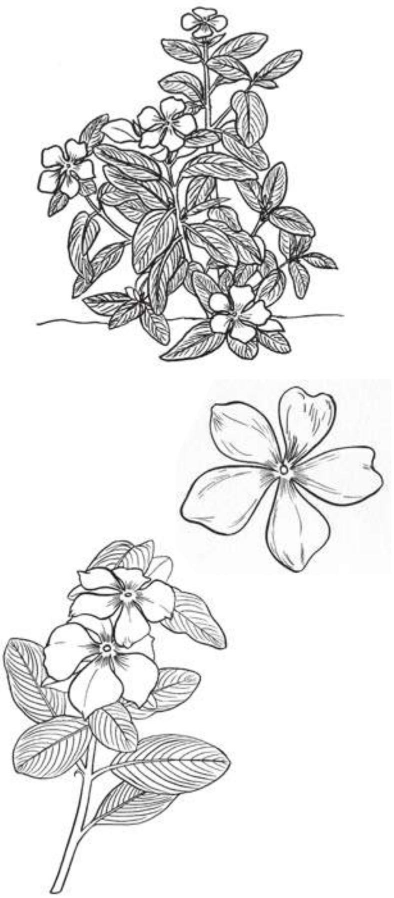
INVADES
Disturbed land, urban open spaces, drainage ditches, savannah, water courses, lowlands, floodplains and gullies.

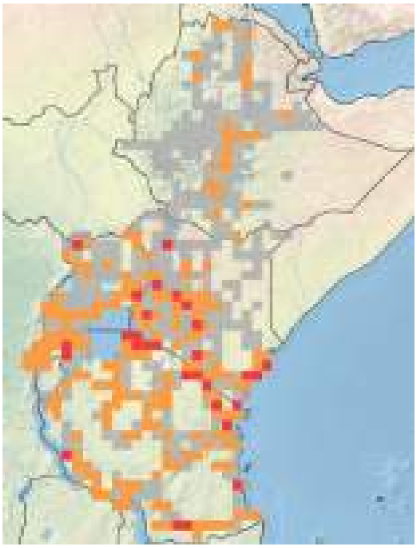
IMPACTS

Yellow oleander forms dense thickets, especially in low-lying areas and along watercourses, displacing native plant and animal species. The plant is extremely toxic. Extracts of the leaves and bark have been found to be toxic to the fingerlings of *Channa punctata* (Bloch) (Channidae) (Singh and Singh, 2000); *Labeo rohita* Hamilton (Cyprinidae) (Singh and Singh, 2010); and *Catla catla* Hamilton (Cyprinidae) (Singh *et al*., 2010); and to be a repellent for *Achatina fulica* (Férussac) (Achatinidae). It is often ingested intentionally by those attempting suicide, with 351 such cases reported in Sri Lanka over a three-year period, and with "thousands" of unreported cases each year, most involving deliberate ingestion by young women (Eddleston *et al*., 1999). In one fatal incident, reported from Cyprus, a tourist from Southeast Asia was seen picking and eating parts of the plant, apparently in order to commit suicide. *C. thevetia* is also allelopathic, suppressing seedling growth in wheat (*Triticum aestivum* L.; Poaceae) (Arora, 2013).

Notes: Although present in the Ilababor Region and elsewhere in Ethiopia, it is not regarded as being problematic (Leeuwenberg, 2003). It is "widely cultivated and naturalized in relict forests along the lower Tana River, Kenya" (Omino, 2002). In Tanzania, it "can become a weed in wetter areas" (Mbuya *et al*., 1994). Surveys found it to be naturalized in many of the areas where it has been cultivated as a living fence, especially along water channels and drainage canals in villages and towns. The banks of the Pangani River near Korogwe, in Tanzania, are dominated by this invasive plant, where it displaces native plant and animal species.

Catharanthus roseus (L.) G. Don





DOGBANE FAMILY
Apocynaceae

SYNONYM
Vinca rosea L.

COMMON NAMES

English: Madagascar periwinkle, rosy periwinkle
Kenya: maua, vinka

DESCRIPTION
Evergreen erect herb or sub-shrub (30–100 cm high); woody at the base, much branched; stems green or dark red, cylindrical and longitudinally ridged or narrowly winged; contain white latex.

Leaves: Bright green, glossy, mid-vein prominent; usually hairy, sometimes hairless, egg-shaped (40–80 mm long and 10–30 mm wide), narrower at base, leaf tip is blunt with a tiny point extending from the mid-vein; short leaf stalk (2.5–9 cm long).

Flowers: Pink or white, solitary or paired, held in the angle between the leaf stalks and stems of the upper leaves.

Fruits: Follicles (dry fruits having one compartment that opens, along one side only, at maturity); easily mistaken for unopened flower buds; green, cylindrical (2–4.7 cm long and 3 mm wide).

ORIGIN
Madagascar

REASON FOR INTRODUCTION
Medicine and ornament.

INVADES
Roadsides, disturbed land, wasteland, drainage ditches, woodland edges/gaps, savannah, rocky outcrops, lowlands, gullies and coastal scrub.

IMPACTS

Rosy periwinkle can form dense stands which may be detrimental to native plant species. It does particularly well in dry savannah areas. In South Africa it invades “riverbanks, rocky outcrops, roadsides, urban areas, open spaces in dry savannah, as well as plantations, forests and coastal scrub margins” (Sztab and Henderson, 2016). It is ranked number 62 out of 200 invasive naturalized environmental weed species in southeast Queensland, and is naturalized on most of the Hawaiian Islands (PIER, 2010). In Fiji, “often found at low elevations escaped and naturalized in clearings, coconut plantations, and waste places, and along roadsides” (Smith, 1988). On other Pacific Islands it is common along roadsides, waste places, and around villages (PIER, 2013). Also invasive on La Réunion Island, Mauritius and Seychelles (PIER, 2013). It is unpalatable to livestock and wildlife. On the Aldabra Atoll, it dominates the low ground vegetation and is not consumed by tortoises (IUCN, undated), probably because it is toxic. Repeated oral administration of *C. roseus* leaf extracts has been found to cause diarrhoea and mortality in rats after few days of treatment (Kevin *et al*., 2012).

Notes: In Kenya, Uganda and Tanzania, it is “widely cultivated and sometimes naturalized” (Omino, 2002). In Ethiopia, it is also cultivated and “naturalized” in the regions of Eritrea West, Shewa, Sidamo and Harerge (Leeuwenberg, 2003). Surveys found it to be naturalized almost everywhere where it has been planted, with large infestations in the Mara Region, Tanzania, and elsewhere. Significant infestations were found around homesteads, on roadsides and in grasslands.

Cestrum aurantiacum Lindl.

TOMATO FAMILY
Solanaceae

COMMON NAMES

English: orange cestrum, orange jessamine, yellow cestrum
Ethiopia: bode
Tanzania: jasmini

DESCRIPTION
Evergreen much-branched, half-climbing shrub [1–2 (–6) m high]; stems and leaves sparsely hairy, bruising easily, emitting an unpleasant smell.

Leaves: Light green, hairless, oval to egg-shaped (7–13 cm long and 2.5–7 cm wide), leaf stalk 1–4 cm long.

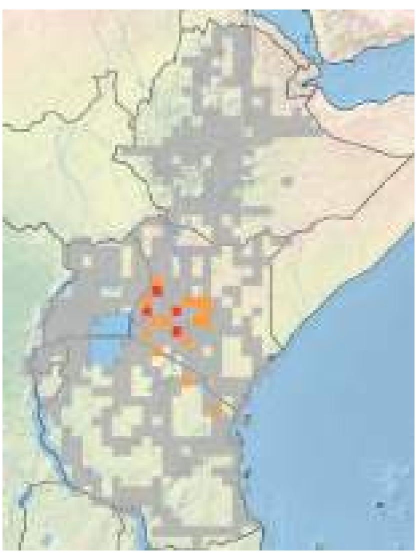
Flowers: Orange-yellow, tubular (17–21 mm long), 10–15 in axillary and terminal clusters.

Fruits: Berries (fleshy fruits that do not open at maturity), white, spongy, round, small (10 mm across).

ORIGIN
Costa Rica, Guatemala, Honduras, Mexico and Nicaragua.

REASON FOR INTRODUCTION
Hedge/barrier and ornament.

INVADES
Roadsides, disturbed land, plantations, drainage ditches, forest edges/gaps, woodlands, savannah, riparian vegetation and gullies.



IMPACTS
Readily ‘climbs’ into trees and over shrubs, smothering native vegetation and impoverishing biodiversity. In Kenya, *C. aurantiacum*, has invaded more than 4,000 hectares of the Cherangani Forest, displacing valuable forage species. However, some newspaper articles referred to this species as *C. parqui*, and as such the true identity of this species remains to be confirmed. *C. aurantiacum* is toxic to people and to livestock and has caused numerous cattle deaths (Edmonds, 2012). The first livestock deaths, as a result of *C. aurantiacum* consumption, were recorded in Kenya in 1948, whereupon it was recommended that it be declared a noxious weed (Thorold, 1950). Cattle that have consumed the plant become tetchy, before becoming paralysed and dying (van der Vlugt *et al.*, 1991). Consumption of the unripe berry is fatal to sheep, and the leaves can lead to non-fatal poisoning (Bizimana, 1994). According to communities in the Cherangani Forest, the species also has a negative impact on bee populations. Also present in woodland and riverine forest in Zimbabwe, where it is considered to be “slightly invasive” in the wetter parts of the country (Flora of Zimbabwe, 2016) and invades forest margins, savannah, plantations and wooded kloofs in South Africa (Henderson, 2001).

Notes: There are no records of its presence in Ethiopia (Friis, 2006). Widely cultivated in East Africa it is an “escape in neglected gardens, old cultivations, roadsides and disturbed montane forest” and is “notoriously toxic to animals and especially poisonous to cattle” (Edmonds, 2012). In East Africa, especially Kenya, it readily escapes cultivation, establishing dense infestations on roadsides and forest edges and gaps. Easily missed when not in flower, and as such probably more widespread than indicated.

Cestrum elegans (Brongn. ex Neumann)

TOMATO FAMILY
Solanaceae

COMMON NAMES

English: crimson cestrum, elegant poison-berry, purple cestrum, red cestrum
Ethiopia: bode
Tanzania: jasmini

DESCRIPTION
Evergreen straggling shrub or small tree [1–3 (–5) m tall]; stems covered with long, simple or branched reddish or purplish hairs; leaves bruise easily, emitting an unpleasant smell; inflorescences sometimes faintly scented.

Leaves: Dark green, hairy when young, oval or egg- to lance-shaped [6–11(–14) cm long and 2–4 (–7) cm wide], bases wedge-shaped, ends with pointed tips, margins entire, held alternately on stems, on leaf stalks (2–) 5–15 mm long.

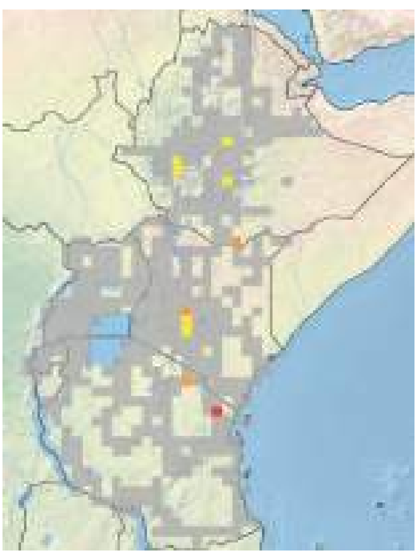
Flowers: Red, pink or violet, tubular (15–23 mm long), in compact nodding clusters.

Fruits: Berries (fleshy fruits that do not open at maturity), green turning dark red to dark purple as they mature, round to egg-shaped (5–13 mm long and 4–9 mm wide), in dense clusters; each containing 2–17 seeds, dark brown (3–4.5 mm long and 1.5–3 mm wide).

ORIGIN
Mexico

REASON FOR INTRODUCTION
Hedge/barrier and ornament.

INVADES
Roadsides, disturbed land, plantations, drainage ditches, forest edges/gaps, woodlands, savannahs, riparian vegetation and gullies.

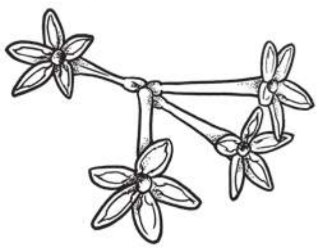


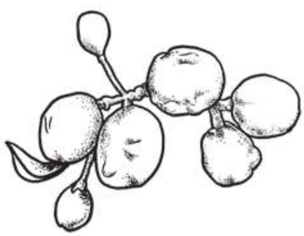
IMPACTS

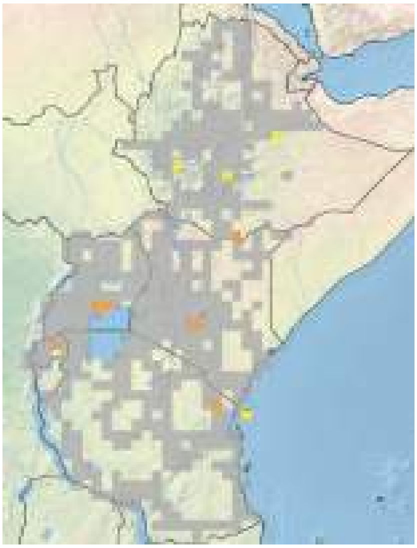
C. elegans can out-compete and displace natural vegetation, to the detriment of native plant and animal species. In parts of Australia, it has "invaded disturbed rainforest margins, moist and wet sclerophyllous forests, urban bushland and creek banks", reducing native wildlife habitats (Environmental Weeds of Australia, 2016). It is also toxic to livestock and to people. Naturalized in Victoria, Australia, it is also present in the coastal and sub-coastal districts of central and northern New South Wales and southeastern Queensland. It is also becoming naturalized in the Democratic Republic of the Congo, Rwanda, Zambia, Malawi, Zimbabwe, South Africa, North Africa, Europe, Sri Lanka and on some Pacific islands (Edmonds, 2012). In South Africa *C. elegans* invades forest margins, savannah, plantations and wooded kloofs (Henderson, 2001).

Notes: In Ethiopia, *C. elegans* is "perhaps sometimes escaped in secondary evergreen scrub around houses" (Friis, 2006), while in East Africa it is considered to be "an escape in disturbed vegetation" (Edmonds, 2012). Plant specimens have been collected in the districts of Naivasha, Kiambu and Nyeri, in Kenya, and in Lushoto District, Tanzania. Our surveys found dense infestations in the East Usambaras, Tanzania; below Sasumua Dam in Kenya; and in Nyungwe Forest, Rwanda.

Cestrum nocturnum L.







TOMATO FAMILY
Solanaceae

COMMON NAMES

English: jessamine, lady of the night, night cestrum, night-blooming jasmine
Ethiopia: bode
Tanzania: jasmini

DESCRIPTION
Evergreen upright woody shrub or small tree [1–4 (–5) m tall]; stems light green, sparsely covered with fine hairs, much-branched, spreading, bending and twining; leaves bruise easily, emitting an unpleasant smell; inflorescences with a strong nocturnal fragrance.

Leaves: Light to dark green, smooth, glossy, elongated and lance-shaped [5–10 (–15) long and 2–3 (7) cm wide], margins entire, leaf stalk 1–1.4 cm long.

Flowers: Greenish to creamy white, tubular (2–2.5 cm long and 1–1.3 cm wide), in dense clusters (10 cm long) at the ends of the branches.

Fruits: Berries (fleshy fruits that do not open at maturity), green becoming white as they mature, round (7–10 mm across), each containing 5–8 seeds (4–5 mm long and 2–2.5 mm wide).

ORIGIN
Belize, Costa Rica, Cuba, El Salvador, Guatemala, Honduras, Mexico, Nicaragua and Panama.

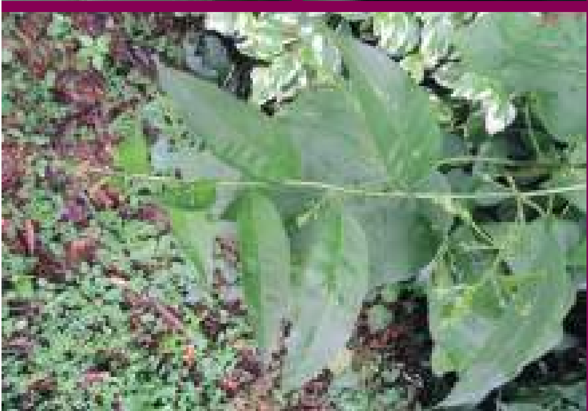
REASON FOR INTRODUCTION
Hedge/barrier and ornament.

INVADES
Roadsides, disturbed land, plantations, drainage ditches, forest edges/gaps, woodlands, savannahs, riparian vegetation and gullies.

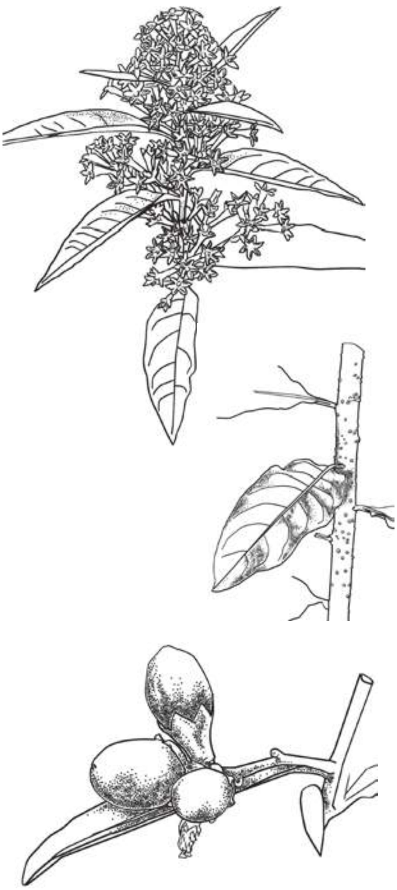
IMPACTS

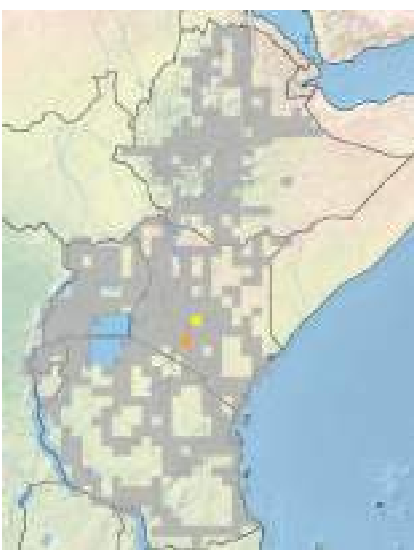
Forms dense stands, to the detriment of native fauna and flora. In New Zealand, *C. nocturnum* has become established in forest understoreys, but has also invaded open forests, forest margins, shrublands and streambanks (Environmental Weeds of Australia, 2016). *C. nocturnum* is thought to be one of the invasive species that drove *Acalypha wilder* Merr. (Euphorbiaceae), a rare endemic species of the Rarotonga Islands, to possible extinction (GISD, 2014). The plant is highly toxic, and its consumption has reportedly resulted in many livestock deaths. The toxicity of a congener, *C. laevigatum*, was first uncovered when livestock died, after consuming the plant, in Chase Valley, just outside Pietermaritzburg, South Africa (Thorburn, 1934). Chase Valley disease, as it became known, causes severe symptoms with the animal struggling and kicking "as if in terrific pain and death seems to come as a welcome relief" (Thorburn, 1934). *C. laevigatum* is also toxic to goats and sheep where the symptoms appear "suddenly and are very severe" leading to death in a few hours (Thorburn, 1934). The flowers *C. nocturnum* emit a strong scent at night, which may contribute to respiratory problems in people, irritation of the nose and throat, headache and nausea. It is also invasive in wet forests and open areas on many Pacific islands. In Australia, it is naturalized in coastal areas of New South Wales (Environmental Weeds of Australia, 2016).

Notes: In Ethiopia, *C. nocturnum* is "perhaps sometimes escaped in secondary evergreen scrub around houses" (Friis, 2006). In East Africa, it is an "occasional escape around villages, sawmills and arboreta" (Edmonds, 2012). Specimens have been collected in Budongo Forest, Uganda, and in the districts of Moshi and Lushoto in Tanzania. It is widely grown as an ornamental and hedge plant throughout East Africa. Occasionally found to have escaped cultivation in Nairobi, Kenya, it is probably more widely naturalized throughout the region than indicated. Mosango *et al*. (2001) considered it to be invasive in Kampala, Uganda.



Cestrum parqui L'Hér.





TOMATO FAMILY
Solanaceae

COMMON NAMES
English: cestrum, Chilean cestrum, Chilean jessamine, green cestrum
Ethiopia: bode
Tanzania: jasmini

DESCRIPTION
Deciduous upright shrub [1–3 (–5) m tall]; much-branched, often suckering; young shoots greenish and finely hairy, newer stems whitish and hairless, older stems woody; leaves bruise easily, emitting an unpleasant smell.

Leaves: Dark green, finely hairy when young becoming hairless and glossy, narrow and lance-shaped (8–11 cm long and 2–4 cm wide), bases wedge-shaped, tips pointed, margins entire, held alternately on stems, on leaf stalks 5–9 (–12) mm long.

Flowers: Yellow or greenish-yellow, tubular (12–25 mm long and 3–5 mm wide), in dense clusters at the ends of the branches.

Fruits: Berries (fleshy fruits that do not open at maturity), green becoming glossy dark purple to blackish as they mature, oval or egg-shaped (10–15 mm long and 6–10 mm wide); seeds dark brown, egg-shaped (3.5–4 mm long).

ORIGIN
Argentina, Brazil, Bolivia, Chile, Peru, Paraguay and Uruguay.

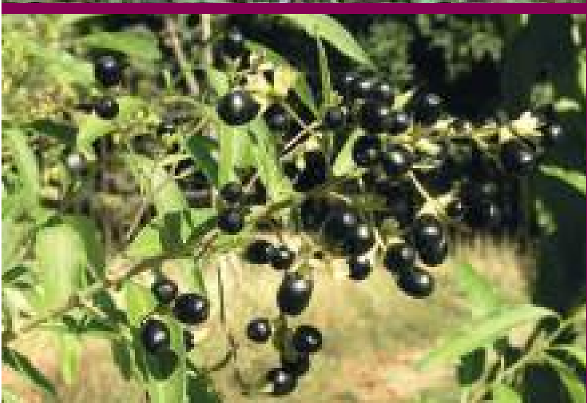
REASON FOR INTRODUCTION
Hedge/barrier and ornament.

INVADES
Roadsides, disturbed land, drainage ditches, forest edges/gaps, woodlands, savannahs, riparian vegetation and gullies.

IMPACTS

Can form dense stands along waterways and on forest edges, out-competing and displacing native plants and preventing their regeneration. Dense stands may also block access to waterways. In Queensland, Australia, *C. parqui* has invaded degraded creek-banks, alluvial floodplains and overgrazed pastures (Environmental Weeds of Australia, 2016). *C. parqui* or *C. aurantiacum*, is reported to have invaded thousands of hectares in the Cherangani Forest, Kenya, where it is commonly known as “chesamisiet” meaning ‘bad thing’ in Kipsigis. Community members are shocked by the vigour and resilience of the plant to “survive and finish off other plants” (Tirop, 2013). According to David Maritim from Keongo village, where the plant is rampant, “it can out-compete and kill other vegetation in less than a year” (Tirop, 2013). *C. parqui* is toxic to animals, including cattle, sheep, horses, pigs and poultry, and skin rashes have been reported among people who have handled the plants. Symptoms of poisoning in cattle include fever, loss of appetite, increased thirst and eventual general paralysis, while in poultry, *C. parqui* has been found to cause acute kidney and liver damage (BQ, 2016). Calves have died within 48 hours of consuming just 30 g of plant/kg bodyweight (McLennan and Kelly, 1984). *C. parqui* is considered to be problematic in the Australian states of New South Wales and Victoria (Environmental Weeds of Australia, 2016). It is naturalized in New Zealand and in some parts of southern USA.

Notes: There are no records of its presence in Ethiopia (Friis, 2006). In East Africa, it is “sometimes an escape”, having been recorded “in open woodlands with Crotalaria” (Edmonds, 2012). It is likely to be invasive and more widespread than indicated.



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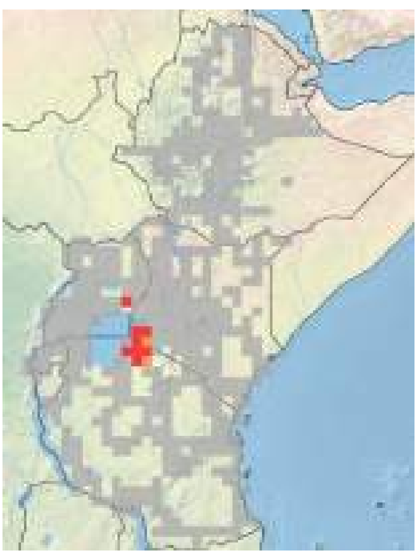
Chromolaena odorata (L.) R.M. King & H. Rob



DAISY FAMILY
Asteraceae

SYNONYM
Eupatorium odoratum L.

COMMON NAMES

English: chromolaena, devil weed, paraffin bush, Siam weed, triffid weed, turpentine weed

DESCRIPTION
Evergreen shrub (3–7 m high), which may take the form of a scrambler when growing among trees, often forming dense thickets; stems yellowish-green, somewhat hairy, woody towards the base, with wide-spreading branches; deep tap-root.

Leaves: Light green, hairy, simple, triangular (5–12 cm long and 3–7 cm wide), tips pointed, margins toothed, 3 conspicuous veins from the base; held opposite each other on stems, smell strongly of turpentine when crushed.

Flowers: Mauve, in cylindrical heads (about 10 mm long and 3 mm wide) clustered at the ends of stems.

Fruits: Achenes (small, dry one-seeded fruits that do not open at maturity), straw-coloured, bristly (4–5 mm long).

ORIGIN
Argentina, Bolivia, Brazil, Colombia, Ecuador, French Guiana, Guyana, Mexico, Surinam, Paraguay, Peru, Southeast USA, Venezuela and the Caribbean.

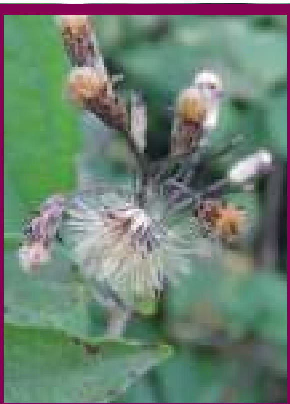
REASON FOR INTRODUCTION
Ornament.

INVADES
Roadsides, disturbed land, wastelands, urban open spaces, fallow land, plantation crops, managed pastures, drainage ditches, forest edges/gaps, savannah, natural pasture, riparian vegetation, lowlands and floodplains.

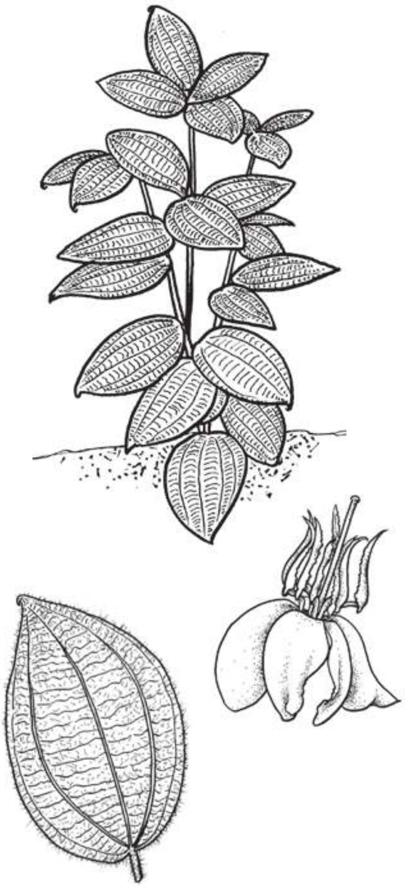
IMPACTS

One mature plant can produce roughly one million seeds per year, which means it can spread very quickly and establish large populations over a relatively short period. Its ability to form dense, impenetrable thickets leads to the displacement of native plant species, while the dry stems and leaves, which are rich in oils, also increase fire intensities (McFadyen, 2004), contributing to additional biodiversity loss. In South Africa, infestations are impacting negatively on the breeding biology of the Nile crocodile (Leslie and Spotila, 2001), while in Cameroon it is displacing native species in the family Zingiberaceae, a major food source for the endangered western lowland gorilla (van der Hoeven and Prins, 2007). In Southeast Asia, it is a serious weed of oil palm, rubber, coffee, cashew, fruit and forestry (Waterhouse, 1993). Some agricultural areas in Southeast Asia "have been abandoned because Siam weed has taken over pasture and crops" (CRC for Australian Weed Management, 2003). It also causes serious health problems in livestock and people (Soerohaldoko, 1971; Sajise *et al*., 1972, 1974; Aterrodo and Talatala-Sanico, 1988), while significantly reducing the livestock carrying capacities of pastures.

Notes: Abundant and widespread in the Mara Region in north-western Tanzania, it is becoming increasingly adventive in southwestern Kenya. Infestations have also been found in Mabira Forest, and elsewhere in western Uganda. Although it has been recorded in Rwanda's Akagera National Park, prior to a reduction in the size of that Park (P. Goodman, Conservation Solutions, *pers. comm*.), it was not seen there during these surveys. In Tanzania it is invading roadsides, savannah habitats, riparian vegetation, open woodlands, forest edges and fallow croplands. Likely that this species is more widespread than indicated, especially in south-western Kenya.



Clidemia hirta (L.) D. Don



TIBOUCHINA FAMILY
Melastomataceae

COMMON NAMES

English: clidemia, Koster's curse, soap bush
Tanzania: uharage

DESCRIPTION
Evergreen shrub [0.5–3 (–5) m tall], branchlets rounded, covered with large reddish-brown hairs/bristles.

Leaves: Light green upper surfaces with a few hairs, lower surfaces more densely hairy, wrinkled or pleated in appearance, simple, oval or egg-shaped (5–18 cm long and 3–8 cm wide) with pointed tips, 5–7 prominent veins from the base running almost parallel; margins finely toothed, held opposite each other on stems.

Flowers: White or sometimes pale pink, in clusters in the leaf forks or tips of branches, on a short flower stalk (0.5–1 mm long); base of flower is swollen into a cup-shaped structure.

Fruits: Berries (fleshy fruits that do not open at maturity), dark blue, purplish or blackish, globular (4–9 mm across), covered in hairs/bristles; seeds light brown (0.5–0.75 mm long).

ORIGIN
Argentina, Belize, Brazil, Bolivia, Colombia, Costa Rica, Ecuador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru and the Caribbean.

REASON FOR INTRODUCTION
Ornament

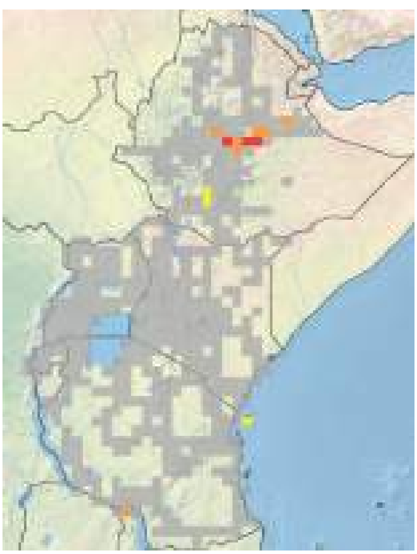
INVADES
Roadsides, disturbed land, wasteland, plantations, managed pasture, forest, forest edges/gaps, woodlands, woodland edges/gaps and riversides.

IMPACTS

This invasive plant has the ability to form dense stands, displacing native plant species. It readily establishes in forest gaps and other disturbed sites, forming "dense and almost impenetrable thickets that shade out all native vegetation due to the large leaves" (Weber, 2003). Smith (1985) has characterized the impacts of *C. hirta* as 'devastating' in Hawaii, where it is threatening endemic species with extinction. In Tanzania, it is suppressing native herbs (Pocs, 1989), while in Fiji it has rendered grazing land useless and is retarding the development of rubber and cocoa plantations. In Southeast Asia, it has invaded orchards, and rubber and oil palm plantations, reducing yields and increasing management costs (Waterhouse, 1993). It came to be known as 'Koster's curse' after being accidentally introduced to Fiji by Koster, and for its subsequent impacts (regarded as a 'curse') on plantation crops. It is also toxic to livestock (Francis, 2004).

Notes: Not recorded as being present in Ethiopia (Gilbert, 1995). In East Africa, more than 40 years ago, it was considered to be a "weed of wayside and open spaces in lowland rainforest, locally dominant" (Wickens, 1975). It is naturalized in the Amani Botanical Garden, East Usambaras, Tanzania (Dawson *et al*., 2008), where our surveys found it to be invasive. It is also abundant on roadsides and forest edges in Shimba Hills National Park, Kenya. Likely to be more widespread and abundant, especially in forested areas, than indicated.

Cryptostegia grandiflora Roxb. ex R. Br



MILKWEED FAMILY
Asclepiadaceae

COMMON NAMES

English: India rubber vine; Palay rubber vine; purple allamanda, rubbervine

DESCRIPTION
Woody climber or many-stemmed shrub [1–3 (–15) m tall], with greyish-brown and slender stems; branched stems (to 2 m long) are leaf-bearing, while unbranched stems are leafless (3–8 m long); stems contain a milky sap; *C. grandiflora* has many, small corky spots or pores on the stems (lenticels), compared to *C. madagascariensis* which has fewer, wart-like lenticels.

Leaves: Dark green and glossy upper surfaces with slightly paler, duller undersides, thick and leathery, oval (6–10 cm long and 2–4 cm wide), margins entire or sometimes slightly wavy, held opposite each other on stems; leaf stalks and midribs on young leaves pinkish, in older leaves white or yellow (5–20 mm long), in contrast to *C. madagascariensis* where the midribs and leaf stalks of young and old leaves are white or yellow.

Flowers: White or very pale pink inside and pale purple to pinkish outside with a much deeper coloured throat, funnel-shaped or tubular [5–6 (–7) cm long and 5–9 cm wide]; *C. madagascariensis* flowers are usually uniformly bright pink or purplish in colour.

Fruits: Follicles (dry fruits having one compartment that opens, along one side only, at maturity), greenish turning brown as they mature, two-horned, three-angled in cross-section (10–12 cm long and 2–4.5 cm wide), held in pairs on one stalk, containing 200–450 brown seeds (5–10 mm long and 1.5–3 mm wide) that are topped with a tuft of white hairs; follicles are generally larger (>10 cm long) than in *C. madagascariensis* (<10 cm long).

ORIGIN

Madagascar

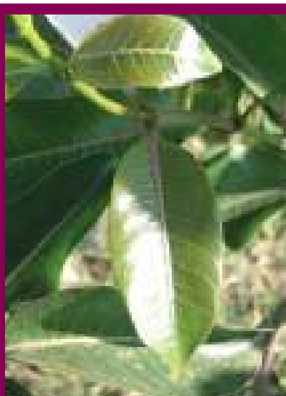
REASON FOR INTRODUCTION
Ornament

INVADES
Roadsides, disturbed land, drainage ditches, woodland edges/gaps, savannah, water courses, floodplains and lowlands.

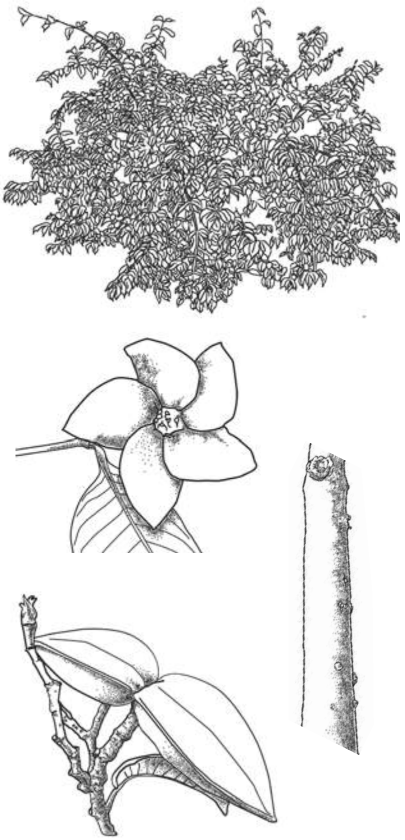
IMPACTS

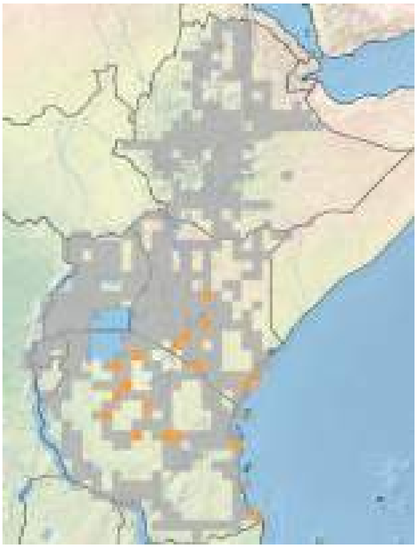
Climbs into trees, smothering native vegetation and often causing canopy collapse, to the detriment of native plant and animal species. Its invasiveness can be attributed largely to its prolific seed production; one large vine can produce more than 8,000 seeds from a single flowering (Grice, 1996). In Australia, *C. grandiflora* was in 1990 estimated to occupy more than 30,000 km^2, "being described as the single biggest threat to natural ecosystems in tropical Australia" (McFadyen and Harvey, 1990). In being able to cover trees up to 40 m high, it has destroyed the upper-storey vegetation, depriving native birds and other endemic animals of important habitats (Humphries *et al*., 1991). It threatens semi-arid monsoonal forest and fragile gallery forest ecosystems, as well as dry rainforest and vine thickets (Humphries *et al*., 1991; Tomley, 1995; Fensham, 1996). Dense infestations can reduce livestock carrying capacities by as much as 100%. The plant contains toxic glycosides which cause heart malfunction as well as stomach and intestinal disorders in both humans and animals (Cook *et al*., 1990; Parsons and Cuthbertson, 1992; Paman, 2008). Economic losses to farmers, through increased management costs and reduced cattle-carrying capacities, have been put at A$ 18 million annually to the north Queensland, Australia, beef industry alone (Agriculture and Resource Management, 2001).

Notes: According to Goyder *et al*. (2003), it is present in the Afar and Shewa regions of Ethiopia and is "naturalized in riverine forest along the Awash River." It is now widespread and abundant in these regions, smothering vegetation, including native *Acacia* species, and is posing a significant threat to biodiversity in the Awash National Park. Goyder *et al.* (2012) claims that it is not present in East Africa "but may have been overlooked". According to KHS (1995) it is present in East Africa. *C. madagascariensis* is widely grown as an ornamental in East Africa.



Cryptostegia madagascariensis Bojer ex Decne.





MILKWEED FAMILY
Asclepiadaceae

COMMON NAMES

English: Madagascar rubber vine, ornamental rubber vine, purple rubber vine, rubbervine

DESCRIPTION

Similar to *C. grandiflora* – woody climber or many-stemmed shrub [1–3 (–15) m tall], with grey or greyish-brown and slender stems; branched stems (to 2 m long) are leaf-bearing, while unbranched stems are leafless (3–8 m long); stems contain a milky sap; *C. madagascariensis* has few, wart-like corky spots or pores on the stems (lenticels), compared to *C. grandiflora* which has many, small lenticels on the stems.

Leaves: Dark green and glossy upper surfaces with slightly paler, duller undersides, thick and leathery, oval or rarely almost round (2–11 cm long and 1.5–5 cm wide), margins entire or sometimes slightly wavy, held opposite each other on stems; leaf stalks and midribs of young and old leaves are white or yellow (4–17 mm long), in contrast to *C. grandiflora* where the midribs and leaf stalks of young leaves are pinkish.

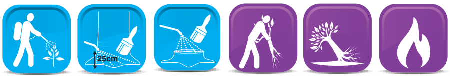
Flowers: Usually uniformly bright pink or purplish in colour, funnel-shaped or tubular (4–5 (–6) cm long and 5–9 cm wide); *C. grandiflora* flowers are generally white or very pale pink inside and pale purple to pinkish outside with a much deeper coloured throat.

Fruits: Follicles (dry fruits having one compartment that opens, along one side only, at maturity), greenish turning brown as they mature, two-horned, three-angled in cross-section (5–9 cm long and 1.4–4 cm wide), held in pairs on one stalk, containing 200–450 brown seeds (5–9 mm long and 2–3.5 mm wide) that are topped with a tuft of white hairs; follicles are generally smaller (<10 cm long) than in *C. grandiflora* (>10 cm long).

ORIGIN
Madagascar

REASON FOR INTRODUCTION
Ornament

INVADES
Roadsides, disturbed land, drainage ditches, woodland edges/gaps, savannah, water courses, floodplains and lowlands.



IMPACTS

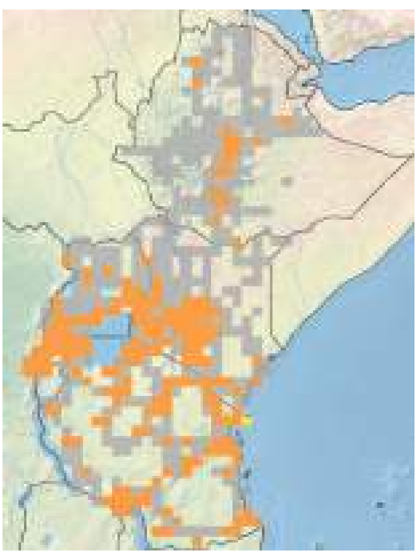
Climbs into trees, smothering native vegetation and often causing canopy collapse, to the detriment of native plant and animal species. Form dense monospecific thickets that can out-compete native vegetation (GISD, 2012). It is thought that the impacts, if this species should also become invasive in Australia, will be similar to those of *C. grandiflora*. In Brazil, *C. madagascariensis* can be found in dry forests, savannah, pasture, and disturbed areas where it usually grows in full sunlight (Silva *et al*., 2008). Invasions in riparian vegetation threaten the survival of the economically important carnauba palm, *Copernicia prunifera* (Mill.) H. E. Moore (Silva *et al*., 2008). This palm, known as the 'tree of life' due to its many uses, is the source of the Carnauba wax, known as the 'queen of waxes'. Some invaded areas are no longer accessible for harvesting and the industry, worth about US$ 120 million a year, is under threat. In Puerto Rico and the Virgin Islands, *C. madagascariensis* invades coastal dry forests. *C. madagascariensis* is already naturalized in Florida and Hawaii (USA), and parts of Australia. In the Northern Territory, Western Australia, and Queensland, it is regarded as a potentially significant environmental weed (Environmental Weeds of Australia, 2016).

Notes: *C. madagascariensis* "may well also be present in Ethiopia" (Goyder *et al*., 2003) but was not seen during surveys. *C. madagascariensis* is widely cultivated in tropical Africa and has "escaped into the wild in coastal grasslands and woodlands in Kenya and Tanzania" (Goyder *et al*., 2012). Occasionally seen as a garden ornamental during surveys; no naturalized plants were ever recorded.





Duranta erecta L.



VERBENA FAMILY
Verbenaceae

SYNONYMS
Duranta integrifolia Tod.; *Duranta microphylla* Willd.; *Duranta plumieri* Jacq.

COMMON NAMES

English: Brazilian skyflower, forget-me-not tree, golden dew drop, golden tears
Rwanda: duranta
Uganda: ekikomamahanga, kawololo, langwila

DESCRIPTION
Usually evergreen, multi-stemmed shrub or small tree [2–4 (–7) m high]; sometimes scrambling, branches with a drooping habit; sometimes with spines in the leaf stalks; branches four-angled.

Leaves: Dark to light green, sparsely hairy to hairless, simple, oval to egg-shaped (15–90 mm long and 12–60 mm wide), margins usually entire but sometimes toothed towards leaf tips; held in pairs on stems or occasionally in whorls of three; two common cultivars, either with white variegation or wholly sickly yellow.

Flowers: Lilac, light blue, pale purple or white, tubular (9–18 mm long), in elongated clusters or sprays (to 30 cm long) at the ends of branches.

Fruits: Berries (fleshy fruits that do not open at maturity), initially green turning orange-yellow as they mature, round or almost round (5–14 mm across), shiny, fleshy, with a curved beak at one end, held in large clusters.

ORIGIN
Argentina, Belize, Bolivia, Brazil, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Surinam, USA, Venezuela and the Caribbean.

REASON FOR INTRODUCTION
Hedge/barrier and ornament.

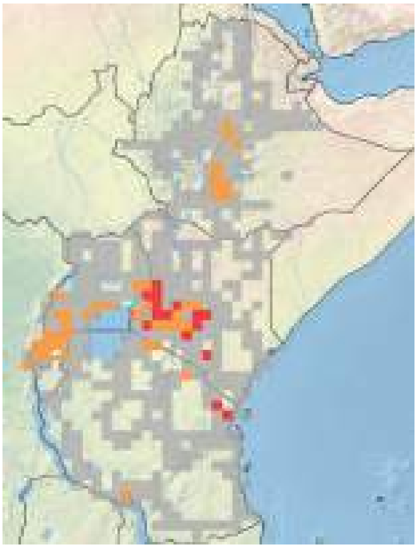
INVADES
Roadsides, disturbed areas, plantations, forest edges/gaps, woodland edges/gaps and riparian vegetation.

IMPACTS

D. erecta has the ability to form dense stands, displacing native plants and the organisms associated with them. It is allelopathic and also has the ability to climb into woodland or forest canopies. Its toxicity has been known for more than 100 years, since ingestion of the fruit was inferred to have killed a two-year-old boy in Queensland, Australia, in the late 19th century (Wheeler, 1895). It has also caused the deaths of numerous pets (Scanlan *et al*., 2006), and has poisoned cattle (Sutherland, 1953). In Zimbabwe, it is spread by birds and is now invasive in “riverine vegetation and on termite mounds, sometimes in woodland and grassland” (Flora of Zimbabwe, 2016). Widely naturalized in the coastal districts of eastern Australia, on Norfolk Island, and possibly naturalized in the Northern Territory (Environmental Weeds of Australia, 2016). Elsewhere it is naturalized in southern USA, Papua New Guinea, the Philippines, India, China, and on several Pacific islands (Environmental Weeds of Australia, 2016).

Notes: “Widely cultivated and naturalized” in East Africa, it is also found “in scrub and riverine thicket, often on termite mounds, *Euclea* and *Olea* forest and clearings” (Verdcourt, 1992), an observation confirmed by Beentje (1994), who found that it “has gone wild in (riverine) forest.” It has also been recorded as present in Kakamega Forest, Kenya (Fischer *et al*., 2010). Present in the Ethiopian regions of Shewa, Welega, Kefa and Hararge, it has not been recorded as naturalized there or invasive (Demissew, 2006). It is considered to be naturalized in the Amani Nature Reserve, East Usambaras, Tanzania (Dawson *et al*., 2008). Widely grown as a hedge plant throughout East Africa and Ethiopia, it was not found to be naturalized or invasive during our surveys, although assessment can sometimes be difficult from roadside observations.

Euryops chrysanthemoides (DC.) B. Nord.



DAISY FAMILY
Asteraceae

COMMON NAMES

English: African bush daisy, daisy-bush, Paris daisy, golden daisy

DESCRIPTION
Evergreen, almost hairless bushy shrub (0.5–2 m tall), with tender stems, much-branched.

Leaves: Deep green, glossy, with greyish, hairy undersides, 7–9 deeply indented lobes (3–10 cm long and 1–3 cm wide) becoming narrower and smaller towards the leaf base, held alternately on stems, clustered towards the tips of branches.

Flowers: Bright yellow, daisy-like (3–4 cm wide), held on long stalks (10–15 cm long).

Fruits: Achenes (small dry, one-seeded fruits that do not open at maturity), black, egg-shaped with narrow end at base (5 mm long and 2 mm wide).

ORIGIN
South Africa

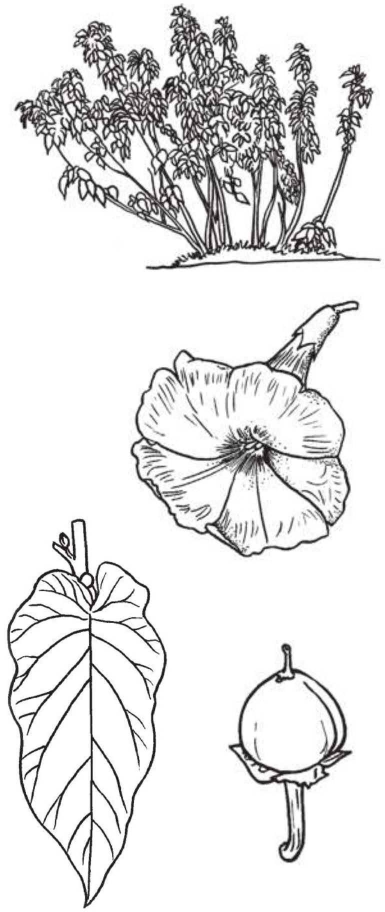
REASON FOR INTRODUCTION
Hedge/barrier and ornament.

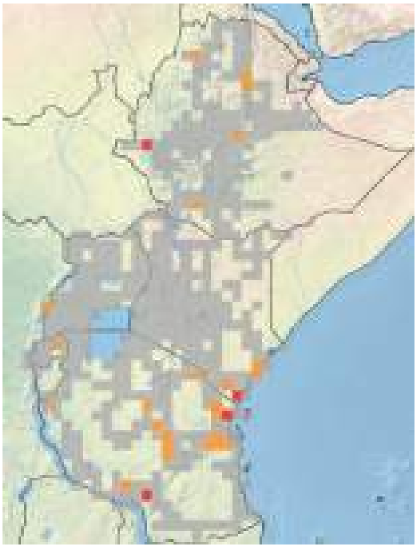
INVADES
Roadsides, disturbed areas, wastelands, urban open spaces, gardens and forest edges/gaps.

IMPACTS
Rapidly forms dense stands, which may displace native plant and animal species. It has been recorded as a garden escape in Harare, and has invaded disturbed forest near Penhalonga, Zimbabwe (Flora of Zimbabwe, 2016). Also recorded as a ruderal weed in New South Wales, Australia.

Notes: There is only one report, from near Kaimosi in Kenya (Beentje *et al*., 2005), of it becoming established in East Africa. Our surveys, by contrast, found large monospecific stands on roadsides and forest edges in many highland localities, especially in Kenya.

Ipomoea carnea Jacq. ssp. *fistulosa* (Mart. ex Choisy) D.F. Austin





MORNING GLORY FAMILY
Convolvulaceae

SYNONYM
I. fistulosa Mart. ex Choisy

COMMON NAMES

English: bush morning glory, morning glory tree, pink morning glory
Ethiopia: awir, gewo

DESCRIPTION
Evergreen, erect to climbing or scrambling shrub (to 3 m high) with hairless woody stems, hollow at the base, soft at the tips.

Leaves: Dull green on upper surface, paler below, hairy but sometimes hairless, thick or slightly fleshy, heart- to egg-shaped (13–23 cm long and 5.5–9.5 cm across), sometimes slightly lobed with pointed tips, margins entire, held alternately on the stems, leaf stalks 5–18 cm long.

Flowers: Deep pink to rose purple, large, trumpet-shaped (7–15 cm long and 10–15 cm wide), in several-flowered clusters, or occasionally singly, in the leaf forks, mainly at the branch tips.

Fruits: Capsules (dry fruits that open at maturity), hairless, small (2–3 cm long) with pointed tips, splitting open to release four large, hairless whitish-coloured seeds (about 10 mm long).

ORIGIN
Argentina, Bolivia, Brazil, Colombia, Costa Rica, Guyana, Guatemala, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru and Venezuela.

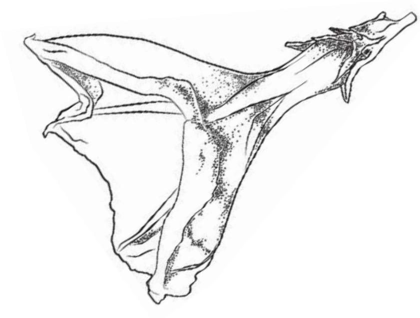
REASON FOR INTRODUCTION
Barrier/hedge and ornament.

INVADES
Roadsides, disturbed areas, wastelands, drainage ditches, savannah, lowlands, gullies and riversides.

IMPACTS

Often grown as a hedge plant, *I. carnea* has the ability to form dense stands, displacing native plant species. It is regarded as invasive in South Africa, and as naturalized in Zimbabwe. In Egypt, it has been recorded as naturalized along canals and drains, roadsides, railways, wastelands and field edges in the Nile Delta (Boulos, 1995; El-Sheikh, 1996; Al-Sodany, 1998), where it forms pure and/or mixed stands, and where invaded areas have been found to support fewer plant species (27) than uninvaded areas (50) (Sadek, 2014). It is also considered to be allelopathic (Sadek, 2014). The shrub is toxic, containing several alkaloids. In feeding trials in Argentina, five goats received fresh leaves and stems of *I. carnea*. At first, the goats did not consume the plant, but later it was preferred over any other, resulting in rapid intoxication. Clinical symptoms most commonly observed in ruminants, within one month after ingesting *I. carnea*, include lethargy, muscle tremors, dilated pupils, weakness of the hind limbs, severe incoordination, wasting and recumbence; all primarily associated with dysfunction of the central nervous system (Tokarnia *et al*., 2002; Haraguchi *et al*., 2003).

Notes: It is sometimes an "escape in open degraded woodland" in the Ethiopian regions of Eritea East, Shewa, Gonder, Gojam and Ilababor (Demissew, 2006). This was confirmed during surveys, which found that it is now invasive in many of these regions in Ethiopia, especially on roadsides, in drainage channels and gullies. The subspecies *I. carnea* subsp. *carnea* is "widely cultivated in Nairobi and some have escaped" (Verdcourt, 1963).



FAMILY
Morning glory

COMMON NAMES
No known common names

DESCRIPTION
Evergreen sub-woody shrub (1–4 m tall) with hairy stems.

Leaves: Green, hairless above with very short, fine hairs below, veins and margins with silvery hairs, ovate to broadly elliptic (2–22 cm long and 3.5–17 cm wide), base rounded or terminates almost abruptly or sometimes almost heart-shaped; leaf stalks 2.5–20 cm long.

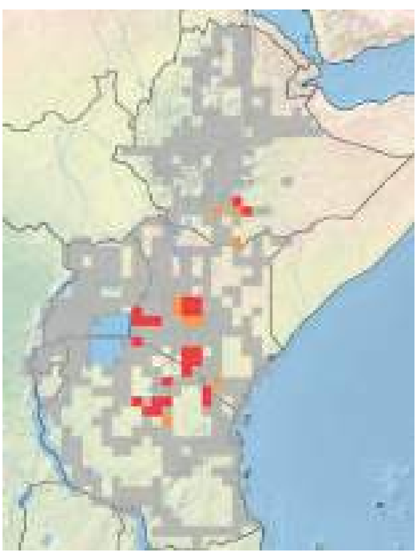
Flowers: White, purple, or white with a purple centre (4–11.5 cm long).

Fruits: Capsules (dry fruits that open at maturity), rounded (12–17 cm across); seeds almost round, angular (7–8 mm long and 5–6 mm wide).

ORIGIN
Kenya, Tanzania, Uganda, Ethiopia, Democratic Republic of the Congo and Rwanda.

REASON FOR INTRODUCTION
Native to the region but often grown as an ornamental.

INVADES
Roadsides, wastelands, overgrazed rangelands and savannah.

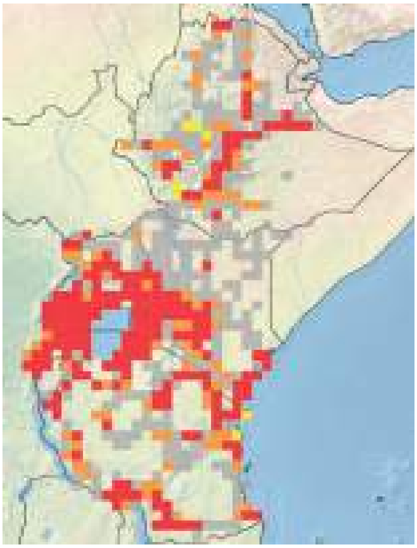


IMPACTS

Although native to the region, *I. hildebrandtii* has become extremely abundant on some rangelands in East Africa, possibly as a result of overgrazing and in the absence of fires. In a rangeland study in Kenya, removal of *I. hildebrandtii* was found, in the absence of grazing, to increase grass biomass by 47%, whereas in the presence of grazing the grass biomass declined by 28% (Mworia *et al*., 2008). Local communities, when interviewed, claimed that the weed was reducing pasture and denying access to land; that it was tainting honey produced in the area (making this bitter and causing dizziness once consumed); that it was causing flu during flowering; and that its flowers are toxic to livestock and even to poultry (Bosco *et al*., 2015).

Notes: Widespread and abundant in many parts of Kenya, especially areas that have been overgrazed. Very common as a roadside and rangeland weed in Kajiado County, Kenya.

Lantana camara L.



VERBENA FAMILY
Verbenaceae

COMMON NAMES

English: curse of India, lantana, Spanish flag, tickberry, prickly lantana, white sage
Ethiopia: burkaati, hamaressa, rate kate, shimbero, qarfa-weyn, yewof kolo
Kenya: bek ap tarit, enkurma-onkayiok, lukurman-oonkayiok, lumenenambuli, magwagwa, mbisavisi, mukenia, musyavisi, muvisavisi, mvepe, mwemberi, niembaemba, nyabend-winy, nyamridhi, nzavisi, obengele, olmagirigiriani, petiapteriet, pipterit, sekechewo, seketeti
Rwanda: akateye
Tanzania: mjungwa, msasa-kilasha
Uganda: abelwinyo, akayuukiyuuki, elantaana, jerenga, kapanga, mushekyera, obwengere, ogwamahwa, omuhuki

DESCRIPTION
Compact, scrambling long-lived shrub (to 2 m or higher), forming dense thickets; stems usually green turning grey or brown with age, square in cross-section with short hairs and hooked/recurved prickles/thorns.

Leaves: Dark green, rough, hairy, simple, egg-shaped with pointed tips (2–13 cm long and 1.5–7 cm wide), margins toothed/rough, wrinkled appearance, grow opposite one another on stems, smell strongly when crushed.

Flowers: Small red, pink, crimson, orange, yellow or white, in dense clusters (2–4 cm) across, each with about 20–40 flowers, on stalks (2–10 cm long); individual flowers are tubular (9–14 mm long and 4–10 mm across).

Fruits: Berries (fleshy fruits that do not open at maturity), initially shiny green turning purplish-black when mature (5–8 mm across), one-seeded.

ORIGIN
Bahamas, Colombia, Costa Rica, Cuba, Hispaniola, Jamaica, Mexico and Venezuela.

REASON FOR INTRODUCTION
Hedging/barrier and ornament.

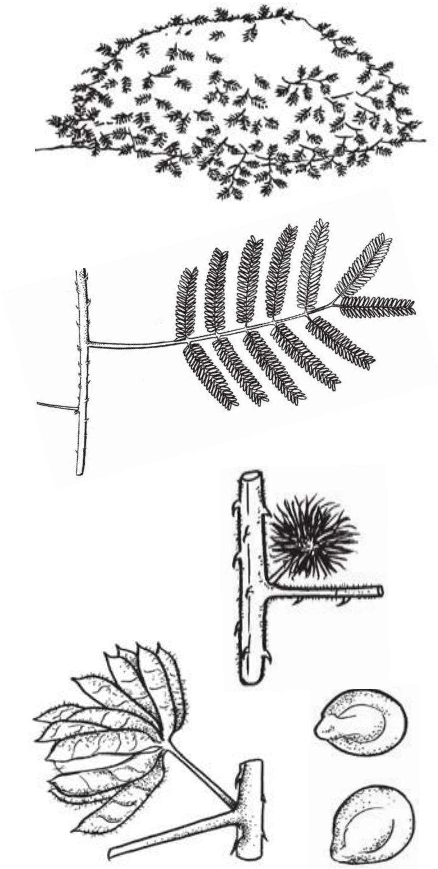
INVADES
Roadsides, railways, disturbed land, wasteland, plantations, managed pasture, drainage ditches, forest edges/gaps, woodland edges/gaps, grassland, savannah, riparian vegetation, lowlands and gullies.

IMPACTS
Lantana forms dense, impenetrable thickets, reducing biodiversity and threatening a host of rare and endangered species. In Australia, Turner and Downey (2010) identified 275 native plant species and 24 native animal species which are threatened by the presence of lantana. In crop production systems in Southeast Asia, lantana has both reduced yields and increased management costs incurred by growers of durian, pineapples, bananas and rubber (Waterhouse, 1993). Lantana is also toxic to livestock, causing pastoral losses that in Queensland, Australia, were in 1985 estimated at A$ 7.7-million, and which included 1,500 animal deaths, reduced productivity, loss of pasture, and higher control costs (van Oosterhout, 2004). In South Africa, lantana poisoning accounts for about 25% of all reported cases of livestock poisoning by plants (Wells and Stirton, 1988). There have even been recorded fatalities in people, especially children, after consuming the green fruit. Lantana can also alter fire regimes, allowing fires to penetrate into forests and woodlands.

Notes: Widespread in East Africa (Verdcourt, 1992), lantana is now a “serious weed on roadsides and in secondary vegetation” (Beentje, 1994). In Ethiopia, it is widely grown as an ornamental, and is considered to be “naturalized in some open disturbed areas” (Demissew, 2006). It is widespread and abundant throughout East Africa and Ethiopia, especially in higher-rainfall areas along roadsides, in riparian vegetation, savannah, woodlands, and forest edges and gaps.




Mimosa diplotricha Sauvalle



PEA FAMILY
Fabaceae; sub-family: Mimosaceae

SYNONYM
Mimosa invisa C. Mart

COMMON NAMES

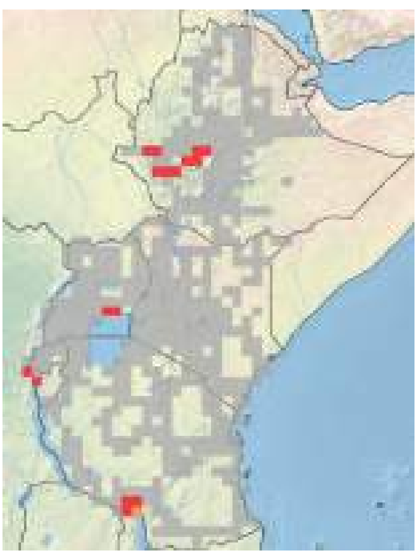
English: creeping sensitive plant, nila grass, tropical blackberry
Tanzania: mgambu, mgama, nguvurukundu, mntobwe, msesi, mseziluguru, mdulu, ngambo

DESCRIPTION
Scrambling, strongly-branched climbing shrub; annual, biennial (living for more than one year but for less than two years) or evergreen; forming dense thickets [2–3 (–6) m tall], becoming woody at the base with age; stems green or purplish-tinged, 4–5-angled in cross-section, covered with sharp, recurved yellowish spines (3–6 mm long).

Leaves: Bright green, twice-divided (10–20 cm long), 4–9 pairs of leaflet branchlets each with 12–30 pairs of small elongated leaflets (6–12 mm long and 1.5 mm wide) with pointed tips; leaves fold together at night or when touched.

Flowers: Pinkish-violet or purplish, round heads (12 mm across), borne singly or in small groups on hairy stalks (3.5–16 mm long).

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning brown as they mature; flat, with softly spiny edges, elongated (8–35 mm long and 3–10 mm wide); held in clusters that break into one-seeded joints; seeds light brown (1.9 mm long and 2.7 mm wide).



ORIGIN
Bolivia, Brazil, Colombia, Costa Rica, Cuba, Ecuador, El Salvador, French Guiana, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Panama, Peru, Paraguay, Puerto Rico and Venezuela.

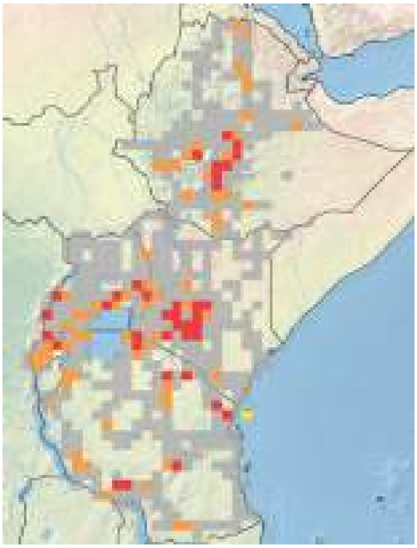
REASON FOR INTRODUCTION
Erosion control, nitrogen fixation, bee forage, hedge/ barrier and ornament.

INVADES
Roadsides, disturbed areas, wastelands, urban open spaces, crops, plantations, managed pasture, drainage diches, woodland edges/gaps, forest edges/gaps, woodland edges/gaps, savannahs, lowlands, wetlands and gullies.

IMPACTS
Smothers other plants, shading out light-demanding species and preventing their natural regeneration. Dense stands may prevent or inhibit the movement of livestock and wildlife. In Nigeria, *M. diplotricha* densities have reached 630,000 plants per ha, reducing cassava-root yields, 12 months after planting, by 80% (Alabi *et al*., 2001). The species readily invades orchards and rice paddies, reducing yields and increasing management costs (Waterhouse, 1993). Invaded cattle ranches in the Markham Valley, Papua New Guinea, are spending up to US$ 130,000 annually on chemical control (Kuniata, 1994). It is apparently also toxic to livestock. In Thailand, 22 swamp buffaloes died 18–36 hours after eating *M. diplotricha* (Tungtrakanpoung and Rhienpanish, 1992). Trials in Queensland, Australia, have indicated its toxicity to sheep, and a report from Flores, Indonesia, suggests that it is also toxic to pigs (Parsons and Cuthbertson, 1992).

Notes: Present in the Ethiopian regions of Ilubabor and Kefa, where it is widely grown as a hedge (Thulin, 1989). Subsequent surveys have revealed that it is one of the most invasive plant species in these regions of Ethiopia and in southern Tanzania, especially around the northern shores of Lake Malawi. Specimens have also previously been collected in the Moshi District of Tanzania. It is abundant on roadsides, in disturbed areas and in urban open spaces and has established stands in savannah, plantations, forest edges and gaps, and lowland habitats.

Mirabilis jalapa L.



FOUR O'CLOCK FAMILY
Nyctaginaceae

COMMON NAMES
English: beauty of the night, false jalap, four o'clock flower, marvel of Peru
Ethiopia: harmele kobera, harmal dima, ilili dimtu
Rwanda: karifuma
Uganda: dodofolome

DESCRIPTION
Evergreeen herb or shrub (0.5–2 m high); stems erect with multiple spreading branches; roots tuberous.

Leaves: Dark green, simple, egg-shaped (3–10 cm long), bases broad and rounded, tips pointed; held opposite each other on the stems, on leaf stalks about 4 cm long.

Flowers: White to red, yellow or striped, tubular or trumpet-like, five-lobed (6.5 cm long and 3.5 cm wide), single but sometimes held in clusters of 3–7, fragrant.

Fruits: Capsules (dry fruits that open at maturity), tiny, one-seeded.

ORIGIN
Peru

REASON FOR INTRODUCTION
Ornament

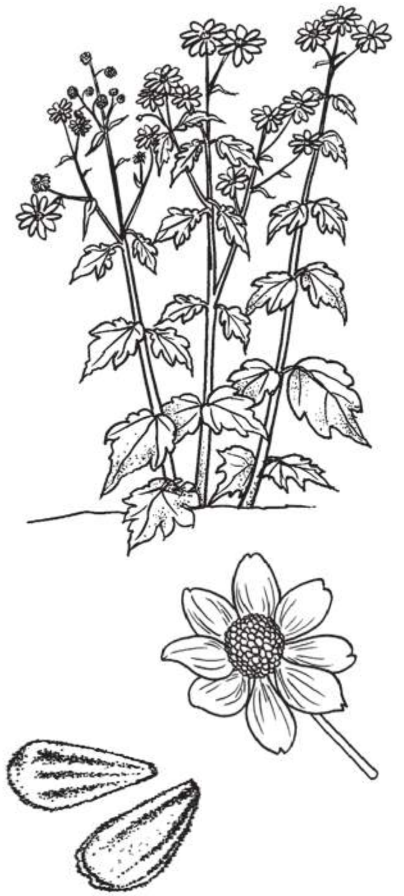
INVADES
Roadsides, disturbed areas, wasteland, drainage ditches, edges of irrigation channels, lowlands, riversides, swamps and gullies.

IMPACTS

Forms dense stands which may displace native plant species, especially in areas with moister soils. Being allelopathic, *M. jalapa* inhibits the germination and growth of other plant species (Anaya and Pelayo-Benavides, 1997). Both the roots and the seeds are poisonous. Symptoms of ingestion by people may include abdominal pain, dermatitis, vomiting, nausea, diarrhoea and hallucinations (ISSA, 2016). Consumption can also cause gastroenteritis in children (Lewis and Elvin-Lewis, 2003). May also be toxic to wildlife. In Hawaii, naturalized in dry, disturbed areas (Wagner *et al*., 1999), and in cultivated fields, including canefields, in Fiji (Smith, 1981). Considered to be invasive on many other Pacific Islands, China, New Zealand and Seychelles (PIER, 2011).

Notes: It is becoming increasingly widespread in the region, especially in areas with moist soils. In Ethiopia, it is "locally common in disturbed areas along roads and near habitations" in the Shewa and Harerge regions (Gilbert, 2000a). In East Africa, it is "naturalized in cultivation, on waste ground and around habitation" (Whitehouse, 1996), an observation supported by our surveys which found it to be abundant on roadsides, urban open spaces and low-lying areas with sufficient soil moisture.

Montanoa hibiscifolia Benth.



DAISY FAMILY
Asteraceae

COMMON NAMES

English: tree daisy, bush daisy, montanoa
Kenya: onunga, mutare, ndae, kitae, mfurusadi, mforsadi
Tanzania: mlobe

DESCRIPTION
Evergreen, hardly branching shrub [2–4 (–6) m tall].

Leaves: Dark green above and paler below, softly hairy on both surfaces, egg-shaped with broad end at base (10–25 cm long and 6–20 cm wide), deeply 3–9-lobed but upper leaves sometimes not lobed, pair of projections or wings on leaf stalk (2–20 cm long).

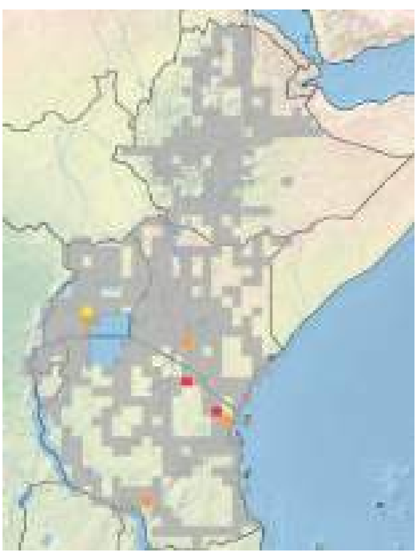
Flowers: White with a yellow centre (4 cm across), often held in terminal, branched inflorescences.

Fruits: Achenes (small, dry one-seeded fruits that do not open at maturity), reddish-brown, winged (10 mm long), held in the rounded, papery old flowerheads.

ORIGIN
Costa Rica, El Salvador, Guatemala, Honduras and Nicaragua.

REASON FOR INTRODUCTION
Ornament

INVADES
Roadsides, disturbed areas, wastelands, urban open spaces, savannahs, woodlands, foreest edges/gaps and riverbanks.



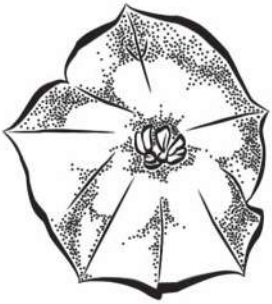
IMPACTS

Forms dense monospecific stands, probably displacing native plant and animal species. In Hawaii, it has formed dense stands in drier mesic areas (Motooka *et al*., 2003), and has also been found in disturbed areas of drier habitats on Kauai, Oahu, Lanai and Maui (PIER, 2016).

Notes: An "ornamental that sometimes naturalizes" in East Africa (Beentje *et al*., 2005), it is usually found along forest margins and on thicket edges near swamps. Very invasive in and around Arusha, Tanzania, it has also established small populations elsewhere. Herbarium specimens have been collected in Lushoto, Tanzania, and in the districts of Masaka and Mengo in Uganda.




Physalis peruviana L.



TOMATO FAMILY
Solanaceae

COMMON NAMES

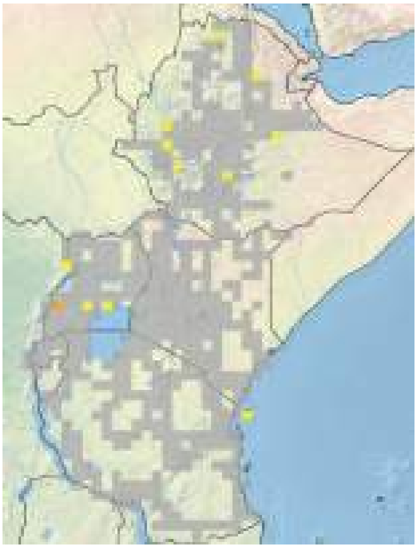
English: bladderberry, common Cape gooseberry, gooseberry tomato, Peruvian cherry, Peruvian groundcherry
Uganda: awet, gongor, simiko
Tanzania: kibwabwa, kichupwa
Uganda: ntuntunu, ntuutu

DESCRIPTION
Evergreen herb or soft-wooded shrub (1–2 m tall) with many ribbed branches, often tinged purple or mauve, densely covered with erect, simple or glandular hairs (1 mm long).

Leaves: Green, velvety, heart-shaped (6–15 cm long and 4–10 cm wide), apex tapering to a point, base heart-shape, margins entire or sometimes with a few blunt lobes, held alternately in pairs (one larger than the other) at each node on the stems, on leaf stalks (2–3 cm long).

Flowers: Yellow with purplish-brown spots, veins prominent, solitary, bell-shaped.

Fruits: Berries, pale yellow becoming pale brown as they mature, succulent, round (1.5–2 cm across), enclosed in an inflated, papery, lantern-like structure (3–3.5 cm long); seeds pale brown (to 2 mm long).



ORIGIN
Colombia, Ecuador and Peru.

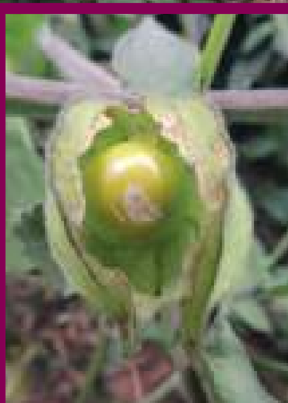
REASON FOR INTRODUCTION
Edible fruit and ornament.

INVADES
Roadsides, disturbed areas, urban open spaces, gardens, forest edges/gaps and savannahs.

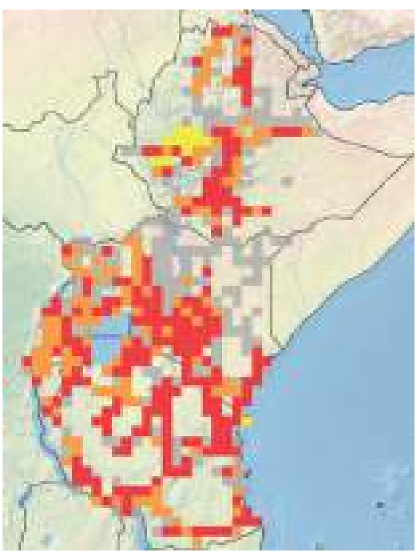
IMPACTS

Often forms dense stands, to the detriment of native flora and fauna. In tropical regions, it may become established in mesic to wet forests, in sub-alpine woodlands and at disturbed sites on mountain slopes (Wagner *et al*., 1999, in PIER, 2002; Motooka *et al*., 2003). In Fiji, it is found in gardens and in forests along trails and streams, in clearings, and in cultivated areas (Smith, 1991). In Niue, it is a common weed in some plantations (Sykes, 1970), and in Tonga it is an occasional plantation weed (Yuncker, 1959, in PIER, 2002). In Hawaii, infestations are threatening two endangered plant species, *Phyllostegia parviflora* (Gaudich.) Benth. (Lamiaceae) and *Urera kaalae* Wawra (Urticaceae) (USFWS, 2008a, 2011). *P. peruviana* is also regarded as an environmental weed in Australia (Environmental Weeds of Australia, 2016). It is a weed of crops in Hawaii, Indonesia, Kenya and Zimbabwe (Holm *et al*., 1979).

Notes: In East Africa, it is naturalized and is spreading rapidly in gardens and on arable land. In Uganda, it "grows in secondary scrub and abandoned plantations" (Katende *et al*., 1995). Cultivated for its edible fruits, it is "often escaped and is becoming a weed in fields and coffee plantations, along paths and roads in forests, and is rather common now in waste places" in many regions of Ethiopia (Friis, 2006). Not actively recorded but considered to be invasive and probably far more widespread than indicated on the map.



Ricinus communis L.



EUPHORBIA FAMILY
Euphorbiaceae

COMMON NAMES
English: castor oil plant
Ethiopia: ati, balambai, balan, fololo, golqwa, gulo, hambaltaa, hara, kalishe, kobo, mbalica, mobonu, qince hara, qobboo, qobo, tofolie
Kenya: bonoo, ebune, fololo, kivunu, kobor, kyaiki, manwa, mbaraki, mbono, mwariki, nyonyo, odagwa
Rwanda: mnyemba
Tanzania: mbono, mhale, mnyono, mnyonyo, mzono
Uganda: kaisaja, kasyoga, mnyemba, mukaale, nsogasoga

DESCRIPTION
Evergreen or annual, hairless soft-woody shrub, sometimes tree-like (1–5 m tall) with a strong tap-root; shoots green or red, with a clear sap; stems hollow.

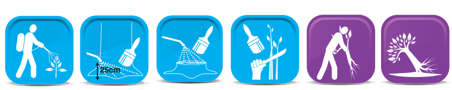
Bark: Smooth, round, often red, with conspicuous nodes and ring-like scars.

Leaves: Deep green or reddish, paler below, simple, large (10–40 cm wide), shaped like a hand with (5–) 7–9 (–12) deep lobes, margins with forward pointing sharp projections or teeth, held alternately on stems, leaf stalks round (3.5–50 cm long); leaves emit a distinctive odour when crushed.

Flowers: Small, upper flowers reddish, lower flowers creamy to greenish; male and female flowers on the same plant, both held erect in terminal clusters (to 40 cm long).

Fruits: Capsules (dry fruits that open at maturity), green turning brown or reddish as they mature, oval to almost round (15–25 mm long), three-lobed, covered in soft spines, containing up to three shiny, smooth, mottled seeds (9–17 mm long) resembling ticks.

ORIGIN
Uncertain; genetic studies of plants collected from around the world, including Ethiopia and Kenya, suggest that regional populations may "have derived from multiple sources or introductions, likely due to human-assisted migration via domestication" (Foster *et al*., 2010). Some consider its native range to include countries in North and northeast Africa and the Middle East.



REASON FOR INTRODUCTION

Castor oil and ornament.

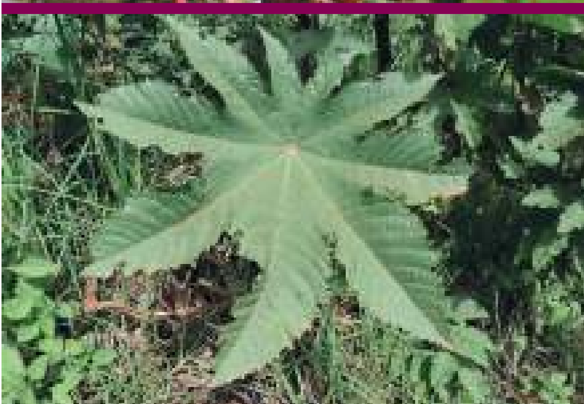
INVADES

Roadsides, culverts, disturbed areas, wasteland, urban open space, drainage ditches, irrigation channels, lowlands, gullies and riverbanks.

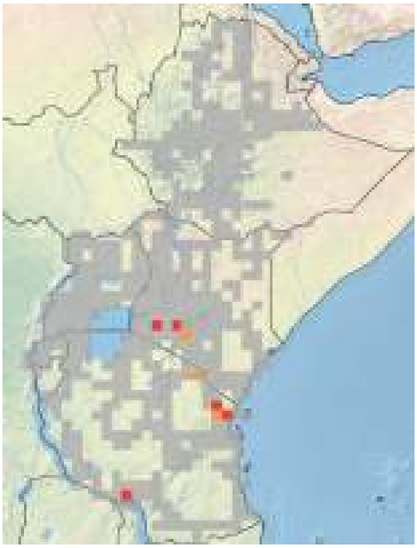
IMPACTS

Forms dense stands which displace native vegetation, especially in riparian areas and along drainage lines (Langeland *et al*., 2008). It readily colonizes disturbed areas, shading out native seedlings, and producing monospecific stands that replace native vegetation (Weber, 2003). In South Africa and Botswana, it has invaded savannahs and riparian and wetland habitats (Buss, 2002; Henderson, 2007), while in Australia in has invaded floodplains and coastal dunes. In Hawaii, it has invaded native dryland forests, and is altering successional processes in riparian areas. It is also invading dry forests and native shrublands in Mexico, Costa Rica, Brazil and Cuba. The plant is toxic, especially the seeds. Consumption of 2.5–6 seeds for humans, and about six seeds for horses, can be fatal (Wedin *et al*., 1986) with symptoms in people including "stomach irritation, diarrhoea, abdominal pain, increased heart rate, profuse sweating, convulsions and collapse, while even the broken seeds can cause skin irritations" (Cal-IPC, undated; Francis, undated in GISD, 2016).

Notes: Widespread and "naturalized" throughout East Africa, in areas with moderate to good rainfall (Smith, 1987). It is also widespread in Ethiopia (Gilbert, 1995). Our surveys found it to be widespread and abundant throughout the region, having formed dense stands along roadsides, disturbed areas, urban open space and in low-lying areas.



Rubus niveus Thunb.



ROSE FAMILY
Rosaceae

COMMON NAMES

English: Ceylon raspberry, hill raspberry, mysore raspberry
Ethiopia: argi, goda, gorco, gumere, haltufa, hamaroo, kwesheshlla, melliano, njore, njorie
Kenya: enyaiyaguji, enyaiyagut, kipsoeniot, mutare, mutare-kigombe, ndare, nemingin, tagainamiei, zirubain
Tanzania: mshaa
Uganda: nkenene

DESCRIPTION
Prickly scrambling shrub or climber (1.5–3 m high); the reddish mature stems have a whitish 'coat' or covering, armed with sharp, hooked thorns (4–7 mm long).

Leaves: Green above and whitish below, with 5–7 toothed, egg-shaped leaflets, (terminal leaflet 5–17 cm long and 4–8 cm wide); leaf stalks 15–50 mm long.

Flowers: Pink or mauve (10–15 mm across) with five petals (brightly coloured parts of flower), in dense clusters (2–5 cm long).

Fruits: Multiple drupes or drupelets (fruits with a stony centre) 'fused' or clustered together, berry-like, white, pink or deep purplish (10–15 mm across).

ORIGIN
Afghanistan, China, India, Malaysia, Philippines, Sri Lanka and Taiwan.

REASON FOR INTRODUCTION
Edible fruits, barrier/hedge and ornament.

INVADES
Roadsides, disturbed areas, urban open space, plantations, forest edges/gaps, woodlands, woodland edges/gaps and riparian vegetation.

IMPACTS

R. niveus has the ability to form dense, thorny thickets up to 4.5 m tall, which out-compete and displace native vegetation, inhibiting the regeneration of native species and threatening rare endemic plants (Rentería *et al.*, 2012). It is a transformer species in that it alters the structure and condition of ecosystems over large areas. Its invasion success can be attributed to its rapid growth, and ability to produce very large numbers of seeds (Rentería *et al.*, 2012). It spread extremely rapidly after being introduced to the Galápagos, covering an estimated 30,000 ha by 2008, while having the potential to spread over 90,000 ha (Atkinson *et al*., 2008). In the *Scalesia* (daisy tree) forests of Los Gemelos, Santa Cruz, thickets of *R. niveus*, by blocking access to available light, are preventing the regeneration of shade-intolerant understorey plants such as *Scalesia pedunculata* Hook.f. (Asteraceae), an endemic species (Rentería and Buddenhagen, 2006). *R. niveus* infestations have led to declines in both the species richness and abundance of native plants (Rentería, 2011), with serious consequences for wildlife dependent on them (Weber, 2003). *R. niveus* has also invaded agricultural land, causing serious economic problems for farmers.

Notes: Present in many larger gardens in Addis Ababa, it is “probably naturalized among bushes in and around” the Ethiopian capital (Hedberg, 1989). In Kenya, it has “gone wild along rivers, in forest margins, in secondary bushland and on roadsides” (Beentje, 1994). Specimens have been collected in Nairobi, Kenya, and in the Moshi District of Tanzania, suggesting that it may be far more widespread than indicated on the distribution map. This species was also seen in Kakamega Forest, Kenya (Fischer *et al.*, 2010).

Rubus rosifolius Sm.

ROSE FAMILY
Rosaceae

COMMON NAMES

English: wine-berry
Ethiopia: argi, goda/gorco/gumere, haltufa, hamaroo, inkeri, kwesheshlla, melliano
Kenya: engaiyagut, mtoje, mtojo
Rwanda: manganga
Tanzania: lutandulu, mawero, mchaa, mshaa
Uganda: mchaa

DESCRIPTION

Prickly herb, scrambler or sub-shrub; stems are hairy with a few prickles.

Leaves: Green, leaflets oval to egg-shaped, broader and rounded at the base, narrowing to a point, with prickles as well as toothed margins, and with glandular hairs on both sides of the leaflets.

Flowers: White, solitary or in flower clusters, with five petals (brightly coloured parts of flower).

Fruits: Multiple drupes or drupelets (fruits with a stony centre) 'fused' or clustered together, berry-like, scarlet-red, fleshy (about 10–20 mm long).

ORIGIN

Cambodia, China, India, Japan, Laos, Malaysia, Myanmar, Nepal, Philippines, Taiwan, Thailand and Vietnam.

REASON FOR INTRODUCTION

Edible fruits, barrier/hedge and ornament.

INVADES

Roadsides, disturbed areas, urban open space, plantations, forests, forest edges/gaps, woodlands and riparian vegetation.

IMPACTS

Has the ability to invade forest understoreys, forming dense thickets where enough sunlight is available, out-competing and crowding out native plants. In Hawaii, *R. rosifolius* is regarded as a threat to native plants of many species (PIER, 2014). There, as a weed in pastures, it is also restricting the movement of people and animals (Motooka *et al*., 2003). In parts of Brazil, *R. rosifolius* infestations are regarded as a serious threat to native biodiversity.

Notes: Having "escaped from cultivation", it is now present in forest, bushland and wooded grassland in the Kefa Region of Ethiopia (Hedberg, 1989). In East Africa it has been recorded in Kakamega Forest, Kenya (Fischer *et al.*, 2010), and is "quite commonly naturalized" on the "edges of upland and lowland forests, in secondary bushland and in plantations and abandoned cultivations" (Graham, 1960). It is invasive in the Amani Nature Reserve, Tanzania (Dawson *et al*., 2008). Specimens have been collected in Moshi District, Tanzania, and in Mengo District, near Entebbe, in Uganda. The species is abundant on roadsides and forest gaps and edges and probably far more widespread than shown on the distribution map.

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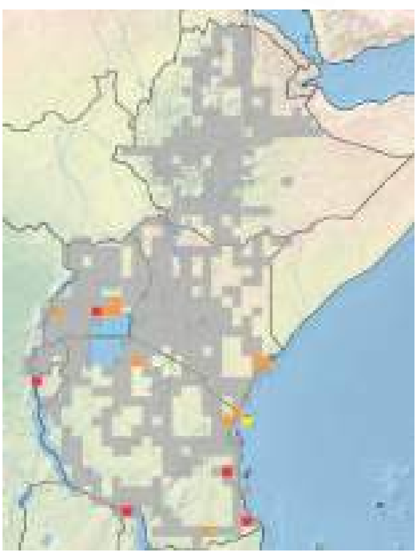
Senna alata (L.) Roxb.



PEA FAMILY
Fabaceae; sub-family: Caesalpiniaceae

COMMON NAMES
English: candle bush, Christmas candle, ringworm senna, stick senna
Ethiopia: itkki, sanu, sene-mekki
Tanzania: upupu-wa-mwitu

DESCRIPTION
Large, spreading shrub [2–3 (–4) m tall], often with thick foliage on a few rather coarse branches.

Leaves: Green, finely hairy, once-divided (45–80 cm long and 12–25 cm wide) with 8–14 pairs of large elongated leaflets with almost parallel sides, leaflets oval or egg-shaped (5–17 cm long and 2–5.5 cm wide), margins entire, tips rounded or slightly notched.

Flowers: Golden yellow or orange (2–3 cm across) in very showy, elongated clusters (15–60 cm long) at the tips of the stems or in the upper leaf forks, on hairy stalks.

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning brown-black as they mature, large, elongated (12–25 cm long and 8–20 mm wide), 4-angled in cross section, containing about 50 seeds.

ORIGIN
Brazil, Colombia, French Guiana, Guyana, Surinam and Venezuela.

REASON FOR INTRODUCTION
Erosion control, ornament.

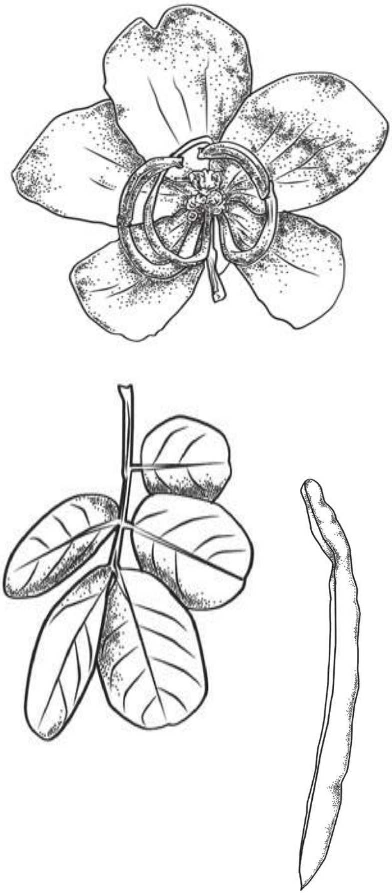
INVADES
Disturbed areas, wastelands, waterways, floodplains and drainage lines.

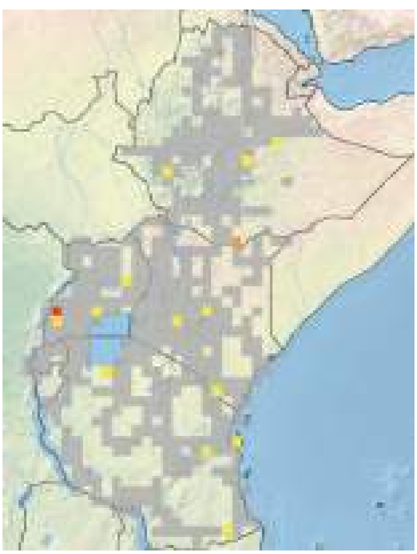
IMPACTS

Has the ability to establish dense stands, especially in areas with a high water table, to the detriment of native plants and animals (Csurhes and Edwards, 1998). Its large leaves shade out native plants, contributing to a reduced plant species richness under canopies. *S. alata* is also damaging to agriculture and to pasture production (Weber, 2003). In Hawaii, it has formed dense stands in pastures (Motooka *et al*., 2003). In Papua New Guinea, it is also proving troublesome on some pasture lands (Henty and Pritchard, 1973). In Fiji, it has become naturalized in some swampy areas (Smith, 1985), while in Australia it is common in moist zones, as well as in some disturbed and overgrazed areas (Smith, 2002).

Notes: In the Ethiopian region of Welega, it has been recorded as "naturalized in secondary growth near streams in Acacia-wooded grassland" (Thulin, 1989). It is wild at moist localities on Zanzibar and Pemba and elsewhere in the region, "always as an escape from cultivation" (Brenan, 1967). Commonly found on lake shores, riverine areas and as a weed on cultivated land in East Africa (Dharani, 2011), it is widely grown as an ornamental, and has occasionally escaped from cultivation and established dense stands in the wild, especially in low-lying areas.

Senna bicapsularis (L.) Roxb.





PEA FAMILY
Fabaceae; sub-family: Caesalpiniaceae

COMMON NAMES
English: Christmas bush, moneybush, rambling cassia, yellow candlewood

DESCRIPTION
Evergreen rounded shrub [1.5–5 (–9) m tall], often spreading, scrambling or climbing, with woody branches.

Leaves: Green with yellow margins, hairless, once-divided (7–12 cm long) with 2 or 3 (–4) pairs of broadly oval to egg-shaped leaflets (1.6–4.5 cm long and 1.1–2.3 cm wide), bases asymmetric, rounded to wedge-shaped, apex rounded or notched, held alternately on stems; conspicuous club-shaped gland on each leaf branchlet, between the lowest pair of leaflets.

Flowers: Yellowish to reddish brown (1.1–1.5 cm long), held in clusters.

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning pale brown as they mature, straight or slightly curved, sausage-shaped (9–17 cm long and 1–1.5 cm wide); seeds brownish, in two rows.

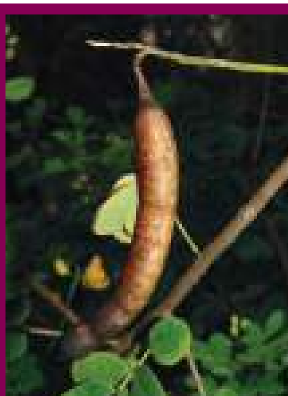
ORIGIN
South America, from Panama south to Venezuela and Colombia, and also the West Indies.

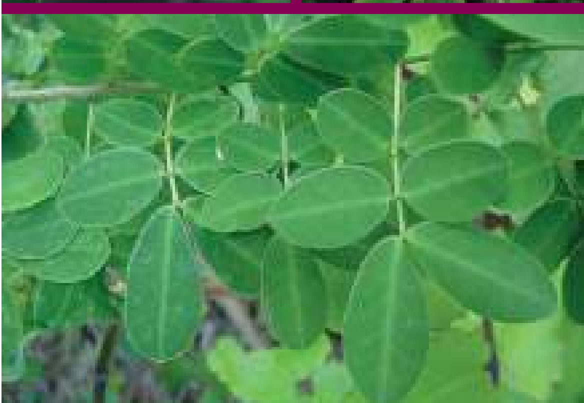
REASON FOR INTRODUCTION
Ornament

INVADES
Roadsides, disturbed areas, woodlands, riparian vegetation and coastal bush.

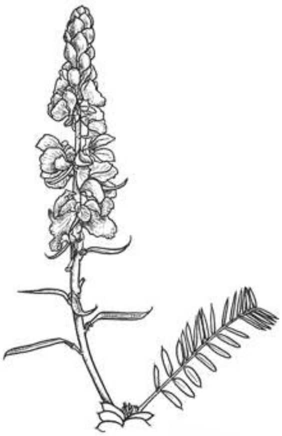
IMPACTS
Has the ability to form extensive, dense thickets, climbing over native vegetation and inhibiting growth and regeneration among native species. Thickets reduce wildlife habitat and restrict access to water (Weber, 2003). In Australia, it is naturalized in urban bushland and farmland, mainly along roadsides and on the banks of water courses (Csurhes and Edwards, 1998). In Florida, USA, it reseeds readily and displaces native vegetation in tropical hammocks and coastal areas. In Zimbabwe, it is naturalized along “roadsides and in woodland or riverine vegetation” (Flora of Zimbabwe, 2016).

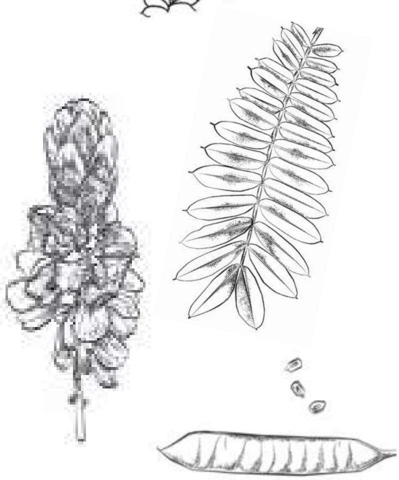
Notes: In Ethiopia, it is found in evergreen bushland and wooded grassland, often riparian, as well as in hedges and disturbed places in the regions of Arsi, Harege and Kefa. In East Africa it is present in “grassland, bushland, old cultivation, roadsides, etc., originally planted or naturalized” (Brenan, 1967) and invasive in Tanzania (Henderson, 2002). Probably far more widespread and abundant than indicated on the distribution map.

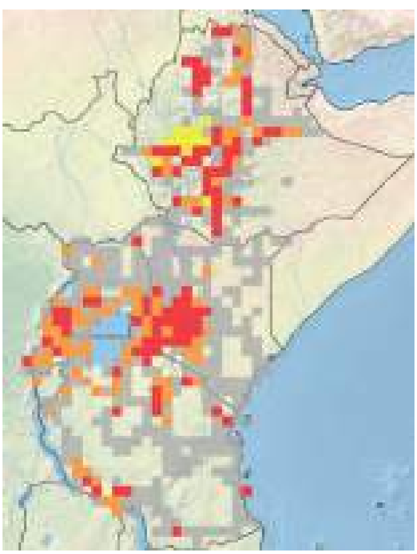




Senna didymobotrya (Fresen.) H.S. Irwin & Barneby







PEA FAMILY

Fabaceae; sub-family: Caesalpiniaceae

COMMON NAMES

English: candle bush, peanut-butter cassia, popcorn senna, wild senna
Ethiopia: salamaka, shoshoro
Kenya: inyumganai, kirao, luvinu, mbinu, mshua, mukengeka, musingili, mwingajini, mwinu, nyai-leka, osenetoi, ovino, senetiet, senetwet
Rwanda: omwitanzoka
Uganda: ekiita njoka, elekmari, etiatia, lomanyin, mubenobeno, mukyula, mwiita njoka, omuttanjoka, omwitanzoka, oyado

DESCRIPTION

Evergreen aromatic large shrub or small tree (1–9 m tall); stems spreading, much-branched, covered with fine hairs; flowers and cut stems smell of peanut butter, although some maintain they smell of mice.

Leaves: Dark green, once divided, main leaf stems to 40 cm long, 8–18 pairs of elongated and narrow to oval leaflets [2–5 (–6.5) cm long] with asymmetric (unequal) bases and short, pointed tips.

Flowers: Bright yellow, 20–30, held on erect spike-like, unbranched inflorescences (10–50 cm long).

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning brown as they mature, flat (10 cm long and 2 cm wide) with a long beak at terminal end; containing up to 16 bean-like seeds (to 1 cm long).

ORIGIN

Angola, Ethiopia, Kenya, Sudan, Uganda and the Democratic Republic of the Congo, south to Namibia, Zimbabwe and Mozambique.

REASON FOR INTRODUCTION

Native, but introduced elsewhere for medicine and ornament.

INVADES

Roadsides, wastelands, disturbed areas, urban open space, grasslands, savannahs, woodlands and riparian vegetation.

IMPACTS
Has the ability to form large, dense monospecific stands, displacing native plant species and inhibiting wildlife movement (Weber, 2003). Its leaves are toxic, and have been the reported cause of numerous livestock deaths. In southern California, it is invasive in wetlands, riparian habitats, oak woodlands, chaparral, grasslands and coastal sage habitats adjacent to cultivated areas. In Hawaii, it is naturalized (Wagner *et al*., 1999). Also considered to be invasive in South Africa and Zimbabwe.

Notes: In Ethiopia, it has proliferated in disturbed areas of montane wooded grassland, evergreen thicket, bushland and riparian woodland in the regions of Welo, Welega, Shewa, Arsi and Sidamo (Thulin, 1989). Forms dense stands on roadsides and in disturbed and low-lying areas throughout eastern Africa.

Senna hirsuta (L.) H.S. Irwin & Barneby

PEA FAMILY
Fabaceae; sub-family: Caesalpiniaceae

COMMON NAMES

English: stinking cassia, hairy senna, sicklepod, shower tree senna

DESCRIPTION
Erect herbaceous plant/shrub, becoming slightly woody with age (0.5–3 m tall); stems, leaves and pods covered with long, pale greyish-white hairs; stems ridged lengthwise.

Leaves: Greyish-green, once-divided (10–25 cm long) with (2–) 3–5 (–6) pairs of large egg-shaped or oval leaflets (50–75 mm long), margins entire with pointed tips; ribbed stalks (40–65 mm long) with a stalkless, finger-like gland.

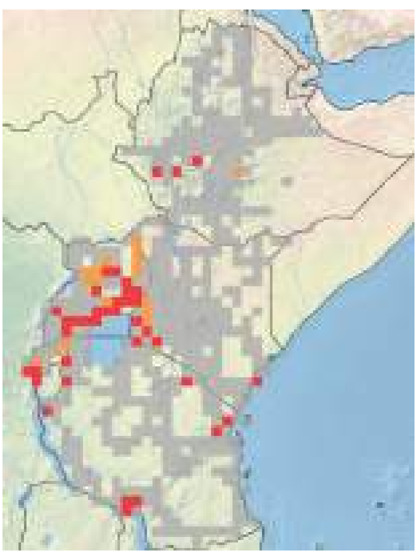
Flowers: Yellow to deep orange-yellow becoming brown-veined with age, in small unbranched clusters of 2–8 in the upper leaf forks or at the tips of the branches.

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning brown as they mature, slender, slightly sickle-shaped (10–18 cm long and 4–6 mm wide), densely covered with long whitish hairs; seeds dark brown, round.

ORIGIN
Central America, tropical and subtropical America and the Caribbean.

REASON FOR INTRODUCTION
Ornament

INVADES
Disturbed areas, wastelands, roadsides, riparian zones (banks of watercourses), forest margins and gaps, open woodlands and pastures.

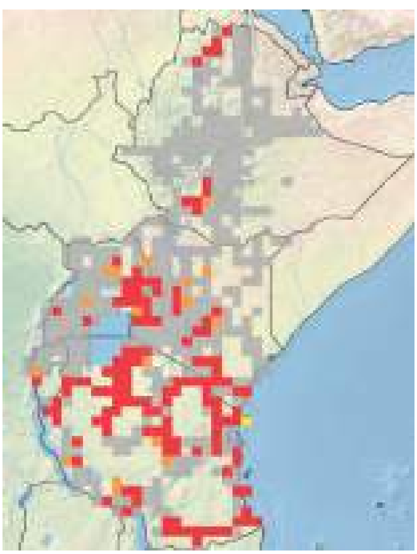


IMPACTS

Has established large monospecific stands, especially on roadsides, displacing native species. In Fiji, it is established in villages and plantations, along roadsides, and on riverbanks (Smith, 1985). In South Africa, it is often grown as a garden plant and has become a competitive weed in summer rainfall areas (Wells *et al*., 1986). The leaves are reported to be toxic to rats and as such the plant is probably not palatable to livestock (Hacker 1990). Also reported as being invasive on a number of other Pacific Islands, Singapore and Australia (PIER, 2010) and regarded as a weed in India (Holm *et al*., 1979). A congener, *S. tora* (L.) Roxb., which is also invasive in a number of countries, and considered to have similar attributes as *S. hirsuta*, is known to be allelopathic, inhibiting seed germination and the growth of *Brassica campestris* L. in field trials undertaken in India (Sarkar *et al*., 2012).

Notes: Not recorded as being present in Ethiopia (Thulin, 1989). In East Africa, it is a naturalized weed of plantations and cultivated ground in "lowland rainforest areas" and said to be very common in Kimboza Forest Reserve (Brenan, 1967). Very abundant, especially on roadsides in Uganda and in the East Usambaras, Tanzania.

Senna obtusifolia (L.) H.S. Irwin &



PEA FAMILY
Fabaceae; sub-family: Caesalpiniaceae

COMMON NAMES
English: coffee weed. Java bean, sickle senna, sicklepod
Ethiopia: srfraf
Kenya: cheporon, emang, emany
Uganda: ekayeriyer, etiatia, kitikili, liguyo, luge, oyado, oyondo

DESCRIPTION
Annual or biennial (plant that lives for longer than one year but less than two) shrub (to 2 m tall), lower stems sprawling (1.5–2 m long), young stems hairy becoming hairless.

Leaves: Green, once divided, arranged alternately on stems, with 2 or 3 pairs of hairless or sparsely hairy, egg-shaped leaflets (17–65 mm long and 10–40 mm wide) with rounded tips.

Flowers: Yellow (10–15 mm across), on stalks (7–28 mm long), usually in pairs in the leaf forks near the tips of branches.

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning brownish-green as they mature, slender, sickle-shaped (6–18 cm long and 2–6 mm wide), almost round in cross section; seeds (3–6 mm long) dark brown, shiny.

ORIGIN
Southern and eastern USA, Mexico, Central America, the Caribbean and tropical South America.

REASON FOR INTRODUCTION
Medicine and accidentally as a contaminant.

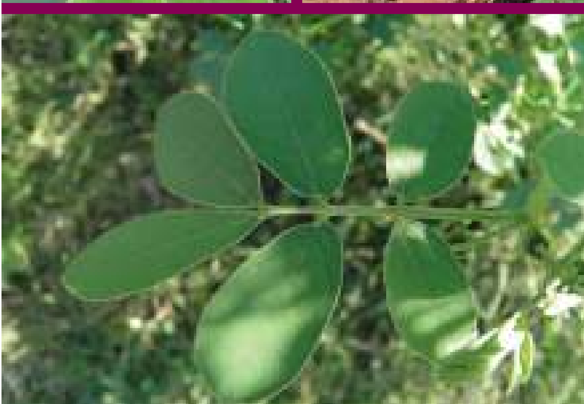
INVADES
Disturbed sites, waste areas, roadsides and riparian zones.

IMPACTS

Forms dense stands that can displace native plant and animal species. In parts of Australia and in the Galápagos archipelago, *S. obtusifolia* is spreading into protected areas (Hoffmann *et al*., 1999; Tye *et al*., 2003), where it may out-compete and displace some vulnerable native species (Mackey *et al*., 1997), causing irreversible ecological change (Tye *et al*., 2003). Infestations in northern Australia are believed to have increased the risk of rainforest degradation by wild fires during the dry season (Russell-Smith and Bowman, 1992). Infestations in Australia's Iron Range National Park may also result in fewer visits by tourists (Mackey *et al*., 1997). In Georgia, USA, *S. obtusifolia* is regarded as the most troublesome crop-weed across the State (Webster and Macdonald, 2001). Failure to control *S. obtusifolia* and *Senna tora* (L.) Roxb. (Fabaceae) within 2–4 weeks after planting has been found to reduce crop yields dramatically (Holm *et al*., 1997), by 25% in the case of cotton (Buchanan and Burns, 1971). Soybean yields, too, may be significantly reduced (Thurlow and Buchanan, 1972). Infestations in Queensland, Australia, have reduced the cattle carrying capacities of some pastures by almost 100% (Mackey *et al*., 1997). *S. obtusifolia* is an alternative host for many crop pests (Subba Rao *et al*., 1974; Patel and Patel, 1972; Davies, 1972; Debrot, 1974; McLean and Roy, 1991). In Benin, *S. obtusifolia* has gained notoriety among farmers as an alternative host for cowpea pests (Kossou *et al*., 2001). The plant is unpalatable, but cattle may occasionally eat it when other forage is scarce, and poisoning may result (Mackey *et al*., 1997). The seeds are known to be harmful to chickens (Cock and Evans, 1984).

Notes: Widespread in Ethiopia, where it is "a weed of cultivation, roadsides, waste places and wooded grasslands, often near lakes and streams" (Thulin, 1989). In East Africa, where it has invaded similar areas (Brenan, 1967), it has become widespread as a weed of roadsides, fallow land and overgrazed pastures.






Senna occidentalis (L.) Link

PEA FAMILY
Fabaceae; sub-family: Caesalpiniaceae

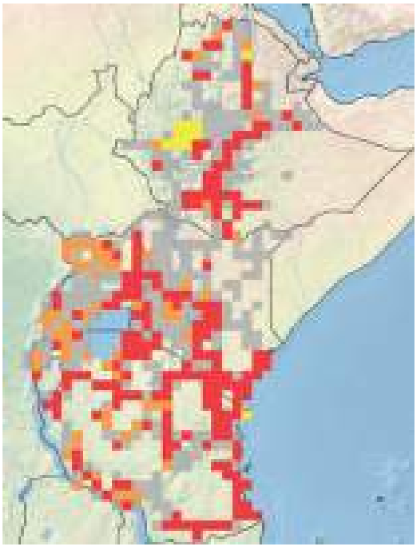
COMMON NAMES
English: ant bush, arsenic bush, coffee senna, sicklepod, stinkweed
Ethiopia: saccara, shuna-shuna
Kenya: inglatiang, mwengajini
Tanzania: kunde-nyika, mbayazi, muumbuzi, segusse
Uganda: imindi

DESCRIPTION
Erect herb or shrub (0.5–2.5 m tall); annual or living for more than one year but for less than two years; stems reddish-purple, smooth, hairless or sparsely hairy, four-angled or grooved when young becoming greenish-brown and rounded; emits an unpleasant smell.

Leaves: Green, once-divided (15–20 cm long), with (3–) 4–5 (–6) pairs of egg- to sword-shaped leaflets (3–10 cm long and 2–3 cm wide) with broad and rounded bases, tapering towards the end, with pointed tips; conspicuous gland at the base of each leaf stalk; held alternately on stems, on reddish stalks (3–5 cm long).

Flowers: Pale yellow (20–30 mm across) in small clusters of 2–6, in the forks of the uppermost leaves.

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning brown as they mature with thickened margins, slightly curled (75–130 mm long and 8–10 mm wide), held upright.



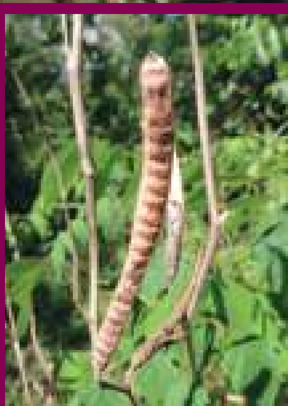
ORIGIN
Argentina, Belize, Bolivia, Brazil, Cayman Islands, Costa Rica, Dominican Republic, Ecuador, El Salvador, French Guiana, Guatemala, Guyana, Haiti, Nicaragua, Panama, Peru, Surinam and Venezuela.

REASON FOR INTRODUCTION
Coffee substitute, medicine and ornament.

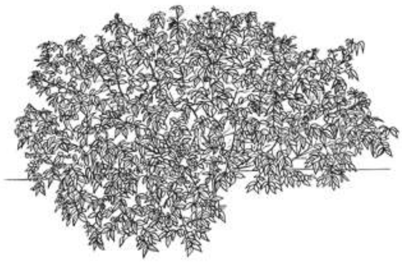
INVADES
Roadsides, wasteland, disturbed land, fallow land, managed pastures, drainage ditches, woodland edges/gaps, savannahs, riparian vegetation and gullies.

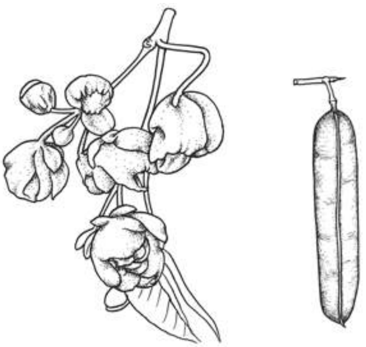
IMPACTS
Dense stands can displace native plant species, and can reduce livestock carrying capacities in managed and natural pastures. In crop production systems, *S. occidentalis* competes aggressively for nutrients, water and light. Being allelopathic, it inhibits the germination and growth of other plants. Studies have shown that it has a negative impact on maize yields (Arora, 2013), and that it significantly reduces seed cotton yields, reducing cotton main stem height by 1.25 cm (Higgins *et al*., 1986). It is also an alternative host for crop diseases such as potato virus Y (Suteri *et al*., 1979). The seeds are highly toxic, containing compounds that damage the liver, the vascular system, and the heart and lungs of domestic livestock, often leading to death in cattle (Schmitz and Denton, 1977; Rogers *et al*., 1979; Barros *et al*., 1999), in horses (Martin *et al*., 1981; Irigoyen *et al*., 1991; Riet-Correa *et al*., 1998), in goats (Suliman *et al*., 1982; Suliman and Shommein, 1986), in pigs (Colvin *et al*., 1986; Martins *et al*., 1986), in poultry (Torres *et al*., 1971; Haraguchi *et al*., 1998), and in rabbits (O'Hara and Pierce, 1974). Consumption of the seeds in western Uttar Pradesh, India, resulted in the deaths of nine children within five days (Vashishtha *et al*., 2007).

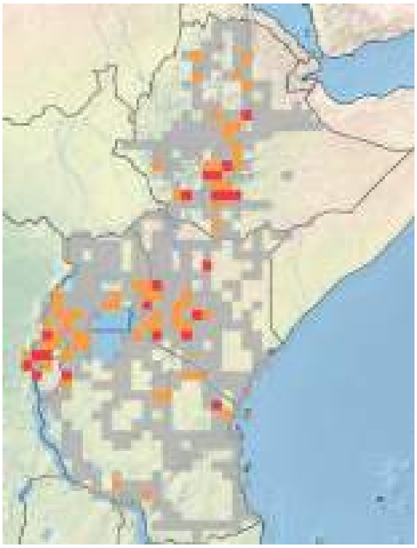
Notes: As a weed of cultivation, roadsides and waste places, but which is also present in "wooded grasslands and near lakes and streams", it is common throughout most of Ethiopia (Thulin, 1989). Usually "a weed of cultivation, roadsides and waste ground near villages and buildings, it has also been recorded in grasslands and on lakeshores" in East Africa (Brenan, 1967). Common throughout East Africa and Ethiopia, especially on roadsides, overgrazed grasslands and fallow land.



Senna septemtrionalis (Viv.) H.S. Irwin & Barneby







PEA FAMILY

Fabaceae; sub-family: Caesalpiniaceae

COMMON NAMES

English: arsenic bush, Brazilian buttercup, smooth senna, yellow shower
Ethiopia: sene-mekki
Kenya: chemul senetwet, esenetoi, omochegechege, senetwet apchimbek

DESCRIPTION

Evergreen medium-sized leafy shrub or small tree [1–3 (–5) m tall], stem erect with spreading branches; stem surface rough with no hairs.

Leaves: Bright green above and paler beneath, once-divided (6–10.5 cm long) with 3–5 pairs of smooth, elongated to egg-shaped leaflets (3.5–9 cm long and 15–35 mm wide), margins entire with pointed tips; cone-shaped structure (gland) between the lowest three or four pairs of leaflets.

Flowers: Bright yellow, sometimes brown-veined, in clusters (2.5–8 cm long) of 4–10 flowers.

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning brown as they mature, cylindrical, inflated, ends rounded (5–10 cm long and 7–12 mm wide), containing about 6 green-brown seeds.

ORIGIN

Costa Rica, Guatemala, Honduras, Mexico and Nicaragua.

REASON FOR INTRODUCTION

Ornament

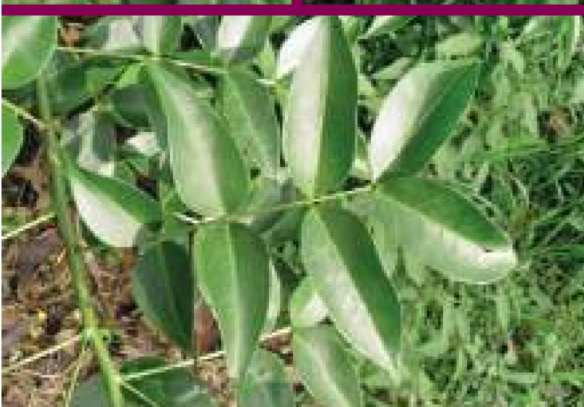
INVADES

Roadsides, disturbed areas, wastelends, urban open space, plantations, forest gaps/edges and riparian vegetation.

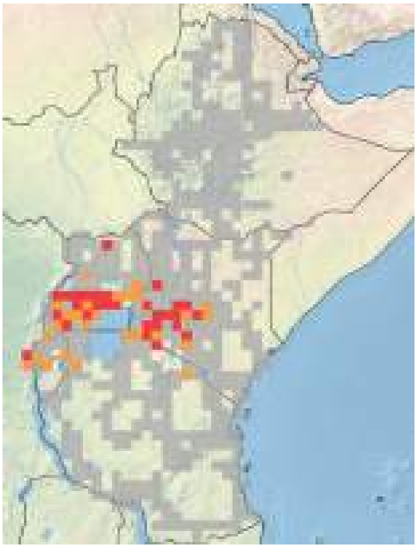
IMPACTS
Forms dense stands which can displace native plant species, and prevent their regeneration. In South Africa it is a "common garden ornamental plant that also invades forest margins, savannah, riverbanks, roadsides, waste ground and plantations" (ISSA, 2016).

Notes: In East Africa, it is considered to be naturalized in "deciduous woodland, evergreen thicket and bushland, and in hedges and disturbed places" (Thulin, 1989). Widespread and invasive throughout East Africa and Ethiopia, especially in higher-rainfall areas on roadsides, forest edges and gaps. Very common in Aberdares National Park, Kenya.






Solanum mauritianum Scop.



TOMATO FAMILY
Solanaceae

COMMON NAMES

English: Asian bug tree, bugweed, nightshade, tobacco weed, wild tobacco, woolly nightshade

DESCRIPTION
Branched shrub or small tree [1.5–4 (–10) m high]; all parts except older stems covered with fine hairs; one or two ear-shaped leafy structures at base of leaf stalks.

Bark: Pale, greenish-brown, smooth, speckled.

Leaves: Dull green and velvety above, white-felty beneath, tobacco-like, egg-shaped or oval (7.5–40 cm long and 3–15 cm wide) with pointed tips, emitting a strong smell when bruised.

Flowers: Purple or lilac blue (15–25 mm across), pale star-shaped area at base, in clusters of 25–100 at the ends of branches, on velvety stalks (3–18 cm long).

Fruits: Berries (fleshy fruits that do not open at maturity), green turning dull yellow as they mature, round (10–15 mm across), in groups of 20–80.

ORIGIN
Argentina, Brazil, Paraguay and Uruguay.

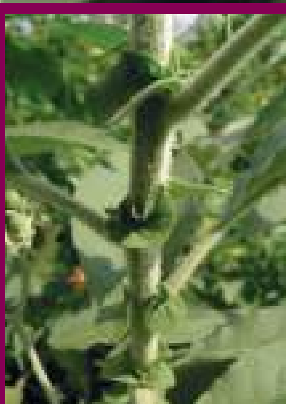
REASON FOR INTRODUCTION
Ornament

INVADES
Roadsides, wasteland, disturbed land, plantations, forest edges/gaps, woodland edges/gaps, riparian vegetation and gullies.

IMPACTS

Infestations displace native plant and animal species (Wells *et al*., 1986). In South Africa, seed dispersers, mainly Rameron (African olive) pigeons, by switching their diets from native plants in favour of *S. mauritianum*, have helped to spread the weed, adding to the number of invaded habitats, and further reducing the abundance of native plant species (Oatley, 1984). *Ocotea bullata* (Burch.) Meyer in Drege (Lauraceae), for example, now an endangered species in natural forests, has suffered, not only through inappropriate utilization, but also because Rameron pigeons no longer disperse its seeds adequately (Pooley, 1993; Scott-Shaw, 1999). Bugweed has been found to have negative impacts, too, on some ground-dwelling invertebrates (Florentine and Westbrooke, 2003). In commercial forestry plantations, bugweed retards the growth of young pine trees and causes deformation of their stems (Hinze, 1985). Bugweed fruits are alternative hosts for fruit flies and other major pests of deciduous and tropical fruit. The plant, if consumed, is also toxic to livestock. Fatalities have been reported among pigs and cattle in Queensland, Australia (Everist, 1974; Van Dyck, 1979). The fine hairs (trichomes) on the stems and leaves are an irritant, and can cause respiratory problems (Henderson, 2001).

Notes: Present throughout East Africa, it is often established along forest paths, river banks and dry river beds (Edmonds, 2012). It is a “widespread weed” in Uganda and a colonizer of “forest openings, stream borders and areas of human disturbance such as roadsides” (Bukenya and Carasco, 1995). It is “naturalized around Nairobi, common on waste ground, sometimes a troublesome weed” (Birnie and Noad, 2011). Our surveys found dense infestations in many parts of Uganda and Kenya, especially on roadsides and in forest gaps and edges, in high-rainfall areas. It has not yet been recorded as present in Ethiopia (Friis, 2006).



Solanum torvum Sw.

TOMATO FAMILY
Solanaceae

COMMON NAMES

English: gully-bean, pea eggplant, turkey berry, wild eggplant
Rwanda: inkarishya

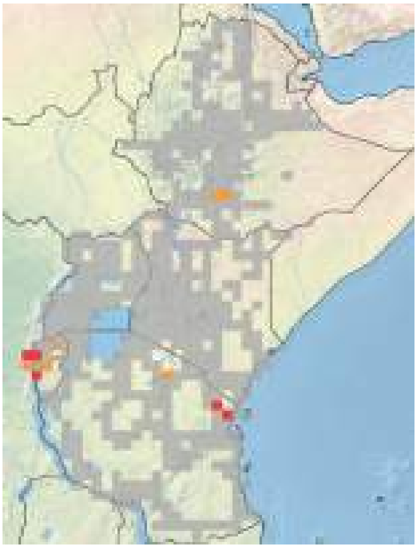
DESCRIPTION
Erect shrub or small tree [0.8–3 (–5) m tall], younger stems green or purplish, densely covered with hairs and sometimes sparsely covered with prickles or thorns (3–7 mm long), old stems brown or greenish-brown with no hairs.

Leaves: Green with whitish undersides covered with hairs; large, egg-shaped or almost round (7.5–25 cm long and 4–15 cm wide), margins entire to shallowly lobed, seedlings and young plants have small prickles on the upper leaf surfaces.

Flowers: Star-shaped (25 mm across), usually white, in branched clusters of 15–100 on the main stalks.

Fruits: Berries (fleshy fruits that don't open at maturity), green turning yellow or yellowish-green as they mature, round (12–17 mm across) containing many white, pale yellow or dull brown flattened seeds.

ORIGIN
Belize, Brazil, Colombia, Costa Rica, Ecuador, French Guiana, Guatemala, Guyana, Honduras, Mexico, Nicaragua, Panama, Venezuela and the Caribbean.



REASON FOR INTRODUCTION
Ornament and as a contaminant.

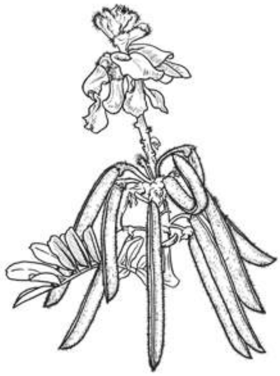
INVADES
Forests, forest margins, waterways, plantation crops, roadsides, pastures, disturbed sites and waste areas.

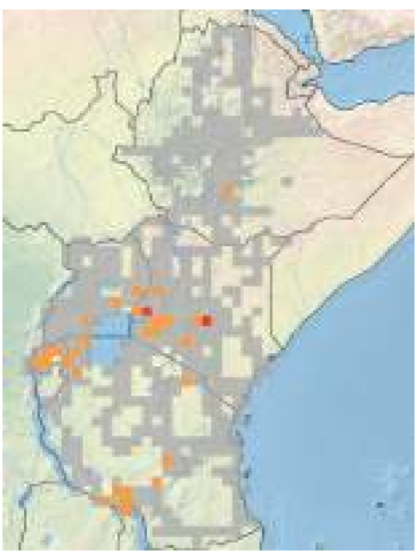
IMPACTS

Once established, *S. torvum* can, by sprouting from the roots, form dense thickets capable of overrunning farmlands and pastures, and of displacing native vegetation. Turkey berry can rapidly overtop most herbs, grasses and other shrubs but cannot survive under a closed forest canopy (PIER, 2016). The vicious spines on the stem and small prickles on the leaves, inhibit the free movement of people, livestock and wildlife. In French Polynesia and Tonga, it is regarded as a pest of agriculture, while in Samoa and in parts of Forida, USA, it is also spreading rapidly, invading a variety of sites, both wet and dry (PIER, 2106). Infestations in cassava, and in other perennial crops, have proved very difficult to control (CABI, 2016). It may also be toxic to livestock, suspected of causing calcinosis in cattle in Papua New Guinea (Morris *et al.,* 1979). Often consumed in traditional meals there have been reports of poisoning in people (Smith *et al.,* 2008). Symptoms included "hypertension, confusion, proximal upper extremity weakness, and hypercapnic respiratory failure" (Smith *et al.,* 2008).

Notes: Common in Central and West Africa, it was only recorded as invasive in the east of Rwanda with unconfirmed reports from the East Usambaras, Tanzania. Also recorded as present in Burundi (Abonyo and Howard, 2012).

Tephrosia vogelli Hook. f.





PEA FAMILY

Fabaceae; sub-family: Papilionaceae

COMMON NAMES

English: fish-poison-bean; fish-poison-tree, Vogel's tephrosia
Ethiopia: yejb-ater
Kenya: kibazi, mibaazi, mtupa, utupa wa kibaazi, utupa wa kingindo, utupa wa mrima
Rwanda: umuruku

DESCRIPTION

Soft woody branching herb or small tree (1–4 m tall) with dense foliage; stems and branches densely covered with long and short white or rusty-brown hairs.

Leaves: Green, covered with short matted hairs above, more densely beneath; once-divided (8–23 cm long) with 13–29 oval to somewhat elongated or oval to sword-shaped leaflets (5 cm long and 2 cm wide) with pointed to rounded bases and tips rounded or with a broad shallow notch, held spirally on the stems.

Flowers: White, violet-purple or blue, in terminal clusters (8–26 cm long).

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning brown as they mature (5.5–14 cm long and 0.8–1.8 cm wide), hairy, containing 6–18 dark brown to black oval seeds (7 mm long and 4.5 mm wide).

ORIGIN

Uncertain (Burkill, 1995), but an origin in Angola has been postulated (Kerharo and Bouquet, 1950). It is not considered to be native in the Flora Zambesiaca region (Mocambique, Malawi, Zambia, Zimbabwe, Botswana and the Caprivi Strip). Gillett *et al*. (1971) claim that its presence in East Africa and elsewhere on the continent may be due to its use as a fish poison, which is in agreement with Beentje (1994) who is of the opinion that it is possibly not native to Kenya.

REASON FOR INTRODUCTION

Nitrogen-fixation, poison (insecticide, fish), medicine and ornament.

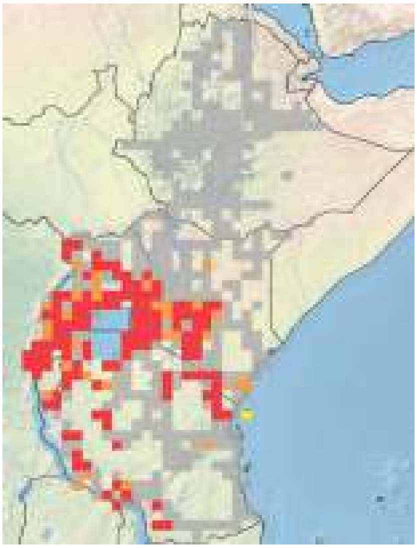
INVADES

Roadsides, disturbed areas, fallow land, cropland, savannahs and grasslands.

IMPACTS

T. vogelii has been found to have allelopathic impacts on three weed species (Wang *et al*., 2011). Its leaves “are highly toxic to frogs and toads, molluscs, worms and insects” (Agbon *et al*., 2004). The leaf extract is reportedly toxic to Nile tilapia (*Oreochromis niloticus* L.; Cichlidae). In southern Africa, *T. vogelii* is an alternate host for the groundnut plant hopper (*Hilda patruelis* Stal; Homoptera: Tettigometridae).

Notes: Used as a hedge and windbreak and as a source of fish poison, *T. vogelii* is present in the regions of Shewa, Harerge and Kefa in Ethiopia, where it is considered to be naturalized (Thulin, 1989). According to Gillett *et al*. (1971), its value as a fish poison may explain its wide distribution in East Africa. In northern Tanzania, it is an abundant weed of field margins (Mkenda *et al*., 2015).



DAISY FAMILY
Asteraceae

COMMON NAMES
English: Mexican sunflower, shrub sunflower, tree marigold
Kenya: amaua amaroro, emaua, ilaa, kirurite, maruru, maua madongo, maua makech, mulaa

DESCRIPTION
Annual or evergreen herbaceous shrub, woody at the base [2–3 (–5) m tall]; young stems slightly ridged and hairy.

Leaves: Greyish-green, finely hairy beneath giving a grey appearance; simple (6–33 cm long and 5–22 cm wide) with 3–5 (–7) pointed lobes; margins with a series of curved projections or toothed; held opposite each other or alternately on the stems, on winged leaf stalks.

Flowers: Bright yellow, daisy or sunflower-like (to 10 cm across), held on long stalks (7–30 cm long) which are visibly swollen and velvety below the heads.

Fruits: Achenes (small, dry one-seeded fruits that do not open at maturity), brown (4–8 mm long), in a brown spiky mass.

ORIGIN
Belize, Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua and Panama.

REASON FOR INTRODUCTION
Medicine, fodder, mulch or green manure, soil improvement, hedge/barrier and ornament.

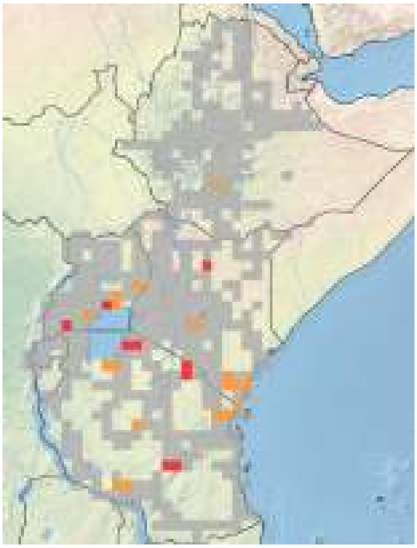
INVADES
Roadsides, disturbed sites, wasteland, fallow land, cropland, woodland edges/gaps, savannahs, lowlands and riparian vegetation.

IMPACTS

Forms dense stands which can displace native plant species and the animals associated with them. Its production of numerous small, light seeds, coupled with its ability to spread vegetatively, allows it to invade and to establish readily and rapidly in new locations (Muoghalu and Chuba, 2005). In Nigeria, where it is displacing native vegetation in the wetlands of the Apete River, Eleyele Lake and Oba Dam near Ibadan, *T. diversifolia* is considered to be one of the most damaging of all invasive species (Borokini, 2011). There, it is reported to be out-competing even the formidable invasive shrub *Chromolaena odorata* (L.) King & H.E. Robins (Asteraceae) (Olubode *et al*., 2011). Mexican sunflower has the ability to compete with agricultural crops (Illori *et al*., 2010), and is contributing to the local extinction of valued native species, including some important medicinal plants (Olubode and Muoghalu, 2014). Infestations have reportedly led to the abandonment of some farms in the Copperbelt region of Zambia.

Notes: Having "gone wild on roadsides, near rivers and on waste ground" (Beentje, 1994), *T. diversifolia* has become "a weed of roadsides, waste ground and valley grassland in high rainfall areas" of Kenya and Tanzania (Beentje *et al*., 2005). It has been recorded as naturalized in the Amani Nature Reserve, Tanzania (Dawson *et al*., 2008). In Ethiopia, it has been recorded at only one locality, on the Alemaya University Experimental Farm (Tadesse, 2004). Already invasive in some parts of East Africa, it has the potential, in higher rainfall areas, to become one of the most abundant and widespread invasive plant species in the region.

Tithonia rotundifolia (Mill.) S.F. Blake



DAISY FAMILY
Asteraceae

COMMON NAMES

English: red sunflower

DESCRIPTION

Annual herbaceous shrub, slightly woody at the base [1.5–2 (–3) m tall].

Leaves: Dark green, rough, hairy, simple, triangular to egg-shaped (15 cm long and 10 cm wide), sometimes deeply three-lobed with bases broad and rounded, tapering towards the tips; margins with forward-pointing sharp or blunt projections or teeth; held opposite each other or alternately on stems, on winged leaf stalks.

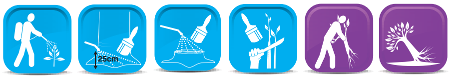
Flowers: Bright orange-red, daisy- or sunflower-like (90 mm across), solitary, held on long stalks which are visibly swollen and velvety below the heads.

Fruits: Achenes (small, dry one-seeded fruits that do not open at maturity), brown (4–8 mm long), in a brown spiky mass.

ORIGIN
Mexico

REASON FOR INTRODUCTION
Hedge, honey source and ornament.

INVADES
Roadsides, wasteland, disturbed land, urban open space, drainage ditches, savannahs.



IMPACTS

Like *T. diversifolia*, it has the ability to form dense stands, to the detriment of native flora and fauna. The heavier seeds of *T. rotundifolia* facilitate vigorous early growth in seedlings, resulting in quick establishment, while enabling the plants to grow in relatively resource-starved environments (Muoghalu and Chuba, 2005). Both *T. diversifolia* and *T. rotundifolia* have become serious weeds of "arable crops, plantations, abandoned lawns and roadsides in various parts of Africa", where, as "aggressive colonizers of new sites, they are probably adversely affecting the composition of the native flora and fauna, and altering ecosystem processes" (Muoghalu and Chuba, 2005).

Notes: Present in East Africa, but not as widespread or abundant as in southern Africa, where it is "common on roadsides and disturbed ground" (Beentje *et al*., 2005). However, it is starting to spread from areas where it has been introduced, and has the potential to become much more abundant and widespread. In East Africa, it is unlikely to become as serious an invader as *T. diversifolia*.

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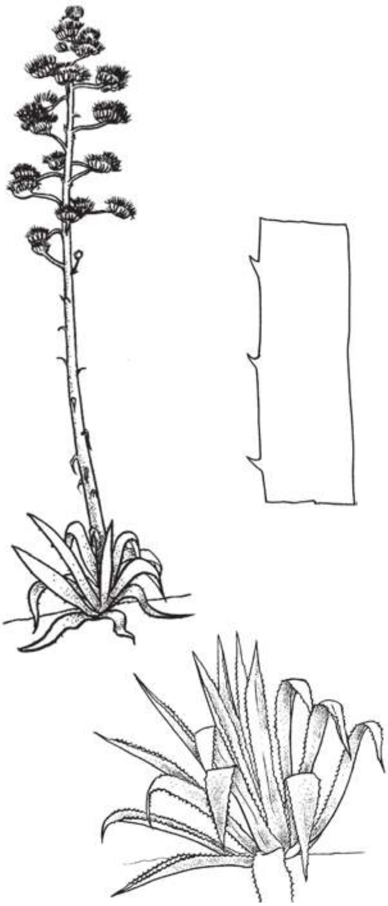
SUCCULENTS

Agave americana L.



SISAL FAMILY
Agavaceae

COMMON NAMES

English: American agave, American aloe, century plant
Ethiopia: qaca, iqa tlyan, j'ra
Rwanda: umugwengwe
Tanzania: katani, mkonge
Uganda: kigoogwa

DESCRIPTION
Succulent shrub with large leaves originating from a basal rosette (1–2 m high and 2–4 m across), with a flowering pole 5–12 m tall; does not produce plantlets (bulbils) on the flowering pole.

Leaves: Greyish-green, long and narrow, sword-shaped (1–2 m long and 15–25 cm wide), margins lined with sharp spines (to 1 cm long) and a terminal spine (3–5 cm long); variegated forms have grey to dark green leaves with yellow or white margins or central stripes; leaves erect at first, becoming reflexed, flopping over to one side in the case of *Agave americana* var. *americana*, but remaining erect to stiffly spreading in *Agave americana* var. *expansa*.

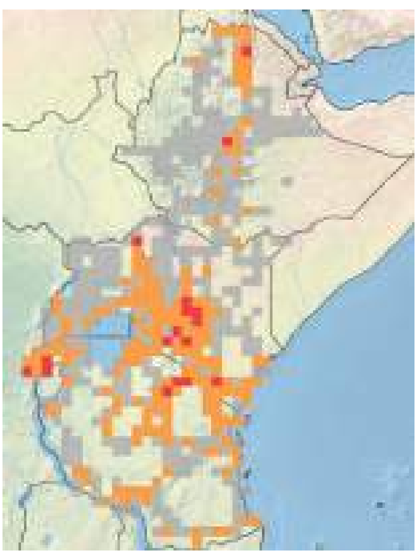
Flowers: Pale yellow (7–10 cm long), borne on flowering pole or stem.

Fruits: Capsules (dry fruits that open at maturity), green turning brown or black as they mature, large (4–5 cm long) with pointed tips.

ORIGIN
Mexico and southern USA.

REASON FOR INTRODUCTION
Flowering poles used in construction, fibre, hedge/barrier and ornament.

INVADES
Disturbed land, urban open spaces, drainage ditches, savannah, rocky outcrops and lowlands.

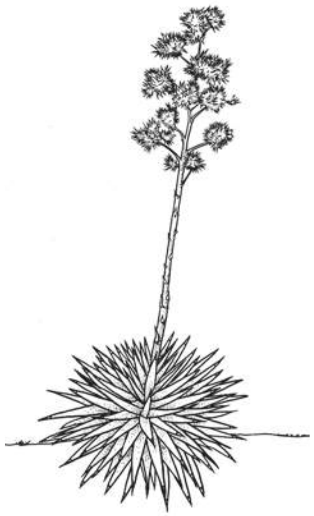


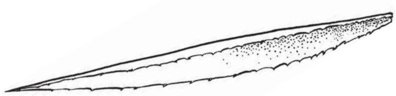
IMPACTS

Spreads by suckering from the root crown, allowing one plant to form a dense, impenetrable stand over time, to the detriment of native plant species. Studies in Spain have shown that invaded areas harbour fewer native species than uninvaded areas (Badano and Pugnaire, 2004). In New Zealand it can smother small plants, especially in coastal and cliff areas, displace vulnerable dune species, and alter the nutrient status of the soil (T.E.R:R.A.I.N., 2014). Thought to "pose a significant threat to rangeland biodiversity in Australia" it readily establishes in natural vegetation forming dense impenetrable thickets (Environmental Weeds of Australia, 2016). The sharp spines can injure people and animals, and may also restrict the movement of animals, while reducing the abundance of forage species. Plants contain calcium oxylate raphides (microscopic daggers of crystaline oxylate) as well as other irritating oils in the sap. Contact with the fresh sap can cause dermatitis and/or digestive problems in people. Sap from the spines and leaf tips may enter the skin through puncture wounds, which can become infected. Also naturalized in parts of Europe, the Canary Islands, southern China, southern Africa and New Zealand (Environmental Weeds of Australia, 2016).

Notes: In Ethiopia, it has been planted in public and private gardens and other places in the regions of Tigray and Shewa, with other site records from Eritrea East, Eritrea West and Welo (Edwards and Tesfaye, 2000). Widely grown as a living fence and as an ornamental, it has escaped cultivation in many areas, especially in semi-arid habitats in East Africa, forming dense impenetrable stands.

Agave angustifolia Haw. var. *angustifolia*





SISAL FAMILY
Agavaceae

COMMON NAMES
English: Caribbean agave, century plant
Rwanda: umugwengwe
Uganda: kigoogwa

DESCRIPTION
Medium-sized evergreen succulent shrub having leaves originating from a basal rosette, and with a branched flowering pole (inflorescence) (3–5 m tall); basal suckers; produces numerous plantlets (bulbils) on the flowering pole.

Leaves: Light green to pale bluish-green or greyish, linear to sword-shaped (0.6–1.2 m long); margins armed with vicious small teeth (2–5 mm long), with terminal leaf spine (1.5–3.5 cm long).

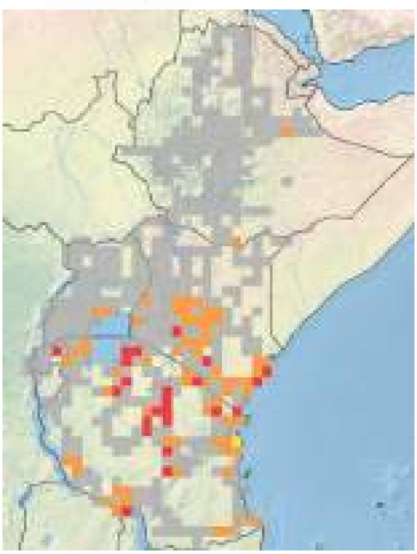
Flowers: Green to yellow, erect (5–6.5 cm long), in branched clusters along flowering pole.

Fruits: Capsules (dry fruits that open at maturity), egg-shaped (3–5 cm long).

ORIGIN
Belize, Costa Rica, El Salvador, Guatemala, Honduras, Mexico and Nicaragua

REASON FOR INTRODUCTION
Fibre, hedge/barrier and ornament.

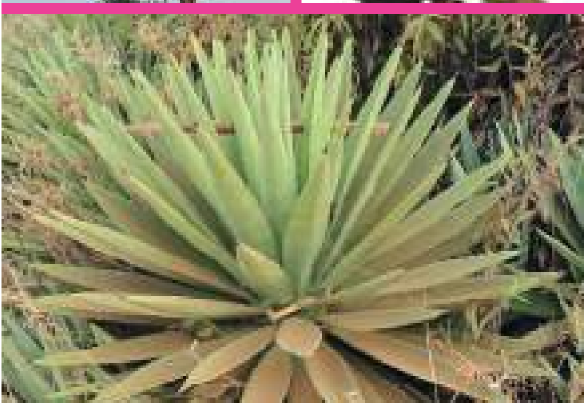
INVADES
Roadsides, wasteland, disturbed land, urban open spaces, plantations, drainage ditches, woodland gaps/edges, savannah, lowlands and gullies.



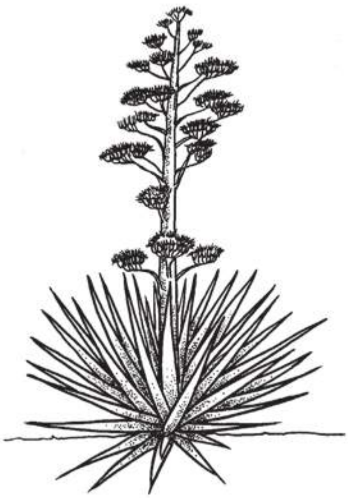
IMPACTS

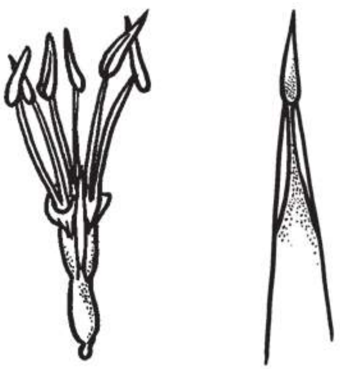
Has escaped from areas where it was planted as a living fence or ornamental, forming dense stands to the detriment of native flora and fauna. Regarded as an environmental weed in southeastern Queensland, Australia, where it is considered to be one of the 200 most invasive plant species in the region; commonly "recorded on coastal sand dunes, sea cliffs and offshore islands" (Environmental Weeds of Australia, 2016). Also recorded as a weed of "roadsides, railway lines, disturbed sites, waste areas, abandoned gardens, urban bushland, riparian vegetation, hillsides and open woodlands in other parts of the region" (Environmental Weeds of Australia, 2016). As with other *Agave* spp. the sap is also allergenic. Individuals on social media who have been exposed to the plant sap have mentioned "itching hands and arms" and "legs and stomach covered with an instant burn and then blisters" followed by comments such as "demon" and "horror" and that "it will spread everywhere" (Dave's Garden, 2016). In South Africa it has invaded rocky outcrops and drainage lines (Henderson, 2001). Other impacts are similar to those of *A. americana* and *A. sisalana*.

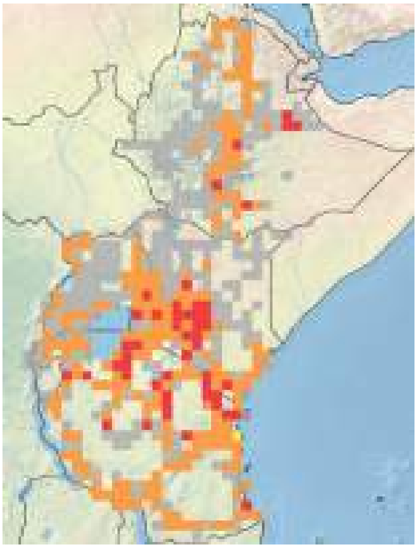
Notes: Readily escapes cultivation, forming dense stands over large areas in many semi-arid areas throughout the region. Large roadside infestations, escapes from living fences, were found between Babati and Dodoma in Tanzania. Readily invades savannah ecosystems where it precludes livestock from accessing valuable forage, especially during the dry season, and inhibits the movement of people and animals. In our opinion this *Agave* spp. proliferates more rapidly than other congeners in the region.



Agave sisalana Perrine







SISAL FAMILY
Agavaceae

COMMON NAMES

English: hemp plant, sisal hemp, sisal
Ethiopia: alghee, kachiya, qaca, qa tlyan, yaa
Kenya: ikonge, katani, likongo, mkonge
Rwanda: umugwengwe
Tanzania: katani, mkonge
Uganda: kigoogwa

DESCRIPTION
Medium-sized to large succulent shrub with thick, sword-shaped leaves originating from a basal rosette with a branched flowering pole (inflorescence) (5–6 m high); suckers from the base through elongated rhizomes; produces numerous plantlets (bulbils) on flowering pole.

Leaves: Dark green, linear or sword-shaped (0.9–1.3 m long), margin smooth, rarely toothed, but with terminal spine (2–2.5 cm long).

Flowers: Greenish yellow, erect (4–6 mm long), with reddish filaments to 6 cm long, in branched clusters along flowering pole.

Fruits: Rare to none; capsules (6 cm long and 2–2.5 cm wide), if present, usually have no seeds.

ORIGIN
Mexico

REASON FOR INTRODUCTION
Flowering poles used in construction, fibre, bee forage, hedge/barrier and ornament.

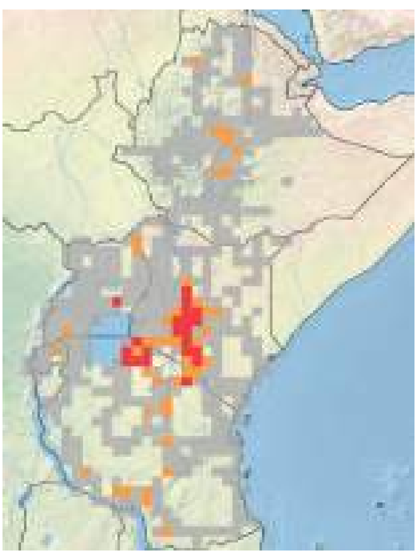
INVADES
Disturbed land, wasteland, urban open spaces, plantations, drainage ditches, savannah, lowlands and gullies.

IMPACTS

Suckering abundantly from the base, it can spread without reproduction from seeds. Also has bulbils which can contribute to spread. Out-competes and displaces native plants in semi-arid and arid environments, through more efficient exploitation of water and nutrients. *A. sisalana* often escapes from plantations into adjacent natural habitats, where it may form dense monospecific stands which reduce biodiversity and forage for native wildlife (Badano and Pugnaire 2004). It threatens biodiversity at the UNESCO World Heritage Site of Aldabra Atoll in the Seychelles (van Dinther *et al*., 2015). In Madagascar, sisal has invaded inselbergs, posing a serious threat to the indigenous vegetation (Porembski, 2000). Sisal also depletes soil fertility and reduces the pH of soils (Hartemink *et al*., 1996; FAO, 2012). As with other *Agave* spp., *A. sisalana* also has a toxic sap that causes pain and burning upon contact with skin, oftening leading to blisters. If ingested, the saponin in the plant can cause kidney and liver damage. *A. sisalana* is also invasive in Australia, South Africa, USA, and on multiple islands in the Pacific (GISD, 2016). In South Africa it invades savannah, erosion channels and watercourses (Henderson, 2001).

Notes: In Ethiopia it is "widely planted as a hedge plant around home gardens, fields, roads and tracks and on terraces, particularly in drier areas" (Edwards and Tesfaye, 1997). Widely grown in plantations, but also used as a living fence, it has escaped cultivation and has established localized infestations in many semi-arid and arid areas in East Africa and Ethiopia.

Austrocylindropuntia subalata (Muelenpf.) Backeb.



CACTUS FAMILY
Cactaceae

SYNONYMS
Cylindropuntia exaltata (A. Berger) Backeb.; *Cylindropuntia subulata* (Muehlenpf.) F.M. Knuth

COMMON NAMES

English: Colville cactus, devil's rope, long-spine cactus

DESCRIPTION
Succulent, spiny, much-branched shrub [3–4 (–5) m tall]; branches elongated (to 0.5 m long), green or pale bluish-green with small wart-like swellings or humps, armed with strong, straight white spines [(1–) 2–4 (–13) cm long].

Leaves: Green, conspicuous (4–8 cm long), persistent.

Flowers: Purple-pink (to 6 cm long), showy, found on the tips of segments.

Fruits: Berries (fleshy fruits that do not open at maturity), green turning yellow-green as they mature, large, egg-shaped to elongated, often in chains; seeds yellow-brown, mostly sterile.

ORIGIN
Bolivia and Peru.

REASON FOR INTRODUCTION
Hedge/barrier and ornament.

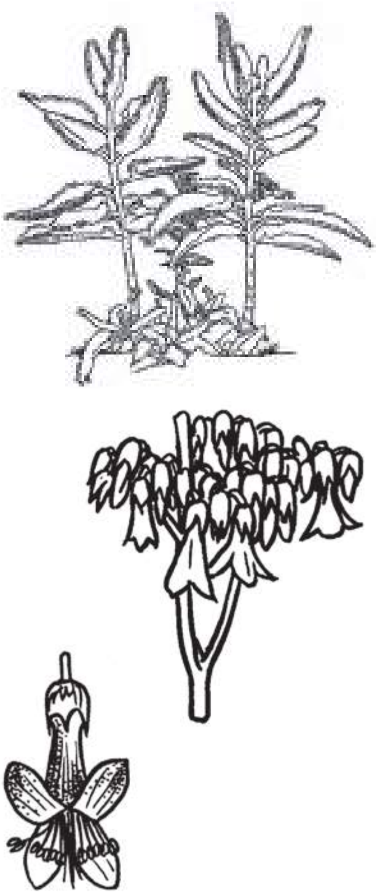
INVADES
Roadsides, disturbed land, wastelands, drainage ditches, grasslands, savannah, riversides and sandy stream beds.

IMPACTS

Forms impenetrable thickets wherever it has been planted, and establishes readily from broken stem segments on riverbanks and in drainage ditches and gullies, particularly after heavy rains. Such thickets prevent access to grazing pastures and water resources. Infestations reduce the livestock carrying capacities of pastures and block the movement of wild animals. The spines cause injuries to livestock, wildlife and people, and in some cases infestations have led to the abandonment of farmlands. In Laikipia County, Kenya, it is often regarded by community members as one of the most problematic cactus species, after *O. stricta*. Additional impacts are assumed to be similar to those recorded for other invasive cactus species.

Notes: Not recorded as being present in Ethiopia but a similar species *Austrocylindropuntia cylindrica* (Lam.) Backeb. [= *Opuntia cylindrica* (Lam.) DC] is used as a live fence in the Ethiopian regions of Eritrea West and Shewa, where it sometimes "forms extensive stands in disturbed areas" (Hunt, 2000). However, it may have been confused with *A. subalata*, a very similar species. *A. subalata* (= *O. exaltata* Berger) was already present in East Africa almost 50 years ago, where it is "said to have escaped and to grow wild" (Hunt, 1968). Having escaped from living fences throughout East Africa, *A. subalata* is now naturalized and locally abundant or invasive in many areas, as indicated in the distribution map.

Bryophyllum daigremontianum (Raym.-Hamet & H. Perrier) A. Berger



STONECROP FAMILY
Crassulaceae

SYNONYM
Kalanchoe daigremontiana Raym.-Hamet & H. Perrier

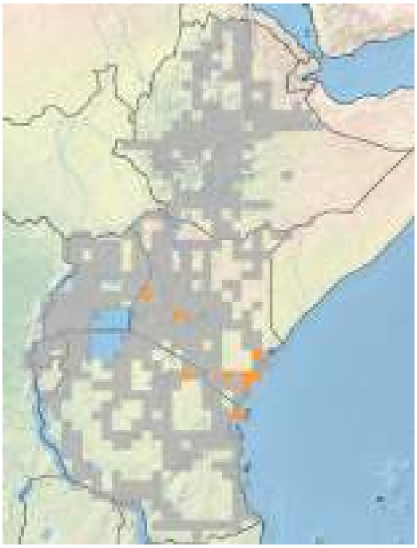
COMMON NAMES
English: alligator plant, devil's backbone, maternity plant
Rwanda: igitenetene
Uganda: kiyondo

DESCRIPTION
Evergreen, erect, succulent herb (0.3–1m high), with a purplish appearance; stems stout and mostly unbranched.

Leaves: Purple blotched on lower surface, green above, simple, triangular sword-shaped with pointed tips (5–25 cm long and 0.5–2 cm wide); margins have forward-pointing sharp projections or teeth, with plantlets (bulbils) forming on leaf notches; leaves opposite on stem and evenly spaced.

Flowers: Purple-orange with yellow margins, tubular, pendulous.

Fruits: Follicles (dry fruits having one compartment that opens, along one side only, at maturity), papery and membranous, containing thousands of tiny, somewhat elongated, longitudinally ridged seeds (0.6–1 mm long and 0.2–0.3 mm wide).



ORIGIN
Madagascar

REASON FOR INTRODUCTION
Ornament

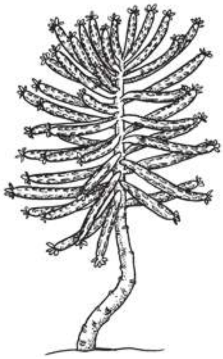
INVADES
Disturbed land, gardens, drainage ditches, gullies and savannah, especially rocky ridges and outcrops.

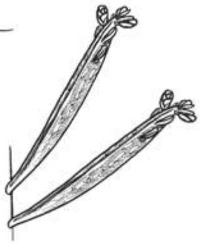
IMPACTS

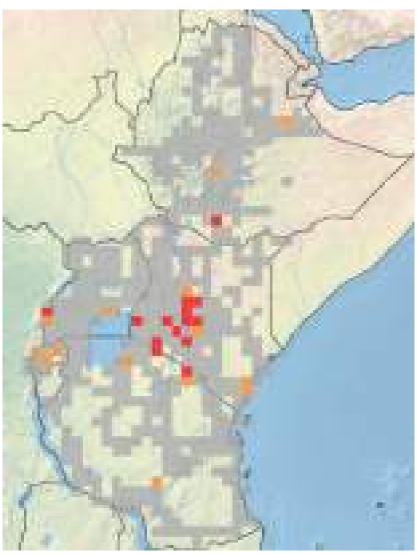
Can form dense monospecific stands which displace plants of other species. Being allelopathic, it inhibits the germination and growth of other plants. It has the potential to alter soil properties (Chacón *et al*., 2009), and to inhibit the regeneration of native vegetation (Groner, 1975; Herrera *et al*., 2011). In a study in the Cerro Saroche National Park, Venezuela, it was found to have a negative impact on the density and species richness of native seedlings (Herrera *et al*., 2011). If infestations are allowed to increase in the National Park it is predicted that it will alter species composition and physiognomy of the native plant communities, putting the richest cactus flora in the region at risk (Herrera *et al*., 2011). It is also highly toxic, and cases of cardiac glycoside poisoning have been reported in calves that were fed flowerheads in trials (McKenzie *et al*., 1987). It is also considered to be toxic to dogs and cats. Several *Bryophyllum* spp., including the hybrid *B. daigremontianum* × *B. delagoense*, are known to have caused 41 poisoning incidents, affecting 379 cattle in Queensland, Australia, between 1960 and 1984 (McKenzie and Dunster, 1986). *Bryophyllum* spp. may also be toxic to wildlife (McKenzie *et al*., 1987).

Notes: Readily forms dense stands, especially in cultivated areas. Plants similar to *B. daigremontianum* have been seen in private and public gardens in Asmera, Ethiopia (Gilbert, 1989). It is widely grown as an ornamental in East Africa. Although this species is not considered to be invasive yet, it readily forms dense stands under mother plants wherever it has been planted, especially in semi-arid regions. Probably more widespread than indicated in the distribution map.

Bryophyllum delagoense (Eckl. & Zeyh.) Schinz







STONECROP FAMILY
Crassulaceae

SYNONYMS
Bryophyllum tubiflorum Harv.; *Kalanchoe delagoensis* Eckl. & Zeyh.

COMMON NAMES

English: mother-of-millions, finger plant, chandelier plant, pregnant plant
Rwanda: igitenetene
Uganda: kiyondo

DESCRIPTION
Erect, spineless, succulent herb (30–180 cm tall), living for more than one but for less than two years; mostly unbranched; reproducing rapidly, mainly from plantlets which develop at the tips of the leaves; often forming dense stands.

Leaves: Pale green, with darker green to violet-brown and reddish spots or mottles; cylindrical in shape, somewhat elongated with almost parallel sides, narrow (15–150 mm long and 2–6 mm wide) with a small lengthwise groove; 2–9 small conical teeth at the end of each leaf produce plantlets (bulbils) which drop to the ground and grow; held opposite each other on young shoots but in whorls of three or alternate on older shoots.

Flowers: Pale orange to magenta red, tubular (2–4 cm long), in terminal clusters (to 150 mm wide), drooping at the end of the stem.

Fruits: Follicles (dry fruit having one compartment that opens, along one side only, at maturity), papery and membranous (about 10 mm long), containing thousands of tiny egg-shaped seeds (0.6–2.5 mm long).

ORIGIN
Madagascar

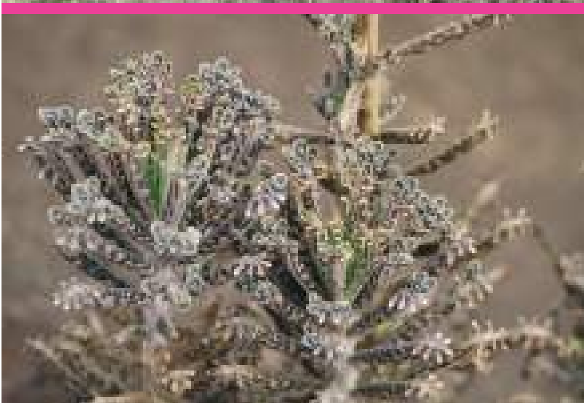
REASON FOR INTRODUCTION
Medicine and ornament.

INVADES
Disturbed land, gardens, drainage ditches, woodlands, gullies, lowlands and savannah, especially rocky ridges and outcrops.

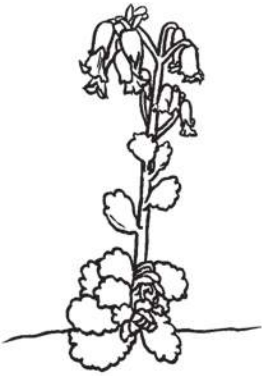
IMPACTS

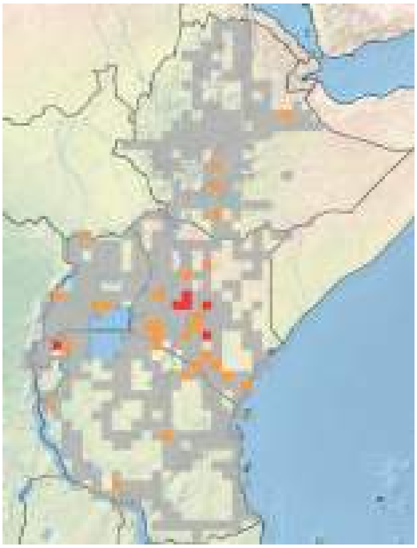
An aggressive weed producing very large numbers of seeds and plantlets, this species forms dense monotypic stands, which displace native plant species. It contains growth-inhibiting root exudates, enabling it to readily displace grasses and legumes (Groner 1975). In Australia it can be found on a range of soils ranging from sand to heavy clay, as long as there is sufficient surface organic matter (Batianoff and Franks, 1998). It is toxic to livestock and humans and probably also to wildlife. Consumption of about 5 kg of mother-of-millions, as much as grows in a square metre within a dense stand, would be enough to kill an adult cow (NSW WeedWise, 2015). Invasive *Bryophyllum* spp., including *B. delagoense*, caused 41 recorded poisoning incidents affecting 379 cattle in Queensland, Australia, between 1960 and 1984 (McKenzie and Armstrong, 1986). In 1997, 125 head of cattle died after eating this species on a travelling stock reserve near Moree in New South Wales, Australia (McKenzie *et al*., 1987). Symptoms of *B. delagoense* poisoning, which ultimately may result in death, include anorexia, depression, ruminal atony, diarrhoea, heart rate and rhythm abnormalities and dyspnoea (McKenzie and Dunster, 1986). Treatment is costly and is effective only if administered before respiratory system damage occurs (McKenzie and Dunster, 1986).

Notes: Has been seen in Ethiopia in Addis Ababa, Alemaya and Asmera (Gilbert, 1989) and reported as naturalized in East Africa (Wickens, 1987). Readily escapes from cultivation, forming dense stands, especially in semi-arid areas within East Africa. Large stands have been seen in Laikipia County, Kenya and elsewhere. Significant potential of becoming more widespread and abundant in semi-arid regions throughout Ethiopia and East Africa.



Bryophyllum fedtschenkoi (Raym.-Hamet & H. Perrier) Lauz.-March





STONECROP FAMILY
Crassulaceae

SYNONYM
Kalanchoe fedtschenkoi Raym.-Hamet & H. Perrier

COMMON NAMES

English: kalanchoe stonecrop, lavender-scallops
Rwanda: igitenetene
Uganda: kiyondo

DESCRIPTION
Evergreen, succulent shrub, erect (to 45 cm tall) to prostrate, often creeping and rooting; stems thin, branched, frequently light purple; reproduces rapidly, mainly from plantlets which develop at the end of the leaves; often forms dense stands.

Leaves: Bluish-green with a reddish tinge, egg-shaped or somewhat elongated (1–5 cm long and 0.5–2.5 wide), margins with blunt or rounded teeth; plantlets (bulbils) sometimes produced in the notches of leaf margins; leaves opposite on the stem and evenly spaced, leaf stalk short.

Flowers: Brownish-pink flowers, tubular (2.5–3 cm long), pendulous.

Fruits: Follicles (dry fruit having one compartment that opens, along one side only, at maturity), papery and membranous, containing thousands of tiny egg-shaped seeds (0.6 mm long).

ORIGIN
Madagascar

REASON FOR INTRODUCTION
Ornament

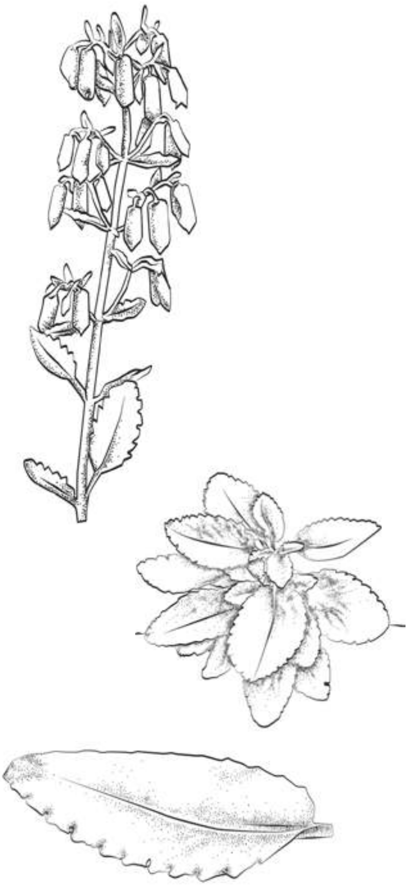
INVADES
Disturbed land, gardens, urban open spaces, drainage ditches, gullies and savannah, especially rocky ridges and outcrops.

IMPACTS

Has the ability to form dense stands, displacing native plant species, especially in semi-arid areas where soil moisture is limited. Impacts are similar to those of other *Bryophyllum* species. As with other *Bryophyllum* spp. (~ *Kalanchoe* spp.) the plants contain cardiac glycosides and are toxic to animals, often resulting in cattle and sheep poisonings, especially in Africa and Australia (Smith, 2004). In Australia most *Bryophyllum* spp. poisonings occur in the summer months because the flowers have much higher concentrations of glycosides than the stems, leaves or roots. In calves the lethal dose is about 7 g of flowers/kg body weight or 40 g of leaves/kg of body weight (McKenzie and Duster, 1986; McKenzie *et al*., 1987). Symptoms of poisoning include "collapse, cyanosis, arrhythmias, dyspnea, and persistent diarrhoea" (Smith, 2004). In South Africa, long term ingestion of plants results in a syndrome referred to as "krimpsiekte," which involves "progressive paresis of the limbs and neck (torticollis)," with animals eventually becoming paralyzed and then having to be euthanized (Smith, 2004). This condition has also been reported in dogs in South Africa. In the USA, "neurologic signs, including nystagmus, delirium, mild seizures, and tetany, have been reported in dogs consuming *Kalanchoe* spp. (Plumlee, 2002, in Smith, 2004). Other impacts are similar to those of other *Bryophyllum* spp.

Notes: Has been reported as being naturalized in East Africa (Wickens, 1987) with no records from Ethiopia. Surveys found it to be naturalized and locally abundant or invasive in some semi-arid areas, especially in Laikipia County. Probably more widespread and naturalized than indicated.

Bryophyllum pinnatum (Lam.) Oken



STONECROP FAMILY
Crassulaceae

SYNONYM
Bryophyllum calycinum Salisb.; *Kalanchoe pinnata* (Lam.) Pers.

COMMON NAMES

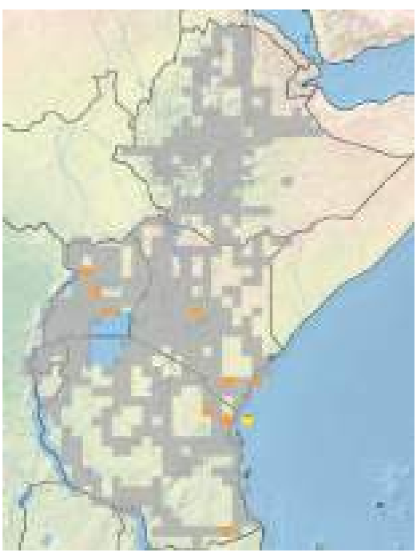
English: air plant, cathedral bells, green mother-of-millions, resurrection plant
Rwanda: igitenetene
Uganda: kiyondo

DESCRIPTION
Evergreen, erect herb with succulent, hairless stems (50–200 cm tall), nearly woody below, simple or little branched, with red stripes or spots.

Leaves: Green, streaked with purple, edged with orange-red; fleshy, simple or with 3–5-leaflets (5–25 cm long and 2–12.5 cm wide); plantlets (bulbils) produced in the notches of leaf margins; leaf stalks broader towards the base (2.5–10 cm long).

Flowers: Pale yellow to green with red to violet lines, becoming denser as the flowers mature, lantern-shaped (7 cm long), pendulous or drooping.

Fruits: Follicles (dry fruits having one compartment that opens, along one side only, at maturity), papery and membranous (about 15 mm long), with four compartments, containing numerous minute brownish seeds (about 0.8 mm long).



ORIGIN
Madagascar

REASON FOR INTRODUCTION
Medicine and ornament.

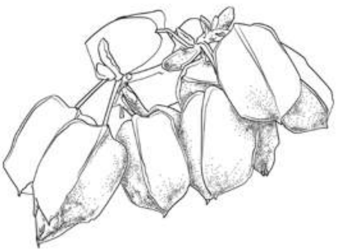
INVADES
Roadsides, disturbed land, wastelands, urban open spaces, gardens, forest edges/gaps, woodland and woodland gaps/edges.

IMPACTS

Readily establishes monospecific stands, to the detriment of native plant species (Weber, 2003). On Saint John, in the US Virgin Islands, large areas of herbaceous vegetation have been replaced by dense stands of *B. pinnatum* (Ting, 1989), and on the Galápagos Islands, thick carpets of *B. pinnatum* are preventing the regeneration of native plant species (Tye, 2001). The species is considered to be allelopathic, which may contribute to its invasion success, including its displacement of crops on the Galápagos Islands (Soria *et al*., 2002). *B. pinnatum* is one of the three most prevalent invasive plant species recorded in rural humid areas on inhabited islands of the Galápagos (Guezou *et al*., 2010). Like other *Bryophyllum* spp., it is also toxic. Two adult cattle died within 48 hours of being fed large amounts of *B. pinnatum* plants (Reppas, 1995). Symptoms included hyper-salivation, ataxia, severe cardiac arrhythmia and laboured respiration (Reppas, 1995). *B. pinnatum* is also an alternative host for crop pests.

Notes: Grown in gardens in Addis Ababa, Ethiopia, it is considered to be an "attractive adventive" (Gilbert, 1989) and has been reported as being present in East Africa (Wickens, 1987). Localized infestations have been seen throughout the region, especially in areas of higher rainfall where it can form dense stands on forest edges or open woodlands. Probably significantly more widespread and locally abundant than indicated.

Bryophyllum proliferum Bowie ex Hook.



STONECROP FAMILY
Crassulaceae

SYNONYM
Kalanchoe prolifera ((Bowie ex Hook.) Raym.-Hamet

COMMON NAMES

English: blooming boxes, green mother of millions
Rwanda: igitenetene
Uganda: kiyondo

DESCRIPTION
Evergreen succulent, erect (to 3 m tall); stems almost woody, robust and four-angled (to 5 cm in diameter).

Leaves: Green, fleshy, once-divided (to 30 cm long), with 7–11 asymmetrical, somewhat elongated, sword- to egg-shaped leaflets (7–15 cm long and 1.5–5 cm wide), margins often purple and blunt/rounded to tooth-like; leaf stalk (to 16 cm long) broadened near base.

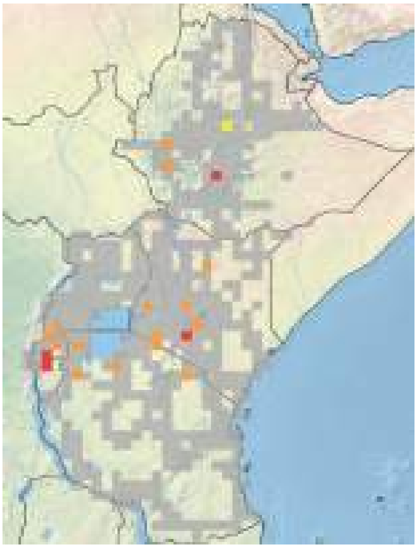
Flowers: Greenish-yellow with pinkish-red tips, bell-shaped, pendulous.

Fruits: Not seen in East Africa.

ORIGIN
Madagascar

REASON FOR INTRODUCTION
Medicine and ornament.

INVADES
Roadsides, disturbed land, gardens, forest gaps/edges and woodland gaps/edges.

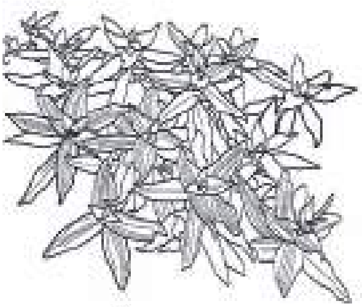


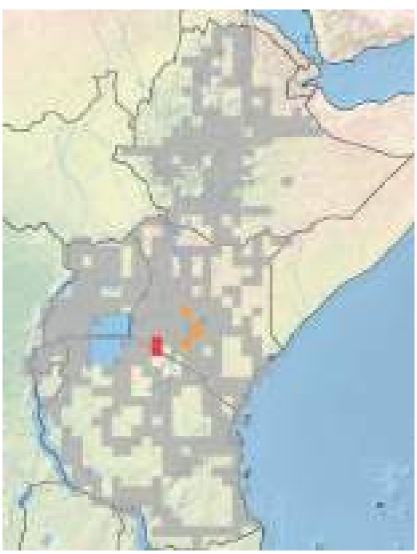
IMPACTS

Forms dense stands which exclude plants of native species and the organisms associated with them. Produces large numbers of bulbils on its inflorescence, facilitating invasions, and establishes easily from discarded plant material. Considered to be naturalized in South Africa (Walters *et al*., 2011). Many impacts are considered to be similar to those of other *Bryophyllum* spp.

Notes: Present in Addis Ababa, Ethiopia, where it is “establishing itself in the wild” (Gilbert, 1989). Has previously been recorded as naturalized in East Africa (Wickens, 1987). It has readily established in forest edges and gaps in parts of Nairobi, Kenya, and has become established in the wild from garden refuse dumps in Laikipia County, Kenya. It has also been recorded in Kakamega Forest, Kenya (Fischer *et al.,* 2010).

Callisia fragrans (Lindl.) Woodson





SPIDERWORT FAMILY
Commelinaceae

COMMON NAMES

English: basket plant, inch-plant, purple succulent

DESCRIPTION
Evergreen herbaceous plant, low-growing and spreading; stems (to 1 m long) fleshy, developing into long runners that produce roots, giving rise to new plants; flowering stems upright (to 1.5 m high).

Leaves: Green, purplish-green or purplish, hairless, elongated (5–40 cm long and 2.5–10 cm wide), tips pointed; clustered towards the ends of the stem, scattered below.

Flowers: White, small, showy, arranged in clusters of three on top of long erect stalks, fragrant.

Fruits: Capsules (dry fruits that open at maturity), tiny, with three cells.

ORIGIN
Mexico

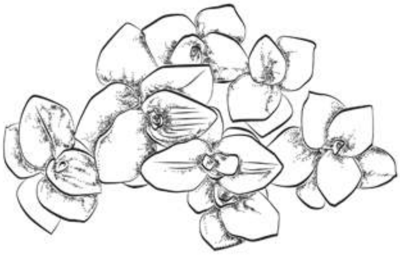
REASON FOR INTRODUCTION
Ornament

INVADES
Disturbed areas, wastelands, urban open spaces, gardens and areas adjoining urban settlements.

IMPACTS
C. fragrans tends to grow in disturbed secondary forest and moist semi-open areas. It has also become invasive in the World Heritage Site of Gros Piton on Saint Lucia, Caribbean, forming extensive "carpets" in forest understoreys, replacing native Caribbean species such as *Callisia repens* Jacq. L (Commelinaceae); *Peperomia trifolia* (L.) A. Dietr. (Piperaceae); *P. myrtifolia* (Vahl) A. Dietr. (Piperaceae), and *Gibasis geniculata* (Jacq.) Rohw. (Commelinaceae) (Graveson, 2012). In parts of Australia, *C. fragrans* forms a dense, spreading ground-cover that can rapidly overtake bushland areas, crowding out native species and preventing their regeneration. In southeastern Queensland, it is regarded as a significant environmental weed in many areas, including the Hervey Bay Local Authority Area, where it is regarded as one of the 12 "most concerning" environmental weeds (BCC, 2015). In dogs that come into contact with the plant, it can cause cell-mediated contact dermatitis (Lee and Mason, 2006).

Notes: Reported by others as present in East Africa but not naturalized or invasive (Faden, 2012). An escape from gardens, it often forms a dense 'ground' cover in woodland understoreys in parts of Kenya, and is considered to be naturalized and invasive, at least locally, in many areas. It was found to be very abundant in woodland understoreys in some lodge premises in the Masai-Mara National Reserve, forming monotypic stands, excluding all other vegetation.

Callisia repens (Jacq.) L.



SPIDERWORT FAMILY
Commelinaceae

SYNONYM
Tradescantia callisia Sw.

COMMON NAMES

English: chain plant, creeping inch-plant, inch plant, inch vine, turtle vine

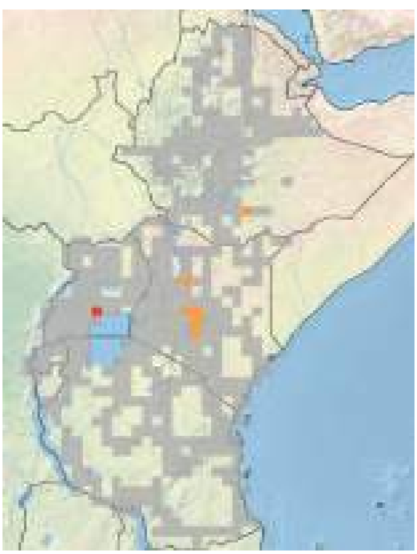
DESCRIPTION
Evergreen herb, creeping, mat-forming, with erect flowering stems, rooting at the nodes.

Leaves: Upper surfaces pale green, often with tiny purple spots and/or purplish edges; undersides purple-tinged to bright purple, fleshy, hairless, egg-shaped (1–4 cm long and 1–2 cm wide), broader and rounded at the base, tapering towards the end, margins with fine hairs; held alternately on stems, becoming smaller and more distant from each other along the flowering stems; no leaf stalk.

Flowers: White with three round petals (part of a flower that is usually brightly coloured), inconspicuous (6–7 mm long), in clusters, odourless.

Fruits: Capsules (dry fruits that open at maturity), lens-shaped (1.7 mm long).

ORIGIN
Argentina, Belize, Bolivia, Brazil, Costa Rica, Dominican Republic, El Salvador, Ecuador, French Guiana, Guatemala, Mexico, Nicaragua, Panama, Paraguay, Peru, Puerto Rico, Venezuela and Caribbean Islands.



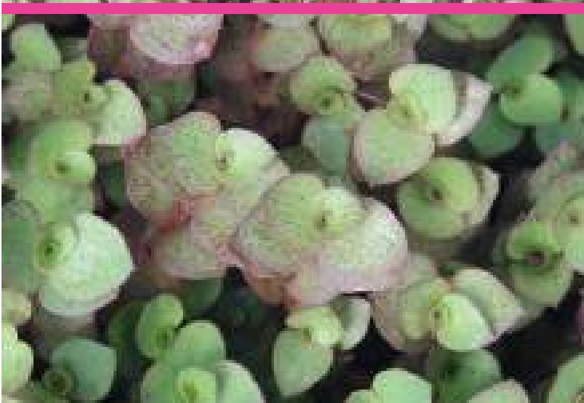
REASON FOR INTRODUCTION
Ornament

INVADES
Disturbed areas, wastelands, roadsides, gardens, urban open spaces and subtropical forests.

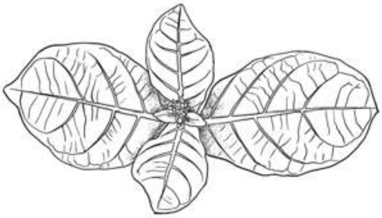
IMPACTS

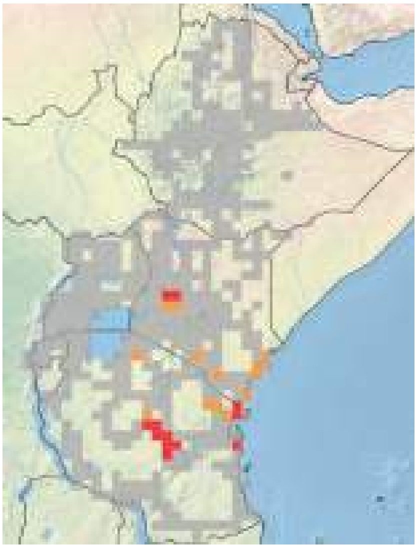
C. repens spreads extremely rapidly, forming dense mats that prevent the germination and growth of native plants. It is considered to be a significant environmental weed, with the potential to crowd out native plants and prevent their regeneration (Acevedo-Rodríguez and Strong, 2007; Foxcroft *et al*., 2007). In Australia, it is a weed of "riparian vegetation, coastal environments, roadsides, forest margins, urban bushland, disturbed sites and waste areas" (Environmental Weeds of Australia, 2016). In Taiwan, wild populations of *C. repens* can be found throughout the island and in urban areas, frequently on the roofs of houses or on roadsides (Tseng *et al*., 2010).

Notes: It is widely grown as ornamental throughout the East African region, escaping cultivation under ideal environmental conditions and smothering native vegetation. Infestations have been seen in urban open spaces and roadsides in Entebbe, Uganda, and Nairobi, Kenya. Not a very conspicuous plant and as such, probably more widespread than indicated.



Calotropis gigantea (L.) Dryand.





MILKWEED FAMILY
Apocynaceae

SYNONYM
Asclepias gigantea L.

COMMON NAMES

English: calotrope, bowstring hemp, giant milkweed, giant rubber bush
Ethiopia: akalo, folfol, tobiya, yahara-zaf
Kenya: mpamba mwitu
Tanzania: ngangazi

DESCRIPTION
Large shrub (to 4 m tall); sometimes branching from the base; exudes copious amounts of milky sap when damaged.

Bark: Younger stems greyish or pale green, smooth, with a covering of whitish hairs which easily rub off, older stems have a fissured cork-like bark, light brown in colour.

Leaves: Greyish-green, waxy, thick, hairless on top and hairy on undersides, rounded or egg-shaped (5–15 cm long and 4–10 cm wide), margins entire with short-pointed tips, held opposite each other on stems, with stem-clasping bases, very short leaf stalks.

Flowers: Five white to pale lilac-blue petals (part of flower that is usually brightly coloured), bent backwards (20–30 mm across), held in clusters, each containing 3–15 flowers, not scented; *C. procera* has white to pink petals with dark purple or purplish tips.

Fruits: Follicles (dry fruits with one compartment opening, along one side only, at maturity), grey-green, bladdery or inflated, greyish-green turning brown as they mature, rounded to egg-shaped (8–12 cm long), or rounded at the base but sharply pointed at the tip, containing numerous seeds, each with a tuft of long, silky hairs.

ORIGIN
China, Iran, India, Indonesia, Laos, Malaysia, Myanmar, Nepal, Pakistan, Sri Lanka and Thailand.

REASON FOR INTRODUCTION
Medicine and ornament.

INVADES

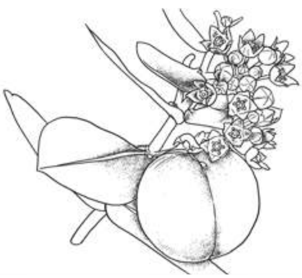
Roadsides, disturbed land, wasteland, urban open spaces, fallow land, croplands, gullies, lowlands and floodplains.

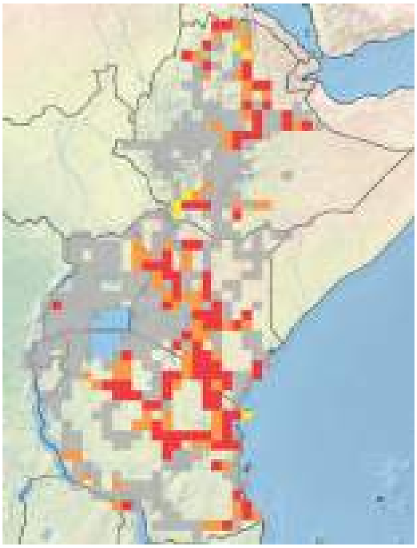
IMPACTS

C. gigantea occurs sympatrically with *C. procera* in many parts of Kenya and Tanzania. As such, their impacts may be considered to be similar. Invades degraded rangeland pastures, river flats and coastal dunes. In Australia it "thrives on poor soils particularly where overgrazing has removed competition from native grasses" (Smith, 2002). It is also invasive along the sandy beachfronts of far north Queensland, Australia (Environmental Weeds of Australia, 2016). In Hawaii it grows anywhere, but "thrives in hot, sunny, dry environments, including areas near the coast that receive salt exposure" (Staples and Herbst, 2005). Also reported as invasive on Mauritius and the Seychelles (PIER, 2009).

Notes: In East Africa, it "grows on bare degraded land often near villages, on sandy soil or coral rock; on the shores of Lake Victoria and in the Kenyan Rift Valley" (Goyder *et al*., 2012). It is an "escape" on the Kenyan coast and at Baringo (Beentje, 1994). It is abundant around Lake Baringo, Kenya, and widespread in Tanzania, especially on roadsides, floodplains, riverbanks and dry sandy riverbeds between Dodoma and Iringa. Not seen in Ethiopia during surveys. Spreading rapidly throughout the region, especially along newly constructed roads.

Calotropis procera (Aiton) Dryand.





MILKWEED FAMILY
Apocynaceae

SYNONYM
Asclepias procera Aiton

COMMON NAMES

English: apple of Sodom, cabbage tree, calotrope, calotropis, rubber bush; Ethiopia: akalo, folfol, ginda, gelehatoo, tobiya, yahara-zaf; Kenya: ararat, etetheru, kmuvuthu, labechi, laibeleh, llumbu, muk-rugha, Tanzania: ngangazi; Uganda: ekwe, epuu

DESCRIPTION
Large shrub or small tree (2–4 m tall); stems waxy, with large leaves containing a milky sap; deep tap-root (3–4 m in length).

Bark: Younger stems greyish green, smooth, with a covering of whitish hairs, older stems have a cork-like bark, light brown in colour.

Leaves: Greyish-green, waxy, thick, hairless on top and hairy on undersides, with a broad, light yellow mid-vein, rounded or egg-shaped (5–30 cm long and 4–15 cm wide), margins entire with short-pointed tips, held opposite each other on stem, with stem-clasping bases, very short leaf stalks (5 mm long).

Flowers: Five white to pink petals (part of a flower that is usually brightly coloured) with dark purple or purplish tips (15–25 mm across), held in clusters, each containing 3–15 flowers; *C. gigantea* has white to pale lilac-blue petals that are bent backwards.

Fruits: Follicles (dry fruits with one compartment opening, along one side only, at maturity), bladdery or inflated, greyish-green turning brown as they mature, rounded to egg-shaped (6–12 cm long and 3–7 mm wide), containing numerous seeds (7 mm long and 5 mm wide), each with a tuft of long, silky hairs.

ORIGIN
Uncertain, but its postulated native range may include South West Asia (Afghanistan, Arabia, India, Iran, Jordan and Pakistan), and Africa (Algeria, Egypt, Libya, Morocco, Mauritania, Senegal and Somalia) (Parsons and Cuthbertson, 2001). However, some are of the opinion that it has a wider native range in Africa, including countries such as Ethiopia, Kenya, Tanzania and Uganda.

REASON FOR INTRODUCTION
Medicine and ornament

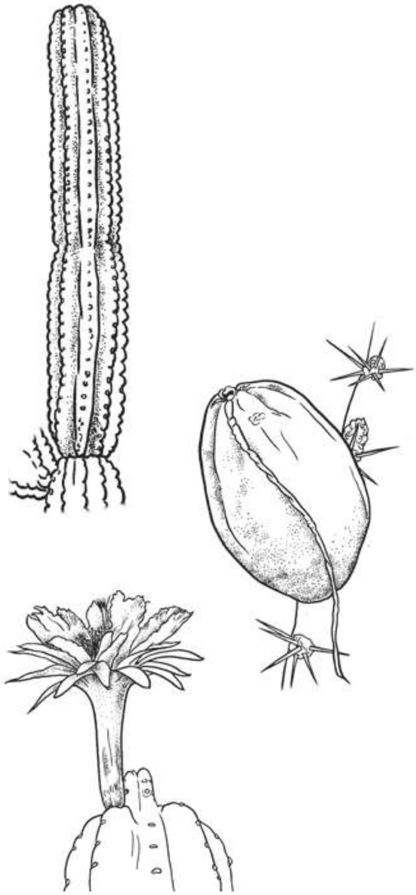
INVADES
Roadsides, gullies, pastures, dry riverbeds and floodplains.

IMPACTS
Forms large and dense thickets, especially along roadsides and in low-lying areas, displacing native species. It has considerable environmental plasticity, being able to tolerate adverse climatic conditions and a wide range of soil types (Farahat *et al*., 2015). It is considered to be a serious weed in pastures, overgrazed rangelands and also in croplands, particularly sisal plantations in East Africa. In Australia, it competes with valuable forage species and is capable of forming dense thickets that interfere with stock management, particularly mustering activities (Smith, 2002). In Brazil, the species has invaded tropical rainforest and seasonally dry forest (Ferreira and Gomes, 1976; Barbosa *et al*., 2007). The plant sap can cause severe irritation if it comes into contact with the eyes, resulting in immediate severe "corneal damage with painless sudden dimness of vision" (Basak *et al*., 2009). Ingestion by livestock is suspected of causing ill-health and sometimes even death (Mahmoud *et al*., 1979; de Lima *et al*., 2011). *C. procera* is very difficult to control because the plants are deep-rooted and fire-resistant and coppice readily from cut stumps.

Notes: Widespread throughout East Africa and Ethiopia, growing "close to villages on disturbed or degraded land, usually on sand or along the banks of dry riverbeds" (Goyder *et al*., 2012). Our surveys found the species to be widespread in East Africa and Ethiopia, especially on roadsides, floodplains and fallow land. Often found growing together with *C. gigantea*, which appears to be spreading more rapidly.




Cereus jamacaru DC.



CACTUS FAMILY
Cactaceae

SYNONYMS
Cactus jamacaru (DC.) Kostel.; *Cereus horribarbis* Salm-Dyck

COMMON NAMES
English: Peruvian apple cactus, pitaya, queen of the night

DESCRIPTION
Evergreen spiny cactus tree [3–10 (–18) m high]; irregularly branched, with thick cylindrical succulent stems covered with spines in groups of 5–10, arising from short, woody trunks; branches grey-green to blue-green with (3–) 6 (–8) prominent ribs.

Leaves: None

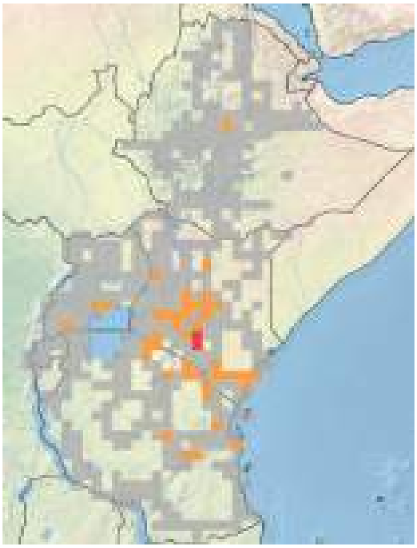
Flowers: Showy white with red tips [15 (–20) cm long and 7–10 cm across], flowering at night; flowers of *Cereus repandus* (L.) Mill. [Syn.: *Cereus peruvianus* (L.) Mill.] are only about 8 cm long.

Fruits: Berries (fleshy fruits that do not open at maturity), green turning red or pink as they mature, smooth with no spines (6–10 cm long and 4–8 cm wide); white pulp with black seeds.

ORIGIN
Northeast Brazil

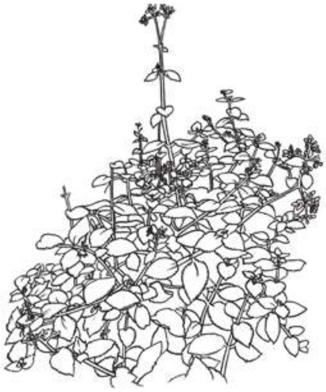
REASON FOR INTRODUCTION
Fruit, hedge/barrier and ornament.

INVADES
Woodland gaps/edges, savannah and rocky outcrops.



IMPACTS
Can form dense stands, displacing native plants and preventing access to forage by grazers and browsers, resulting in reduced livestock and/or wildlife carrying capacities. Thickets may impede the movement of livestock and wild herbivores, while the spines may cause injuries to people as well as to animals. Large stands growing under trees may prevent access to shade by livestock animals, contributing to heat stress. Additional impacts are similar to those recorded for other invasive cactus species. Recorded as invasive in South Africa, establishing stands in savannah and rocky ridges (Henderson, 2001).

Notes: Although not previously recorded as being present in Ethiopia (Hunt, 2000) or East Africa (Hunt, 1968), it is now widely grown as an ornamental throughout East Africa. *C. peruvianus* (L.) Mill, now considered to be a synonym of *C. repandus* (L.) Mill, has been reported as being present in Nairobi, Kenya (Newton and Mbugua, 1993), although this may be a misidentification. Further research is required to confirm this. *C. jamacaru* is invasive in the Nairobi National Park, Kenya, and in savannah grasslands near Lukenya, to the southeast of Nairobi. It is also naturalized and spreading in parts of Laikipia County, Kenya.



STONECROP FAMILY
Crassulaceae

COMMON NAMES

English: Jade-tree, showy trailing jade

DESCRIPTION
Evergreen, hairless, low-growing, creeping, succulent herb (40 cm tall) with stems to 80 cm long, rarely branched; young stems sometimes tinged with reddish-purple.

Leaves: Green to yellowish-green and occasionally with a reddish tinge on the leaf margins, rubbery, thick, egg- to oval- to sword-shaped [2-3.5 (-6) long and 1.5-2 (-3.5) cm wide], margins have small teeth, leaves held opposite each other on stems; leaf stalks to 3 mm long.

Flowers: Pinkish white, star-shaped, petals (brightly coloured part of flower) (3.5-5 mm long and 1 mm wide), held in dense and branched terminal clusters.

Fruits: Follicles (dry fruits having one compartment that opens, along one side only, at maturity) slightly recurved, smooth.

ORIGIN
South Africa

REASON FOR INTRODUCTION
Ornament

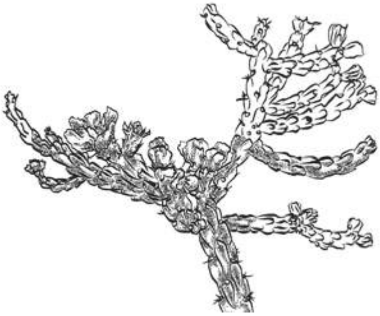
INVADES
Roadsides, disturbed areas, plantations, forest understorey, forest gaps/edges, woodland understorey and woodland gaps/edges wherever there is sufficient shade.

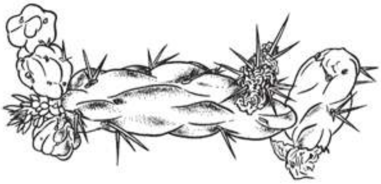
IMPACTS

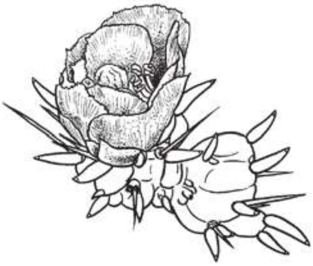
C. sarmentosa is a fast grower that can form thick mats below trees, displacing other plant species. Little is known about the impacts of this plant, although casual observation suggests that it has the ability to smother plants of other species. In Zimbabwe it is naturalized on roadsides and on disturbed ground, "often near gardens" (Flora of Zimbabwe, 2016). In New South Wales, Australia, it is naturalized on "sandy soils in sclerophyll forest of *Eucalyptus maculata* Hook. f. (Myrtaceae), *E. paniculata* Sm. and *E. longifolia* Link (Toelken, 1981).

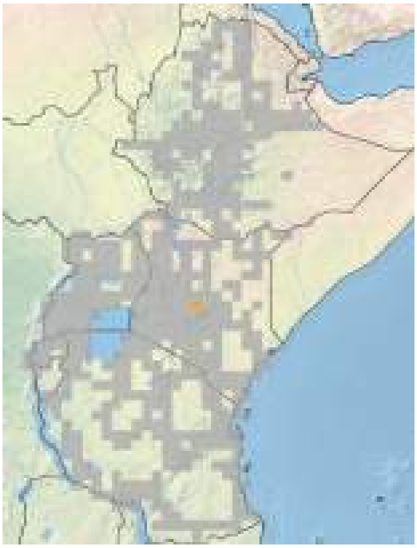
Notes: It has escaped from cultivation in Laikipia County and in parts of Nairobi, Kenya, forming dense mats in plantation and woodland understoreys. Likely to be far more widespread than surveys suggest.

Cylindropuntia imbricata (Haw.) F.M. Knuth









CACTUS FAMILY
Cactaceae

SYNONYM
Opuntia imbricata (Haw.) DC.

COMMON NAMES

English: cane cactus, chain-link cactus, devil's rope pear, imbricate prickly pear, tree cholla

DESCRIPTION
Succulent spiny, much-branched shrub (2–4 m tall), trunk erect with dull grey-green stems made up of a number of cylindrical segments (30–40 cm long and 3–5 cm thick) covered with small humps that give them a woven, rope-like appearance; armed with white spines (2–3 cm long), initially covered with loose, silver-grey to yellow papery sheaths (tubular structures that surround or clasp the spines); old branches hang downwards.

Leaves: Green, reduced, cylindrical or cone-shaped (1–2 cm long), shed early.

Flowers: Purple-pink or reddish-purple (to 6 cm long and 3–9 cm across), found at the tips of segments, showy.

Fruits: Berries (fleshy fruits that do not open at maturity), fleshy, green turning yellow-green as they mature, egg-shaped with the narrower end at the base (25–70 mm long and 20–40 mm wide), spineless; seeds yellow-brown, mostly sterile.

ORIGIN
Mexico and southern USA.

REASON FOR INTRODUCTION
Hedge/barrier and ornament.

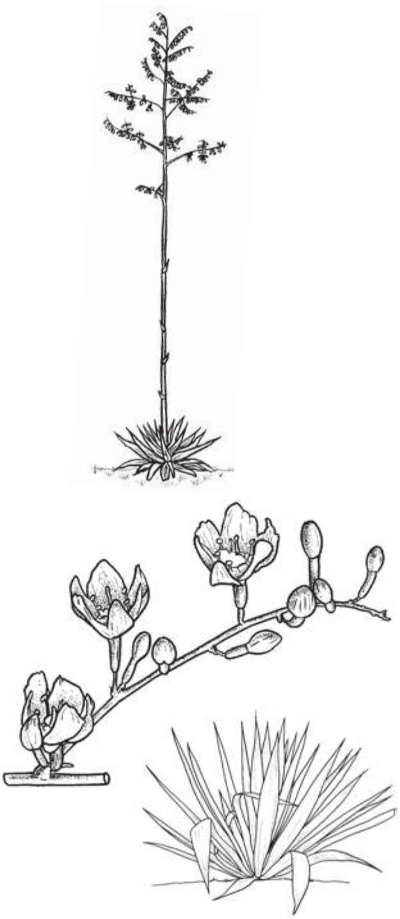
INVADES
Disturbed land, woodland edges/gaps, savannah, grassland and gullies.

IMPACTS

Rope pear forms dense thickets which displace native species and inhibit the movement of people, livestock and wildlife (ISSA, 2016). At lower densities, infestations prevent livestock and wildlife from gaining access to forage species growing under its canopy, and so reduce the livestock carrying capacities of pastures. The plant is also very spiny, and may cause injuries to humans and to animals. The spiny cladodes adhere to "passing animals and the barbed spines can penetrate their skin and feet causing severe injuries" contributing to a devaluation of agricultural land (ISSA, 2016). Additional impacts are assumed to be similar to those recorded for other invasive cactus species.

Notes: Was recorded at only one site near the town of Doldol in Laikipia County, Kenya, but has the potential to become more widespread unless eradicated.

Furcraea foetida (L.) Haw.



SISAL FAMILY
Agavaceae

SYNONYMS
Agave foetida L; *Furcraea gigantea* Ventenat

COMMON NAMES
English: furcraea, green aloe, Mauritius hemp

DESCRIPTION
Large, short-stemmed evergreen succulent shrub with stiff, sword-shaped leaves originating from a basal rosette; has a branched, robust, hairless flowering pole (inflorescence) (5–12 m high), on which numerous plantlets (bulbils) are produced.

Leaves: Light green to yellowish green, elongated (1.2–2.5 m long and 7–20 cm wide); margins hard, distally smooth, with a sharp brown spine (4–8 cm long) and a few hooked, simple teeth or hooked prickes (4–10 mm long) towards the base.

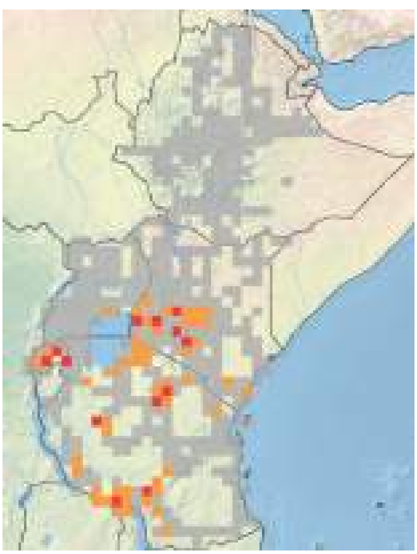
Flowers: White to greenish-white, pendulous (3.5–4 cm long and 4–4.5 cm across), in large branched clusters (1–6 m long) towards the top of the flowering pole.

Fruits: Capsules (dry fruits that open at maturity) are rare; spread mainly by plantlets (1–16 cm long).

ORIGIN
Brazil, Bolivia, French Guiana, Guadeloupe, Guyana, Martinique and Surinam.

REASON FOR INTRODUCTION
Barrier/hedge and ornament.

INVADES
Roadsides, urban open spaces, plantation edges, forest edges/gaps and savannah.

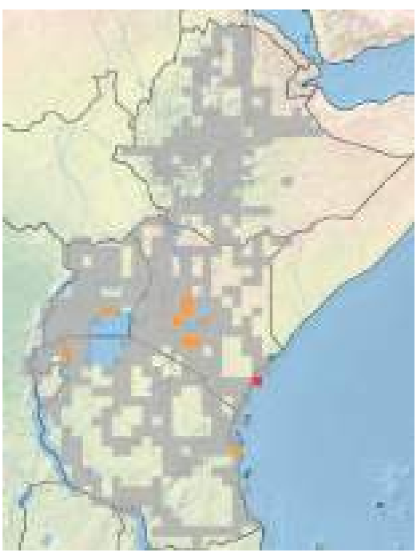


IMPACTS

Often grown as a hedge plant, *F. foetida* has escaped cultivation and has established populations in the wild, to the detriment of native flora and fauna. It is dominant on many tropical islands, displacing surrounding vegetation. In Africa, it has invaded inselberg plant communities, which are known to support a high diversity of rare plants (Barthlott and Porembski, 1996; Fischer and Theisen, 2000). Invasions threaten bromeliad species and coastal plants of conservation concern in Brazil (Dechoum and Ziller, 2013), while an orchid, *Eulophia guineensis* Lindl. (Orchidaceae), rare on the island of Cape Verde, is threatened by *F. foetida* invasions (Marrero and Almeida Pérez, 2013). In Hawaii, the sub-shrubs *Schiedea apokremnos* H. St. John (Caryophyllaceae) and *S. spergulina* A. Gray var. *leiopoda* Sherff. are being displaced by *F. foetida* (USFWS, 2003; 2010). In Western Australia and Queensland, Mauritius hemp invades coastal sites and cliffs, gullies, hillsides and open woodlands, where it crowds out native species. In New Zealand, it is having a significant effect on indigenous plant communities.

Notes: Introduced to East Africa in the latter part of the 19th century for fibre production, it is "still found as an escape throughout the region" (Brink and Achigan-Dako, 2012). Widely grown throughout East Africa as a hedge plant or ornamental, it has established populations in a range of habitats including roadsides, urban open spaces and plantation edges, among others. Surveys found it to be naturalized and locally abundant in many parts of Rwanda, Kenya and Tanzania.

Hylocereus undatus (Haw.) Britton & Rose



CACTUS FAMILY
Cactaceae

COMMON NAMES

English: dragon fruit, moonlight cactus, night-blooming cactus, strawberry pear

DESCRIPTION
Evergreen, vine-like with long stems (to 6 m tall); stems triangular (3-sided) or sometimes 4- or 5-sided, fleshy, jointed, many-branched, in segments each with 1–3 small spines; forms aerial roots that adhere to the surface on which the plant grows or 'climbs'.

Leaves:

Flowers: White to yellow; large, showy, bell-shaped (25–30 cm long), highly fragrant, nocturnal.

Fruits: Berries (fleshy fruits that do not open at maturity), green turning red with green scales as they mature, fleshy, elongated with almost parallel sides (5–12.5 cm long and 4–9 cm across), surface with scales and sometimes spiny; pulp white, red or purple, with numerous black seeds.

ORIGIN
Unknown, but probably Mexico, Central America and northern South America.

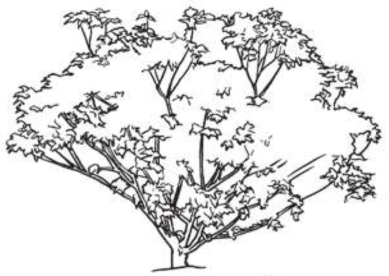
REASON FOR INTRODUCTION
Edible fruit and ornament.

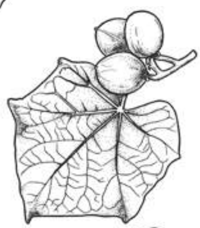
INVADES
Disturbed areas, forest edges/gaps, woodlands and woodland edge/gaps.

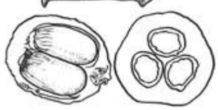
IMPACTS
Has the ability to climb into trees and over shrubs, shading out native plant species and causing canopy collapse. In South Africa, infestations have reportedly disrupted the local ecology (ISSA, 2015), while in Florida, USA, *H. undatus* is one of several invasive plants cited as threatening the endangered Cape Sable thoroughwort (*Chromolaena frustrata* (B.L. Rob.) R.M. King & H. Rob.; Asteraceae); the Florida semaphore cactus (*Consolea corallicola* Small; Cactaceae); and the aboriginal prickly-apple (*Harrisia aboriginum* Small ex Britton & Rose; Cactaceae) (USFWS, 2012, 2013). Both *C. frustrata* and *C. corallicola* are now extinct from half of the islands in the Florida Keys (USFWS, 2012, 2013). In warmer parts of eastern Australia, it has escaped cultivation, and is becoming a weed of open woodlands, dry rainforest, riparian areas and coastal vegetation (Environmental Weeds of Australia, 2016).

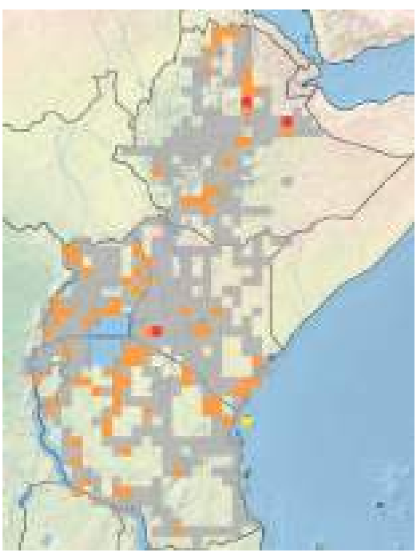
Notes: Widely grown as an ornamental, it has escaped cultivation in and around Nairobi, often in urban open spaces. Probably invasive in a number of additional localities throughout East Africa and Ethiopia, although its presence has not been recorded in the latter.

Jatropha curcas L.









SPURGE FAMILY
Euphorbiaceae

COMMON NAMES

English: Barbados nut, curcas bean, physic nut, purge nut
Ethiopia: andelmeluc, antelmeluc, anthalmelou, gebo, gibo, perideegu
Kenya: jok, kyaika kyakyeni, kya muunyi

DESCRIPTION

Soft-wooded succulent shrub or small tree [3–4 (–7) m tall], deciduous (sheds all or most of its leaves at the end of the growing season); stems exude a watery sap when cut.

Bark: Olive grey-green, smooth, thin with a papery peel.

Leaves: Dark green, smooth, shiny, heart-shaped (10–15 cm long and 7.5–12.5 cm wide), 3–5 shallow lobes, tips rounded or pointed, held alternately on stems, on leaf stalks 6–14 (–20) cm long.

Flowers: Yellow to greenish-yellow, small, inconspicuous, in loose clusters at the ends of the branches or in the forks of the upper leaves.

Fruits: Capsules (dry fruits that open at maturity), green turning yellow then brown-black as they mature, egg-shaped (2.5–3 cm long and 2–2.5 cm wide); seeds smooth, brown or black, mottled, elongated to egg-shaped (1.8 cm long).

ORIGIN

Argentina, Belize, Bolivia, Brazil, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay and Peru.

REASON FOR INTRODUCTION

Medicine, natural oils, hedge/barrier and ornament.

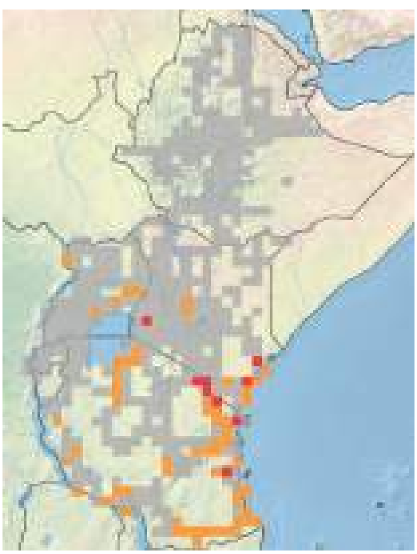
INVADES

Roadsides, urban open spaces and water channels, including floodplains and canals.

IMPACTS
Has escaped cultivation in many parts of the world, establishing populations in the wild, to the possible detriment of native fauna and flora. It is regarded as naturalized and/or invasive in parts of India, Australia, Fiji, Samoa, Tonga, La Réunion and Hawaii. In Australia, it is seen as posing a threat to biodiversity in the Einasleigh and Desert Uplands bio-region of inland northern Queensland (Environmental Weeds of Australia, 2016). In Chattisgarth, India, it is invading pasture lands, forests and National Parks, threatening biodiversity (CABI, 2016). It is also allelopathic, inhibiting the germination and growth of native plant species (Rastogi and Mehrotra, 1991), and of crops such as pigeon peas (*Cajanus cajan* (L.) Millsp.: Fabaceae), chickpeas lentils and rice (Oudhia, 2000). It may also act as an alternative host for pests of cotton. *J. curcas* is toxic both to livestock and to people, and accidental ingestion of the fruit, often by children, can be fatal. However, some strains or biotypes are less toxic than others (Kingsbury, 1964).

Notes: Widely cultivated in Kenya, *J. curcas* "has gone wild in bushland and along rivers in the western, central and coastal parts of Kenya" (Maundu and Tengnäs, 2005), while its congener, *J. multifida*, has "occasionally gone wild at the coast" (Beentje, 1994). *J. curcas* is "apparently naturalized in riverine forest and deciduous woodland" in the Ethiopian regions of Shewa, Ilubabor, Kefa, Sidamo and Bale (Gilbert, 1995). Naturalization of *J. curcas* in the western and south-western lowlands of Ethiopia has been confirmed by Bekele-Tessema (2007). Widely naturalized and sometimes invasive around hedges, along water channels, floodplains and dry riverbeds in Ethiopia and East Africa.

Jatropha gossypiifolia L.



SPURGE FAMILY
Euphorbiaceae

COMMON NAMES

English: American purging nut, bellyache bush, red fig-nut flower, red physic nut, wild cassava
Ethiopia: anthlmelou, gebo, gibo, perideegu, sihinii
Kenya: jok, kya muuunyi, kyaiki, kyakyeni
Tanzania: mbono, mkabuli

DESCRIPTION
Evergreen erect shrub [1–3 (–4) m tall]; older stems thick and succulent-like, young branches purplish and pubescent, exuding a brownish latex when damaged.

Leaves: Reddish-brown to dark bronze or purplish turning bright green with age, hairless, simple, usually 3 or 5 deep lobes (4.5–10 cm long and 5–13 cm wide), 3–5 veins from the base, margins glandular and minutely toothed; leaf stalks 6–9 cm long, covered in sticky hairs.

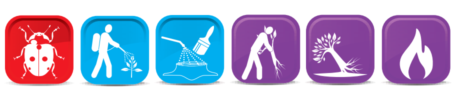
Flowers: Five dark red or deep purple petals (brightly coloured part of flower) with yellow centres, held in branched clusters (8–15 cm long) at the tips of branches.

Fruits: Capsules (dry fruits that open at maturity), glossy green turning brown as they mature, three-lobed, slightly hairy, somewhat elongated with almost parallel sides to almost round (about 12 mm long and 10 mm wide), containing three large light brown seeds.

ORIGIN
Antigua, Barbuda, Brazil, Bolivia, Colombia, Costa Rica, Dominica, Ecuador, Guadeloupe, Honduras, Mexico, Nicaragua, Peru, Paraguay, Puerto Rico, St. Kitts and Nevis, St. Lucia and Venezuela.

REASON FOR INTRODUCTION
Medicine, natural oils, hedge/barrier and ornament.

INVADES
Roadsides, disturbed areas, urban open spaces, drainage ditches, savannahs, lowlands, gullies and dry riverbeds.

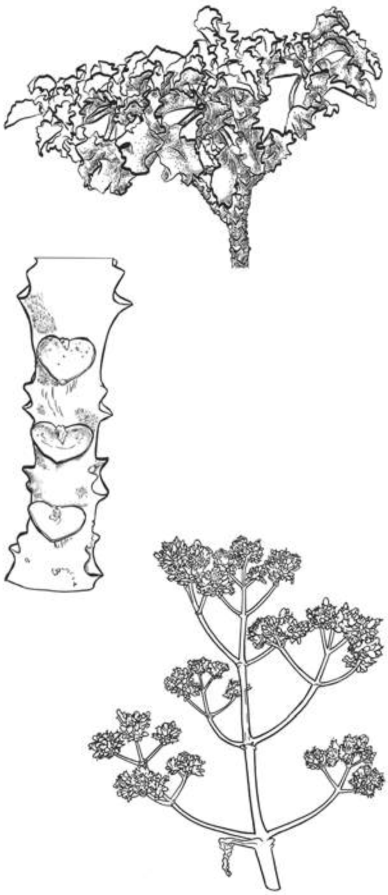


IMPACTS

This weed forms dense thickets, especially in riparian areas, where it readily displaces native plant species and prevents their regeneration. In Australia it readily establishes in disturbed habitats and is common in areas where the natural vegetation has been overgrazed or otherwise removed. Infestations in Australia are common in riparian zones, ephemeral water courses and pastures. According to Csurhes (1999), dense stands contribute to a loss in biodiversity and wildlife habitat, alter fire regimes, increase soil erosion and destabilize creek and river banks. By out-competing valuable forage species, it also significantly reduces the livestock carrying capacities of rangelands. The plant is toxic, and may cause death if accidentally consumed by livestock. In 1995, 312 head of livestock (290 cattle, 7 horses and 15 goats), in northern Queensland, died after consuming the plant during a drought (Csurhes, 1999).

Notes: In Tanzania, it has "escaped from cultivation" (Radcliff-Smith, 1987). Our surveys found it to be naturalized and invasive in many areas throughout the region, especially on roadsides and in drainage ditches, gullies, dry riverbeds and lowlands.

Kalanchoe beharensis Drake



STONECROP FAMILY
Crassulaceae

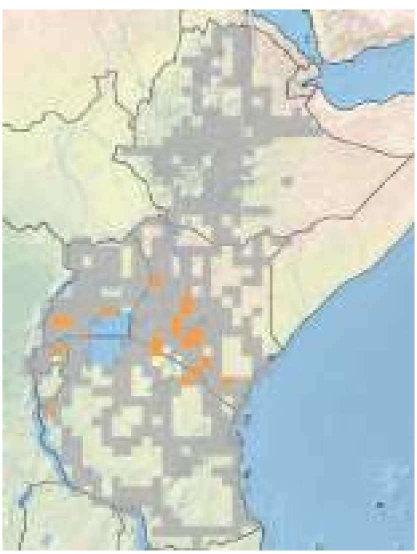
COMMON NAMES
English: elephant's ear kalanchoe, felt bush, velvet bush, velvet elephant ear, velvet leaf
Ethiopia: andaho, ancorura, mantera
Rwanda: igitenetene
Tanzania: gowongo, mkerampindi

DESCRIPTION
Succulent shrub or small tree (to 3 m tall) with a slender stem (diameter 2–12 cm), succulent, becoming hard and woody with age, with conspicuous, sharply projecting leaf scars, covered with brownish hairs.

Leaves: Olive green to dark green, hairless to densely covered with felt-like glandular hairs, mature leaves are rust-coloured on top and silvery underneath; fleshy, triangular (7–40 cm long and 8–30 cm wide), irregularly lobed and crimped at the edges, held opposite each other on the stems and crowded at the tips of branches.

Flowers: Red-orange or yellowish in terminal inflorescences (50–60 cm high).

Fruits: Follicles (dry fruits having one compartment that opens, along one side only, at maturity), papery and membranous, containing thousands of tiny seeds.



ORIGIN
Madagascar

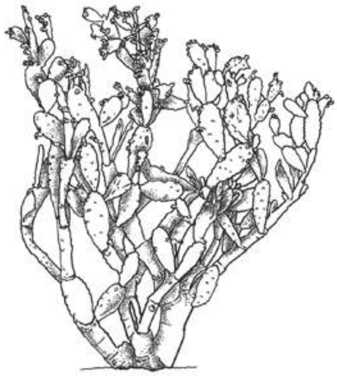
REASON FOR INTRODUCTION
Ornament

INVADES
Disturbed areas, gardens and rocky outcrops in savannahs.

IMPACTS
Naturalizes rapidly and can form dense stands which exclude native plant species and their associated organisms. No research has been undertaken on the negative impacts of this species.

Notes: In eastern Africa, it has been found to occur in "dry open bushland and grassland, thickets, stony hillsides, riverine bushland and forest, mostly on rocky ground, sometimes on steep rocks in shade" (Wickens, 1987). Our surveys found it to be naturalized in places, but with seedlings generally confined to areas near mother plants.

Opuntia cochenillifera (L.) Mill.



CACTUS FAMILY
Cactaceae

COMMON NAMES
English: cochineal cactus, cochineal nopal cactus, velvet Opuntia, woolly joint prickly pear

DESCRIPTION
Succulent shrub or small tree (2–4 m tall) with several main branches arising from the base; modified stems (called cladodes) green, oval to egg-shaped [8–35 (–50) cm long and 5–12 (–15) cm wide]; areoles [raised structures or bumps on the stems (cladodes) of cacti, out of which grow clusters of spines] 2 mm across and 2–3 cm apart, usually without spines but sometimes with 1–3 spines per areole; spines brown becoming grey (3–9 mm long).

Leaves: Green, conic, small (3–4 mm long).

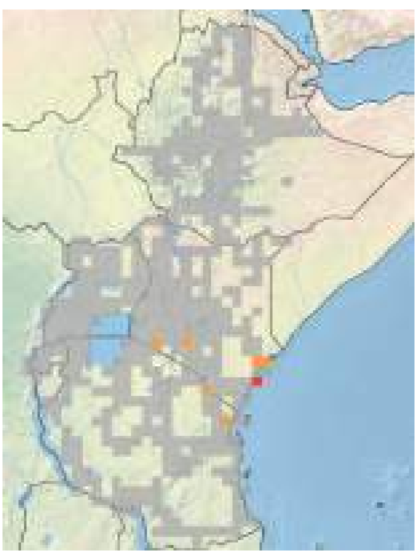
Flowers: Reddish-pink, narrow [5–6 (–7) cm long and 1.2–1.5 cm across]

Fruits: Berries (fleshy fruits that do not open at maturity), red, oval (3–5 cm long and 2.5–3 cm across).

ORIGIN
Mexico

REASON FOR INTRODUCTION
Edible fruit, hedge/barrier and ornament.

INVADES
Roadsides, disturbed areas, savannahs, rocky outcrops, lowlands and gullies.

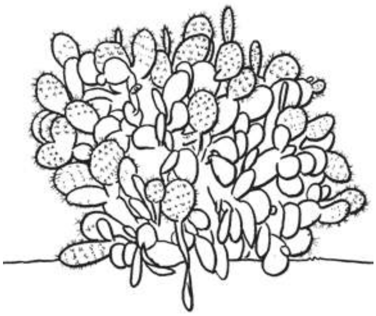


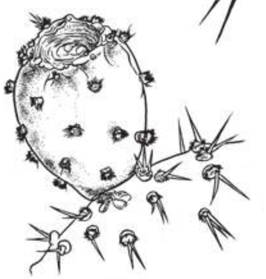
IMPACTS

Grows well in a wide range of conditions and is now naturalized throughout many of the warmer regions of the world. The fruits are very attractive to birds and to bats, which has contributed to the spread of the species. Consumption of the fruit by livestock may result in impacts of the kind reported for other *Opuntia* spp. It is naturalized on many of the Pacific islands including Hawaii (Novoa *et al*., 2014).

Notes: Has been present in East Africa for more than 50 years, with one record, from Lushoto, Tanzania, dating back to 1942 (Hunt, 1968). No records for Ethiopia (Hunt, 2000). Often grown as an ornamental in East Africa, it has escaped cultivation in some areas.

Opuntia elatior Mill.





CACTUS FAMILY
Cactaceae

COMMON NAMES

English: prickly pear
Rwanda: ngabo

DESCRIPTION
Succulent shrub, forming dense, branched clumps (to 5 m high); modified stems (called cladodes) olive-green, egg-shaped to nearly round to somewhat elongated with almost parallel sides (30–40 cm long); areoles [raised structures or bumps on the stems (cladodes) of cacti, out of which grow clusters of spines] 2–4 cm apart, each with 2–8 spines, which are needle-like and dark brown (2–7 cm long).

Leaves: Green with reddish tips, tiny (to 4 mm long).

Flowers: Yellow with reddish or red stripes (to 5 cm across).

Fruits: Berries (fleshy fruits that do not open at maturity), green turning reddish as they mature, egg-shaped.

ORIGIN
Colombia, Costa Rica, Panama, Venezuela and the Caribbean.

REASON FOR INTRODUCTION
Edible fruit, hedge/barrier and ornament.

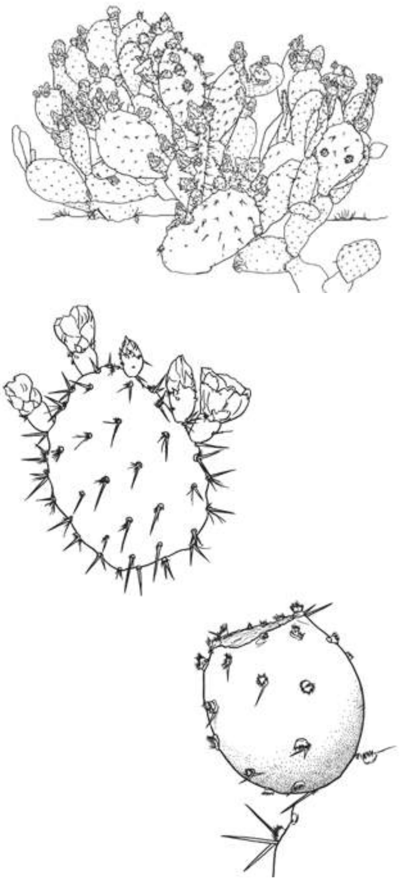
INVADES
Roadsides, disturbed areas, savannah, rocky outcrops, lowlands and gullies.

IMPACTS

Forms dense, impenetrable thickets, reducing access to available forage and to other natural resources such as water. Communities around Lake Baringo, Kenya, have lost valuable grazing land and claim the thickets harbour dangerous animals. The spines also cause injuries to people, livestock, and wild animals. Consumption of the fruit by livestock may result in impacts of the kind recorded for *Opuntia stricta*. Additional impacts are assumed to be similar to those recorded for other invasive cactus species. Prior to the introduction of biocontrol agents, *O. elatior* was considered to be one of the first important invasive weeds in South and Southeast Asia, where it was already widespread and abundant by the mid-1800s (Ooi *et al*., 1994). Regarded as a potential environmental weed or 'sleeper weed' in many parts of Australia, it is capable of forming dense thickets and is likely to establish in semi-arid areas and drier coastal habitats (Environmental Weeds of Australia, 2014).

Notes: Within the region it has been recorded only from the western shores of Lake Baringo, Kenya, where it is invasive, forming dense thickets. There are no records of its presence in Ethiopia (Hunt, 2000).

Opuntia engelmannii Salm-Dyck ex Engelm.



CACTUS FAMILY
Cactaceae

SYNONYM
Opuntia lindheimeri Engelm.

COMMON NAMES

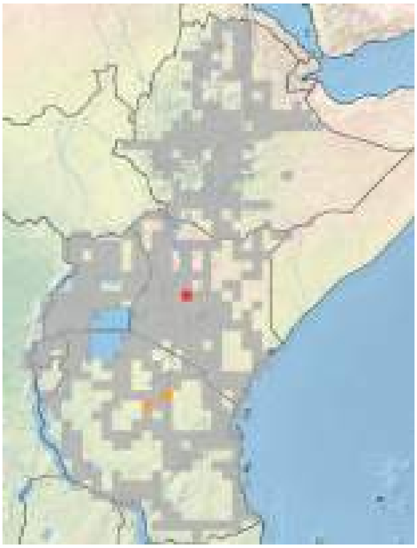
English: cows' tongue cactus, desert prickly pear, Engelmann's prickly pear
Rwanda: ngabo

DESCRIPTION
Erect succulent shrub with many ascending to sprawling branches, forming dense clumps [1–3 (–3.5) m high]; modified stems (called cladodes) yellow-green to blue-green, flattened, or rounded to broadly egg- or diamond-shaped, sometimes tapering at the end (15–40 cm long and 10–40 cm wide); 5–8 oval areoles [raised structures or bumps on the stems (cladodes) of cacti, out of which grow clusters of spines] in rows extending diagonally across the centres of the cladodes, 2.5–4 cm apart; (0–) 1–6 (–12) spines per areole; spines [1–4 (–5) cm long], white to yellow, red to dark brown at the base.

Leaves: Green, reduced (3–9 mm long), shed early.

Flowers: Orange-yellow or orange, rarely pink to red or whitish (30–40 mm long).

Fruits: Berries (fleshy fruits that do not open at maturity), green turning purple or dark red throughout as they mature, egg-shaped with narrower end at base (3.5–9 cm long and 2–4 cm wide), almost spineless.



ORIGIN
Southern and Central USA to Mexico.

REASON FOR INTRODUCTION
Edible fruit, hedge/barrier and ornament.

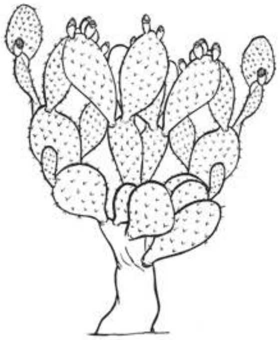
INVADES
Roadsides, disturbed land, savannahs and rocky outcrops, especially in semi-arid areas.

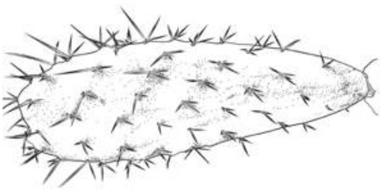
IMPACTS

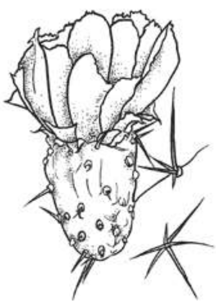
Forms dense thickets wherever it establishes, displacing native plant and animal species. Grasses and other forage species growing around the plants are not consumed because the cactus spines pose a hazard to livestock and wild animals. Large infestations significantly reduce livestock carrying capacities, and deprive wildlife of habitat. Dense stands also inhibit or prevent free movement by people, livestock and wild animals. Consumption of the fruits by livestock may result in impacts of the kind recorded for *Opuntia stricta*. Additional impacts are assumed to be similar to those recorded for other invasive cactus species. Regarded as invasive in parts of the USA, Saudi Arabia and Australia (CABI, 2016) and South Africa.

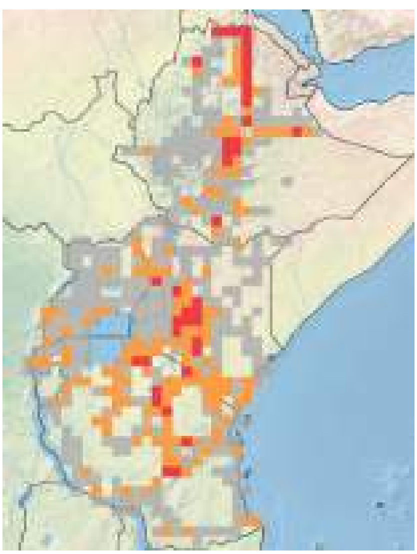
Notes: In East Africa, it has been found only to be invasive on Loisaba Conservancy in Laikipia County, Kenya, where it is invading savannah habitats, forming dense stands. It has not been recorded in Ethiopia (Hunt, 2000).

Opuntia ficus-indica (L.) Mill.









CACTUS FAMILY
Cactaceae

SYNONYM
Opuntia megacantha Salm-Dyck

COMMON NAMES

English: cactus pear, Indian fig, mission prickly pear, prickly pear, sweet prickly pear
Ethiopia: beles, gura, hadaamii, qulqwal, tini, tin
Kenya: mpungate
Rwanda: ngabo

DESCRIPTION
Large succulent shrub or small tree [1.5–3 (–7) m tall], forming a trunk with age; modified stems (called cladodes) dull green or blue-green, flattened, much longer (20–60 cm) than broad (10–20 cm); spines (to 2.5 cm long) white or off-white, variable, one or more per areole [the raised structures or bumps on the stems (cladodes) of cacti, out of which grow clusters of spines], spines sometimes absent.

Leaves: Minute, shed early.

Flowers: Orange or yellow, showy (2–3 cm wide).

Fruits: Berries (fleshy fruits that do not open at maturity), green turning yellow, orange, red or purple as they mature, succulent, oval (5–10 cm long and 4–9 cm wide), with a pale pulp.

ORIGIN
Mexico

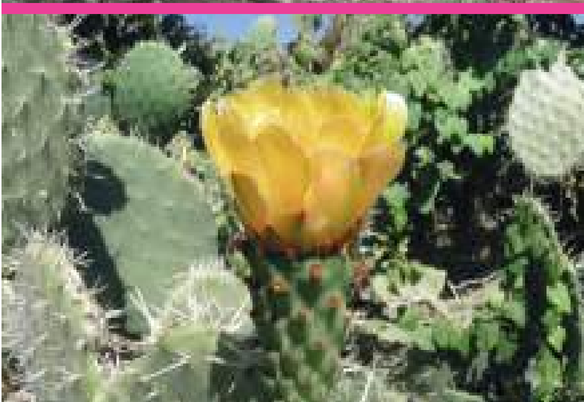
REASON FOR INTRODUCTION
Edible fruits, fodder, hedge/barrier and ornament.

INVADES
Roadsides, disturbed land, savannahs, dry and rocky places in arid and semi-arid regions.

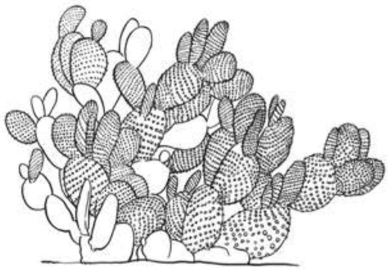
IMPACTS

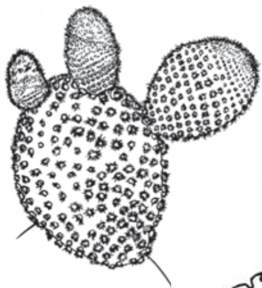
Readily establishes large stands, displacing native plants and animals. Infestations can dramatically reduce the extent of forage available to livestock. In South Africa, this led to the abandonment of many farms early in the 20th Century. Beinart (2003) cites the example of a farmer in the Karoo, South Africa, who "lost control of prickly pear on his farm and was forced to sell" because the prickly pear infestations had become so dense that his livestock could no longer be herded and his sheep were dying. The glochids (barbed hairs or bristles) on the fruits cause internal swellings and sores if ingested, extending down the gullet to the internal linings of the digestive system, diminishing an animal's capacity to eat, and sometimes resulting in death (Beinart, 2003). The claim was made in 1893 that prickly pear was spreading so fast in South Africa that half the farming population of the Cape would be reduced to poverty if nothing were done. Additional impacts are assumed to be similar to those recorded for other invasive cactus species.

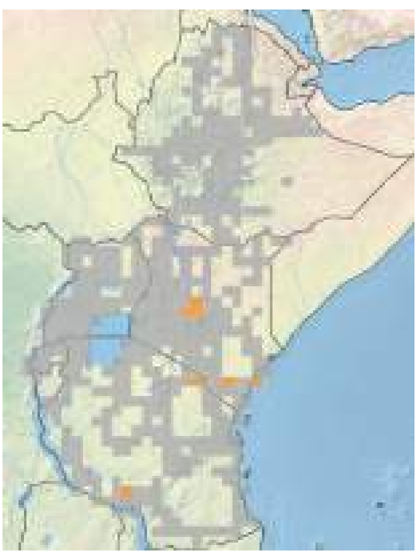
Notes: In Kenya, it "is cultivated in Nairobi and is reported to be very common and to be spreading rapidly around Naivasha" and elsewhere on roadsides, in grasslands and along rivers (Hunt, 1968). It is also present in the regions of Eritrea West and Shewa and probably elsewhere in the drier eastern parts of Ethiopia (Hunt, 2000), where it "is displacing indigenous vegetation" (Bein *et al*., 1996). Widely grown throughout the region, escapes from cultivation have formed dense stands, especially in arid and semi-arid regions of Kenya and Ethiopia.



Opuntia microdasys (Lehm.) Pfeiff.







CACTUS FAMILY
Cactaceae

COMMON NAMES
English: angel's wings, bunny-ear prickly pear, teddy bear cactus
Rwanda: ngabo

DESCRIPTION
Succulent evergreen shrub, forming thickets (0.4–0.6 m or taller); modified stems (called cladodes) green, velvety, somewhat elongated with almost parallel sides, egg-shaped to almost round (6–15 cm long and 6–12 cm wide); 8–13 (–16) areoles [raised structures or bumps on the stems (cladodes) of cacti, out of which grow clusters of spines or, in the case of this species, glochidea (barbed hairs or bristles)], prominent in diagonal rows across mid-stem sections; no spines, glochidea are yellow to reddish brown.

Leaves: None

Flowers: Yellow turning apricot to orange with age, outer petals often tinged with red (4 cm long and 4 cm wide).

Fruits: Berries (fleshy fruits that do not open at maturity), green turning red-purple as they mature, almost round (3 cm in diameter), fleshy, with black oval seeds.

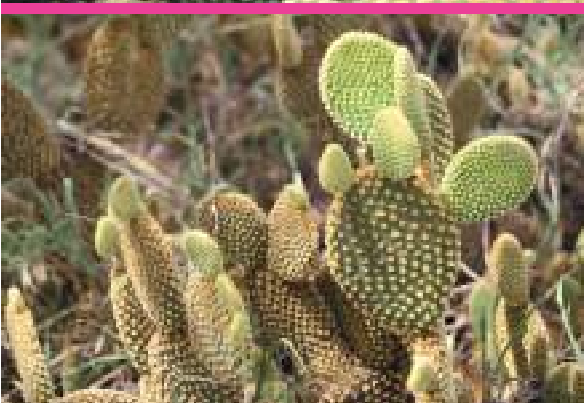
ORIGIN
Northern Mexico

REASON FOR INTRODUCTION
Hedge/barrier and ornament.

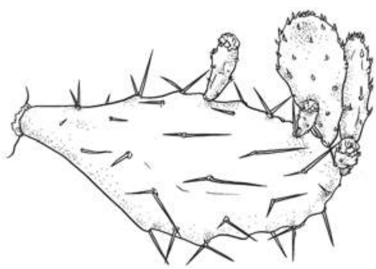
INVADES
Roadsides, disturbed land and savannahs in semi-arid areas.

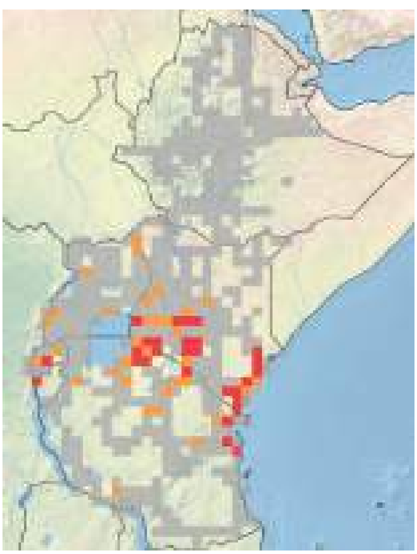
IMPACTS
Rapidly establishes large, dense infestations, probably to the detriment of native plant species. Large infestations reduce the livestock carrying capacities of pastures and prevent access to water and other resources. Infestations also inhibit the movement of people, livestock and wildlife. Additional impacts are assumed to be similar to those recorded for other invasive cactus species.

Notes: Widely grown as an ornamental in East Africa, but known to have escaped from cultivation only in Doldol, Laikipia County, Kenya.



Opuntia monacantha Haw.





CACTUS FAMILY
Cactaceae

SYNONYM
Opuntia vulgaris sensu. auct. non Mill. (misapplied name)

COMMON NAMES

English: Barbary fig, cochineal prickly pear, common prickly pear, drooping prickly pear
Rwanda: ngabo

DESCRIPTION
Succulent shrub or small tree [2–3 (–6) m tall], sometimes with a short trunk, usually large and much-branched on top with drooping upper segments; modified stems (called cladodes) bright green and shiny, especially when young, flattened, usually thin, egg-shaped to somewhat elongated with almost parallel sides [10–30 cm long and 7.5–10 (–12.5) cm wide], tapering towards the base; 1 or 2 (–3) spines per areole [raised structures or bumps on the stems (cladodes) of cacti, out of which grow clusters of spines], with numerous spines (2–4 cm long) on the trunks.

Leaves: Green, minute (2–3 mm long), cone-shaped, shed early.

Flowers: Yellow or orange-yellow, outer petals tinged with red (5–7.5 cm long and 7.5–10 cm wide).

Fruits: Berries (fleshy fruits that do not open at maturity), green turning light green to yellow with red-purple streaks as they mature, egg- to pear-shaped (about 6 cm long and 4–5 cm wide).

ORIGIN
Argentina, Brazil, Paraguay and Uruguay.

REASON FOR INTRODUCTION
Edible fruits, fodder, hedge/barrier and ornament.

INVADES
Roadsides, disturbed land, forest edges/gaps, woodland edges/gaps, savannahs and coastal bush.

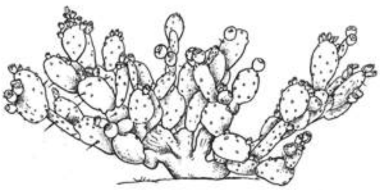
IMPACTS

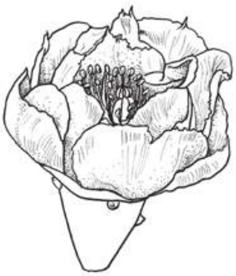
Forms dense, impenetrable thickets, probably displacing native plant species. Infestations also inhibit access to natural resources such as grazing and water. Expansive stands reduce livestock carrying capacities. Pastoralists in Kenya claim that dense stands provide cover for dangerous animals, posing an added threat to livestock. One farmer near Thika, Kenya, claimed that he had lost many chickens to predators, which seek refuge in dense infestations. Additional impacts are assumed to be similar to those recorded for other invasive cactus species. Recorded as invasive in China, India, Philippines, Taiwan, South Africa, Hawaii, Australia, New Caledonia and New Zealand (CABI, 2016).

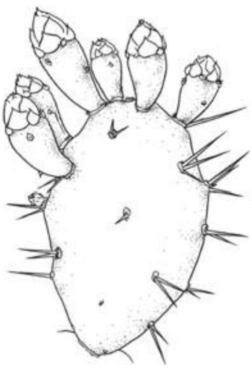
Notes: Having escaped from cultivation throughout East Africa, it is widely established in the field in savannahs, in coastal bush and forest edges/gaps. Not recorded in Ethiopia, where it may be present, although no correctly named material has been seen (Hunt, 2000). Almost 50 years ago, it was reported to be "naturalized along the beach at Mbweni" on Zanzibar, and to be common elsewhere on the East African coast, in bushland and on coastal bluffs and roadsides (Hunt, 1968). The biocontrol agent, *Dactylopius ceylonicus* Green (Dactylopiidae), is present in East Africa, although infestations are still localized. The agent should be redistributed to areas where it is not yet present.

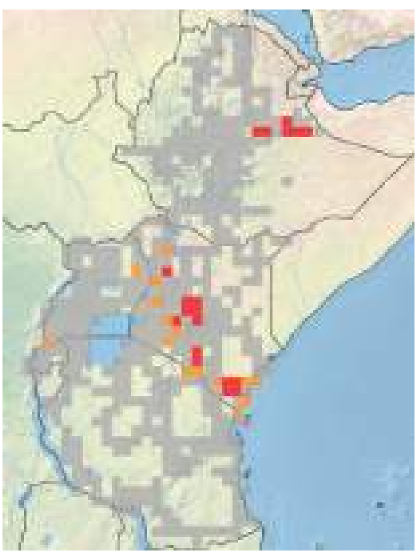



Opuntia stricta (Haw.) Haw.









CACTUS FAMILY
Cactaceae

COMMON NAMES

English: Australian pest pear, common pest pear, erect prickly pear, sour prickly pear
Rwanda: ngabo

DESCRIPTION

Succulent erect, spreading shrub [0.5–1.3 (–2) m high]; thicket-forming; modified stems (called cladodes) blue-green, longer than broad (10–20 cm long and 7.5–14 cm wide); 3–5 areoles [raised structures or bumps on the stems (cladodes) of cacti, out of which grow clusters of spines] in a diagonal row on each cladode; 1 or 2 straight, flattened yellow spines (1.5–4 cm long), usually restricted to marginal areoles [as opposed to *O. stricta* (Haw.) Haw. var. *dillenii* (Ker Gawl.) L.D. Benson, which has 4–7 (–11) banded spines (1.5–4 cm long) on most areoles].

Leaves: Cylindrical, minute, shed early.

Flowers: Yellow, large (5–6 cm long and 5–6 cm wide).

Fruits: Berries (fleshy fruits that do not open at maturity), green turning red-purple as they mature, fleshy, egg-shaped (4–6 cm long and 2.5–3 cm wide), outer surface smooth with clusters of glochids (barbed hairs or bristles), narrowed at the base; pulp purple and sour; seeds white.

ORIGIN
Southeastern USA, Mexico and the Caribbean.

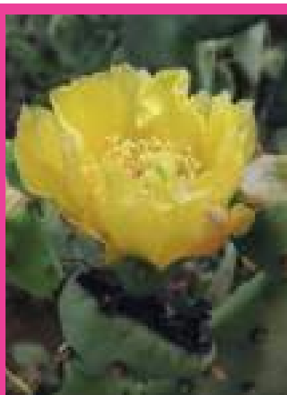
REASON FOR INTRODUCTION
Hedge/barrier and ornament.

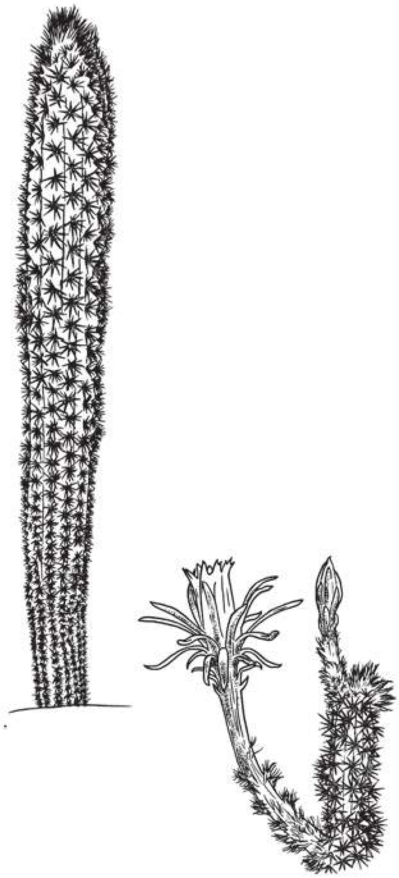
INVADES
Roadsides, wastelands, disturbed areas, rocky outcrops, savannahs, grasslands and riverbanks in arid to semi-arid regions.

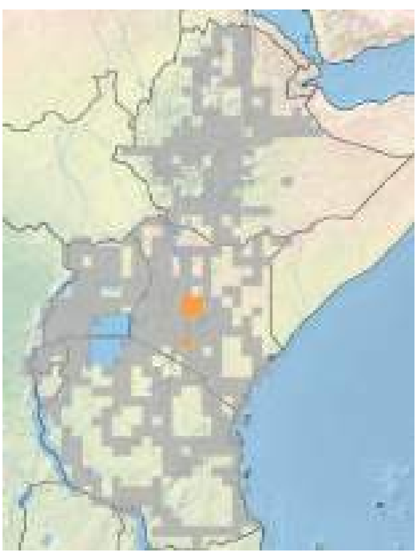
IMPACTS

Can form dense stands, preventing access to homes, water resources and pasture. On Madagascar, *O. stricta* has invaded land used for crop and pasture production, and has encroached on villages and roads, impeding human mobility (Larsson, 2004). Here, the cactus has had a negative impact on native grasses and herbs, and it is even affecting trees by inhibiting their growth and regeneration (Larsson, 2004). The small spines (known as glochids) on the fruit, when consumed by livestock, lodge in their gums, on their tongues or in their gastrointestinal tracts, causing bacterial infections, while the hard seeds may cause rumen impaction, which can be fatal, and which often leads to excessive, enforced culling of affected animals (Ueckert *et al*., 1990). Similar impacts have been recorded in Laikipia County, Kenya, where pastoralists have lost significant numbers of livestock. People who consume the fruits develop diarrhoea and may suffer from serious infections caused by the spines (Larsson, 2004). In Kenya, *O. stricta* infestations have resulted in the abandonment of farmlands.

Notes: Grows on steep hillsides among boulders in the Tigray and Harerge regions of Ethiopia. It is "naturalized and has become a major pest in the Harerge Region" (Hunt, 2000). In Kenya, it has invaded hundreds of square kilometres in Laikipia County and in Tsavo East National Park and adjoining rangelands. *O. stricta* var. *dillenii* is common along parts of the Kenyan and Tanzanian coast, and in the Moshi District and Mara Region of Tanzania.







CACTUS FAMILY
Cactaceae

SYNONYM
Echinocereus serpentinus (Lag. & Rodr.) Lem.;
Nyctocereus serpentinus (Lag. & Rodr.) Britton & Rose

COMMON NAMES
English: Mexican night-blooming cereus, serpent cactus, snake cactus

DESCRIPTION
Succulent with green stems, erect or arching (to 2 m tall), branching from the base (3–5 cm in diameter), with 10–12 (–17) ribs; areoles (raised structures or bumps on the stems of cacti, out of which grow clusters of spines) 1 cm apart; spines soft, 10–14 per group, unequal, white to brown but red or purplish when young.

Leaves: White, tinged red outside [(12–) 15–20 (–25) cm long and 8–10 (–15cm) wide], flowering at night.

Flowers: Purple or lilac blue, pale star-shaped area at base, located in groups at the end of branches, on velvety stalks up to 10 cm long.

Fruits: Berries (fleshy fruits that do not open at maturity), red, egg-shaped to round (to 4 cm long), having many areoles with whitish hairs.

ORIGIN
Mexico

REASON FOR INTRODUCTION
Hedge/barrier and ornament.

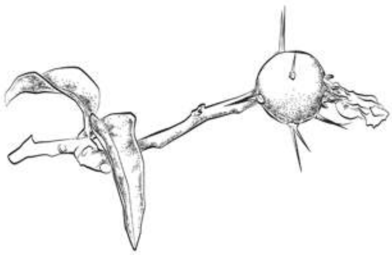
INVADES
Roadsides, disturbed areas, wastelands, urban open spaces and savannahs.

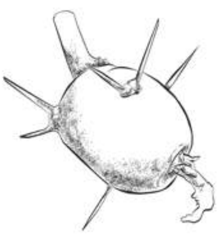
IMPACTS

Forms dense stands which may displace native plant and animal species. Impacts are similar to those of other invasive cactus species.

Notes: Currently not very abundant in Kenya, although our surveys found some localized infestations in Laikipia County, escapes from garden refuse dumps. Not seen in Ethiopia.

Pereskia aculeata Mill.





CACTUS FAMILY
Cactaceae

COMMON NAMES

English: Barbados gooseberry, Barbados shrub, leaf cactus, pereskia, pereskia creeper, rose cactus, Surinam gooseberry

DESCRIPTION
Large, slender succulent shrub or climber (to 20 m tall) with long, whip-like branches; straight spines (2.5–5 cm long) in clusters on older woody stems; young stems fleshy and hairless with 1–3 smaller spines (3–5 mm long) in the leaf forks.

Leaves: Dark green, smooth, hairless, fleshy, oval or egg-shaped (4–7 cm long and 2–4 cm wide), margins entire with pointed tips, stalks short (3–7 mm).

Flowers: White, creamy or yellowish (25–40 mm across), in clusters in the leaf forks or at the tips of branches; lemon-scented.

Fruits: Berries (fleshy fruits that do not open at maturity), round (1.5–2 cm across), green turning bright yellow then orange, fleshy, covered with small spines.

ORIGIN
Argentina, Brazil, Colombia, French Guiana, Guyana, Panama, Paraguay, Surinam, Venezuela and the Caribbean.

REASON FOR INTRODUCTION
Barrier/hedge and ornament.

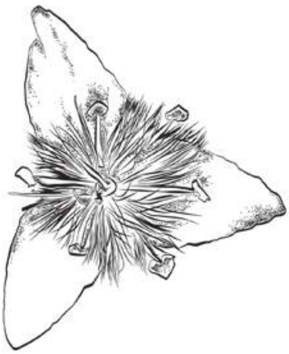
INVADES
Roadsides, disturbed areas, urban open spaces, forest edges/gaps, woodland edges/gaps and coastal forests.

IMPACTS

Climbs into trees and over shrubs, smothering plants and forming dense, impenetrable thickets, to the detriment of native plants and animals (Weber, 2003). It has the ability to re-grow from pieces of stem and even from detached leaves. The seeds in the fruit are readily dispersed by birds and other organisms. According to Paterson *et al*. (2011), *P. aculeata* is having a negative impact on biodiversity in South Africa, where decreases in plant species richness and diversity are associated with increasing *P. aculeata* densities. Even at relatively low densities, *P. aculeata* has been found to have a negative impact on plant species in forest biome vegetation types in South Africa that boast high levels of endemism and which support many rare species (Mucina and Rutherford, 2006). In the Hawaiian archipelago, Barbados gooseberry is present on the islands of Moloka'i and Oahu, as well as in North Kohala on the Big Island. In Australia, *P. aculeata* is naturalized among riparian vegetation along the banks of the Brisbane River and may become invasive in coastal, sub-tropical areas of southern Queensland and northeastern New South Wales (Csurhes and Edwards, 1998). Also invasive in China (PIER, 2011).

Notes: A variegated, supposedly 'sterile' garden variety is widely grown as an ornamental throughout East Africa. Some believe that, under certain conditions, this variety may 'revert' back its wild form. In and around Bungoma, Kenya, and in the Entebbe Botanical Gardens, Uganda, the natural wild form has established outside of cultivation and is now locally abundant. In Bungoma, Kenya, where it was planted as a hedge around homesteads, it has now spread into adjoining vegetation, including gardens, where it smothers other plants, to the dismay of landowners, who don't have the means to control it effectively.

Tradescantia fluminensis Vell.



SPIDERWORT FAMILY
Commelinaceae

COMMON NAMES

English: green wandering Jew, inch plant, spider wort, wandering creeper, wandering Jew, white-flowered wandering Jew

DESCRIPTION
Evergreen herbaceous plant with trailing or creeping branched, fleshy stems to 4 m long, producing roots at swollen joints; forms a dense mat.

Leaves: Dark green above and slightly purplish below, glossy, fleshy, hairless, sword- to egg-shaped or somewhat elongated (3–6.5 cm long and 1–3 cm wide) with pointed tips; margins entire, occasionally with small hairs on the edges; held alternately on stems by short leaf sheaths (tubular structures that surround or clasp the stem) (5–10 mm long).

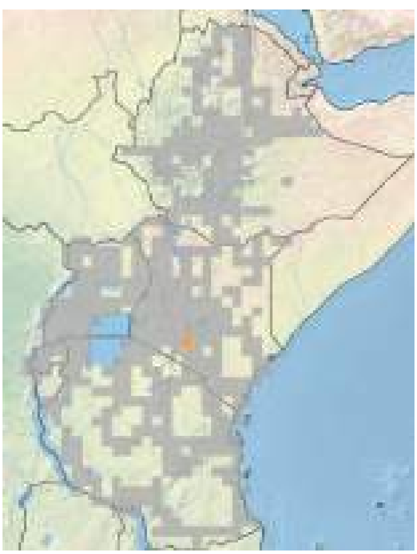
Flowers: White, small (2 cm across), in clusters near the tips of the branches.

Fruits: Capsules (dry fruits that open at maturity) with three chambers.

ORIGIN
Argentina, Brazil and Uruguay.

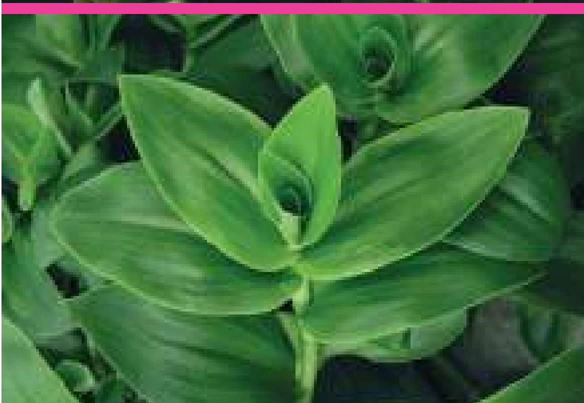
REASON FOR INTRODUCTION
Ornament

INVADES
Roadsides, disturbed areas, wastelands, urban open space, gardens, forest, forest edges/gaps, woodlands and riparian vegetation.



IMPACTS
Forms dense stands, displacing native plant and animal species. It is shade-tolerant and can form mats 30 cm thick beneath forest trees, smothering ground-level plants and preventing the regeneration of taller species. The succulent stems break easily at the nodes, and the broken stems can, in moist soils, develop into new plants. In lowland forest remnants in New Zealand, *T. fluminensis* has replaced the native herbs, and has prevented the regeneration of woody seedlings (Esler, 1978). In New Zealand "native forest seedling species richness and abundance decreased exponentially with increasing *T. fluminensis* biomass, for example from 3.4 and 81.5 m^2, respectively, in the absence of the weed, to 0.37 and 6.28 m^2 at maximum *T. fluminensis* biomass" (Standish *et al*., 2001). At high biomass, the species accelerates litter decomposition and alters nutrient cycling (Standish *et al*., 2004). The vegetation structure of forests invaded by *T. fluminensis* may change because tall-canopy species cannot replace themselves (Standish, 2002). Allergenic reactions have been reported in dogs and even in some people who have come into contact with the plants (Marsella *et al*., 1997). Symptoms in people included "itching of the face, throat, and conjunctiva; swelling of the lips; and dyspnea and wheezing" (Johansson, 1997). Recorded reactions in dogs are generally less severe and include the development of pustules surrounded by red skin which may be aggravated by biting, scratching or licking the affected area, sometimes to the point of raw or bleeding skin. Invasive in Australia, New Zealand, Portugal, USA (CABI, 2016) and South Africa.

Notes: In Ethiopia, it is cultivated in private and public gardens in Addis Ababa (Kelbessa and Faden, 1997). Not very common in East Africa, it is reported to be naturalized at Tigoni, Kenya (Faden, 2012). Not found elsewhere during surveys, but likely to be more widespread.



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Tradescantia pallida (Rose) D.R. Hunt

SPIDERWORT FAMILY
Commelinaceae

COMMON NAMES

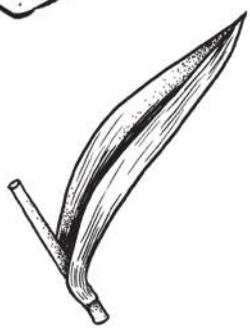
English: purple heart, purple queen, spider lily, wandering Jew

DESCRIPTION
Evergreen succulent herbaceous plant with spreading stems, rooting at the nodes, hairless, forming a dense ground cover with sub-erect flowering branches.

Leaves: Dark green or purple above with purple undersides, elongated to oval (6–10 cm long and 2–3 cm wide), pointed at ends, margins entire, leaf sheaths (clasping tubular structures) (0.5–1.5 cm long) enclose parts of the stem.

Flowers: Bright pink to rose-purple with three petals (each 15–20 mm long).

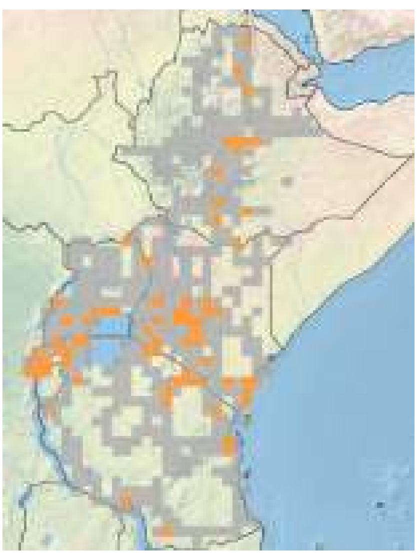
Fruits: Capsules (dry fruits that open at maturity) (4–5 mm long), hairless, containing small brown seeds (2.5–3 mm long).



ORIGIN
Mexico

REASON FOR INTRODUCTION
Ornament

INVADES
Disturbed areas, urban open space, gardens, savannahs, forest gaps/edges, riparian vegetation and coastal scrub.

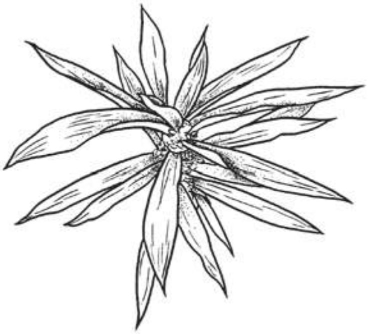


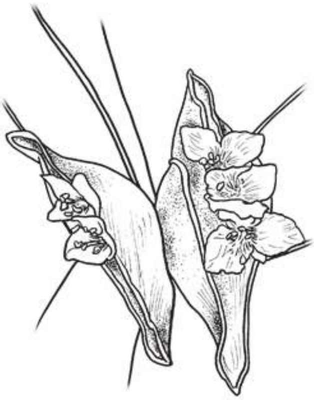
IMPACTS

T. pallida has the ability to form a dense ground cover, preventing the germination and establishment of native plant species. In Australia, it grows in the understoreys of disturbed and secondary forests, as well as in riparian areas and on the margins of coastal forests. Some gardeners have commented that one should never plant *T. pallida* unless "you want a full yard" and that "it takes over everything". The sap from the leaves and stems can cause irritations of the skin and other allergies (Acevedo-Rodríguez and Strong, 2005; Foxcroft *et al*., 2007). In some individuals, handling of the plant can produce an instant stinging red rash (Morton 1971). Apparently it is also toxic to cattle and sheep. According to CABI (2016) it is only regarded as being invasive in South Africa and Cuba, although unpublished reports indicate that it is probably also problematic in other countries.

Notes: Cultivated in the Ethiopia regions of Eritrea West, Shewa, Kefa and Harerge (Kelbessa and Faden, 1997). It is present in East Africa, where Faden (2012) does not consider it to be invasive. However, our surveys found evidence to suggest that it readily escapes from gardens and is establishing populations in adjoining areas.

Tradescantia spathacea Sw.





SPIDERWORT FAMILY
Commelinaceae

COMMON NAMES
English: boat lily, Moses-in-a-boat, Moses-in-the-cradle, oyster plant

DESCRIPTION
Evergreen rosette-forming succulent herb (to 15 cm high), purplish and hairless, with short stems, hidden by leaf bases, nodes crowded, internodes (part of the stem between two nodes or joints) short.

Leaves: Upper surface green, lower surface reddish-purple, hairless, crowded; elongate, broadly linear to spear-shaped (30–40 cm long and 4–6 cm wide); margins entire, leaf sheaths (clasping tubular structures) covering the stem.

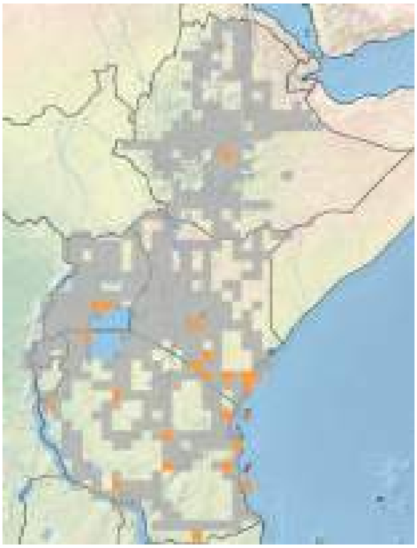
Flowers: White, small and clustered within a folded bract (3–4 cm long).

Fruits: Capsules (dry fruits that open at maturity) (4 mm long and 4 mm wide), with 3 chambers, each containing one elongated seed (3.2–4 mm long and 1.8 mm wide).

ORIGIN
Belize, Guatemala, Mexico and the Caribbean.

REASON FOR INTRODUCTION
Ornament

INVADES
Roadsides, disturbed areas, urban open space and forest edges/gaps.

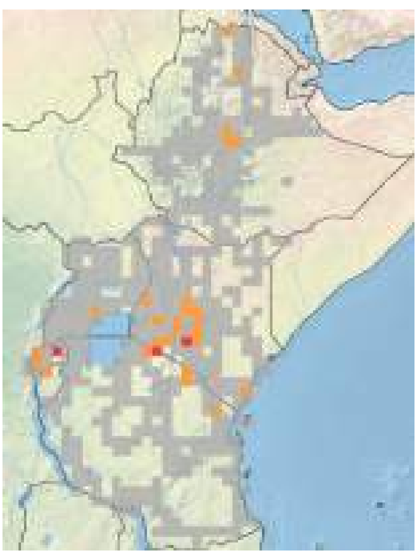


IMPACTS

Has escaped from cultivation and has formed monospecific stands, to the detriment of native plant and animal species. It has the ability to grow in the understoreys of forests, forming a dense ground cover that prevents the germination and establishment of seedlings of native plants (Weber, 2003; Richard and Ramey, 2007; Langeland and Burks, 2008). In Florida it is invading and disrupting native plant communities. Contact with the leaves and the plant sap of *T. spathacea* can cause stinging, itching and rashes of the skin (Morton, 1982). The plants are poisonous, if swallowed in large quantities. Severe allergies have been reported in pets, particularly dogs. Ingestion of the plant may result in irritation of the lips, mouth and throat, and in abdominal pain (Morton, 1982). It is occasionally naturalized or invasive in coastal districts of northern and central Queensland, Australia (Environmental Weeds of Australia, 2016). It is also invasive in China, Cuba, Puerto Rico, American Samoa, La Réunion, United States Virgin Islands (CABI, 2016) and possibly also elsewhere.

Notes: Present in the Eritrea East region of Ethiopia (Kelbessa and Faden, 1997), but not recorded as naturalized or invasive either there or in East Africa (Faden, 2012). Widely grown as an ornamental, *T. spathacea* occasionally escapes cultivation, but there is no evidence, yet, of its having established in natural vegetation.

Tradescantia zebrina Bosse



SPIDERWORT FAMILY
Commelinaceae

COMMON NAMES

English: inch plant, striped wandering Jew, wandering Jew

DESCRIPTION
Succulent evergreen herbaceous plant with spreading stems, hairless and purple-red, producing roots at the joints.

Leaves: Green, silver and purple longitudinal stripes on upper surface, with purple undersides, hairless; egg-shaped or broadly sword-shaped (3–7 cm long and 1.5–3 cm wide); margins entire, narrowing to a pointed tip; leaf-sheath (clasping tubular structure) (0.8–1.2 cm long) surrounds or encloses part of stem.

Flowers: Bright pink or purple, in small clusters at the tips of the stems.

Fruits: Capsules (dry fruits that open at maturity), small, seeds brown.

ORIGIN
Mexico

REASON FOR INTRODUCTION
Ornament

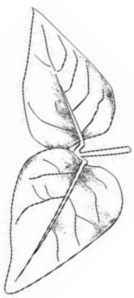
INVADES
Savannahs, roadsides, forest edges and coastal scrub.

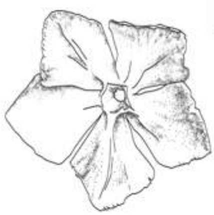
IMPACTS

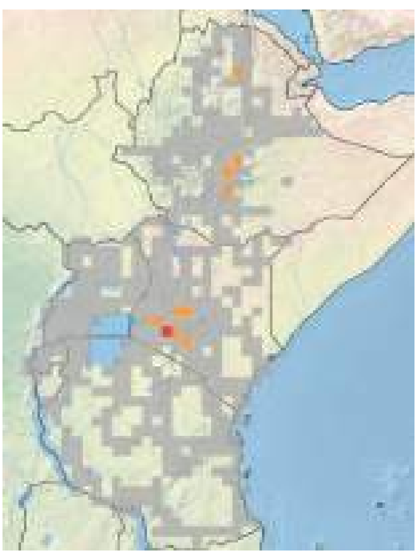
Has the ability to form dense monospecific stands, displacing native plants and animals. It tends to grow in disturbed secondary forest and in moist semi-open areas. It also readily establishes in "waste areas, disturbed sites, roadsides, urban bushland, riparian vegetation, open woodlands and forests in sub-tropical and warmer temperate regions" (Environmental Weeds of Australia, 2016). It has become invasive in a World Heritage Site on Saint Lucia on the middle slopes of Gros Piton, where its dense carpets are displacing indigenous plant species such as *Peperomia trifolia* (L.) A. Dietr. (Piperaceae); *P. myrtifolia* (Vahl) A. Dietr.; *Callisia repens* (Jacq.) L. (Commelinaceae), and *Gibasis geniculata* (Jacq.) Rohweder (Commelinaceae) (Graveson, 2012). In a regenerating Atlantic Forest fragment, *T. zebrina* proved to be a strong competitor, influencing species richness and abundance (Mantoani *et al*., 2013). In Australia, "it has formed dense infestations (up to 1 m thick) along the edges of rainforests, particularly near settlements" (Humphries and Stanton, 1992, in Csurhes and Edwards, 1998). Contact with the foliage can cause irritations of the skin (Floridata, 2012; Dave's Garden, 2013). Recorded as invasive on many Pacific Islands and in Australia, China, Philippines, Singapore, Taiwan, Canary Islands, Brazil and Portugal (PIER, 2009; CABI, 2016).

Notes: Naturalized in Nairobi and Thika and perhaps elsewhere in Kenya (Agnew and Agnew, 1994). This observation is supported by Faden (2012), who found it to be "naturalized and sometimes an invasive weed" in East Africa. According to KHS (1995) "the garden varieties will cover large areas and may become a nuisance" an observation supported by our surveys. It has been recorded in the regions of Shewa and Harerge, in Ethiopia (Kelbessa and Faden, 1997).

Vinca major L.







DOGBANE FAMILY
Apocynaceae

COMMON NAMES

English: blue periwinkle, vinca

DESCRIPTION
Spreading evergreen herbaceous vine with dark green, hairless stems (to 1.5 m long) that can develop roots; the stems have a milky sap.

Leaves: Glossy green above with paler undersides; egg-shaped or almost round (1.5–9 cm long and 1.5–6 cm wide) with heart-shaped bases and pointed or rounded tips; margins entire with fine hairs on edges, held opposite each other on stems, on leaf stalks 4–15 mm long.

Flowers: Blue to purple, tubular (3–6 cm across), usually held singly on stalks (2–6 cm long).

Fruits: Follicles (dry fruits with one compartment that opens, along one side only, at maturity), pod-like, green turning brown as they mature, round in cross-section, tapering to a pointed tip (3.5–5 cm long and 4 mm wide).

ORIGIN
Albania, France, Italy, Spain, the former Yugoslavia and possibly also northern Africa.

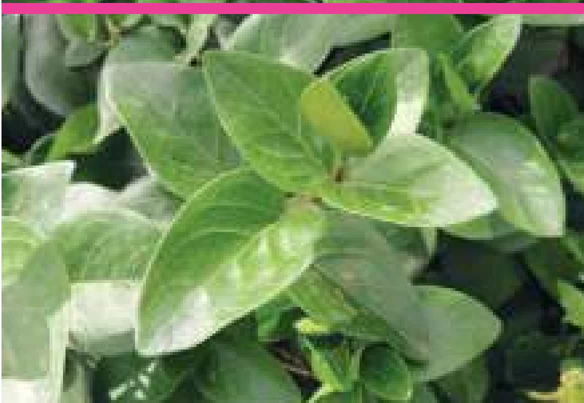
REASON FOR INTRODUCTION
Ornament

INVADES
Forest edges and gaps, watercourses and roadsides.

IMPACTS

V. major can grow in deep shade and in poor soils, giving it a competitive advantage over other plants (McClintock, 1985, in Bean and Russo, 2003). Being allelopathic, it can inhibit germination and seedling growth in plants of other species (Darcy and Burkhart, 2002), which may add to its competitive advantage. On streambanks, it forms dense mats which smother the native vegetation of riverine understoreys, preventing the regeneration of trees and shrubs, and contributing to increased erosion (Eurobodolla Shire Council, undated). By reducing the amount of forage available on riverbanks, it impacts negatively on animals utilizing riparian corridors. A study, carried out in a riparian zone invaded by periwinkle in Victoria, Australia, found that survival rates among native manna gum trees (*Eucalyptus viminalis* Labill.; Myrtaceae) were higher in plots cleared of periwinkle, and that blackwood (*Acacia melanoxylon* R.Br.; Fabaceae) seedlings were taller in plots cleared of periwinkle than in uncleared plots of similar size (CRC for Australian Weed Management, 2008). In Australia, *V. major* is listed as a priority environmental weed in six Natural Resource Management regions.

Notes: Both *V. major* and *V. minor* are very similar morphologically, and as such species at some localities may have been misidentified. However, impacts of invasions of both species appear to be similar. *Vinca* spp. occasionally escape from cultivation, forming stands on roadsides or forest edges. Plants have escaped from cultivation and established in forest gaps and edges in Mount Kenya National Park. In Ethiopia, *V. major* is cultivated in the regions of Shewa and Eritrea West, but is not considered to be invasive (Leeuwenberg, 2003). Its congener, *Vinca minor*, is "sometimes naturalized" in East Africa (Omino, 2002).



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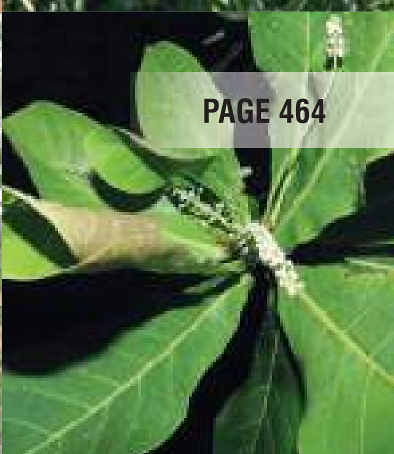
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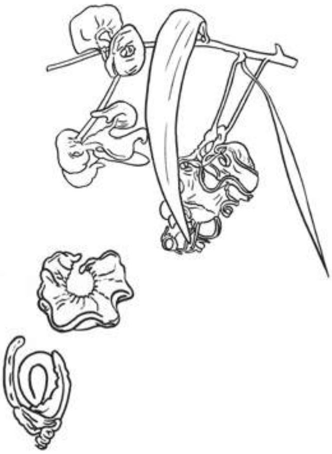
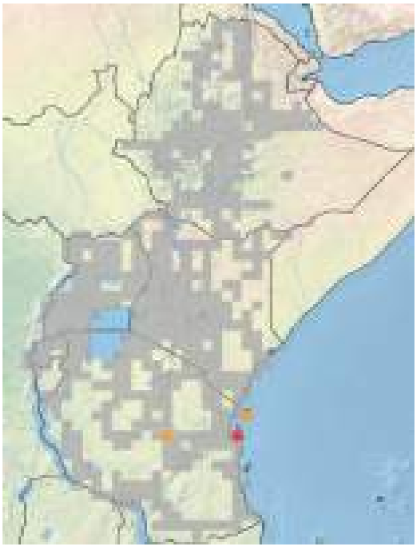
TREES

Acacia auriculiformis Benth.





PEA FAMILY
Fabaceae; sub-family: Mimosaceae

SYNONYM
Racosperma auriculiforme (Benth.) Pedley

COMMON NAMES
English: earleaf acacia, Japanese acacia, northern black wattle, tan wattle
Tanzania: mkwaju-wa-kihindi

DESCRIPTION
Evergreen tree with no thorns/spines [8–20 (–35) m tall]; trunk to 60 cm in diameter; often multi-stemmed with compact spread.

Bark: Grey or brown, sometimes black at the base, smooth in young trees becoming rough and longitudinally fissured with age.

Leaves: Greyish-green, 'leaves' are flattened leaf stalks called phyllodes, hairless and thinly textured, slightly curved (8–20 cm long and 1–4.5 cm wide), 3–7 longitudinal veins, running together towards the lower margin or in the middle near the base, with many fine, crowded secondary veins, and a distinct gland at the base of the phyllodes.

Flowers: Light golden-orange, minute, in long unbranched inflorescences or spikes (8.5 cm long), fragrant.

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning brown as they mature, initially straight or curved becoming twisted and coiled (6.5 cm long and 1.5 cm wide) containing shiny black seeds (0.4–0.6 cm long and 0.3–0.4 cm wide) encircled by a long red, yellow or orange structure (aril).

ORIGIN
Australia and Papua New Guinea.

REASON FOR INTRODUCTION
Fuelwood, building materials, timber, pulp, erosion control, land reclamation, shade and ornament.

INVADES
Roadsides, disturbed areas, wastelands, urban open space, forest edges/gaps and riparian vegetation.

IMPACTS
Has the ability to displace native vegetation and to shade out indigenous plant species. By fixing nitrogen, the species also alters nutrient cycling, making soils unsuitable for some native plant species. *A. auriculiformis* may also increase phosphorus availability when it invades low-nutrient habitats (Gordon, 1998). In Florida, USA, it threatens rare plant species such as the listed scrub pinweed, *Lechea cernua* Sm. (Cistaceae), in remnant scrub areas (K. C. Burks, Florida Department of Environmental Protection, *pers*. *obs*., in FLEPPC, 2015). In Singapore, it is very persistent in disturbed and secondary forests (Tan, 2011). It is also considered to be allelopathic, inhibiting the germination and growth of agricultural crops (Hoque *et al*., 2003). It has been introduced to many countries as an agro-forestry species but has only been reported as being invasive in Bangladesh, Malaysia, Singapore, Bahamas and Florida (USA) (CABI, 2016).

Notes: It is currently considered to be invasive on Unguja Island, Zanzibar (Kotiluoto *et al.*, 2009) and there are records of its presence on Pemba Island (Koenders, 1992). During surveys only found at one locality on the Tanzania mainland but probably more widespread.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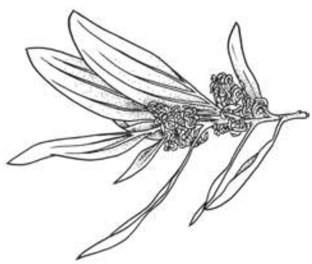
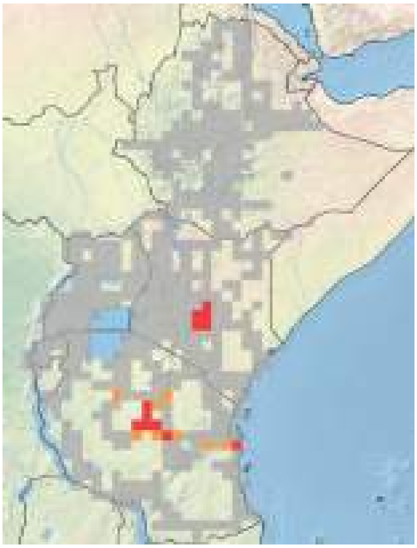
Acacia colei Maslin & L.A.J. Thomson





PEA FAMILY
Fabaceae; sub-family: Mimosaceae

COMMON NAMES

English: Cole's wattle

DESCRIPTION
Spreading evergreen shrub or small tree [2–4 (–9) m tall], with no thorns/spines; multi-stemmed; branchlets angular; new shoots yellow.

Bark: Grey and smooth on main trunks but reddish brown towards the ends of the branches.

Leaves: Green, 'leaves' are expanded leaf stalks called phyllodes, upright to erect, hairless and thinly textured, narrowly oval (9–23 cm long and 2–5 cm wide) with three conspicuous main longitudinal veins.

Flowers: Bright golden, in long unbranched inflorescences or spikes (3–7 cm long) on short stalks (3–6 mm).

Fruits: Pods (several-seeded dry fruits that split open at maturity), green becoming brown as they mature, initially linear or straight becoming strongly curved and twisted and entangled after releasing brown to black seeds [3–3.5 (–4) mm long] with a yellow appendage.

ORIGIN
Australia.

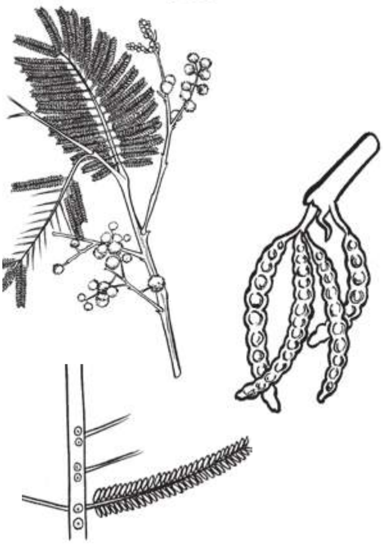
REASON FOR INTRODUCTION
Fuelwood, building materials, food source, soil improvement and shade.

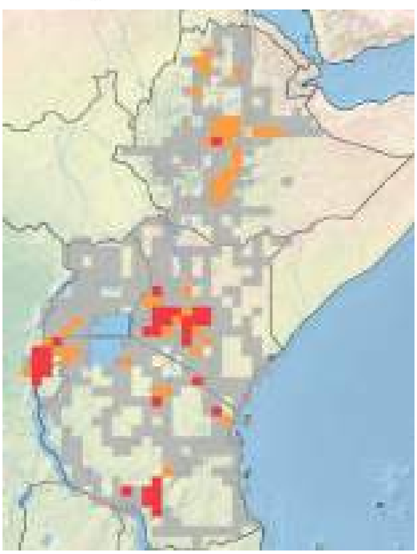
INVADES
Roadsides, disturbed land, urban open spaces, fallow land, cropland, drainage ditches, savannah.

IMPACTS

A prolific seeder, *A. colei* produces seeds two years after planting, has foliage that is unattractive to livestock and wildlife, grows well on disturbed sites, and is self-fertile (Harwood *et al.,* 1999), all attributes shared by many invasive plant species. By fixing nitrogen, the species also alters nutrient cycling, making soils unsuitable for some native plant species.

Notes: It has escaped cultivation in parts of Tanzania and Kenya, where it is now considered to be invasive, forming dense stands, which appear to be displacing native vegetation. It is locally abundant along roadsides, in savannah and in croplands from Dodoma to Singida via Manyoni in Tanzania. Localized infestations have been found near the Masinga Dam, south of Mount Kenya. Current infestations are relatively localized, but judging by the large number of seedlings produced this introduced Australian acacia predicted to become far more widespread.





PEA FAMILY

Fabaceae; sub-family: Mimosaceae

SYNONYM

Acacia decurrens var. *mollis* Lindl.; *Racosperma mearnsii* (De Wild.) Pedley

COMMON NAMES

English: Australian acacia, black wattle, tan wattle
Ethiopia: mimosa
Kenya: gesonge, man'goi, munyoonyoo, muwati, mwati, nonotebwe, omotandege
Tanzania: misyamba mititu, muwati, man'goi, muwato
Rwanda: indakatsi

DESCRIPTION

Evergreen tree with no thorns/spines; round or shapeless [5–10 (–20) m high]; all parts finely hairy with growth tips golden-hairy.

Bark: Smooth, green-grey, later black and grooved, producing a brown resinous gum.

Leaves: Dark olive-green, twice-divided (8–12 cm long), 9–20 pairs of leaf branchlets (2–5 cm long), each with 20–60 pairs of leaflets (1.5–4 mm long); raised glands occur at and between the junctions of leaflet stalks along the whole midrib; held alternately on stems.

Flowers: Pale yellow or creamy in rounded heads or balls (5 mm across), fragrant.

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning brown as they mature, straight or twisted (6–15 cm long and 5–9 mm wide), usually constricted between seeds and finely hairy; seeds bean-like, flattened, black (4 mm long).

ORIGIN

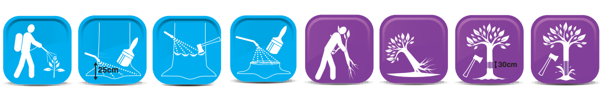
Southeast Australia and Tasmania.

REASON FOR INTRODUCTION

Fuelwood, building materials, shelter, ornamental, erosion control and tanning.

INVADES

Roadsides, disturbed land, wasteland, plantation edges/gaps, drainage ditches, forest edges/gaps, woodland edges/gaps, grassland, water courses, lowlands and gullies.

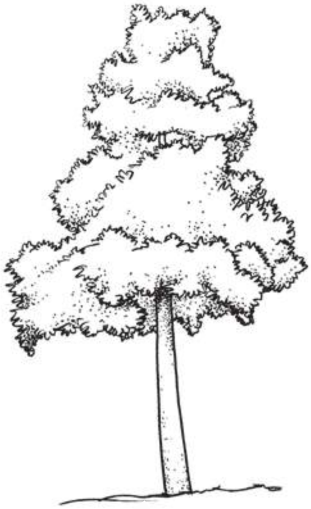


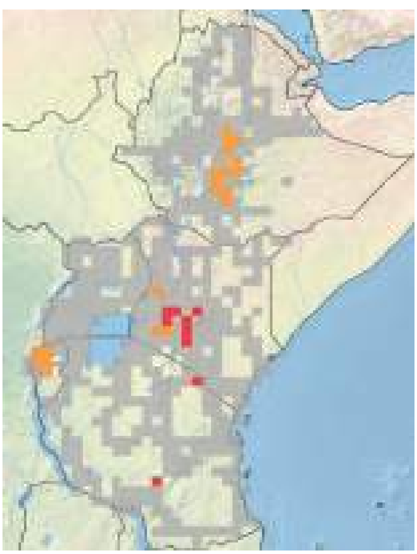
IMPACTS

By shading out plants of native species, and by shedding large quantities of litter, black wattle reduces floral diversity (Weber, 2003), including grass communities and reduces the carrying capacity of the land (Sanakaran and Suresh, 2013). By fixing nitrogen, the species alters nutrient cycling, making soils unsuitable for some native plant species. In South Africa, costs associated with black wattle infestations include reduced stream flows, a heightened fire risk, increased erosion, destabilization of riverbanks, loss of grazing, nitrogen pollution, impairment of recreational activities, and diminished aesthetic appeal (de Wit, 2001). Losses in water runoff in South Africa, attributed to infestations of *A. mearnsii*, amount to an estimated 577 million m^3 of water annually (Versfeld *et al.,* 1998). *A. mearnsii* is considered to be the "most aggressive invader" of stream banks, forest margins and miombo woodlands above 1,600 metres above sea level in the mist belts of the eastern highlands of Zimbabwe. It has already invaded large tracts of land in the Nyanga and Chimanimani National Parks and in the botanical gardens of La Rochelle and Vumba. Black wattle is also extremely invasive in India, having invaded shola forests and associated grasslands.

Notes: More than 50 years ago, Brenan (1959) commented that it had "made itself sufficiently at home in East Africa" to be considered a part of the native flora, having been recorded as "frequently naturalized in uplands around Njombe." It is now naturalized in highland areas of Kenya such as Trans Nzoia, Kisii, Limuru, Muguga, Eldoret and Nairobi (Maundu and Tengnäs, 2005). While present in several regions in Ethiopia, along with other Australian acacias such as *A. dealbata* Link and *A. decurrens* Willd., it has not been recorded as naturalized or invasive there (Thulin, 1989), although Bekele-Tesemma *et al*. (1993) claim that it is "potentially a weed on cropland and can be difficult to eradicate." Widespread and abundant, forming very dense infestations, especially in higher lying areas throughout East Africa, especially in grasslands, forest edges and in riparian vegetation. Probably far more common in Uganda than indicated.

Acacia melanoxylon R. Br.





PEA FAMILY
Fabaceae; sub-family: Mimosaceae

COMMON NAMES

English: Australian blackwood, blackwood, hickory, Tasmanian blackwood
Ethiopia: omedla
Kenya: kanuga
Tanzania: mtasimana

DESCRIPTION
Evergreen tree with no thorns/spines; tall, conical or pyramidal [8–15 (–35) m high] with a straight trunk (0.5 m in diameter) and a dense crown.

Bark: Dark greyish to black and deeply fissured.

Leaves: Dark green to greyish green, twice-divided on young plants and coppicing shoots; mature leaves are expanded leaf-stalks called phyllodes which are almost erect, straight to slightly curved, somewhat elongated (4–16 cm long and 6–30 mm wide) with 3–5 prominent longitudinal veins and fine net-veins in between; leaves held alternately on stems.

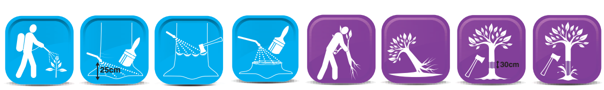
Flowers: Pale yellow, creamy or whitish in rounded heads or balls (5–10 mm across).

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning reddish-brown as they mature, flattened and twisted or coiled (4–15 cm long and 3.5–8 mm wide); seeds almost encircled by a pinkish-red/orange fleshy structure.

ORIGIN
Southeastern and eastern Australia and Tasmania.

REASON FOR INTRODUCTION
Fuelwood, building materials, timber, erosion control, shelter and ornament.

INVADES
Roadsides, disturbed areas, plantations, drainage ditches, forest edges/gaps, grasslands, riparian areas and lowlands.

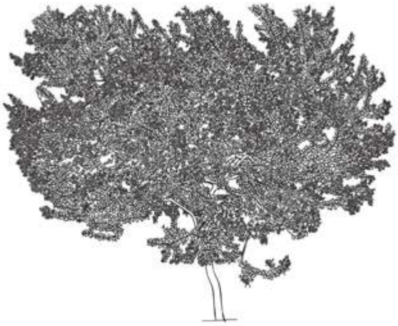


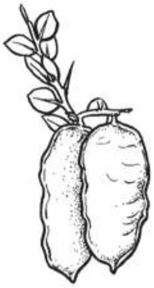
IMPACTS

Forms dense thickets which may out-compete native plant species for water and light. Increases soil nitrogen levels, altering soil nutrient cycling. According to Souto *et al*. (1994), phenolic compounds released in the litter decomposition process, inhibit germination and growth of other species contributing to low plant diversity in the understory of *A. melanoxylon* stands. Uses copious amounts of water, significantly more water than the native vegetation it replaces, changing soil moisture conditions (Rutherford *et al*., 1986). *A. melanoxylon* is also considered to be one of the most "aggressive invaders" of montane grasslands in the eastern highlands of Zimbabwe. The montane grassland ecosystem, one of the most threatened habitats in Zimbabwe, is disappearing rapidly under a host of invaders. *A. melanoxylon* is also the cause of allergenic contact dermatitis and asthma in people who work with the wood. Other impacts are similar to those of *A. mearnsii* and other invasive *Acacia* spp. Naturalized and/or invasive along the coast of southwestern Western Australia; western Europe, including Belgium, France, Portugal and Spain; Kenya, Lesotho, South Africa, Swaziland and Tanzania in Africa; southern Asia including Bhutan, China, India, Pakistan and Sri Lanka; New Zealand; Hawaii; the west coast of the USA; La Réunion; Mauritius; the Azores (Environmental Weeds of Australia, 2016); and Argentina (CABI, 2016), Chile, Colombia, Mexico and Peru in Central and South America (PIER, 2012).

Notes: Not recorded as being problematic in Ethiopia (Thulin, 1989). Surveys found this species to be widespread and locally abundant in higher lying areas throughout East Africa, especially in grasslands, forest edges and riparian vegetation, often growing in association with *A. mearnsii.*

Acacia podalyriifolia G. Don





PEA FAMILY
Fabaceae; sub-family: Mimosaceae

COMMON NAMES
English: golden wattle, pearl acacia, Queensland silver wattle
Ethiopia: gmarda, gwmero
Kenya: wamuu

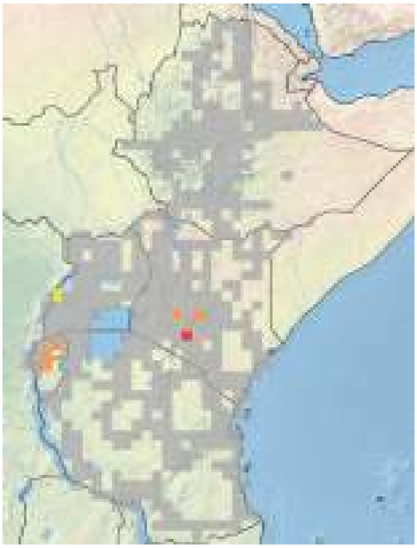
DESCRIPTION
Small evergreen tree or shrub [2–6 (–10) m tall] with no thorns/spines; young branchlets round or almost round in cross-section and covered with soft hairs.

Bark: Grey or greyish-brown, smoothly fissured and cracking with age.

Leaves: Greyish to bluish-green turning dark dull-green, velvety; mature 'leaves' are expanded leaf-stalks called phyllodes which are thin and egg-shaped to elongate (20–50 mm long and 10–27 mm wide), broader at base, tips rounded to pointed, margins sometimes slightly wavy, mid-vein prominent.

Flowers: Pale to golden yellow, in rounded heads or balls (5–8 mm across) arranged in compound clusters containing 8–22 heads.

Fruits: Pods (several-seeded dry fruits that split open at maturity), bluish-green or silvery-grey turning brown or reddish-brown as they mature, flattened, thin (50–120 mm long and 10–22 mm wide), velvety, relatively twisted; seeds black, elongated (6–7.5 mm long and 3–4 mm wide) with fleshy structure (aril) attached.



ORIGIN
Australia.

REASON FOR INTRODUCTION
Bee forage, shade and ornament.

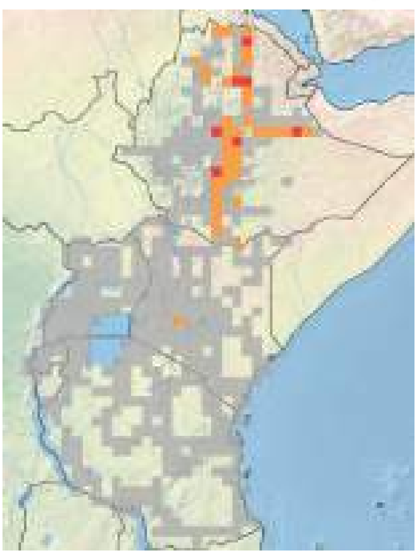
INVADES
Roadsides, disturbed areas, urban open spaces, forest edges/gaps, grasslands and watercourses.

IMPACTS

Can establish readily in a wide variety of climates, including dry areas, and tolerates mild frost. It grows rapidly and has the ability to form dense stands within a relatively short period, displacing native species and their associated organisms. By fixing nitrogen, it also alters soil nutrient cycling. In Australia, *A. podalyriifolia* can become naturalized wherever it has been planted (Simmons, 1987). It is invasive in natural vegetation in Victoria, Australia (Blood *et al*., 1998), where it is considered to be a threat to one or more vegetation types (Carr *et al.*, 1992). It is also considered to be invasive in South Africa, where it invades riparian habitats and urban open space, and in the La Rochelle Botanical Gardens in the eastern highlands of Zimbabwe. *A. podalyriifolia* is one of 17 *Acacia* spp. that was intentionally introduced to Zimbabwe of which nine are considered to be casuals, naturalized or invasive (Maroyi, 2015). *A. podalyriifolia* is also naturalized in India, Sri Lanka, Indonesia and Malaysia in Asia; Mauritius; La Réunion; New Zealand; Argentina and Brazil in South America; and in California (Environmental Weeds of Australia, 2016).

Notes: Naturalized in some parts of East Africa, forming small stands, especially in higher lying areas (Birnie and Noad, 2011). In Ethiopia, it is cultivated in Addis Ababa and in the Shewa Region (Thulin, 1989). An escape from garden plantings, particularly in higher-lying areas, surveys found it to be occasionally naturalized and locally abundant in a few localities in Kenya. Probably more widespread than indicated.

Acacia saligna (Labill.) Wendl.



PEA FAMILY

Fabaceae; sub-family: Mimosaceae

COMMON NAMES

English: Blue-leaf wattle, golden willow wattle, Port Jackson wattle, weeping wattle
Ethiopia: akacha saligna

DESCRIPTION

Small evergreen tree or shrub [2–6 (–10) m tall] with no thorns/spines, young branchlets green or reddish-green, covered with soft hairs; younger branches and leaves drooping by nature.

Bark: Grey or brownish-grey, smoothly fissured.

Leaves: Greyish turning dark dull-green, velvety, mature 'leaves' are expanded leaf-stalks called phyllodes which are narrow and straight to slightly curved, about 10 times longer than wide (70–300 mm long and 2–20 mm wide) with a prominent mid-vein.

Flowers: Pale to golden yellow, in rounded heads or balls (7–12 mm across) arranged in compound clusters.

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning brown as they mature, flattened, thin and velvety (50–140 mm long and 4–6 mm wide), relatively twisted; seeds black (5–6 mm long and 2.5–3 mm wide) with fleshy structure (aril) attached.

ORIGIN

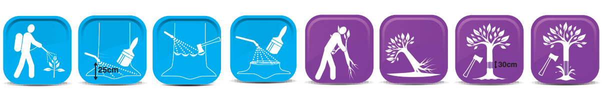
Southwestern Western Australia.

REASON FOR INTRODUCTION

Fuelwood, tannins, fodder, restoration, erosion control, shade and shelter.

INVADES

Roadsides, disturbed land, urban open spaces, grasslands and savannah.

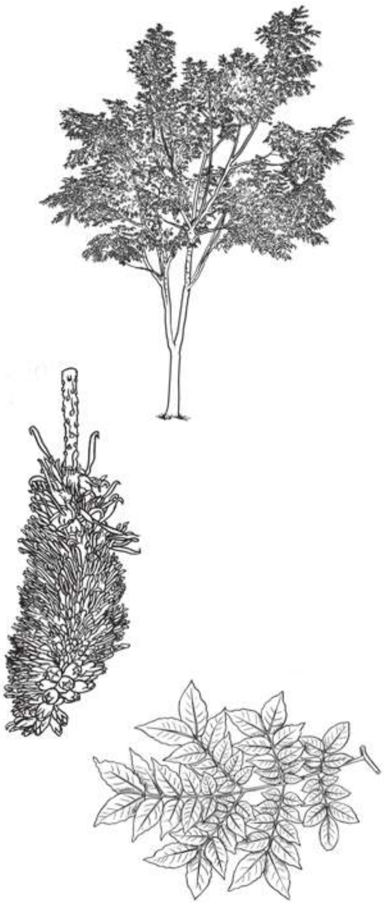


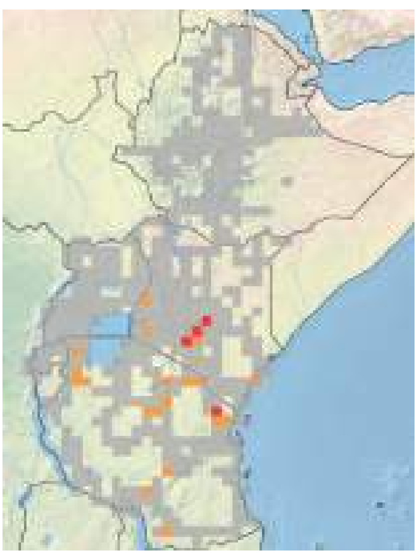
IMPACTS

Growing rapidly and producing copious quantities of seeds, it forms dense, impenetrable thickets, which displace native species and prevent their regeneration (Holmes and Cowling, 1997; Hadjikyriakou and Hadjisterkotis, 2002). In South Africa it has been identified as a threat to several IUCN-listed species, including *Chondropetalum acockii* Pillans (Restionaceae); *Gladiolus aureus* Baker (Iridaceae); *Leucadendron verticillatum* Meissn. (Proteaceae); *Restio acockii* Pillans (Restionaceae), and *Serruria ciliata* R. Br. (Proteaceae) (Cronk and Fuller, 1995). *Acacia saligna* increases the nitrogen content of soils, altering soil nutrient cycling (Witkowski, 1991). It also increases the intensity and frequency of fires (Holmes, 2002), and reduces stream flows through increased water use, especially in water catchments (Le Maitre *et al*., 2000). Changes in nitrogen availability have increased growth rates of the weedy grass *Ehrharta calycina* Sm. (Poaceae) in South Africa, which may contribute to invasions by other nitrophilous weedy plants (Yelenik *et al*., 2004). In some areas, it has invaded cropland (Hadjikyriakou and Hadjisterkotis, 2002). The foliage has also been found to be allelopathic, reducing germination rates in maize and rice (El Baha, 2003).

Notes: It is cultivated in Tanzania (Mbuya *et al.*, 1994) but was not seen during surveys. In Ethiopia, “there is some danger that it could become a weed if grown on farmland” (Bekele-Tesemma, 2007). Widely used for fuelwood and restoration in Ethiopia, it has become locally abundant and invasive in some areas, especially between Addis Ababa and Adama (Nazret). Probably far more common in East Africa than indicated.





PEA FAMILY

Fabaceae; sub-family: Caesalpiniaceae

COMMON NAMES

English: Australian ash, Indian ash, shingle tree, pink cedar
Tanzania: mtikivuli

DESCRIPTION

Large deciduous tree (shedding most or all of its leaves at the end of the growing season); 30–60 m tall, with a round, straight stem [90 (–200) cm in diameter], free of branches over most of its elevation, having large, thick buttresses and deep roots.

Bark: Light grey, thin, fairly smooth, often with horizontal markings.

Leaves: Bright red when young, turning green, twice-divided [30 (–100) cm long] with 3–5 leaf branchlets (pinnae), each with 5–6 oval to sword-shaped opposite leaflets (4–15 cm long and 1.5–4.5 cm wide) which taper to a sharp point, bases slanted and narrowing gradually to a slender point; margins entire but with sharp projections or teeth that are forward pointing in seedlings; held in opposite pairs on stems.

Flowers: Reddish-green to orange, in dense clusters (12 cm long) of about 20 flowers at branch ends; appear on tree when leafless.

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning brown as they mature, long and flattened (8–16 cm long and 1–2 cm wide), containing 10–18 winged seeds (4.6–6.8 mm long and 3.4–4.2 mm wide).

ORIGIN

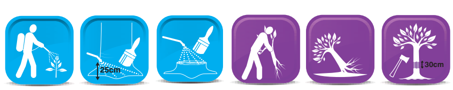
Bangladesh, Borneo, Burma, China, India, Indonesia, Sumatra and Vietnam.

REASON FOR INTRODUCTION

Fuelwood, timber, fodder, bee forage, erosion control, shade and ornament.

INVADES

Roadsides, disturbed land, urban open spaces, forest edges/gaps, woodlands and riparian vegetation.



IMPACTS
Forms dense stands, shading out native species. Like so many invasive plants it is a pioneer species in its native range, regenerating rapidly in burnt areas and where the soil has recently been exposed. Coppices readily and grows extremely rapidly (1.3–3 m annually), producing large numbers of seeds (Whitmore and Otarola, 1976), many of which germinate under parent canopies, forming large monospecific stands, to the detriment of native plant and animal species. The winged seeds can also be dispersal over long distances and "because the seed germinate readily, may cause it to be potentially invasive" (Iplantz, 2016). Young plants often behave as climbers and stranglers of other trees. It is also known to be invasive in parts of India. In Zimbabwe it "rarely escapes in disturbed ground" (Flora of Zimbabwe, 2016).

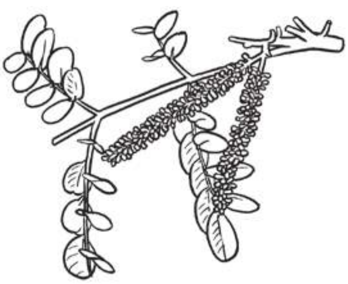
Notes: Present in the Shewa Region of Ethiopia but not recorded as problematic (Thulin, 1989). Often naturalized or locally abundant in higher lying areas such as the East Usambaras, Tanzania, and in green belts and urban open spaces in and around Nairobi, Kenya. Although not recorded in Uganda it has been present there for over 60 years (Dale, 1953) and may have been missed there during these surveys.

Adenanthera pavonina L.

PEA FAMILY
Fabaceae; sub-family: Mimosaceae

COMMON NAMES

English: bead tree, Circassian seed, crab's eyes, red sandalwood

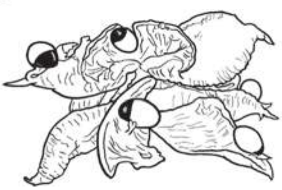


DESCRIPTION
Spreading evergreen tree (4–20 m tall) that sheds most of its leaves at the end of the growing season, with low leafy branches and slightly buttressed trunks in older trees.

Bark: Dark brown to greyish.

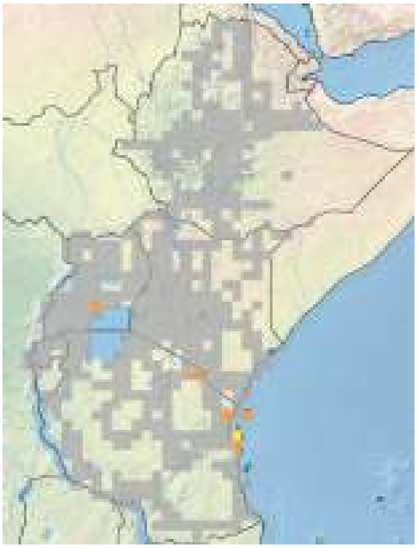
Leaves: Dull-green above, blue-green beneath, twice-divided (to 40 cm long), 2–6 pairs of leaflet branchlets, each bearing 8–21 oval to somewhat elongated (elliptic to oblong) leaflets with almost parallel sides (2–5 cm long and 2–2.5 cm wide) and rounded tips.

Flowers: Yellow-brown or white, small, narrow and spike-like (10–15 cm long), on slender, drooping stalks.



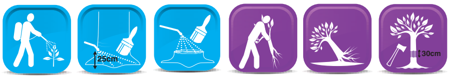
Fruits: Pods (several-seeded dry fruits that split open at maturity), initially green, turning brown and then black as they mature (15–25 cm long and 2 cm wide), slight constrictions between seeds; pods split into two twisted halves, revealing tiny scarlet seeds against the yellow inner pod.

ORIGIN
Bangladesh, China, India and Sri Lanka.



REASON FOR INTRODUCTION
Timber, nitrogen fixation, shelter and ornament.

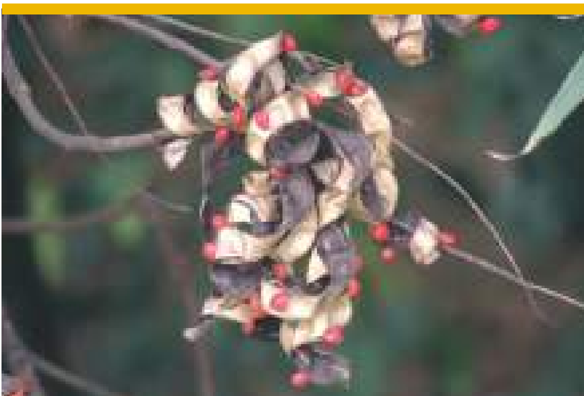
INVADES
Roadsides, disturbed land, urban open spaces, woodlands and coastal forests.

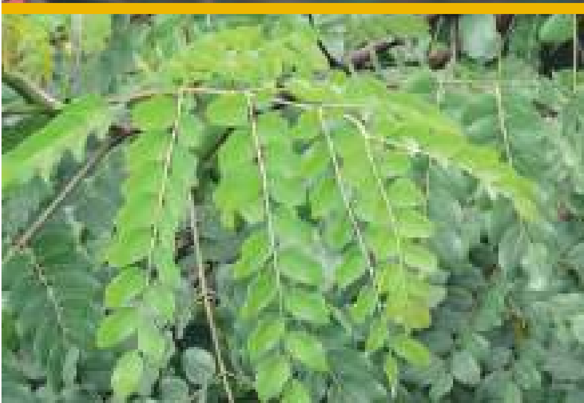


IMPACTS

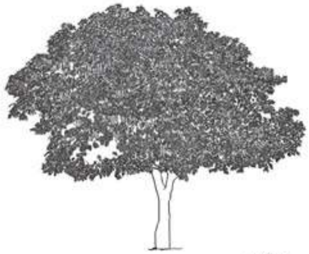
Can form dense stands, probably displacing native trees and shrubs in areas where it has established. It is a very fast growing species with the potential to invade both undisturbed and disturbed forests (Sankaran and Suresh, 2013). In the Seychelles, *A. pavonina* has spread rapidly in secondary forests, displacing native trees and shrubs and preventing their regeneration (Weber, 2003). In Fiji, it is naturalized along roads, in dry forest, and occasionally in dense forest (Smith, 1985). It is listed as one of the worst invasive species in Jamaica, and is also regarded as being invasive in Cuba, Puerto Rico, and on many islands in the Pacific, including American Samoa, Hawaii, French Polynesia, Micronesia and Australia (Acevedo-Rodríguez and Strong, 2012; USDA-ARS, 2012). It is also spreading rapidly in the Seychelles (Weber, 2003).

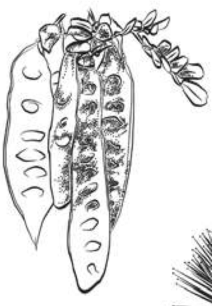
Notes: Present in Uganda (Entebbe) and in Tanzania (Moshi, Amani, Dar es Salaam), it is also quite common on Zanzibar (Brenan, 1959) and has been recorded on Pemba Island (Koenders, 1992). Brenan (1959) suggested more than 50 years ago that it "may well become naturalized more often than the evidence suggests." According to Mbuya *et al.* (1994) and Maundu and Tengnäs (2005), it is "often naturalized" in East Africa. During surveys it was occasionally seen and only rarely found to be naturalized. Probably more common than indicated but not invasive yet, based on our observations.

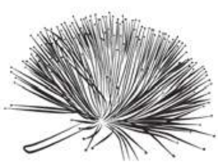


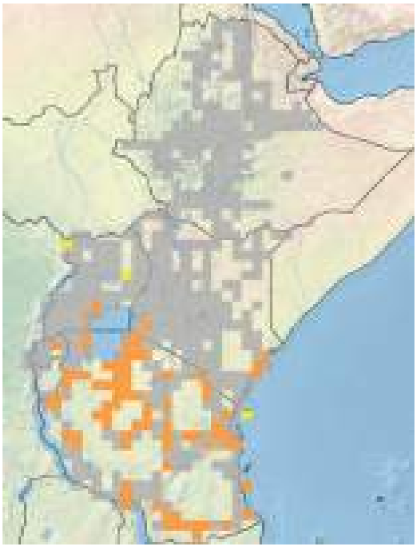


Albizia lebbeck (Jacq.) F. Muell.









PEA FAMILY
Fabaceae; sub-family: Mimosaceae

COMMON NAMES
English: East Indian walnut, Indian albizia, rain tree, siris tree, woman's tongue tree
Ethiopia: lebbeck, shasho, yoke
Kenya: kirongo, mboromo, mcani-mbao, mchani, mkingu, mkungu, ortuba
Tanzania: mkenge-kipini, mkingu, mpepe, mshai
Uganda: nienyienyi, yangasali

DESCRIPTION
Medium-sized tree [8–14 (–20) m tall]; deciduous (sheds most or all of its leaves at the end of the growing season); trunk 1(–3) m in diameter; young branches covered in soft golden hairs.

Bark: Grey-violet, smooth becoming rough and fissured but not peeling.

Leaves: Green, twice-divided (15–40 cm long) with 2–5 pairs of leaflet branchlets, each with 4–12 pairs of leaflets which are elongated and with almost parallel sides (2–5 cm long and 1–2.5 cm wide) and rounded tips.

Flowers: Green-yellow, in 'puffball-like' flowerheads (3–4 cm across) held on flower stalks (1.5–4.5 mm long), fragrant.

Fruits: Pods (several-seeded dry fruits that split open at maturity), shiny green turning yellow-brown as they mature (10–25 cm long and 2.5–4 cm wide), flat and papery, in clusters, bulging over the brown, flat seeds (8–10 mm long and 6–7 mm wide).

ORIGIN
Bangladesh, India, Nepal, Myanmar and Pakistan.

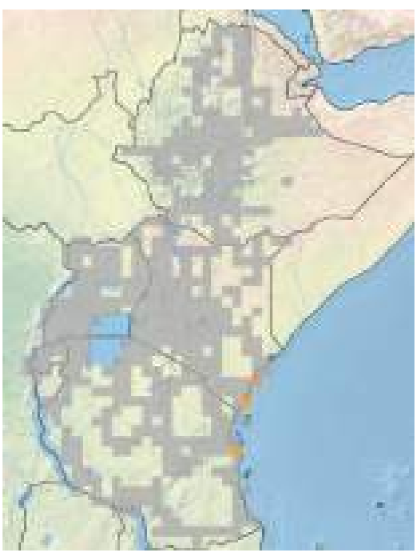
REASON FOR INTRODUCTION
Fuelwood, carving, construction, furniture, livestock feed, green fertilizer and ornament.

INVADES
Disturbed land, urban open spaces, savannahs and water courses.

IMPACTS

Produces numerous seeds, while suckers from the roots form dense stands, to the detriment of native flora and fauna. Being able to fix nitrogen, it alters nutrient cycling processes, contributing to changes in the composition of above-ground species. In Puerto Rico it has escaped cultivation and now occurs in a variety of natural and disturbed habitats (Dumphy and Hamrick, 2005). By forming monospecific stands, it can dominate and replace the canopy and sub-canopy layers of natural or semi-natural ecosystems (Henderson, 2001). In Australia, it is present in coastal forests, monsoonal vine thickets, savannah woodlands and riparian areas, where it is spreading rapidly, restricting the growth of native species (Environmental Weeds of Australia, 2016). It has also been reported from conservation areas in Florida, USA, such as the the Big Cypress National Preserve and the Everglades National Park (Environmental Weeds of Australia, 2016).

Notes: In East Africa, *A. lebbeck's* problematic nature was observed more that 50 years ago. Brenan (1959) reported that it was “becoming naturalized but always associated with human habitations”. More recently, this has been corroborated by Maundu and Tengnäs (2005) and by Birnie and Noad (2011), who have also found it to be naturalized in some places. In Ethiopia, where it is present in gardens in Ginda (Eritrea West Region) and Dire Dawa (Harerge Region), *A. lebbeck* is also considered to be naturalized (Thulin, 1989). This view is echoed by Bekele-Tesemma (2007), who found that it was becoming naturalized in Shoa and in other lowland areas of Ethiopia. Yet, despite these observations, field studies undertaken for this Guide have found only rare instances of its naturalization in East Africa and Ethiopia. This despite the fact that *A. lebbeck* produces copious amounts of seeds and seems well adapted to local conditions.



PEA FAMILY
Fabaceae; sub-family: Mimosaceae

COMMON NAMES

English: raintree, monkey pod, saman, French tamarind
Tanzania: mkenge-kipini, mshai-mkingu

DESCRIPTION
Large tree [45 (–60) m tall], trunk to 2 m in diameter, short and thick with horizontal spreading branches to 30 m long; new growth velvety; sheds some of its leaves at the end of the growing season.

Bark: Smooth, yellow to cream-brown becoming brown to black with fissures, peeling off in long fibrous strips.

Leaves: Dark olive green, hairless, slightly glossy above, dull grey-green and hairy below, large, twice-divided (25–40 cm long and 3–8 cm wide) with 8–12 leaflet branchlets, each with 3–8 pairs of somewhat elongated leaflets having almost parallel sides (1.5–6 cm long and 0.7–4 cm wide) and with a minute point at the tip, unequal at the base; leaflets larger towards the ends of the leaf branchlets.

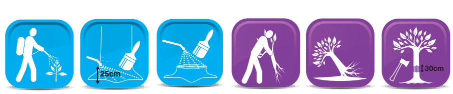
Flowers: Fluffy pink or pale pink stamens (male reproductive organ) protruding from a cream-coloured base (5–7 cm across) in groups or clusters of 2–5.

Fruits: Pods (several-seeded dry fruits that split open at maturity), green and fleshy turning black as they mature, straight (12–25 cm long and 2 cm wide), with an edible sticky pulp around the 5–10 seeds (8–11.5 mm long and 5–7.5 mm wide).

ORIGIN
Bolivia, Brazil, Colombia, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama and Venezuela.

REASON FOR INTRODUCTION
Fuelwood, carving, furniture, construction, plywood, forage, edible pods and ornament.

INVADES
Roadsides, disturbed areas, savannah, woodlands, forest edges/gaps and riparian vegetation.



IMPACTS

Forms dense stands which may displace native plant and animal species. It is highly adaptable, thriving in many tropical and sub-tropical areas and in light, medium and heavy soils. Once established, *A. saman* seedlings grow very fast and are tolerant of heavy competition from other plants (Staples and Elevitch, 2006). Produce copious amounts of seeds in long pods, which are readily consumed by livestock, and then moved to new areas, contributing to further invasions (Staples and Elevitch, 2006). Fixes nitrogen, altering soil nutrient cycling, which may make soils unsuitable for native species that thrive in nutrient-poor soils. It may also be allelopathic (Magnus and Seaforth, 1965). In the Markham area of Papua New Guinea, it has invaded pasture land, displacing valuable pasture species, and on floodplains it has shaded out many native plants. In Hawaii and Fiji, it has invaded native forests (PIER, 2015).

Notes: Common along the coast of Tanzania (Mbuya *et al.*, 1994), it is also "widely planted and has gone wild along the Tana River" in Kenya (Beentje, 1994). Based on these observations it could be regarded as invasive but no naturalized populations were found during surveys but it is probably more common as an ornamental in East Africa than shown.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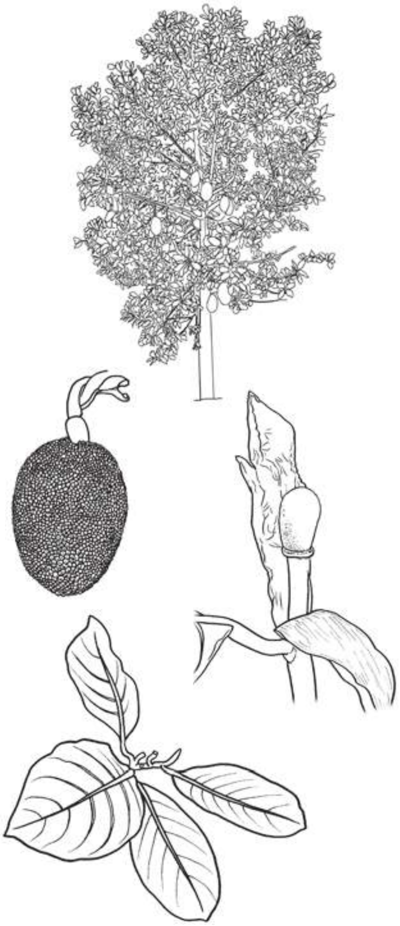
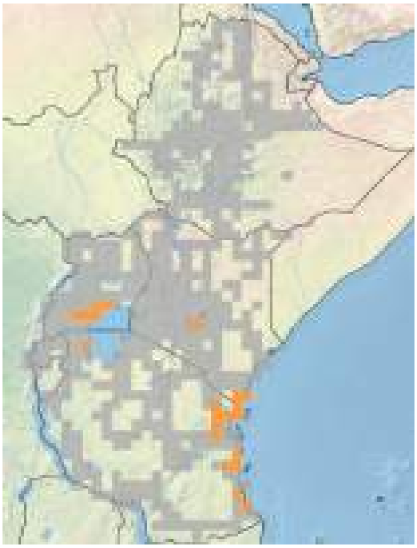
Artocarpus heterophyllus Lam.





MULBERRY FAMILY
Moraceae

COMMON NAMES
English: jacquir, jackfruit, jack tree
Kenya: efenesi, kifenensi, mfuu, yakobo
Tanzania: mfenesi, mfenesi mfuu
Uganda: kifenensi, yakobo

DESCRIPTION
Medium-sized evergreen tree [8–25 (–30) m tall]; stem straight, of diameter 30–80 (–200) cm, branching near the base, rarely buttressed; twigs sometimes covered with minute hairs; crown dome-shaped, sometimes pyramidal, dense; exudes a white gummy latex when damaged.

Bark: Greyish-brown, rough, uneven, somewhat scaly.

Leaves: Dark green and glossy above, undersides pale; stiff, usually hairless; leaves of young plants 2- or 3-lobed, margins entire on older leaves, obovate to elliptic, broadest at the middle (4–25 cm long and 2–12 cm wide), held alternately on the stems.

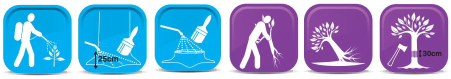
Flowers: Whitish-green or dark green becoming yellowish, in hanging clusters.

Fruits: Syncarps (multiple fruits consisting of several achenes, each of which is indehiscent and one-seeded), pale or dark green turning greenish-yellow, yellow or brownish as they mature; oval, oblong or ellipsoid (20–100 cm long and 15–50 cm wide); seeds light brown to brown, rounded (2–3 cm long and 1–1.5 cm wide).

ORIGIN
Bangladesh, India, Malaysia.

REASON FOR INTRODUCTION
Food, fodder, medicine, shade and ornament.

INVADES
Roadsides, disturbed areas, urban open spaces, forest edges/gaps and secondary forest.

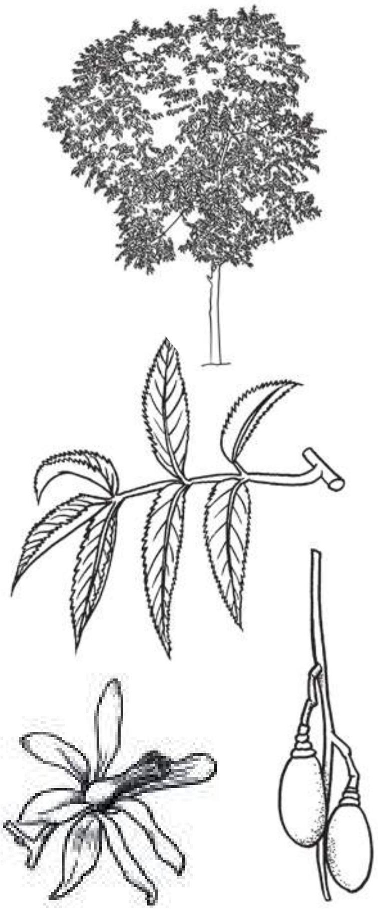


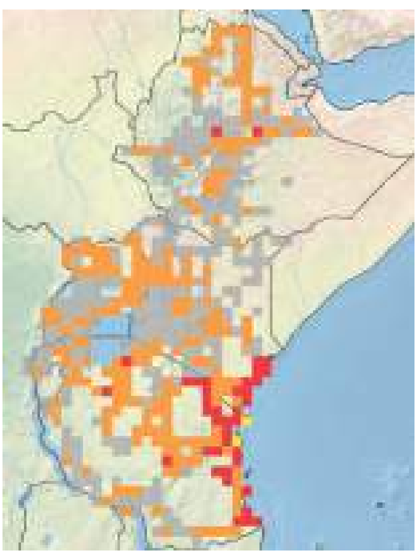
IMPACTS

Has the ability to form dense stands, to the detriment of native flora and fauna. In Brazil, it has invaded a wide range of habitats, colonizing open and forested areas (Carauta and Diaz, 2002). In Rio de Janeiro, it has established on edges of the Atlantic Forest, and it is also found in protected areas such as the Tijuca National Park and the Poço das Antas, União, and Tinguá Biological Reserves (Abreu and Rodrigues, 2005). Jackfruit trees were introduced amid efforts to restore large tracts of forest in the Tijuca Forest National Park. There, the large fallen fruits were eagerly consumed by small mammals, such as the common marmoset (*Callithrix jacchus* L.; Callitrichidae) and coati (*Nasua nasua* L.; Procyonidae). This led to an increase in the dispersal and establishment of *A. heterophyllus* trees, and to the displacement of native tree species (Abreu and Rodrigues 2005; Mello *et al*., 2015). Local bird populations declined, as a result of the increased populations of marmoset and coati, which prey opportunistically on birds' eggs and chicks (Mello *et al.*, 2015). Jackfruit trees are also considered to be allelopathic (Perdomo and Magalhães, 2007).

Notes: Not recorded as being present in Ethiopia (Friis, 1989). More than 65 years ago it was already considered to be naturalized in East Africa (Brenan and Greenway, 1949). In Uganda, it is invasive in secondary vegetation along the shores of Lake Victoria (Katende *et al.*, 1995). In the Amani Nature Reserve, East Usambaras, Tanzania, it is considered to be naturalized (Dawson *et al*., 2008). This view, while supported by some communities, which regard the jackfruit as "naturalizing readily", was not borne out during our surveys although it is widely planted throughout East Africa.

Azadirachta indica A.Juss.





MAHOGANY FAMILY
Meliaceae

COMMON NAMES

English: Indian lilac, lilac tree, margosa, neem
Ethiopia: kinin, nib, nim
Kenya: mkilifi, mwarubaini kamili
Rwanda: musiringa, ndya, mkina
Tanzania: mkilifi, mnimu, mtunda, mwarobaini, mzamnda

DESCRIPTION

Medium-sized, usually evergreen tree (to 20 m tall) with trunk to 1 m in diameter; leafy and dense, usually rounded canopy; sometimes shedding its leaves at the end of the growing season.

Bark: Brown when young turning pale grey-brown with deep furrows and scaly plates, flaking in older trees.

Leaves: Glossy green, once-divided (to 40 cm long), 9–17 egg- to lance-shaped leaflets (4–8 cm long), curved and pointed with a broad base, leaf blades unequal, margins roughly saw-toothed; held alternately on the stems, on leaf stalks 2–7 cm long; leaves crowded at the ends of branches.

Flowers: Creamy-white or pale yellow, small, in terminal clusters (to 30 cm long), fragrant.

Fruits: Berries (fleshy fruits that do not open at maturity), initially green turning yellow or greenish-yellow as they mature, oval (20 mm long), containing 1 or 2 seeds.

ORIGIN

Bangladesh, India, Malaysia and Myanmar.

REASON FOR INTRODUCTION

Fuelwood, timber, fodder, tannin, medicine, erosion control, restoration, windbreak, shade and ornament.

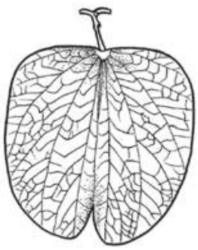
INVADES

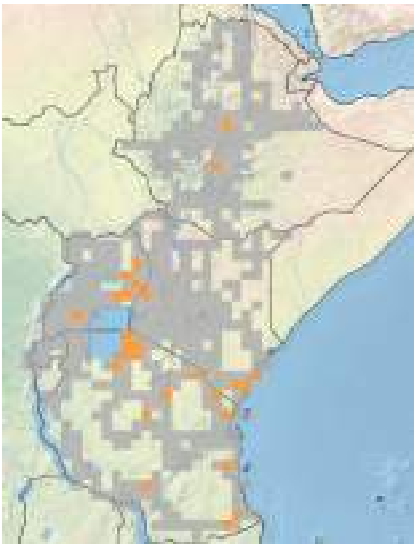
Roadsides, disturbed areas, urban open spaces, pasture, forest edges/gaps, coastal forests and savannah.

IMPACTS
Has the ability to form dense stands, displacing native plant species. *A. indica* is invading natural areas, including savannah and in some cases forests too, in the Middle East, Brazil, Dominican Republic, northern Australia and much of sub-Saharan Africa (Kairo *et al*., 2003; Freire *et al.*, 2013). According to Chamberlain (2000), neem poses a threat to Ghana's endangered dry coastal forest, where it is displacing rare trees such as *Talbotiella gentii* Hutch. & Greenway (Fabaceae). Chamberlain (2000) further suggests that a reduction in mammalian abundance and diversity on the Accra Plains in Ghana may be the result of *A. indica* invasions. In southern Togo, where neem has invaded a number of forest fragments, it is regarded as the most problematic of invasive species (Radji *et al.*, 2010). *A. indica* infestations in Kenya are considered to be a threat to endemic coastal forests. In Tanzania, it is has invaded the Saadani National Park (Silayo and Kiwango, 2010). Neem is also considered to be one of the worst invasive species in Brazil, where it has invaded coastal, moist and Atlantic dry forests and southern Atlantic mangroves (Zenni and Ziller, 2011). In the east Kimberleys, Australia, 37% of boab (*Adansonia gregorii* Muell.) trees appeared to be threatened by neem trees growing at their bases (Noel Wilson, *pers*. *comm*., in NT-WRA on neem, 2007).

Notes: Neem is widely planted as an avenue tree in the regions of Eritrea East, Eritrea West, Ilubabor and Kefa in Ethiopia (Styles and White, 1989), but it is not recorded as invasive there. It has "escaped and regenerated plentifully" in northeast Kenya (Styles and White, 1991), an observation supported by Maundu and Tengnäs (2005), who found it to be "widely naturalized" along the Kenyan coast. In Tanzania, it "spreads easily and may become a weed in some areas" (Mbuya *et al*., 1994). There have been similar reports from Uganda, where neem grows well in Moroto, Kotido, Soroti, Kumi and Mbale Districts (Katende *et al*., 1995). Our surveys found it to be widespread and abundant, especially in coastal areas, where it has invaded urban open spaces, riparian areas, forest edges and gaps and open woodlands.

Bauhinia monandra Kurz





PEA FAMILY
Fabaceae; sub-family: Caesalpiniaceae

COMMON NAMES

English: butterfly flower, orchid tree, pink bauhinia
Rwanda: muketite
Tanzania: mupondo, upondopondo

DESCRIPTION
Small tree (to 7.5 m tall) which sheds its leaves during the dry season.

Bark: Grey, smooth, covered with many small darker spots.

Leaves: Green, hairless on upper surfaces, simple with two heart-shaped lobes folded in the centre along the mid-vein; resembling a pair of butterfly wings (7–20 cm long and 7–20 cm wide); margins entire.

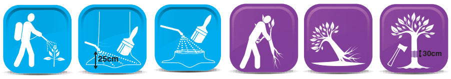
Flowers: Pink mottled with darker reddish-purple petals (40–55mm long and 20–30 mm wide); four similar lower petals are wider near their tips, single upper petal usually wider near the base, flowers held in clusters in leaf forks.

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning brown as they mature, large, elongated and flattened (15–22 cm long and 2–3 cm wide).

ORIGIN
Madagascar.

REASON FOR INTRODUCTION
Fuelwood and ornament.

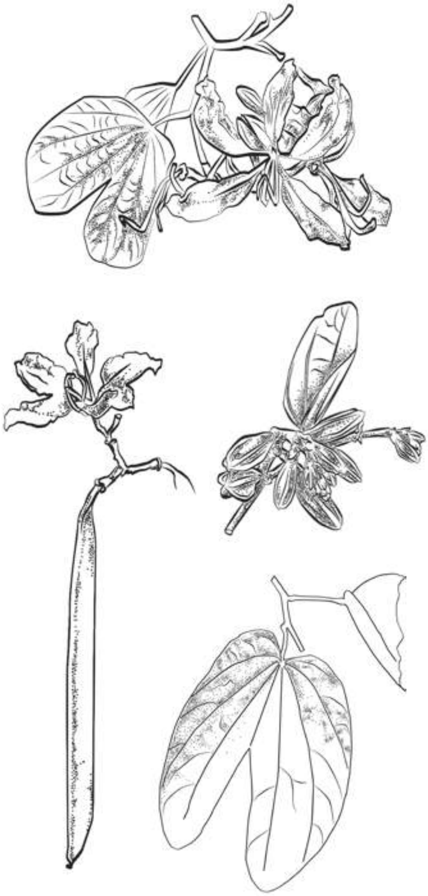
INVADES
Roadsides, disturbed areas, urban open spaces, woodlands and riparian areas.

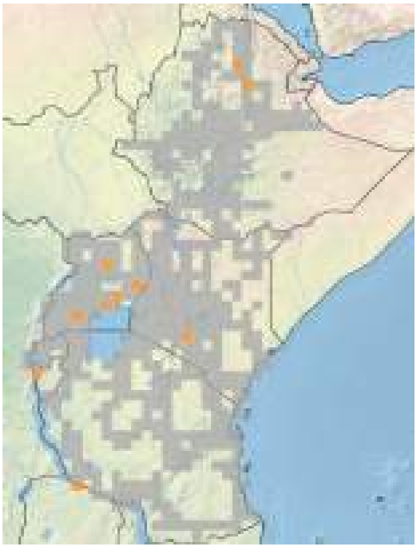


IMPACTS

It has escaped cultivation in some areas and formed dense stands, displacing native plant and animal species. Has been recorded in "disturbed forests, roadsides, natural thickets, and riverbanks in coastal, limestone and dry forests" in Australia (Environmental Weeds of Australia, 2016). In the Cook Shire, Australia, it has invaded open woodlands, forests and conservation areas, including Lakefield National Park (Environmental Weeds of Australia, 2016). It has also invaded disturbed forests and drier sites on several Pacific islands, including the Galápagos (McMullen, 1999). It is naturalized in Florida and Texas, USA, and considered to be invasive on Christmas Island and in the Dominican Republic (CABI, 2016).

Notes: Although widely planted in some parts of East Africa, it is rarely, if ever naturalized. However, evidence from elsewhere suggests that it has the potential to possibly become problematic in the region considering that its congener, *B. variegata*, is already locally abundant in Rwanda and invasive in Zambia and South Africa.





PEA FAMILY
Fabaceae; sub-family: Caesalpiniaceae

SYNONYM
Bauhinia violacea Corner

COMMON NAMES

English: butterfly tree, camel's foot tree, geranium tree, orchid tree, purple bauhinia

DESCRIPTION
Fast-growing shrub or tree (6–10 m high) with a rounded, moderately dense crown; trunk slender with numerous branches; sheds its leaves at the end of the growing season.

Bark: Pale grey to brown, smooth to slightly fissured and scaly.

Leaves: Green, hairless, simple with two heart-shaped lobes folded in the centre along the central vein, resembling a pair of butterfly wings (12 cm long and 12 cm wide); margins entire, held alternately on stems, leaf stalks 2.5–3.5 cm long.

Flowers: Purple, red or pink (8–10 cm across); four similar lower petals are wider near their tips, single upper petal usually wider near the base; petals (18 mm wide) not overlapping (in *B. variegata* petals are 30 mm wide, overlapping), 3 fertile stamens (male reproductive organ); flower buds ribbed (not ribbed in *B. variegata*); flowers are produced while there are leaves on the plant.

Fruits: Pods (several-seeded dry fruits that split open at maturity), green becoming dark brown as they mature (10–30 cm long and 1.4–2.5 cm wide), pointed tips; splitting open to release black oval seeds (1.2 cm long).

ORIGIN
Bangladesh, Bhutan, China, India, Indonesia, Japan, Malaysia, Myanmar, Nepal, Pakistan, Sri Lanka, Taiwan and Thailand.

REASON FOR INTRODUCTION
Fuelwood, timber and ornament.

INVADES
Roadsides, disturbed land, urban open spaces and savannah.

IMPACTS
Forms dense monospecific stands which may displace native plant and animal species. It is considered to be invasive in Florida (IFAS Invasive Plant Working Group 2008), Cuba (Oviedo Prieto *et al*., 2012) and South Africa.

Notes: "Sometimes naturalized" near Gambela in the Ilubabor Region of Ethiopia (Thulin, 1989). Although widely grown as an ornamental in East Africa, it has not been found to be naturalized or invasive but has the potential to become problematic in the future, based on its biology/ecology, and the fact that it has been recorded as invasive elsewhere.

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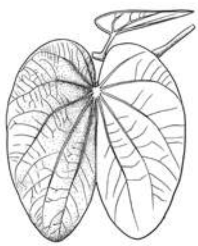
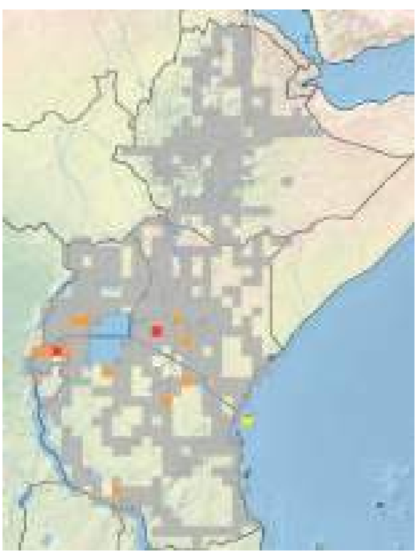
Bauhinia variegata L.





PEA FAMILY
Fabaceae; sub-family Caesalpiniaceae

SYNONYM
Bauhinia decora Uribe

COMMON NAMES

English: bauhinia, camel's foot, orchid tree, purple orchid tree, white bauhinia
Kenya: mfumbwi

DESCRIPTION
Fast-growing small to medium-sized tree (to 10 m tall) with a spread of 5 m; deciduous (sheds most or all of its leaves at the end of the growing season); trunk slender, topped with arching branches; canopy irregular in shape, crown moderately dense; twigs slender and angled.

Bark: Light brownish grey, smooth to slightly fissured and scaly.

Leaves: Blue-green, hairless, veins prominent, simple with two heart-shaped lobes folded in the centre along the mid-vein, resembling a pair of butterfly wings (12 cm long and 12 cm wide), margins entire.

Flowers: White (in *B. variegata* var. *candida*) or deep pink marked with rose, crimson or yellowish green (in *B. variegata* var. *variegata*) (8–10 cm across), 4 similar lower petals (part of flower that is usually brightly coloured) are wider near their tips, single upper petal usually wider near the base, petals (30 mm wide) overlapping (in *B. purpurea* petals are 18 mm wide, not overlapping), 5 fertile stamens (male reproductive organ); flower buds not ribbed (ribbed in *B. purpurea*), flowers during or after leaf-fall.

Fruits: Pods (several-seeded dry fruits that split open at maturity), green becoming dark brown as they mature (10–30 cm long and 1.5–2.5 cm wide), pointed tips; splitting open to release black oval seeds (1.2 cm long).

ORIGIN
Bhutan, China, India, Laos, Myanmar, Nepal, Pakistan, Thailand and Vietnam.

REASON FOR INTRODUCTION
Fuelwood, timber and ornament.

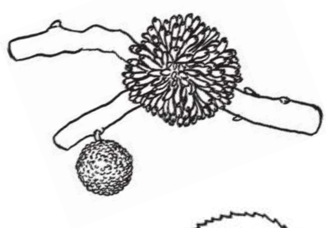
INVADES
Roadsides, disturbed land, urban open spaces and savannah.

IMPACTS

Forms dense monospecific stands, displacing native plant and animal species. It is considered to be an environmental weed in Australia, where it is invading and displacing native vegetation (Queensland Department of Primary Industries and Fisheries, 2011). In New Caledonia and Western Samoa it is invading insular forests (MacKee, 1994; Space and Flynn, 2002; PIER, 2014). It is also regarded as an invasive plant in Florida (USA), Cuba, and the Bahamas where it forms thickets in open forests and along roadsides (Langeland *et al.*, 2008; Oviedo Prieto *et al.*, 2012). In the USA it has been reported from a number of natural areas including the Loxahatchee National Wildlife Refuge and Everglades National Park where it displaces native vegetation (EPPC, 1996). It is also considered to be a "major invader, especially in mining areas" in Zambia (M.G. Bingham, *pers. comm*.) and invasive in parts of South Africa.

Notes: Cultivated as an ornamental in the regions of Harerge, Kefa and Sidamo in Ethiopia, where it is "perhaps sometimes naturalized" (Thulin, 1989). Found to be locally abundant and invasive on vacant plots in Kigali, Rwanda, and naturalized in Nairobi, Kenya. It has the potential to spread elsewhere in the region and is probably far more widespread than indicated.

Broussonetia papyrifera (L.) L'Hér. ex Vent.



MULBERRY FAMILY
Moraceae

COMMON NAMES
English: paper mulberry, tapa cloth tree
Tanzania: msiafu

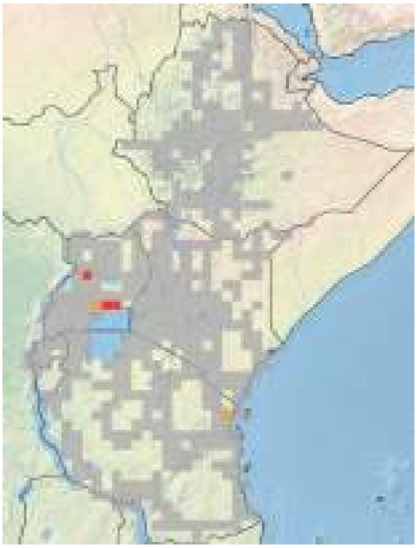
DESCRIPTION
Small tree or shrub (to 20 m or higher); trunk to 0.6 m in diameter; crown round or spreading; branches smooth and mottled grey, marked with orange-tan stipular scars; shallow rooted; exudes a milky sap when damaged; sheds most of its leaves at the end of the growing season.

Bark: Tan or light grey with pale orange to light tan stripes, becoming yellowish with age, smooth to slightly fissured.

Leaves: Greyish, rough surface above, fuzzy-downy below; simple (7–20 cm long), shape variable, either egg-shaped with a broad, rounded base tapering towards the end, or heart-shaped and deeply lobed, margins with forward-pointing fine projections or teeth; held alternately or almost opposite each other on stems; leaf stalks 3–10 cm long.

Flowers: Male flower yellowish-white, in clusters (3.5–7.5 cm wide); female flowers in rounded clusters, with round heads (about 1.3 cm wide), hairy.

Fruits: Multiple drupes or drupelets (fruits with a stony centre), 'fused' or clustered together, berry-like, green turning red or purple to orange as they mature, fleshy, round (1–2 cm across) with many embedded or protruding drupes.



ORIGIN
China, India, Japan, Korea, Malaysia, Pakistan and Thailand.

REASON FOR INTRODUCTION
Fuelwood, paper, pulp, fodder, shade and ornament.

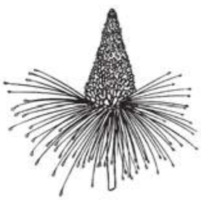
INVADES
Roadsides, disturbed areas, wastelands, urban open spaces, plantations, forest edges/gaps and riparian vegetation.

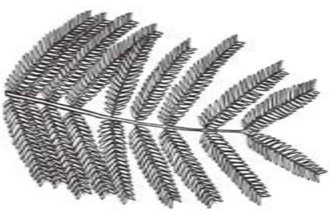
IMPACTS

Forms dense stands which displace native plant species, prevent forest regeneration, and reduce water availability. In Pakistan, *B. papyrifera* limits the growth of *Dalbergia sissoo* Roxb. (Fabaceae); *Morus alba* L. (Moraceae), and *Ziziphus* spp. In the Philippines, paper mulberry has displaced native species such as *Trema orientalis* (L.) Blume (Cannabaceae); *Macaranga tanarius* (L.) Müll. Arg. (Euphorbiaceae); *Melanolepis multiglandulosus* (Reinw. ex Blume) Rchb.f. & Zoll. (Euphorbiaceae); *Mallotus philippinensis* (Lam.) Muell. Arg. (Euphorbiaceae); *Ficus nota* (Blanco) Merr. (Moraceae); *Ficus septica* Burm., *Ficus ulmifolia* Lam., and *Polyscias nodosa* (Blume) Seem (Araliaceae), among others (Baguinon *et al.*, 2003). Paper mulberry produces vast quantities of allergenic pollen, which has been shown to exacerbate asthma in sufferers. In Islamabad, Pakistan, paper mulberry can account for as much as 75% of the total pollen count, contributing to ill health or even death in the old and infirm.

Notes: Present in Uganda and Tanzania (Berg and Hijman, 1989). In Uganda it is considered to be invasive (Lyons and Miller, 1999; Haysom and Murphy, 2003), especially in Mabira and Budongo Forests, where it has formed dense stands along forest edges and within gaps. It is also naturalized in the Amani Nature Reserve, East Usambaras, Tanzania (Dawson *et al*., 2008). Probably more common than indicated with significant potential of expanding its range into other forested high rainfall areas.

Calliandra houstoniana (Mill.) Standl. var. *calothyrsus* (Meisn.) Barneby





PEA FAMILY

Fabaceae; sub-family: Mimosaceae

SYNONYM

Calliandra calothyrsus Meisn.

COMMON NAMES

English: calliandra, red calliandra
Rwanda: kariyandara

DESCRIPTION

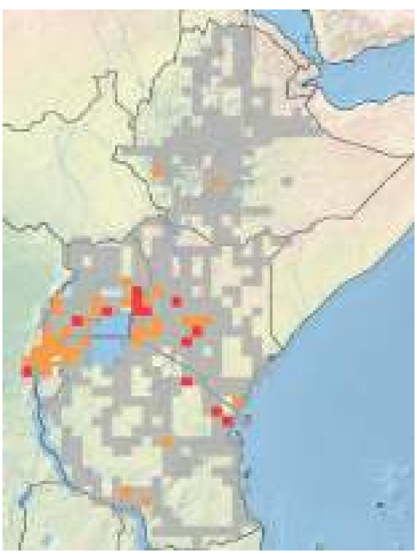
Evergreen, thornless, often multi-stemmed leguminous shrub or small tree [5–6 (–12 m) tall] with a trunk of diameter 20 (–30) cm.

Bark: White to red-brown and hairless, sometimes finely hairy.

Leaves: Dark green, twice-divided (10–19 cm long) with 6–20 pairs of leaflet branchlets, each with 19–60 pairs of linear, somewhat elongated and pointed leaflets (5–8 mm long and 1 mm wide).

Flowers: Red, in terminal clusters to 30 cm long with numerous long shiny red stamens (male reproductive organ consisting of a pollen-bearing anther and its stalk), showy.

Fruits: Pods (several-seeded dry pods that split open at maturity), green turning brown as they mature; straight, flattened (8–13 cm long and 1–1.6 cm wide) with raised, thickened margins, splitting open with each half curling back, held erect on stem; seeds oval-shaped (5-7 mm long).



ORIGIN

Belize, Costa Rica, Guatemala, Honduras, El Salvador, Mexico, Nicaragua and Panama.

REASON FOR INTRODUCTION

Fuelwood, building materials, fodder, nitrogen fixation, green manure, soil conservation and ornament.

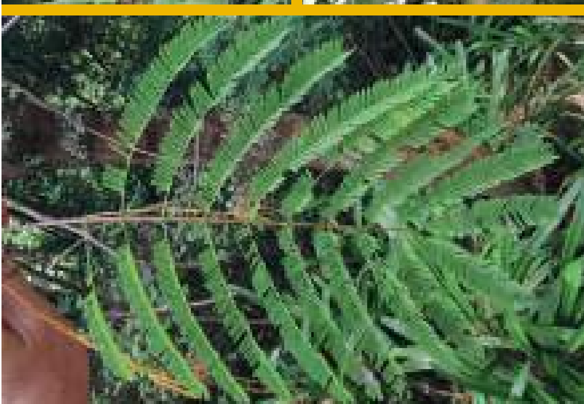
INVADES

Roadsides, disturbed land, urban open spaces, plantation edges/gaps, forest edges/gaps, riparian vegetation and lowlands.

IMPACTS

Has the ability to form dense thickets, displacing native species, especially in riparian areas. An aggressive colonizer of disturbed habitats, it is highly adaptable and is able to grow under a wide variety of soil and environmental conditions (Macqueen, 1992; Palmer *et al*., 1994). It has the potential to suppress other plants very quickly when competing for water and nutrients (CONABIO, 2014). In Cameroon, farmers are abandoning its use because of the effort required to remove it from their land (Hauser *et al.*, 2008). The “invasive character of calliandra is a concern to many farmers who have abandoned this fallow” with many farmers perceiving it to be a weed (Hauser *et al.*, 2008). In Kabale, Uganda, some farmers have claimed that it competes with food crops, impacting negatively on soil nutrients and harbouring pest birds. By fixing nitrogen, calliandra also impacts on soil nutrient cycling.

Notes: Widely promoted as a fodder shrub in East Africa because it establishes easily, grows fast, tolerates acidic soils, coppices readily and fixes nitrogen (Wambugu *et al*., 2006), the same attributes shared by many invasive species. It was largely assumed that it would not become problematic in eastern Africa due to its low seed production. To the contrary, seed production appears to be very high, judging by the large number of seedlings establishing under parent canopies. It is widely grown in East Africa, where it has escaped cultivation, and is now considered to be naturalized and invasive in some higher rainfall areas within the region. Stands are especially common in riparian vegetation and forest edges, but also in urban open spaces and along roadsides. Dense stands have been seen in Nairobi, parts of Uganda and in the East Usambaras, Tanzania. It was not recorded in Ethiopia.



Cananga odorata (Lam.) Hook. f. & Thomson

CUSTARD APPLE FAMILY

Annonaceae

COMMON NAMES

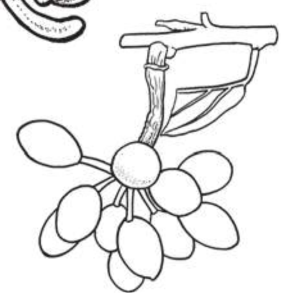
English: kenanga wood, perfume tree, sananga oil, ylangylang
Kenya: chingade, mkilua, mlua

DESCRIPTION

Small to large evergreen tree [6–18 (–40) m tall], with a straight cylindrical stem (to 45 cm across); crown irregular in shape.

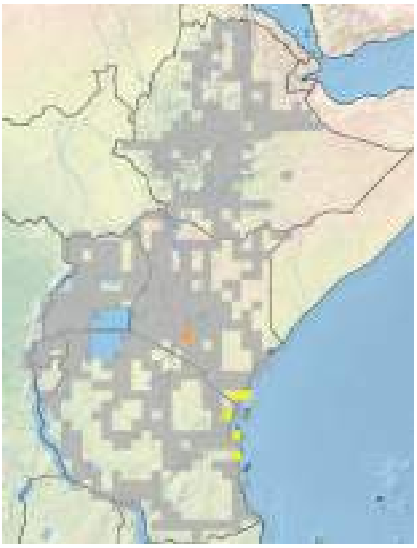
Bark: Light or dark brown to greyish or silvery, smooth when young becoming fissured and rough with age.

Leaves: Green, smooth above, undersides sparsely covered with very short, fine hairs, simple, egg-shaped to somewhat elongated [10–21 (–29) cm long and 4–10 cm wide], base sometimes rounded or heart-shaped, margins wavy, mid-veins on both sides whitish, hairy, held alternately on stems; leaf stalks slender (1–2 cm long).



Flowers: White turning yellowish-green and then orange-red with age, shaped like a sea star, having six petals (brightly coloured parts of flower), tongue-like and twisted (5–7.5 cm long); 2–6 flowers held in unbranched inflorescences (1–4 cm long).

Fruits: Berries (fleshy fruits that do not open at maturity), dark green turning black as they mature, hairless, olive-like, round to egg-shaped (1.5–2.3 cm long and 1–1.5 cm wide); in pendulous clusters of 6–12 (–20) fruits, each containing 2–12 brown, flat, oval seeds (9 mm long and 6 mm wide).



ORIGIN

Cambodia, Indonesia, Laos, Malaysia, Myanmar, Papua New Guinea, Philippines, Solomon Islands, Thailand and Vietnam.

REASON FOR INTRODUCTION

Essential oil, medicine and ornament.

INVADES

Roadsides, disturbed areas, urban open spaces and coastal forests.

IMPACTS

Forms dense stands which may displace native plant species. Being a pioneer species, it grows easily from seed, rapidly forming dense stands, especially in secondary forests. In Guam, it is found in secondary forests, together with other introduced species such as *Leucaena leucocephala* L. (Fabaceae); *Spathodea campanulata* Beauv. (Bignoniaceae), and *Areca catechu* L. (Arecaceae) (Manner and Elevitch, 2006). It is also naturalized on other Pacific Islands such as Samoa and Pohnpei. On Fiji it is often naturalized in forests and on forest edges, in gullies and on slopes (Smith, 1981). Common on Piton Springs, St Lucia, it poses a potential threat to lower montane rainforest and riparian habitats (Graveson, 2012). In the lowlands of Sri Lanka, it is locally naturalized in moist secondary forests (Dassanayake and Fosberg, 1985).

Notes: According to Beentje (1994), it has "gone wild" in places along the Kenyan coast. Confirmed by Verdcourt (1971) who found it to be present in "plantations, native cultivation, and also in bushland and thicket near villages." No naturalized plants were seen during surveys but may have been overlooked.

Castilla elastica Cerv.

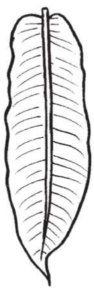


FIG FAMILY
Moraceae

SYNONYM
Castilla gummifera (Bertol.) Standl.

COMMON NAMES

English: Mexican rubber tree, Panama rubber
Tanzania: mpira, mpia

DESCRIPTION
Evergreen tree [5–10 (–30) m high], with spreading branches, bark and leaves exude a milky sap if damaged.

Bark: Pale grey, fibrous.

Leaves: Green, hairy on both surfaces, egg-shaped (20–45 cm long and 10–17 cm wide), 18 pairs of longitudinal veins visible; margins appear to be toothed, but the 'teeth' are tufts of hair; leaf stalks 1–1.5 cm long.

Flowers: Clustered in groups of (1–) 2–4; male flower clusters (2–3 cm across) stalked (2.5–3 cm long); female flower clusters (2 cm across) almost stalkless.

Fruits: A flat disk of numerous green bracts with 20–30 individual, fleshy, one-seeded green fruits turning orange as they mature; seeds fairly large (8–10 mm long and 6–8 mm wide).

ORIGIN
Belize, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua and Panama.

REASON FOR INTRODUCTION
Rubber and ornament.

INVADES
Roadsides, disturbed areas and forest edges/gaps.

IMPACTS

Castilla elastica has the potential to displace slow-growing native plant species that are sensitive to competition. On forest edges in the lowlands of the Amani Nature Reserve, East Usambaras, Tanzania, *C. elastica* is dominant (Mbwambo, 2007). While there is little baseline information, anecdotal evidence suggests that *C. elastica* has displaced species such as *Milicia excelsa* (Welw.) C.C. Berg (Moraceae); *Synsepalum msolo* (Engl.) T.D. Penn. (Sapotaceae); *Khaya anthotheca* (Welw.) C. DC. (Meliaceae), and *Leptonychia usambarensis* K. Schum. (Sterculiaceae) (Mbwambo, 2007). *C. elastica* has increased in density (to more than 80 stems/ha), and has spread some 300 m into the interior of the forest (Mbwambo, 2007). Low-elevation moist forests elsewhere, even in its native range, are at risk, given its ability to establish in undisturbed rainforest (Woodson and Schery, 1960). In Brazil, *C. elastica* dominates the understorey of some invaded habitats (accounting for up to 96% of total plant numbers). *C. elastica* also produces significantly more leaves, flowers and fruits than native species, altering the above-ground dynamics of invaded forests. Infestations of *C. elastica* and *Falcataria moluccana* (Miq.) Barneby & Grimes (Fabaceae) in American Samoa have displaced valuable native forest species such as *Intsia bijuga* (Colebr.) Kuntze (Fabaceae).

Notes: Introduced to Entebbe in Uganda (Berg and Hijman, 1989), as well as to Tanzania, where it is considered to be invasive in the Amani Nature Reserve, East Usambaras (Dawson *et al*., 2008). Not seen elsewhere in East Africa.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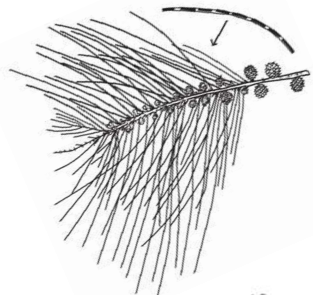
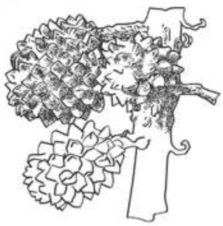
Casuarina cunninghamiana Miq.





BEEFWOOD FAMILY
Casuarinaceae

COMMON NAMES
English: Australian beefwood, Australian pine, beefwood, casuarina, coast beefwood, creek oak, Cunningham's beefwood
Ethiopia: arzelibanos, shewshewe
Kenya: ngezi

DESCRIPTION
Evergreen medium to large tree (12–35 m tall); trunk (30–150 cm in diameter), supporting a pyramidal crown, becoming cylindrical, on upward-turning branches, with thin, soft and droopy jointed branchlets.

Bark: Scaly brown and finely fissured.

Leaves: On grey-green branchlets resembling pine needles, the leaves are reduced to minute scales at the nodes of these green branchlets; scales occur in whorls with a transverse brown band, internodes (part of the stem between two nodes or joints) with rounded ribbing.

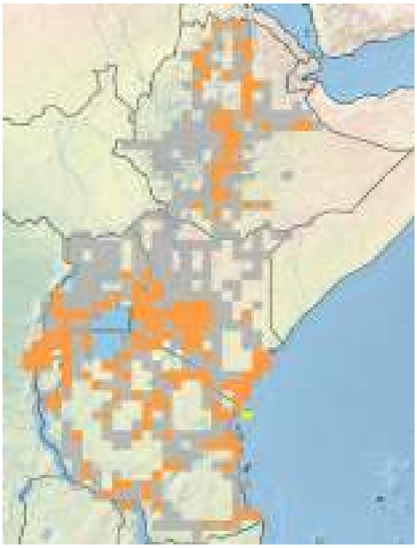
Flowers: Light brown or yellowish spikes to 20 mm long (male); male flowerheads (0.4–4 cm long and less than 3 mm wide), in whorls; female flowerheads in reddish, rounded heads (5 mm long).

Fruits: Conelets, brown, woody, almost round (7–14 mm long and 4–6 mm wide).

ORIGIN
Australia.

REASON FOR INTRODUCTION
Fuelwood, timber, building materials and ornament.

INVADES
Roadsides, disturbed areas, plantations, grasslands, forest gaps/edges and riverbeds.

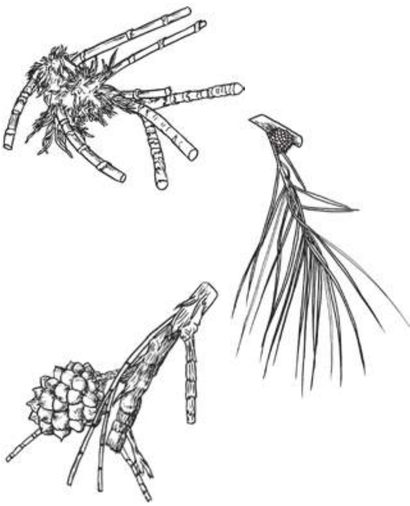


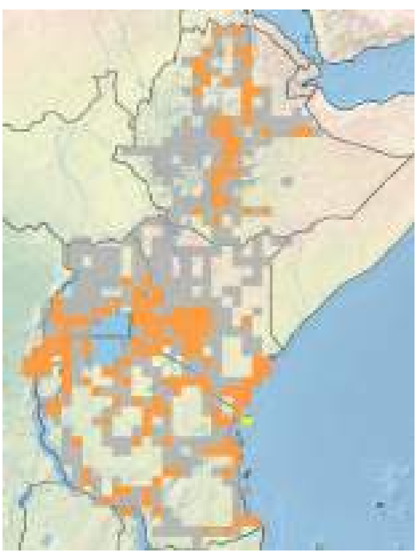
IMPACTS

Has the ability to form dense stands, to the possible detriment of native flora and fauna. *Casuarina* spp. have the ability to fix nitrogen and as such can alter nutrient cycling processes (Potgieter *et al*., 2014). Once established, they shade out native vegetation, producing a thick litter layer which prevents the regeneration of indigenous understorey species, resulting in monospecific stands (Batish *et al.*, 2001); species in the genus can accumulate as much as 120 t/ha of litter (Bernhard-Reversat and Loumeto, 2002). This is confirmed by Maundu and Tengnäs (2005), who found that few other plants grow underneath mature trees, leading some farmers to claim that the trees poison the soil. Mbuya *et al.* (1994) claim that its aggressive growth may compete with crops. Among populations surveyed in the Western Cape, South Africa, 81% exhibited naturalization, with water bodies and water courses found to be highly suitable for establishment (Potgieter *et al*., 2014).

Notes: It is one of the most commonly grown *Casuarina* spp. in the highlands of Ethiopia (Wilmot-Dear and Gilbert, 1989). Also widely grown in East Africa, it has been recorded as being invasive near Lushoto in the East Usambaras, Tanzania (S. Mathias, Lushoto Silviculture Research Centre, *pers. comm*.). Because of difficulties in distinguishing between the various *Casuarina* spp., the distribution map shows regional distribution for the genus as a whole.

Casuarina equisetifolia L.





BEEFWOOD FAMILY
Casuarinaceae

COMMON NAMES

English: Australian pine, casuarina, horse tail casuarina, She Oak, Whistling Pine
Kenya: moinga, mvinje
Rwanda: kazwarina
Tanzania: mkorolo, ngezi, nsata, mvinje

DESCRIPTION
Evergreen much-branched tree (15–50 m tall) with 'weeping' foliage and slender, jointed branchlets, forming a greyish-green pyramidal crown, becoming cylindrical; looks like a pine tree from a distance.

Bark: Initially smooth and light grey-brown becoming thick, rough and fissured, splitting into strips and flakes, exposing a reddish-brown inner layer.

Leaves: On grey-green branchlets (30 cm long and 1 mm thick) which resemble pine needles, leaves reduced to minute scales at the nodes of these green branchlets; scales in whorls with a tranverse brown band, internodes (part of the stem between two nodes or joints) sharply ribbed.

Flowers: Yellowish spikes to 20 mm long (male); male flowerheads (0.4–4 cm along and less than 3 mm wide); female flowerheads in reddish, rounded heads (3–5mm long).

Fruits: Conelets, brown, woody, almost round (20 mm across).

ORIGIN
Australia, but considered by some to be indigenous to the region (the seeds may have drifted to African shores).

REASON FOR INTRODUCTION
Fuelwood, timber, building materials, dune stabilization and ornament.

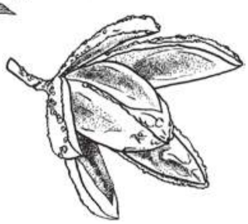
INVADES
Coastal dunes and sandy sea shores.

IMPACTS

Invades a range of habitats, is salt-tolerant and wind-resistant, and can grow in moderately poor soils. It has the ability to fix nitrogen and as such can alter soil nutrient cycling processes (Little and Skomen, 1989, in Snyder, 1992). Once established, *C. equisetifolia* alters the light conditions, temperature, soil chemistry and hydrology of habitats. By creating a dense canopy and depositing a thick layer of leaves on the soil surface, it displaces and inhibits the growth of other plant species and their associated organisms (Klukas, 1969). In the Everglades, Florida, USA, infestations of *C. equisetifolia* and *Melaleuca quinquenervia* (Cav.) S.T. Blake (Myrtaceae) support fewer rodents than other habitats (Mazzotti *et al*., 1981). Infestations also threaten nesting sites of the rare and threatened American crocodile (*Crocodylus acutus* Cuvier; Crocodylidae), loggerhead turtles (*Caretta caretta* ssp. *caretta* L.; Cheloniidae) and green turtles (*Chelonia mydas* L.; Cheloniidae) (Binggeli, 1997; Klukas, 1969; Doren and Jones, 1997), and those of olive ridley turtles [*Lepidochelys olivacea* (Eschscholtz); Cheloniidae] in India (Chaudhari *et al*., 2009). Infestations also threaten the gopher tortoise in the USA (*Gopherus polyphemus* Daudin; Testudinidae) (Mazzotti *et al*., 1981), and the sand skink (*Eutropis bibronii* Gray; Scincidae) on the coast of India (Subramanean and Reddy, 2010). The continued spread of *C. equisetifolia* also poses a major threat to Réunion's few remaining tracts of native lowland rainforest. Large plantations may also restrict sand dune formation – an integral part of seashore topography and beach ecosystems (Chaudhari *et al*., 2009). *Casuarina* spp. pollen is also source of respiratory irritation and allergies in people (Elfers, 1988; Binggeli, 1997).

Notes: Widely cultivated in the Ethiopian regions of Eritrea West and Shewa (Wilmot-Dear and Gilbert, 1989), it is considered to be naturalized in some areas (Bekele-Tesemma, 2007). In Tanzania, it is "naturalized along the coast" (Mbuya *et al*., 1994), and invasive on Mbudya Island, Tanzania. Because of difficulties in distinguishing between the various *Casuarina* spp., the distribution map shows regional distribution for the genus as a whole.

Cedrela odorata L.



MAHOGANY FAMILY
Meliaceae

COMMON NAMES
English: cedar, cedarwood, cigar box cedar, West Indian cedar
Kenya: sedrela, msedrela
Rwanda: umuhumuro
Tanzania: msedrela, mti kunuka, mvuje, mwerezi

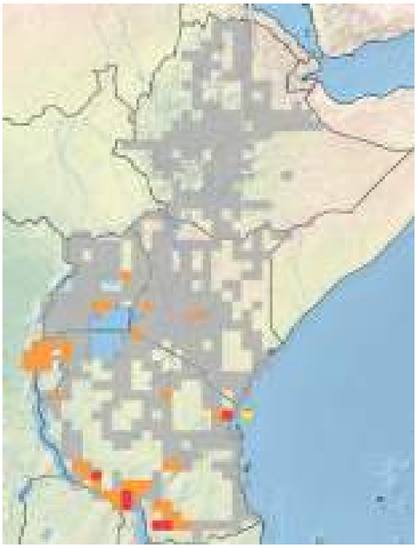
DESCRIPTION
Large tree (10–40 m tall) that sheds most or all of its leaves at the end of the growing season; trunk to 2 m in diameter, often buttressed up to 1 m in height; leafy branches, forming a dense crown.

Bark: Smooth, grey to grey-black, regularly and evenly fissured.

Leaves: Green, once-divided (30–60 cm long), with 6–14 pairs of sword- to egg-shaped leaflets (8–15 cm long and 3–5 cm wide), leaflets opposite or alternate, margins entire, onion-like smell when crushed.

Flowers: Greenish-white to yellowish, small (5 mm long), in large (to 90 cm long) terminal panicles or clusters, unpleasant odour; in *Toona ciliata* the terminal panicles are shorter (25–35 cm long) and are sweetly scented.

Fruits: Capsules (dry fruits that open at maturity), green turning brown and woody as they mature, oblong to ellipsoid (17–45 mm long and 14–21 mm wide), with five chambers; seeds flat and winged (20 mm long and 5 mm wide including the wing).



ORIGIN
Argentina, Brazil, Cuba, Dominican Republic, Ecuador, French Guiana, Haiti, Honduras, Jamaica, Mexico, Peru, Trinidad and Tobago.

REASON FOR INTRODUCTION
Fuelwood, timber and ornament.

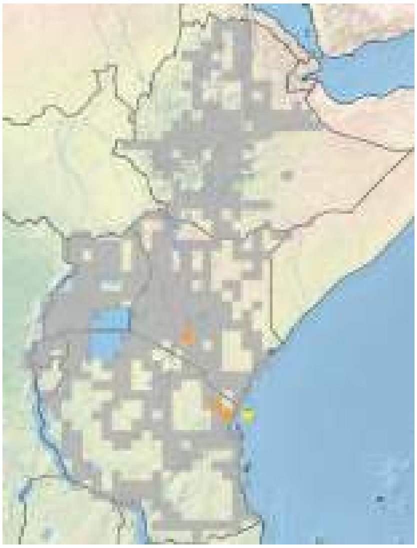
INVADES
Roadsides, disturbed areas, wastelands, urban open spaces, gardens and forest edges/gaps.

IMPACTS

Shades out native plants, forming dense monospecific stands. It can spread very quickly, owing to its prolific seed production and wind-dispersed seeds, rapidly invading disturbed areas and interfering with natural forest succession processes. It is considered to be one of the most invasive species in the Galápagos Archipelago, creating monocultures and preventing native species from growing (Weber, 2003). It has spread in regions of Floreana, Isabela, San Cristóbal and Santa Cruz (Guézou *et al*., 2010). It has been found, along with *Cestrum auriculatum* L'Hér. (Solanaceae); *Cinchona pubescens* Vahl. (Rubiaceae); *Passiflora edulis* Sims (Passifloraceae), and *Rubus niveus* Thunb. (Rosaceae), to be among the dominant invaders of 25 ha of one of the best remnants of *Scalesia pedunculata* Hook. f. (Asteraceae) forest at Los Gemelos, Santa Cruz Island, Galápagos (Renteria and Buddenhagen, 2006). Without intervention, this site is likely to be transformed into a forest of tall *C. odorata* trees, with an understorey of *R. niveus*. In East Africa, *C. odorata* is threatening native biodiversity in the forests of the East Usambaras, Tanzania. In the Kimboza Forest Reserve, near Morogoro, Tanzania, *C. odorata* has escaped from cultivation, and has established in the forest where it threatens native plant species and the habitat of the critically endangered Tanzanian turquoise dwarf gecko, *Lygodactylus williamsi* Loveridge (Flecks *et al*., 2012). Trees of this species are also invasive in the Semuliki National Park in Uganda and elsewhere in the region.

Notes: In Uganda, it grows well around Lake Victoria and in the Western Region near Fort Portal, where growth rates of 1.75 m/year have been recorded (Katende *et al.*, 1995). In Tanzania, *C. odorata* is invasive in the Amani Nature Reserve, East Usambaras (Dawson *et al*., 2008) and in the Kimboza Forest Reserve (Flecks *et al*., 2012). It is occasionally naturalized in gardens, roadsides and urban open spaces in Nairobi, Kenya, and elsewhere. Probably more widespread than indicated.

Cinnamomum camphora (L.) J. Presl



AVOCADO FAMILY
Lauraceae

SYNONYM
Cinnamomum officinarum Nees ex Steud.

COMMON NAMES

English: camphor tree, camphor laurel, gum camphor
Ethiopia: brgud, ebam, qerefa
Kenya: mdalasini
Tanzania: mkafuri-maita, mkarafuu-maiti, mkanfa
Uganda: budalaasini, kalaafu

DESCRIPTION
Evergreen, hairless broad-leaved tree (6–30 m tall) with dense, spreading crown; trunk large (to 0.6 m in diameter); young branches green or reddish-green, smooth and hairless.

Bark: Green and smooth becoming light brown or greyish-brown and scaly or fissured.

Leaves: Reddish or coppery when young becoming green, upper surfaces bright green with dull undersides, sword-shaped, oval to egg-shaped (4.5–11 cm long and 2.4–6 cm wide), margins entire, three distinct veins spreading from the base; held alternately on stems; leaf stalks slender (2–3 cm long).

Flowers: Greenish, white or pale yellowish, tiny, in small branched clusters at the tips of branches.

Fruits: Drupes (fruits with a stony centre), green turning black as they mature, fleshy, round (8–10 mm across), on green stalks; usually produced in abundance.

ORIGIN
China, Japan, Taiwan and Vietnam.

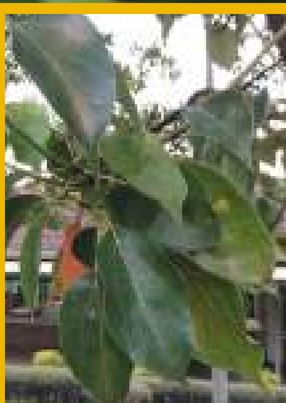
REASON FOR INTRODUCTION
Essential oils and ornament.

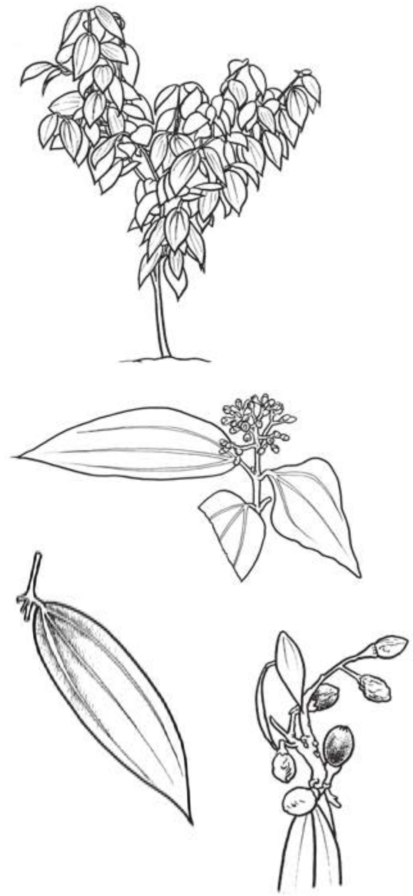
INVADES
Roadsides, woodlands, woodland edges/gaps, forest edges/gaps, savannah, riparian vegetation.

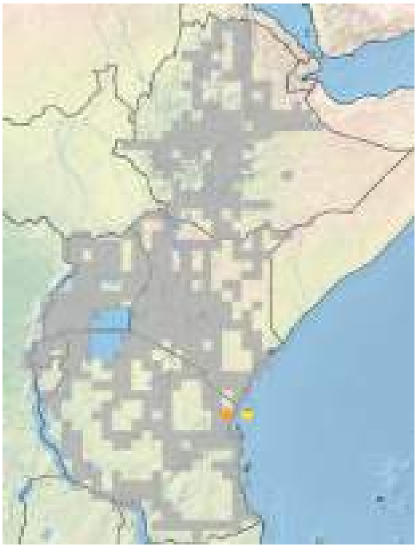
IMPACTS

Spreads both through seeds and vegetatively through root suckering, producing monospecific stands that prevent forest establishment or regeneration (Murray and Ramey, 2003). In southeastern Queensland, Australia, it is ranked among the top 10 most invasive plants because of its ability to form a dense canopy, out-competing and replacing native species and inhibiting their regeneration, even after removal. Coutts-Smith and Downey (2006) have reported that camphor laurel invasions in Australia are threatening six plant species, one animal species, Coxen's fig-parrot [*Cyclopsitta diophthalma coxeni* Gould (Psittacidae)], and four ecological communities. The threatened plants include *Angiopteris evecta* (G. Forst.) Hoffm. (Marattiaceae); *Davidsonia jerseyana* (F.M. Bailey) G.J. Harden & J.B. Williams (Cunoniaceae); *D. johnsonii* J.B. Williams & G.J. Harden, *Elaeocarpus williamsianus* Guymer (Elaeocarpaceae); *Endiandra floydii* B. Hyland (Lauraceae), and *E. muelleri* Meisn. ssp. *bracteata* B. Hyland (Lauraceae). The threatened ecological communities are the Illawarra sub-tropical rainforest, sub-tropical coastal floodplain forest, coastal-plain swamp sclerophyll forest, and swampoak floodplain forest. Essential oil from the leaves of *C. camphora* is phytotoxic to lettuce, antifungal to *Aspergillus niger* van Tieghem (Trichocomaceae), and insecticidal, particularly toward midge and butterfly larvae, fruit flies, and fire ants. *C. camphora* oil is also toxic to brine shrimp (Satyal *et al*., 2013). The berries contain saffrole, which can make birds sterile. Consumed in large doses, *C. camphora* fruits, leaves, and roots are apparently also toxic to humans.

Notes: Grown as an ornamental plant in East Africa, it has been recorded as naturalized (Dawson *et al*., 2008) and invasive (TBA, 2010) in the Amani Nature Reserve, East Usambaras, Tanzania. Elsewhere, not found to be naturalized during surveys.







AVOCADO FAMILY

Lauraceae

SYNONYMS

Cinnamomum aromaticum J. Graham; *Cinnamomum cayennense* Lukman.

COMMON NAMES

English: ceylon cinnamon, cinnamon tree, true cinnamon
Tanzania: mdalasini

DESCRIPTION

Evergreen small to medium-sized tree (8–17 m tall) with a stout trunk (30–60 cm in diameter) and low branches.

Bark: Dark brown or brownish-grey, thick, rough.

Leaves: Young leaves reddish turning shiny dark green, stiff, oval or egg-shaped (5–18 cm long and 3–10 cm wide), bases rounded, ends pointed, margins entire, three but sometimes five conspicuous longitudinal veins, held alternately on stems, leaf stalks grooved on upper surface (1–2 cm long).

Flowers: Pale yellow, small (3 mm wide), unpleasant smell.

Fruits: Drupes (fruits with a stony centre), black, egg-shaped (1.5–2 cm long and 2 cm wide).

ORIGIN

India and Sri Lanka.

REASON FOR INTRODUCTION

Timber, food, essential oil, medicine and ornament.

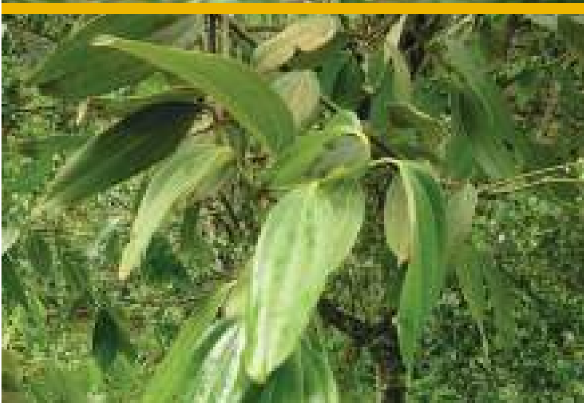
INVADES

Roadsides, disturbed areas and forest edges/gaps.

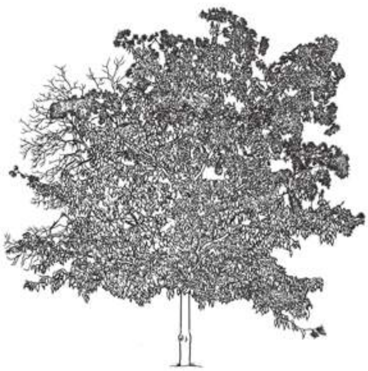
IMPACTS

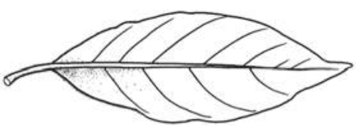
Forms dense stands which displace native plant species and prevent their regeneration. The dense root mat under mature trees inhibits the growth of young trees, mainly by increasing competition for scarce nutrients (Kueffer *et al*., 2007). In the Seychelles, it has invaded mountain mist forest and intermediate forest habitats. In mid-altitude forests on Mahé, *C. verum* makes up more than 80% of the canopy, while in disturbed montane forests it accounts for 30–40% of the canopy, threatening endemic palm species, such as *Phoenicophorium borsigianum* (K. Koch) Stuntz (Arecaceae); *Deckenia nobilis* H. Wendl. ex Seem (Arecaceae), and *Roscheria melanochaetes* (H. Wendl.) H. Wendl. ex Balf. f. (Arecaceae) (Fleischmann *et al*., 2005), and other indigenous trees, including *Northea hornei* (Hartog) Pierre (Kueffer *et al*., 2008). In nutrient-poor environments, *C. verum* may also alter rates of nutrient cycling by producing more decomposable litter (Kueffer *et al*., 2008).

Notes: Naturalized in the Amani Nature Reserve, East Usambaras, Tanzania (Dawson *et al*., 2008), it has also “gone wild” on Zanzibar (Faulkner, in Verdcourt, 1996). Also grown in the Central Region of Uganda where it is not considered to be naturalized or invasive (Katende *et al.*, 1995). Not found to have escaped cultivation elsewhere in East Africa or Ethiopia.



Cordia alliodora (Ruiz & Pav.) Oken





FORGET-ME-NOT FAMILY

Boraginaceae

COMMON NAMES

English: Icorallilo, cordia, cypress, Ecuador laurel, laurel, salmwood, Spanish elm, spruce
Kenya: makobokobo
Tanzania: mringaringa, mkombeti, ngezi
Uganda: mukebu

DESCRIPTION

Annual, tall, thin tree [20 (–40) m high] with a straight trunk (30–50 cm in diameter) with no branches for up to 50–60% of its height, sometimes buttressed (to 1–1.5 m up the trunk).

Bark: Greenish when young turning greenish-black with age, smooth to narrowly fissured.

Leaves: Green, upper surfaces with scattered hairs when young, but mature leaves are hairless, lower surfaces with star-shaped hairs, simple (18 cm long and 5 cm wide), pointed at the base; leaf stalks 1–2 cm long.

Flowers: White (1 cm long), in large terminal clusters (10–30 cm across) of 50–3,000 flowers.

Fruits: Nutlets (one-seeded, hard-shelled fruits that do not open at maturity), small (5–8 mm long), surrounded by the persistent dried flower petals and sepals, the lobes of which act as a sort of helicopter in aiding dispersal.

ORIGIN

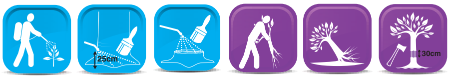
Antigua and Barbuda, Argentina, Barbados, Belize, Bolivia, Brazil, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Grenada, Guadeloupe, Guatemala, Haiti, Honduras, Martinique, Mexico, Netherlands Antilles, Nicaragua, Panama, Puerto Rico, St Kitts and Nevis, St Lucia, St Vincent and the Grenadines, Trinidad and Tobago, Venezuela and the Virgin Islands (US).

REASON FOR INTRODUCTION

Timber and ornament.

INVADES

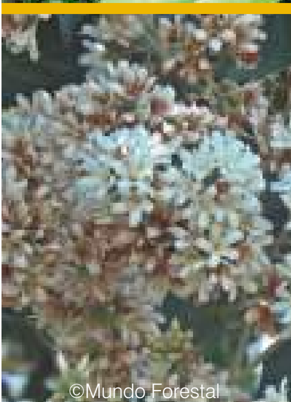
Roadsides, disturbed areas and forest edges/gaps.



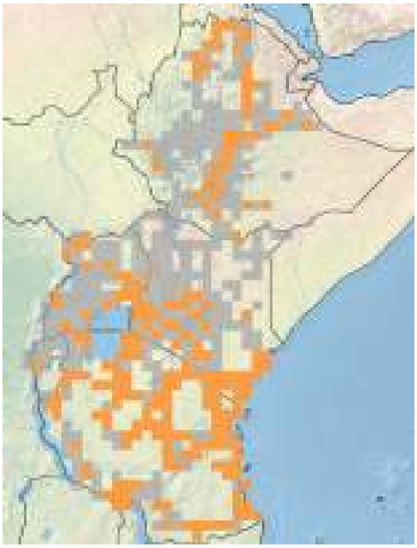
IMPACTS

C. alliodora has the ability to form dense stands, displacing native flora and fauna. Large trees can produce about one million seeds in a year. It poses a significant threat to biodiversity in the East Usambaras, in Tanzania, and to other humid forests, with annual population growth rates of roughly 3.5%, equivalent to the population's doubling every 20 years (Edward *et al*., 2008). On Vanuatu, it is becoming a "nuisance, as it slowly penetrates natural forests". Communities on islands, especially, such as Eromango and Maewo in the Pacific, have made formal complaints about its negative impacts. It is also invasive on Samoa and Tonga (Tolfts, 1997).

Notes: Not recorded as being present in Ethiopia, although a congener *C. myxa* L., native to tropical Asia, is "now cultivated and naturalized in many places" (Riedl and Edwards, 2006). *C. myxa* is also "naturalized in coastal and other bushland" in East Africa (Verdcourt, 1991). *C. alliodora* is invasive in the Amani Nature Reserve, East Usambaras, Tanzania (Dawson *et al*., 2008), but has not been recorded elsewhere in the region (Verdcourt, 1991).



Delonix regia (Hook.) Raf.



PEA-FAMILY
Fabaceae; sub-family: Caesalpiniaceae

SYNONYMS
Poinciana regia Hook.

COMMON NAMES

English: flamboyant, flame tree, peacock flower, Poinciana
Kenya: mjohoro, msikukuu, mwangi, sukella
Rwanda: umutarabana
Tanzania: mkrisimasi, mzalia, X-mas tree

DESCRIPTION
Evergreen tree (to 18 m tall) with a spreading crown; trunk with buttress roots.

Bark: Smooth, pale brown or greyish, with vertical lines of brown spots.

Leaves: Light green, feathery, twice-divided (15–60 cm long), 7–20 pairs of leaflet branchlets, each bearing 10–35 pairs of small, somewhat elongated, almost parallel-sided leaflets (5–13 mm long and 2–5 mm wide).

Flowers: Red/white, with five petals (4 red and 1 usually white blotched with red and yellow), held in clusters at the terminal ends of branches, showy.

Fruit: Pods (several-seeded dry fruits that split open at maturity), green turning brown or black as they mature, flat (30–60 cm long and 3–5.5 cm wide), soft when young, woody when mature; seeds brown and glossy (2 cm long).

ORIGIN
Madagascar.

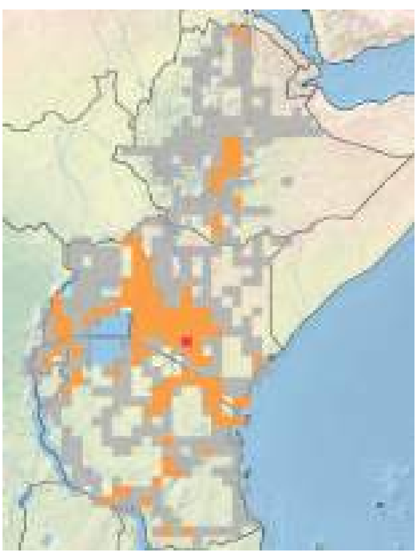
REASON FOR INTRODUCTION
Ornament.

INVADES
Roadsides, disturbed areas, wastelands, urban open spaces and woodland edges/gaps.

IMPACTS

Has the ability to form dense stands, possibly excluding native species. Seedlings germinate readily under parent trees, forming monospecific stands which compete strongly with other plants (PIER, 2009). It also has the ability to increase soil nitrogen levels, so impacting on soil nutrient cycling, negatively affecting species which thrive in low nutrient soils (Isaac *et al*., 2003). It has been recorded as invasive in the arid lowlands and moist uplands of the Galápagos Islands (McMullen, 1999), and in Hawaii it is naturalized at low elevation sites (Wagner *et al.*, 1999). On Christmas Island (Indian Ocean), it has formed monospecific stands within disturbed marginal rainforest, where it is considered to be very competitive (Swarbrick, 1997). In the Northern Territory, Australia, it has invaded disturbed coastal monsoon vine thickets (Cowie, cited in Csurhes and Edwards, 1998). In Africa, it is considered to be invasive in Ghana, where seeds readily germinate under mature trees, forming a dense carpet of seedlings, to the exclusion of other species (A.B.R. Witt, *pers*. *obs*.).

Notes: Widely grown as an ornamental in East Africa (Brenan, 1967) and in the Dire Dawa and Ginda regions of Ethiopia (Thulin, 1989). A popular ornamental it is occasionally naturalized at some localities along the Kenyan coast but has not been found invading undisturbed natural vegetation.



COFFEE PLUM FAMILY
Salicaceae

COMMON NAMES
English: Kei-apple
Ethiopia: akoko, fentoflas, hokoku, menhetem, mentoflas
Kenya: kaiyaba, kikambua
Tanzania: mkarato

DESCRIPTION
Evergreen small to medium-sized shrub or small tree [3–5 (–8) m high], much branched, woody trunk; young branches with long spines (4–7 cm long).

Bark: Grey, smooth on young branches, fissured and flaky to corky on older branches and stems.

Leaves: Bright green and glossy, simple, narrowly egg-shaped to oval with narrow end at base (2–5.5 cm long and 0.5–3 cm wide), base and terminal end or apex rounded with end sometimes notched, 3–5 prominent veins from base, margins entire, short leaf stalks (5 mm long).

Flowers: Creamish-green, small, inconspicuous, clustered or solitary in the upper angle between the leaf stalk and stem, male flowers (3 mm long) in clusters of 5–10; female flowers solitary or in groups of up to three.

Fruits: Berries (fleshy fruits that do not open at maturity), green turning yellow-orange as they mature, round (6 cm across), 5–10 seeds inside the pulp.

ORIGIN
Mozambique, South Africa, Swaziland and Zimbabwe.

REASON FOR INTRODUCTION
Fruit, barrier/hedge and ornament.

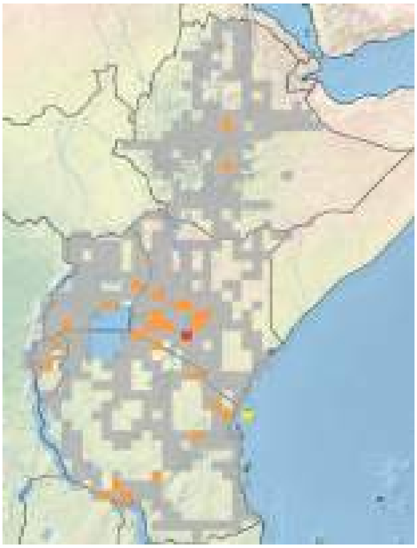
INVADES
Savannah and woodland edges/gaps.

IMPACTS

It has the ability to form thickets which may lead to the displacement of native plant species and to loss of biodiversity. Kei-apple does well in almost any soil that does not have a high water table. It is also extremely drought-resistant and tolerant of saline soils and salt spray. These factors contribute to its invasiveness. The Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann) (Tephritidae), is known to infest the fruit of Kei-apple (Copeland *et al*., 2002), which may contribute to an increased abundance and distribution of fruitflies, impacting negatively on crop production. In Zimbabwe *D. caffra* has "become naturalized in many areas outside their natural habitats" (Flora of Zimbabwe, 2016).

Notes: Widely grown as a hedge plant throughout East Africa and in Ethiopia, especially in the Shewa Region (Vollesen, 2000). It is "becoming naturalized" in some areas in Kenya (Birnie and Noad, 2011). Our surveys found it to be one of the most widely grown hedge plants in East Africa, where it has escaped cultivation in some regions and is considered to be invasive, in Nairobi National Park, and possibly elsewhere.

Eriobotrya japonica (Thunb.) Lindl.



ROSE FAMILY
Rosaceae

COMMON NAMES

Rose family: Rosaceae
English: Japanese medlar, Japanese plum, loquat
Ethiopia: weshmella
Kenya: ekeragwathi, lqogat, minoria, muburuti, murungati, murungati haru, musabibu
Rwanda: umutini
Tanzania: mlakuati, msambia-wa-kizungu
Uganda: kayimbi, kizungu, msambwawa, msambia, mtangawizi, shitunda

DESCRIPTION

Evergreen small to medium-sized tree (10 m tall), with a rounded crown; woody at the base, primary stems erect, young stems stout, white and hairy.

Bark: Greyish-brown, transversely calloused with prominent leaf scars.

Leaves: Deep green and glossy above with greyish, hairy undersides; stiff, leathery, narrowly oval to sword-shaped with narrow end at base [15–35 (–40) cm long and 7.5–10 (–13) cm wide], tips pointed, upper-half margins with forward-pointing sharp projections or teeth; held alternately on stems near branch tips.

Flowers: White, small (2 cm across), in clusters (10–16 cm long) of about 20 flowers, fragrant.

Fruits: Drupes (fruits with a stony centre), green turning yellow-orange as they mature, surface smooth or covered with tiny hairs; oval to pear-shaped (35–50 mm long and 35 mm wide), fleshy and succulent with one or two brown seeds.

ORIGIN
China, Japan and Taiwan.

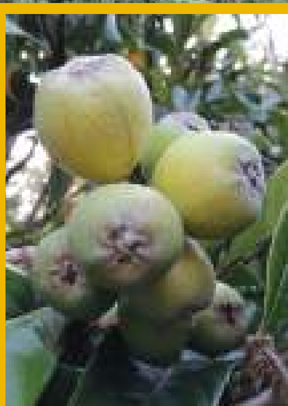
REASON FOR INTRODUCTION
Edible fruit and ornament.

INVADES
Roadsides, disturbed land and forest edges/gaps.

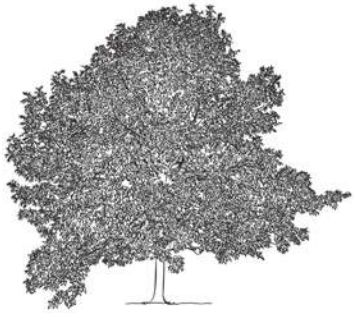
IMPACTS

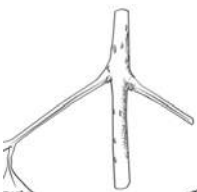
Loquat seeds germinate readily under or near their parent plants, forming dense stands, to the possible detriment of native plant species. The species has been recorded as invasive in a range of habitats in Brazil, including forests (Zenni and Ziller, 2011). In Hawaii it is naturalized in mixed mesic forest and along roadsides (Lorence *et al*., 1995) and in Tonga it is "occasionally an escape" (Yuncker, 1959). In New Zealand it has invaded "hillsides, scrub, plantations, and wastelands" (Webb *et al*., 1988). Has been recorded as invasive on a number of other Pacific islands, Australia, and South Africa (PIER, 2011). Invasive trees may also contribute to an abundance of introduced fruit flies. Research in Tanzania has shown that mango, loquat, guava and grapefruit are the favoured host fruits of the invasive fruit fly, *Bactrocera invadens* Drew, Tsura & White (Tephritidae) (Mwatawala *et al.,* 2006). Invasions of loquat, by increasing the abundance and distribution of fruit flies, may impact negatively on crop production.

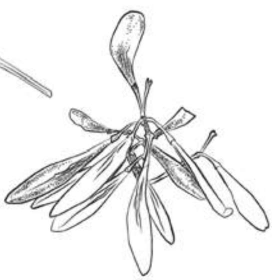
Notes: It is cultivated in gardens in the Ethiopian regions of Eritrea West, Shewa, Kefa and Harerge (Hedberg, 1989). Surveys found it to be naturalized, and nearly invasive, in many areas throughout East Africa, with seedlings readily establishing under or near parent canopies.



Fraxinus pennsylvanica Marshall







OLIVE FAMILY
Oleaceae

COMMON NAMES
English: downy ash, green ash, red ash, swamp ash, water ash, Mexican ash
Kenya: munyukwa

DESCRIPTION
Medium-sized tree [12–25 (–45) m tall] with a trunk to 60 cm in diameter; deciduous (sheds most or all of its leaves at the end of the growing season), crown irregular to round, twigs grey to green-brown; root system shallow, wide and spreading.

Bark: Ashy grey to brown and smooth in young trees becoming corky with ridges forming diamond-like shapes.

Leaves: Green above and hairless to silky-hairy with conspicuous veins below, golden-yellow in autumn, once-divided (15–30 cm long and 1.2–9 cm wide) with 5–7 (–9) oval to spear-shaped leaflets (6–10 cm long and 2–5 cm wide), margins toothed, held opposite each other on the stems.

Flowers: Light green to purplish, inconspicuous; female flowers in loose clusters of 200–300; males in tighter clusters.

Fruits: Samaras (simple dry, winged fruits that do not open along a seam), linear (5–7.5 cm long) with pointed end at the base, containing a single seed (1.5–3 cm long) with an elongated apical wing (2–4 cm long and 3–7 mm broad).

ORIGIN
USA.

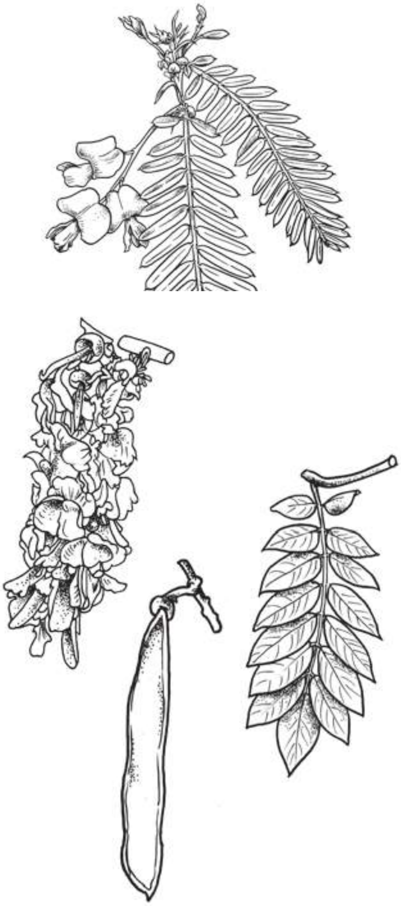
REASON FOR INTRODUCTION
Fuelwood, timber and ornament.

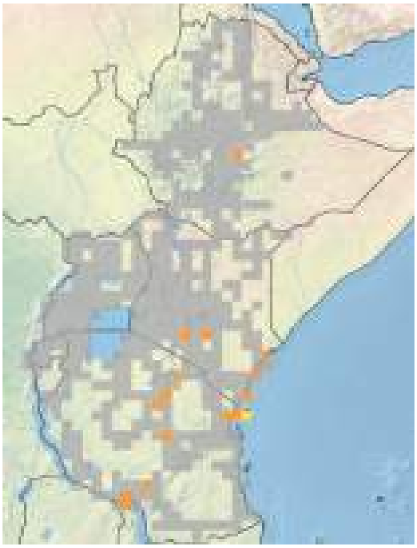
INVADES
Various habitats, including floodplain woodlands, mesic woodlands, riverbanks, swamps and abandoned fields.

IMPACTS
F. pennsylvanica was in 1948 planted as a fire break around commercial forestry plantations in the Mau Forest, Kenya. Seedlings, saplings and mature trees are now found in areas outside of these original plantings (Mullah *et al*., 2014). In invaded areas, *F. pennsylvanica* "appears to affect community diversity, reducing species richness and abundance among the seedlings and saplings of trees of other species" (Mullah *et al*., 2014). A congener, *F. angustifolia* Vahl ssp. *angustifolia*, has also spread from deliberate plantings in Australia "into creeks and river systems, wetlands, urban bushland, lowland grasslands and grassy woodlands" (Environmental Weeds of Australia, 2016) where it also forms dense monocultures, spreading via suckers, that shade out native vegetation, and prevent the regeneration of native shrubs and trees (Weber, 2003). Another congener, *F. uhdei* (Wenz.) Lingelsh., is invasive on Hawaii where it colonizes disturbed areas in forests, preventing the establishment of native species (Weber, 2003).

Notes: It is widely planted in Nairobi and elsewhere in the highlands of Kenya (Bernie and Noad, 2011) and Tanzania, mainly as a shade tree. There are no records of its presence in Ethiopia (Green, 2003). Only record of it being invasive in the region is from the Mau Forest, Kenya (Mullah *et al*., 2014). Not actively recorded during surveys so it is probably more widespread than indicated.

Gliricidia sepium (Jacq.) Walp.





PEA FAMILY

Fabaceae; sub-family: Papilionaceae

COMMON NAMES

English: gliricidia, Nicaraguan cocoa shade, quick-stick
Tanzania: mjenga-ua, mgliricidia

DESCRIPTION

Thornless medium-sized tree [2–15 (–20) m tall] with an erect trunk [5–30 (–100) cm in diameter], heavily branched, often from the base; crown spreading.

Bark: Initially smooth and green becoming greyish-deep brown with raised pores.

Leaves: Green with dark purplish tannin patches on lower surface, once-divided (15–30 cm long) with 6–24 opposite leaflets, oval or egg-shaped (4.4–8.3 cm long and 1.7–4.8 cm wide) with distinctive pointed tips, held alternately on the stems.

Flowers: Bright pink to whitish or purple with a yellow base, in clusters (4–8 cm long) of 30–100 flowers.

Fruits: Pods (several-seeded dry fruits that split open at maturity), green but sometimes tinged reddish-purple turning yellow-brown as they mature, narrowly elongated (10–17 cm long and 1.4–2.2 cm wide); seeds (4–10), rounded, yellow-brown.

ORIGIN

El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, USA.

REASON FOR INTRODUCTION

Fuelwood, tool handles, nitrogen fixation, support for climbers (vanilla), restoration, windbreak, shade and ornament.

INVADES

Disturbed lands and savannah.

IMPACTS
Has the potential to become invasive. In its native range, it is considered to be an "aggressive pioneer species" that forms monospecific stands "following slash and burn agriculture," but "in exotic locations, limited seed production, due to lack of pollinators, may limit its weed risk" (Simons, 1996a). That said, it is considered to be a "severe weed" in Jamaica (Simons, 1996b). It is also toxic, and its leaves and bark are reportedly used as a rodenticide in its native range, although this has been refuted by Gale *et al*. (1954). It may also be toxic or inhibit growth in animals such as rabbits and poultry, if ingested in sufficient quantities. High levels of nitrates in the plant are one of the suspected causes of 'cattle fall syndrome' in Colombia. The balance of evidence suggests that the plant may be toxic to non-ruminants, but conclusive evidence of toxicity to ruminants under normal feeding regimens is lacking. *G. sepium* also fixes nitrogen, and as such may alter natural nutrient cycling processes.

Notes: Widely grown throughout Ethiopia and East Africa, mainly for agro-forestry purposes. In our surveys, it was occasionally found to be naturalized. Based on its biology and toxicity it may become problematic in the future, but at this stage we found no evidence of it being invasive.

Gmelina arborea Roxb.

MINT FAMILY
Lamiaceae

COMMON NAMES

English: gmelina, Malay beechwood, snapdragon tree, white beech
Tanzania: malaina, mtiki mweupe, mutuntula, ndunge

DESCRIPTION

Thornless medium to large tree [12–30 (–40) m tall] with an erect trunk (to 140 cm in diameter), branching over a wide area.

Bark: Smooth, greyish-yellow with black patches and conspicuous corky spots, thin.

Leaves: Green, velvety with yellow-brown hairs underneath, heart-shaped (10–25cm long and 5–18 cm wide), margins entire on mature plants but strongly toothed or lobed on young plants; held opposite each other on stems, each pair at right angles to the pair below; leaf stalks round (5–15 cm long).

Flowers: Red, brown or yellow, large, funnel-shaped (4 cm long and 2.5–5 cm across) on a hairy stalk, in clusters (8–40 cm long), fragrant, showy.

Fruits: Drupes (fruits with a stony centre), orange-yellow, egg-shaped (2–3 cm long), surfaces hairy, containing 1–4 seeds.

ORIGIN

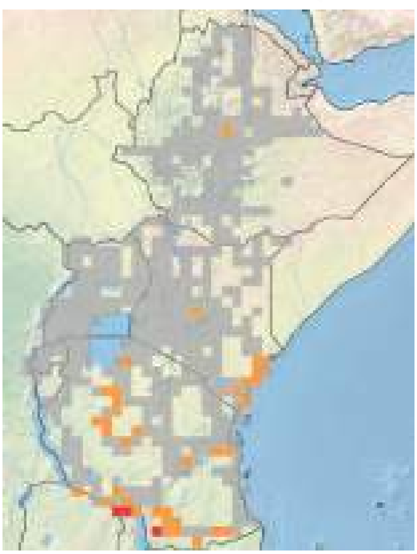
Bangladesh, Bhutan, China, India, Indonesia, Laos, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Thailand and Vietnam.

REASON FOR INTRODUCTION

Fuelwood, light construction, pulp, fodder and ornament.

INVADES

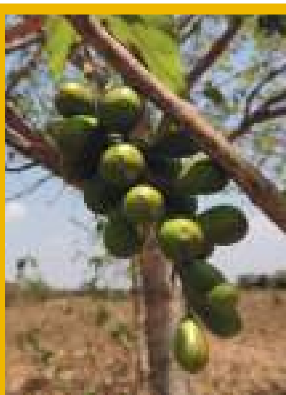
Roadsides, disturbed areas, drainage channels, woodlands, savannah, lowlands and gulllies.



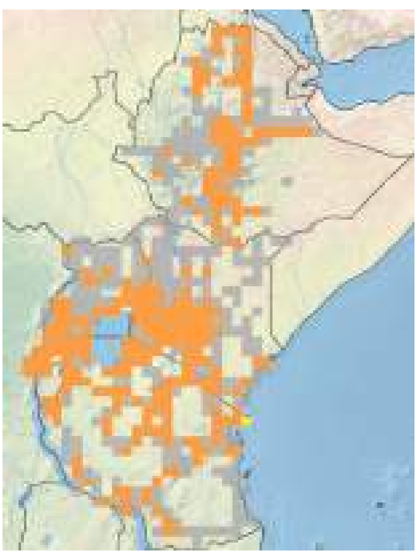
IMPACTS

G. arborea establishes easily, grows rapidly, coppices readily, and is relatively free of pests outside of its natural range (Orwa *et al*., 2009). In the Arnhem region of northern Australia, it is naturalizing around numerous settlements. It is also allelopathic; its leaf extracts inhibit the germination and growth of black gram, green gram, red gram and chickpea (Shankar *et al*., 2014). In Sierra Leone, *G. arborea* has been found significantly to inhibit cowpea root growth at extractions of as low as 25% (Kamara, 2006).

Notes: In Tanzania, it is "performing well" in Rau Forest, Moshi and Geita Districts (Mbuya *et al.,* 1994). Widely naturalized under or near mother plants in southern Tanzania, and occasionally invasive, as it is in parts of northern Malawi, to the possible detriment of native plant and animal species. It is grown in the west of Ethiopia, where it competes with crops (Bekele-Tesemma *et al*., 1993).



Grevillea robusta A. Cunn. ex R. Br.



PROTEA FAMILY
Proteaceae

COMMON NAMES

English: grevillea, river oak, silky oak, silk oak, southern silky oak, silver oak, silk-oak grevillea
Kenya: eshichuma, kapkawet, meresi, mgrivea, mubariti, mukima, omokabiria, wakhuisi
Tanzania: gereveriya, mgrevilea
Rwanda: gereveriya

DESCRIPTION
Medium-sized to large tree [12–25 (–40) m tall], semi-deciduous (sheds some of its leaves at the end of the growing season); erect, single-stemmed (stem diameter to 80 cm); crown conical and symmetrical with branches projecting upward, young branchlets are hairy and rusty brown, angular and ridged.

Bark: Dark grey and furrowed or fissured (in a lace-like pattern) with orange-brown inner bark.

Leaves: Olive green, upper surfaces are glossy, dark and hairless, undersides silky, silvery and hairy; fern-like, once- or twice-divided (10–34 cm long and 9–15 cm wide), deeply divided with narrow, long, pointed lobes, held alternately on the stems, on leaf stalks (1.5–6.5 cm long).

Flowers: Bright orange (2 cm long), numerous pairs held in one-sided, unbranched clusters (7.5–15 cm long).

Fruits: Follicles (dry fruits having one compartment that opens, on one side only, at maturity), black, broad, slightly flattened (2 cm long), containing 1 or 2 winged seeds (13–19 mm long and 0.8–0.9 mm thick).

ORIGIN
Australia.

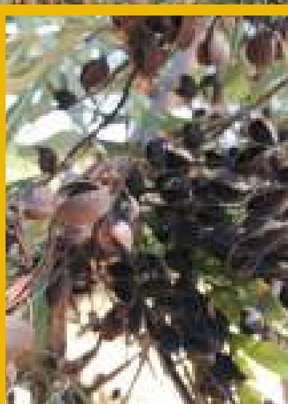
REASON FOR INTRODUCTION
Fuelwood, timber, bee forage, shade and ornament.

INVADES
Roadsides, disturbed areas, urban open spaces and fallow land.

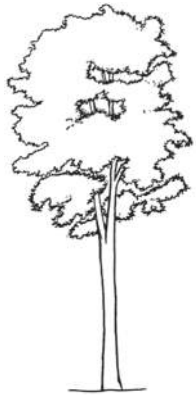
IMPACTS

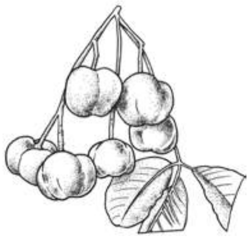
Has escaped cultivation in some countries, forming dense stands, to the detriment of native flora and fauna. An aggressive colonizer, it has demonstrated invasive behaviour in Australia (New South Wales), Jamaica, Zimbabwe, South Africa and Hawaii, USA. Henderson (2001) regards *G. robusta* as a potential transformer of habitats, while in Hawaii it is listed as one of the most invasive horticultural plants. In Zimbabwe, it is regenerating naturally in the Vumba area. It is a common environmental weed at Hunt's Creek in western Sydney, and has become naturalized in Lane Cove National Park in Sydney, Australia (Environmental Weeds of Australia, 2016). It was often grown in tea plantations, but in Kenya and Rwanda this practice has largely been discontinued, owing to the risk of allowing *Armillaria* spp. and other primary root-rot pathogens of tea (such as *Camellia sinensis* (L.) Kuntze; Theaceae) to spread from dead *G. robusta* roots to the roots of tea plants (Tea Research Institute of East Africa, 1969). It is also considered to be allelopathic (Smith, 1998), inhibiting the growth of other plants. The pollen may trigger hay fever (Motooka *et al*., 2003), and some people may develop contact dermatitis on being exposed to parts of the plant, especially sawdust (Derraik and Rademaker, 2009).

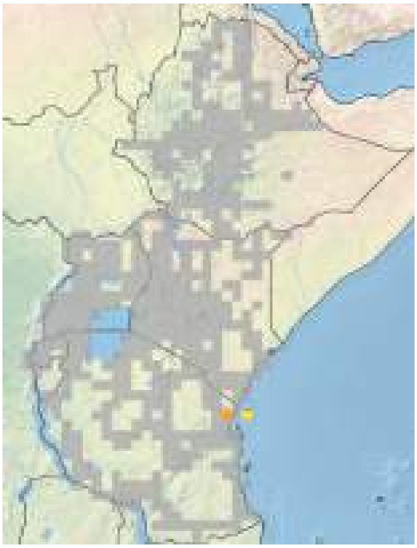
Notes: In Ethiopia, it is grown as an ornamental and is used in afforestation in the regions of Eritrea West, Tigray, Shewa, Kefa and Harerge (Friis, 2000). It is "often naturalized" in Kenya (Birnie and Noad, 2011). This was confirmed by surveys, which found seedlings germinating readily under or near parent canopies. However, it is not considered to be invasive.



Hevea brasiliensis (Willd. ex A. Juss.) Müll.







EUPHORBIA FAMILY
Euphorbiaceae

COMMON NAMES
English: natural rubber, para rubber, rubber tree
Ethiopia: yegoma zaf
Tanzania: mpia, mpira

DESCRIPTION
Large evergreen tree (to 40 m tall) with a straight trunk (50 cm in diameter), branching at top to form a dense canopy.

Bark: Smooth, grey in colour, inner bark has milky sap (rubber).

Leaves: Green, smooth above, paler below, once-divided (60 cm long) with three (trifoliate) egg-shaped or oval leaflets [10–15 (–50) cm long and 3–6 (–15 cm) wide], with narrower end at the base, pointed tips, margins entire, long leaf stalk [7.5–10 (–70) cm long].

Flowers: Creamy, yellow or green, small with no petals, male and female flowers (8 mm long) in the same inflorescence, fragrant.

Fruits: Capsules (dry fruits that open at maturity), 3-lobed (3–6 cm long), seeds flat (2.5–3 cm long), grey with darker mottling and streaking.

ORIGIN
Bolivia, Brazil, Colombia, Peru and Venezuela.

REASON FOR INTRODUCTION
Timber and rubber.

INVADES
Roadsides, disturbed areas and forest gaps/edges.

IMPACTS

Introduced as a plantation crop, it has escaped cultivation and established dense stands, to the possible detriment of native plant and animal species. It is reported to be naturalizing on Christmas Island (Indian Ocean) (Swarbrick, 1997). In Singapore, it "appears to be strongly entrenched" in secondary forests (Tan, 2011). Studies in West Trupura, India, have found that, as rubber plantations become older, the density, biomass and dominance of earthworms increases, but that the species diversity, richness and evenness of earthworm communities declines (Chaudhuri *et al.*, 2012). The exotic earthworm *Pontoscolex corethrurus* (Müller) (Glossoscolecidae) was found to account for most of the earthworms present in 10–25-year-old plantations (Chaudhuri *et al.*, 2012). The invasion of this earthworm species may be ascribed to the fact that exotic species tolerate anthropogenic disturbances better than indigenous species (Kalisz and Wood, 1995), or it may be that the content of the leaf litter favours exotic over indigenous species.

Notes: Planted at a few localities in Tanzania and Uganda (Smith, 1987), and with one record from the Ilubabor Region of Ethiopia (Gilbert, 1995). It is naturalized in the Amani Nature Reserve, East Usambaras, Tanzania (Dawson *et al.*, 2008) and considered by others to be invasive (Mosango *et al.*, 2001; TBA, 2007). Not seen elsewhere other than in the East Usambaras in East Africa.

Hovenia dulcis Thunb.

BUCKTHORN FAMILY
Rhamnaceae

COMMON NAMES

English: Japanese raisin tree

DESCRIPTION
Scented tree (to 10 m tall), rarely a shrub; deciduous (sheds most of its leaves at the end of the growing season); branchlets smooth, brown-purple.

Bark: Grey with orange-brown inner bark, flattened ridges with shallow furrows.

Leaves: Green, glossy and smooth above, pale green below, large, egg-shaped with broad heart-shaped base (8–15 cm long and 6–12 cm wide), margins with triangular blunt or rounded teeth, held alternately on stems, leaf stalk 2.5–6 cm long.

Flowers: Creamy, yellow-green (6–8 mm across), in terminal clusters.

Fruits: Capsules (dry fruits that open at maturity), lime-green becoming red-brown to purple-black, fleshy (6.9–8.5 mm long and 6–7.5 mm wide); three-lobed, each lobe containing one seed; fruit stalks contorted above each fruit becoming swollen, fleshy and juicy (3–7 mm in diameter), initially green turning reddish-brown to black.

ORIGIN
China, Japan, North Korea, South Korea, Thailand and Vietnam.

REASON FOR INTRODUCTION
Edible food (fruit stalks only), medicine and ornament.

INVADES
Roadsides, disturbed areas, forest gaps/edges and regenerating forests.

IMPACTS

H. dulcis is a fast-growing annual tree species that has escaped cultivation and which is establishing populations in the wild, often to the detriment of biodiversity. In South America, it has invaded forest fragments in different successional stages, including forest edges. It has invaded closed-canopy forest fragments in sub-tropical Atlantic forest habitats (Padilha *et al.*, 2015). It has also changed the structure and composition of plant communities in sub-tropical forests of different types (Bardall *et al.*, 2004; Schaff *et al.*, 2006; Boeni, 2011). In fact, it is considered to be one of the four worst invasive plant species in Brazilian subtropical forests, competing with native species for space, light and nutrients (Zenni and Ziller, 2011). Its fruits are readily consumed by a large number of animal species, contributing to the further spread of *H. dulcis*.

Notes: "Well cultivated" in East Africa (Johnston, 1972), it is considered to be invasive in the Amani Nature Reserve, East Usambaras, Tanzania (Dawson *et al*., 2008). There are no records of its presence in Ethiopia (Vollesen, 1989). Surveys did not reveal its presence elsewhere.

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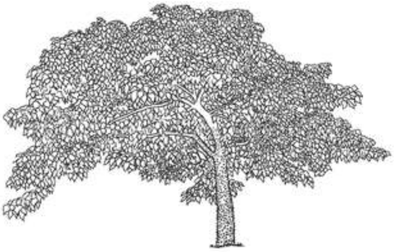
Hura crepitans L.

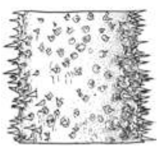


SPURGE FAMILY
Euphorbiaceae

SYNONYM
Hura brasiliensis Willd.

COMMON NAMES

English: dynamite tree, hura tree, jabillo, monkey's dinner bell, sandbox, possumwood



DESCRIPTION
Evergreen tree (to 40 m tall); stem and branches yellow to brown, densely covered with conical spines.

Bark: Densely spiny, yellow-brown, hairless.

Leaves: Green, large, papery, broadly egg- or heart-shaped [5–29 (–60) cm long and 5–17 cm wide] ending in a sharp point, mid-vein elevated, margins with shallow tooth-like projections, leaf stalk 4–20 cm long.

Flowers: Dark red male flowers have no petals (part of the flower that is brightly coloured), held in egg- to cone-shaped clusters [1.6–4.5 cm long and (0.8–) 1.5–2 cm wide], female flowers solitary.

Fruits: Capsules (dry fruits that open at maturity), green becoming reddish-brown, pumpkin-shaped (3–5 cm long and 5–8 cm across), longitudinally grooved; seeds flattened (1–2 cm across).

ORIGIN
Bolivia, Brazil, Cuba, Colombia, Costa Rica, Ecuador, French Guiana, Jamaica, Nicaragua, Panama, Puerto Rico, Peru, Surinam, Trinidad, Venezuela, Virgin Islands and West Indies.

REASON FOR INTRODUCTION
Timber and ornament.

INVADES
Forest edges/gaps, riparian vegetation and moist valleys.

IMPACTS

Forms dense stands, probably excluding native plant and animal species. Its large leaves enable it to grow in deep shade, allowing the plant to establish in undisturbed forest where it may out-compete indigenous species. In Australia, it has established populations in native bushland (Csurhes and Edwards, 1998). In parts of the Old World tropics, it is cultivated and occasionally naturalized (Little and Wadsworth, 1964). The tree has an extremely toxic sap, which if it comes into contact with human skin can cause red welts, and which may even blind those who get it into their eyes. The sap is used to poison fish.

Notes: Cultivated at a few localities in East Africa (Radcliff-Smith, 1987), it is considered to be naturalized in the Amani Nature Reserve, East Usambaras, Tanzania (Dawson *et al.*, 2008), but invasive there by others (TBA, 2010). It is not recorded as being present in the flora of Ethiopia (Gilbert, 1995). Not seen outside of the Amani Nature Reserve.

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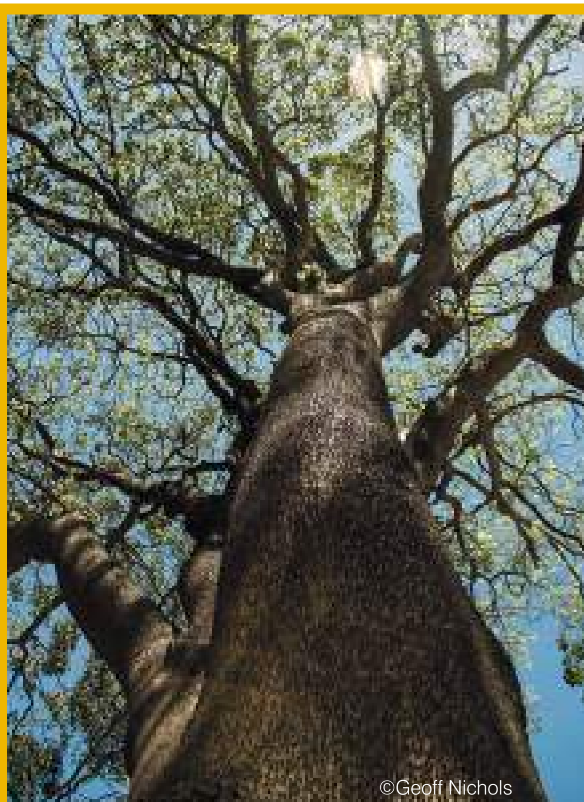

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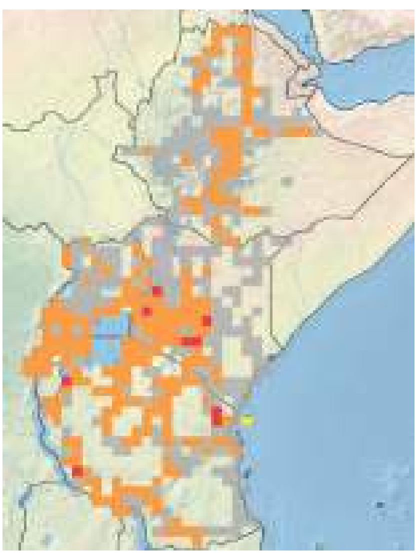
Jacaranda mimosifolia D. Don



JACARANDA FAMILY
Bignoniaceae

COMMON NAMES

English: Brazilian rosewood, green ebony, jacaranda
Ethiopia: ytemnja zaf
Kenya: mujakaranda
Rwanda: jakaranda
Tanzania: mjakaranda
Uganda: jakaranda

DESCRIPTION

Medium-sized to large tree [5–15 m (–30) tall]; evergreen or deciduous (shedding most of its leaves at the end of the growing season); with a rounded, spreading crown; trunk (40–50 cm in diameter) short and often malformed; twigs light reddish brown, slender and slightly zigzagged.

Bark: Thin, grey-brown, smooth in young trees becoming finely scaly and peeling with age.

Leaves: Dark green turning yellow in autumn/winter, feathery or fern-like, twice-divided (20–80 cm long) with 20–40 pairs of leaf branchlets, each with 19–45 sharply pointed leaflets.

Flowers: Lavender blue, rarely white, bell-shaped or tubular (3–5 cm long and 4–5 cm wide), in terminal clusters (20–30 cm long) at the ends of the branches.

Fruits: Capsules (dry fruits that open at maturity), green turning reddish brown-black as they mature, woody with a wavy edge (5–7 cm wide), splitting on the tree to release many small winged seeds.

ORIGIN

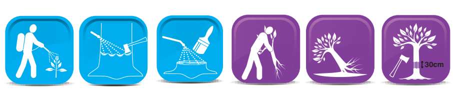
Argentina and Bolivia.

REASON FOR INTRODUCTION

Fuelwood, timber, carving, shade and ornament.

INVADES

Roadsides, disturbed areas, urban open spaces, savannah and riparian vegetation.

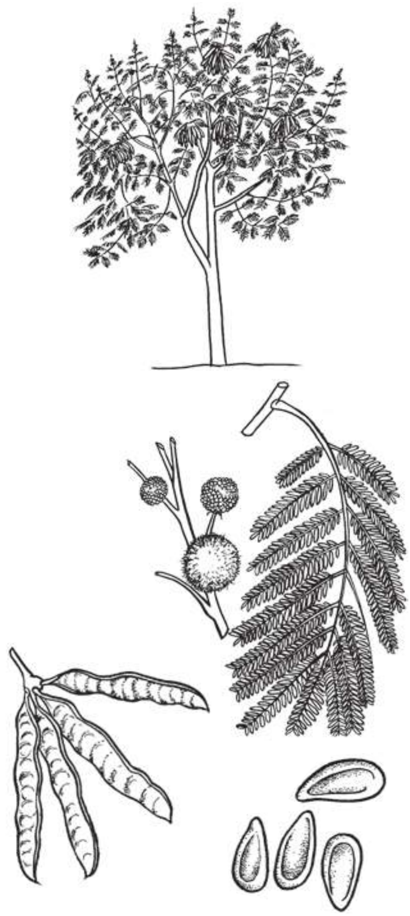


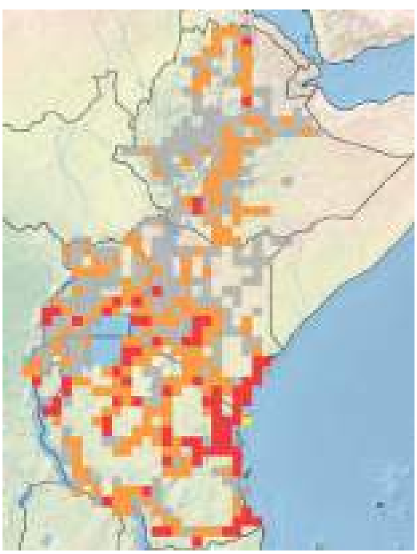
IMPACTS

J. mimosifolia has the ability to form dense stands, possibly displacing native plant and animal species. It is a "greedy feeder with an aggressive root system" (Maundu and Tengnäs, 2005). In South Africa, it is invading large tracts of land, affecting biodiversity and causing a reduction in water availability from rivers and streams (Carrere, 2000). It has been ranked as one of the biggest water users in South Africa (Le Maitre *et al*., 2000). Elsewhere in southern Africa, *J. mimosifolia* has been recorded as invasive in the Matopos, Hwange and Kyle National Parks in Zimbabwe (Nyoka, 2003). It is also naturalized in the warmer parts of eastern Australia, Hawaii and southeastern USA, as well as in parts of southern South America, outside its native range. On Rodos Island, Greece, it is regarded as a casual weed (Galanos, 2015).

Notes: Widely cultivated in East Africa as a garden and street tree (Bidgood *et al.*, 2006), it is "becoming naturalized" in some areas (Birnie and Noad, 2011). It is also widely cultivated in Ethiopia (Bidgood, 2006), but it has not been recorded as naturalized or invasive there. During our surveys, it was found to be naturalized in many areas, and locally abundant (invasive) in some.

Leucaena leucocephala (Lam.) de Wit





PEA FAMILY
Fabaceae; sub-family: Mimosaceae

COMMON NAMES
English: jumbie bean, lead tree, leucaena, wild tamarind
Ethiopia: lukina
Kenya: lusia, mlusina
Rwanda: resene

DESCRIPTION
Evergreen thornless shrub or small tree [2–10 (–15) m high]; young stems green and densely covered with greyish hairs.

Bark: Smooth, greyish-brown with numerous small raised spots.

Leaves: Dark green, often grey-hairy, twice-divided [70–150 (–350) mm long] with 3–10 pairs of leaf branchlets, each 2–10 cm long and bearing 5–22 pairs of somewhat elongated or sword-shaped leaflets (7–21 mm long and 1.5–5 mm wide) with almost parallel sides; there is usually a small raised structure (gland) on the leaf stalks.

Flowers: White or pale yellow, in round clusters (12–30 mm across), held singly or in groups of 2 or 3 at the junctures of the leaves and stems.

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning brown or reddish brown as they mature, elongated, almost straight (8–18 cm long and 2 cm wide), flattened but raised over the seeds, tips pointed; containing 10–25 hard seeds.

ORIGIN
Belize, Guatemala and Mexico.

REASON FOR INTRODUCTION
Fuelwood, fodder, tannins, nitrogen fixation, soil conservation, shade and ornament.

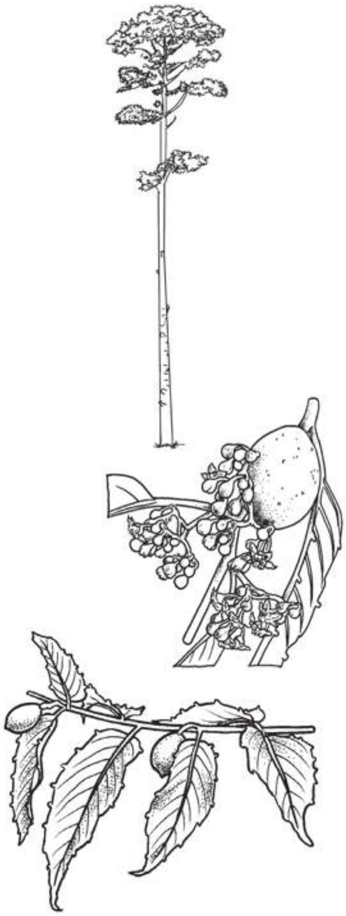
INVADES
Roadsides, disturbed land, urban open spaces, drainage ditches, forest edges/gaps, woodland edges/gaps, riparian vegetation, lowlands and coastal shrub.

IMPACTS

Forms large monocultures, displacing native plant and animal species. In Hawaii, it is out-competing open forest species (Cronk and Fuller, 1995), while on the Brazilian island of Fernando de Noronha it is displacing the endemic flora. On Japan's Ogasawara (Bonin) Islands, leucaena infestations have severely affected native plant communities, altering secondary succession processes and facilitating establishment by other, more aggressive invading alien plant species (Yoshida and Oka, 2004). On Guam, infestations are preventing the regeneration of indigenous plant species (B. Lawrence, *pers. comm*., in Walton, 2003). On Vanuatu, where its infestations are threatening the native flora and "rendering extensive areas unusable and inaccessible", leucaena is proving "very difficult to eradicate" (Nakeo and Qarani, 2003). In Papua New Guinea, dense monospecific stands of leucaena in the Erap Valley, and alongside other rivers, are replacing the native riparian vegetation (G. Werren, *pers. comm.*, in Walton, 2003).

Notes: Grown in the Ethiopian regions of Eritrea East, Eritrea West, Welo, Harerge, Kefa and Gamo Gofa, it is "sometimes naturalized" (Thulin, 1989). Widely grown in East Africa, it has escaped cultivation in many areas, especially along the Kenyan and Tanzanian coast, where it has established dense infestations on roadsides, urban open spaces, coastal scrub and riversides. More than 50 years ago Brenan (1959) observed that it was "escaping, seeding freely, and becoming naturalized here and there, in suitable places forming dense thickets". Its congener, *L. diversifolia*, which grows faster at higher altitudes and which is more resistant to the leucaena psyllid (Maundu and Tegnäs, 2005), may also become invasive. Localized infestations of *L. diversifolia* were found in Rwanda and Tanzania.

Maesopsis eminii Engl.



BUCKTHORN FAMILY

Rhamnaceae

COMMON NAMES

English: umbrella tree
Kenya: muhunya, mutere
Rwanda: masira, msira, musira
Tanzania: msira, musira, muhumula, masira, mheru
Uganda: masira, msira, msisi, muhongera, muguruka, musinde, musira musizi

DESCRIPTION

Large unarmed tree [15–25 (–45) m tall], evergreen to deciduous (sheds most or all of its leaves at the end of the growing season), with an open and spreading crown; trunk straight and cylindrical [50 (–180) cm in diameter], sometimes with small buttresses.

Bark: Pale grey to grey-brown or almost white, smooth or with deep, vertical, often twisted furrows.

Leaves: Bright green above, paler beneath, simple, egg-shaped with broad end at base, or oval to elongated with almost parallel sides (7–14 cm long and 2.5–6 cm wide), margins with minute teeth, almost paired (sub-opposite); leaf stalks 6-12 mm long; stipules (leafy structures at the bases of leaves) 2–6 mm long.

Flowers: Yellowish-green, held in many flowered clusters (1–5 cm long).

Fruits: Drupes (fruits with a stony centre), green to yellow to purple-black, egg-shaped with narrower end at base (20–35 mm long and 10–18 mm across).

ORIGIN

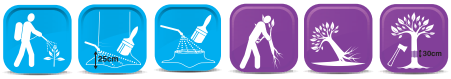
Moist Tropical Africa from Liberia to Uganda and south to Angola.

REASON FOR INTRODUCTION

Fuelwood, timber and ornament.

INVADES

Roadsides, disturbed areas, forest edges/gaps.

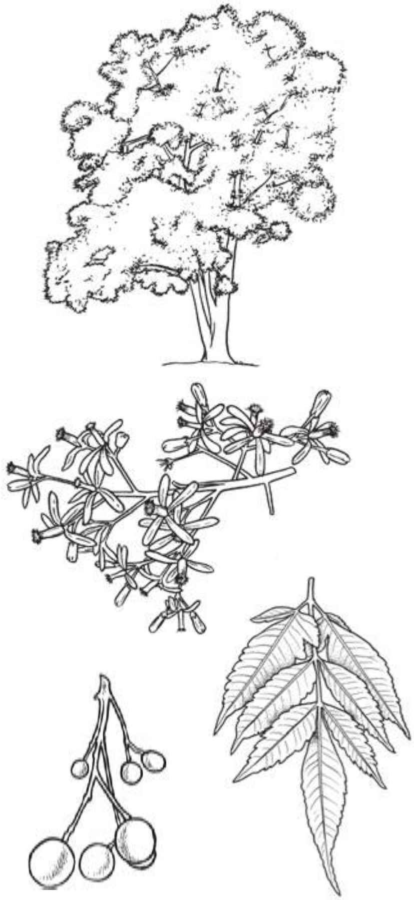


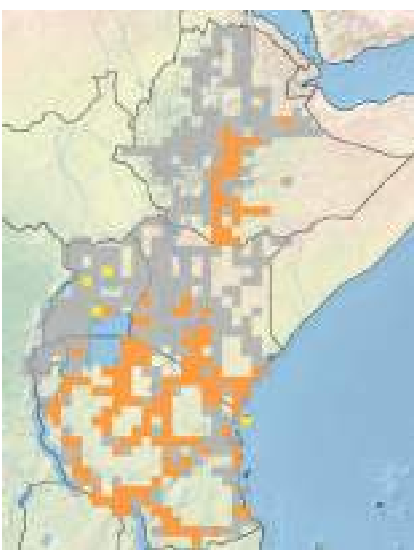
IMPACTS

Introduced into many countries as a timber tree, *M. eminii* has escaped and has established populations in the wild, to the detriment of native flora and fauna. In the East Usambaras, Tanzania, it is extremely competitive, establishing in forest gaps "undisturbed by man", where infestations cause "major ecological modifications" (Binggeli and Hamilton, 1993). It is an aggressive colonizer of disturbed areas within forests and grasslands (Eggeling, 1940). Seedlings, being shade-tolerant, can establish in undisturbed forests. Dense infestations can contribute to increased soil erosion and to the complete loss of upper organic soil horizons. Its leaf litter can increase soil pH, altering the composition of soil-dwelling fauna species. *M. eminii* is considered to be invasive in India, Rwanda and Puerto Rico (Haysom and Murphy, 2003). It has also been introduced to Fiji, where it is starting to naturalize.

Notes: In eastern Africa, the only locality where it has been recorded as invasive is the Amani Nature Reserve, East Usambaras, Tanzania (Dawson *et al*., 2008), an observation confirmed by our surveys. Infestations in Rwanda were not confirmed. Its impacts, though, have been debated, with some arguing that it may contribute to forest regeneration. In its native Uganda, where it grows in low moist tropical forests, it is becoming increasingly dominant in the regenerating vegetation of disturbed forests and forest margins, notably in Budongo and Mabira (Katende *et al.*, 1995).

Melia azedarach L.





MAHOGANY FAMILY
Meliaceae

COMMON NAMES

English: bead tree, Cape lilac, Persian lilac, pride of India, syringe, white cedar
Kenya: dwele, lira, mmelia, mwarubaina, nusu
Uganda: lira

DESCRIPTION

Spreading tree (to 20 m tall), deciduous (sheds most or all of its leaves at the end of the growing season); bark on young stems reddish-brown and smooth.

Bark: Grey-brown and smooth becoming browner, rougher and furrowed with age.

Leaves: Deep green, glossy above turning yellow in autumn, twice-divided (50 cm long), 4–6 pairs of leaf branchlets, each bearing 3–6 sword-shaped, almost hairless leaflets (5 cm long and 2.5 cm wide), margins toothed.

Flowers: Blue to mauve (15–20 mm wide), in large, axillary panicles or clusters, with a pleasant scent.

Fruits: Berries (fleshy fruits that do not open at maturity), green turning yellow and wrinkling as they mature, round (12 mm across), three-seeded, remain on trees after leaf-fall.

ORIGIN

Australia, China, India, Indonesia, Japan, Papua New Guinea and Sri Lanka.

REASON FOR INTRODUCTION

Fuelwood, building materials, medicine, shade and ornament.

INVADES

Roadsides, wasteland, urban open spaces, forest edges/gaps and riverbanks.

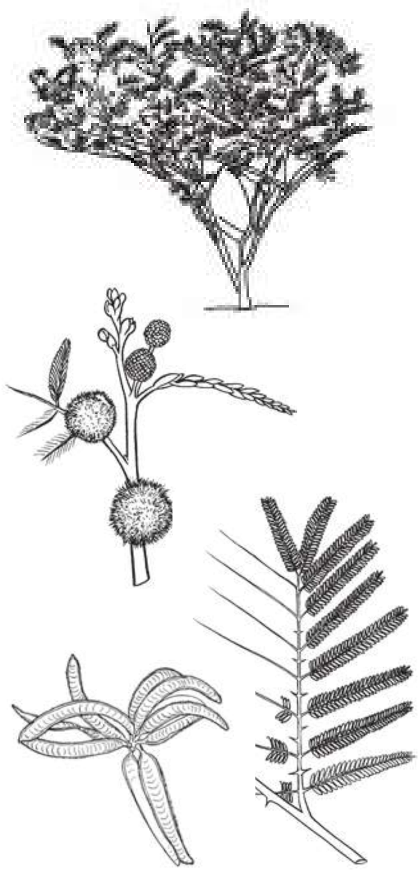
IMPACTS

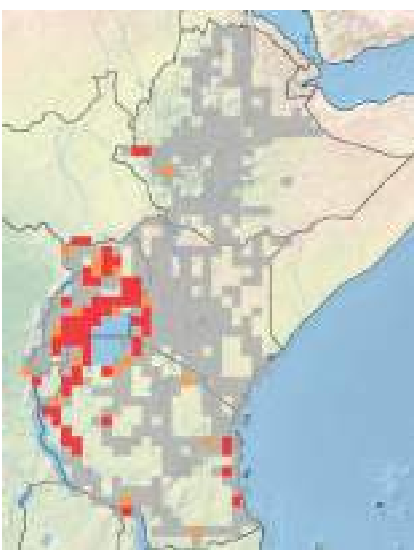
Syringa has the ability to form dense, impenetrable stands, displacing native plant and animal species (Weber, 2003) and “impoverishing biodiversity” (Batcher, 2000). Its leaf litter increases soil pH and nitrogen levels, altering soil chemistries (Noble *et al*. 1996, in Batcher, 2000). According to van Wilgen *et al.* (2001), it can also change the feeding dymanics of frugivorous birds. In its adventive range, *M. azedarach* has successfully invaded South African savannahs, the pampas of Argentina and relatively undisturbed floodplain hammocks, marshes and upland woods in Florida (Langeland and Burks, 1998; Hood and Naiman, 2000; Van Wilgen *et al.*, 2001; Ghersa *et al*., 2002; Henderson, 2007). It has also been recorded as invasive in the Matopos, Hwange and Kyle National Parks in Zimbabwe (Nyoka, 2003). Natural regeneration of *M. azedarach* was observed in Zimbabwe in about 1956, roughly 55 years after its introduction (SRFC, 1956). *M. azedarach* flowers are a respiratory irritant, and the leaves, bark, flowers and fruits are toxic (Henderson, 2001), having led to recorded incidences of poisoning in pigs (Everist, 1974; Ottino and Renner, 1997), sheep, cattle and dogs. There have also been reports of poisonings in children who have eaten the fruit (Cremer, 1990).

Notes: Widely cultivated in Ethiopia (Styles and White, 1989). In East Africa, it is “locally naturalized, occurring in secondary grasslands and thicket and on waste ground” but “does not seem to become a serious pest” (Styles and White, 1991). Yet, because it produces many suckers, it “may become a weedy nuisance” (Katende *et al*., 1995). Our surveys found that in some localities it is naturalized, but that seedlings are generally confined to areas beneath or near a parent canopy, around homesteads or in urban open spaces.




Mimosa pigra L.





PEA FAMILY

Fabaceae; sub-family: Mimosaceae

COMMON NAMES

English: bashful bush, black mimosa, giant mimosa, giant sensitive plant
Ethiopia: dalana, esswarwod
Kenya: dalana, murendazia, siri-siri
Rwanda: umugeyo
Tanzania: mgama, mgambu, mgeigei, mntobwe, msesi, mseziluguru, ndulu, ngambo, nguvurukundu
Uganda: kawule, ekodokodo, ekorau, akagyeya

DESCRIPTION

Evergreen shrub or small tree (3–6 m high), forming dense thickets; young stems green, rounded, armed with scattered prickles (5–12 mm long); tap-root 1–2 m deep.

Bark: Older stems are grey and woody.

Leaves: Yellowish-green with short fine hairs below, twice-divided (20–31 cm long), straight thorn at the junction of each of 6–16 pairs of leaflet branchlets, each branchlet with 20–45 pairs of small elongated leaflets (3–12 mm long and 0.5–2 mm wide), leaves fold together at night or when touched.

Flowers: Pink or mauve, in fluffy round heads (1–2 cm wide), borne singly or in groups of two or three, on stalks (2–7 cm long) arising from each upper-leaf fork.

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning brown as they mature, flat and elongated (3–12 cm long and 7–14 mm wide), covered with bristly hairs, borne in clusters (of 1–30), break transversely into 14–26 segments; seeds greenish-brown to light brown (4–6 mm long and 2–2.5 mm wide).

ORIGIN

Argentina, Belize, Brazil, Colombia, Costa Rica, Ecuador, El Salvador, French Guiana, Guatemala, Guyana, Honduras, Mexico, Nicaragua, Panama, Peru, Surinam and Venezuela.

REASON FOR INTRODUCTION

Green manure, nitrogen fixation, medicine, hedge/barrier and ornament.

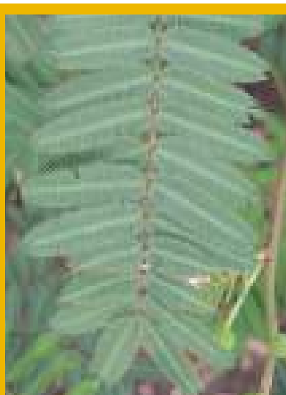
INVADES

Roadsides, disturbed land, wastelands, urban open spaces, drainage ditches, irrigation channels, dams, riversides, floodplains, swamps, wetlands, lake edges and gullies.

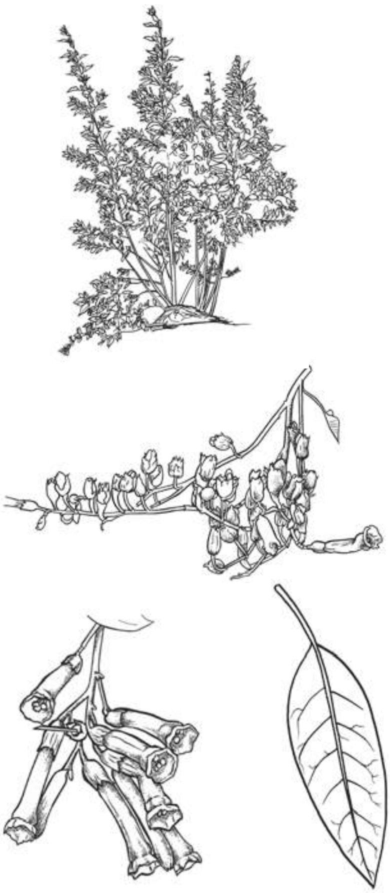
IMPACTS

Research has shown that dense infestations of *M. pigra* contribute to steep declines, both in the numbers of species of native plants and animals and in their population sizes. In the Tram Chim National Park, Vietnam, declining densities of native plant species in infested habitats are threatening the sarus crane (Triet and Dung, 2001), which is listed as vulnerable. *M. pigra* thickets in Australia have been found to support fewer birds and lizards, less herbaceous vegetation, and fewer tree seedlings than native vegetation (Braithwaite *et al*., 1989). In Lochinvar National Park, Zambia, infestations have reduced bird diversity by almost 50% and bird abundance by more than 95% (Shanungu, 2009). In Cambodia, farmers have ranked mimosa as the most significant problem affecting rice farming, "ahead of rodents, other pests, and drought" (Chamroeun *et al*., 2002). *M. pigra* also hampers fishing activities, and blocks access to water bodies.

Notes: Occurs on riverbanks, lakeshores and around swamps in the Ethiopian regions of Gonder, Gojam, Shewa, Ilubabor and Kefa (Thulin, 1989). Our surveys found it to be widespread and abundant across most of Uganda, on floodplains, around swamps and on lakeshores. In Tanzania, it is particularly abundant on the southern shores of Lake Victoria. It is probably significantly more widespread than indicated on the distribution map.



Nicotiana glauca Graham



NIGHTSHADE FAMILY
Solanaceae

COMMON NAMES
English: mustard tree, tobacco bush, tree tobacco, wild tobacco

DESCRIPTION
Evergreen, hairless soft-wooded shrub or small tree (2–8 m tall); blue-green with purplish tints.

Leaves: Bluish or greyish-green, leathery and thick, sword-shaped or oval (5–25 cm long and 12 cm wide) with pointed tips, held alternately on stems on long stalks; leaves larger on young growth.

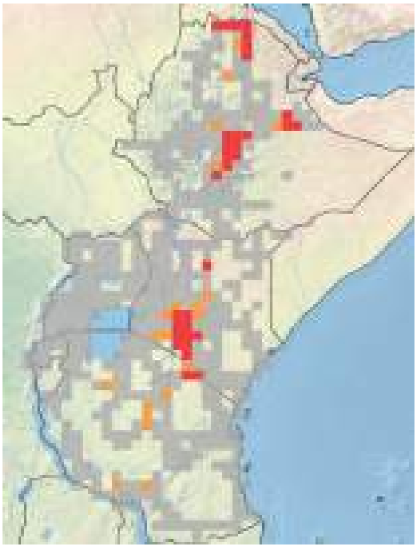
Flowers: Greenish-yellow, tubular (3–4 cm long), in terminal drooping clusters.

Fruits: Capsules (dry fruits that open at maturity), green turning brown-black as they mature, egg-shaped, with four chambers (15 mm long) containing tiny seeds.

ORIGIN
Argentina, Brazil, Bolivia, Chile, Ecuador, Paraguay, Peru and Uruguay.

REASON FOR INTRODUCTION
Medicine, insecticide and ornament.

INVADES
Roadsides, wasteland, disturbed land, drainage ditches, floodplains, riverbanks, riverbeds and dry water channels.



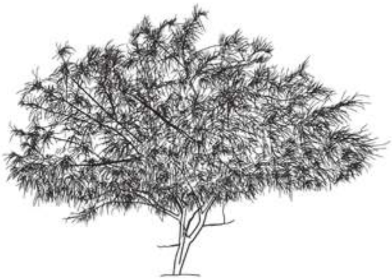
IMPACTS

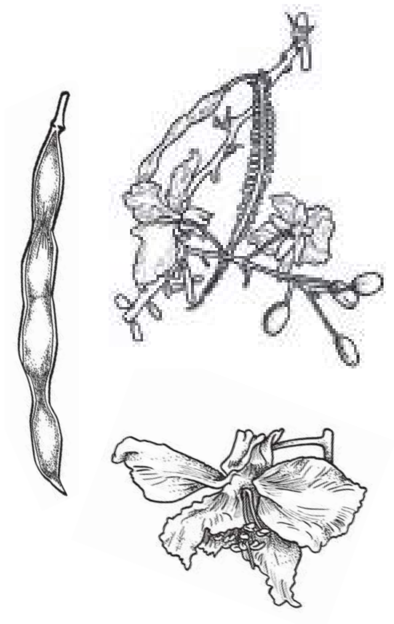
Grows rapidly, forming dense stands which displace native species. Leaf-litter and twig leachates inhibit the germination of native plant species (Florentine and Westbrooke, 2005). On Ascension Island, *N. glauca* may be displacing endemic species such as *Euphorbia origanoides* L. (Euphorbiaceae) (critically endangered) and *Anogramma ascensionis* (Hook.) Dielsby (Pteridaceae), dominating sites and altering ecological conditions (Gray *et al.*, 2005). *N. glauca* is highly toxic. Its ingestion has reportedly caused the deaths of farmed ostriches (Botha *et al.*, 2011). Toxic signs in sheep include "excess salivation, irregular gait, wobbling while walking or standing, recumbency and death" (Keeler and Crowe, 1984). Birth defects in goats and sheep have also been reported (Panter *et al.,* 2000). Some people have died after eating the plant, having mistaken it for spinach or for another palatable vegetable (Hassen *et al.*, 2014). It is also an alternative host for vectors of solanaceous crop diseases (Aviña-Padilla *et al.*, 2008).

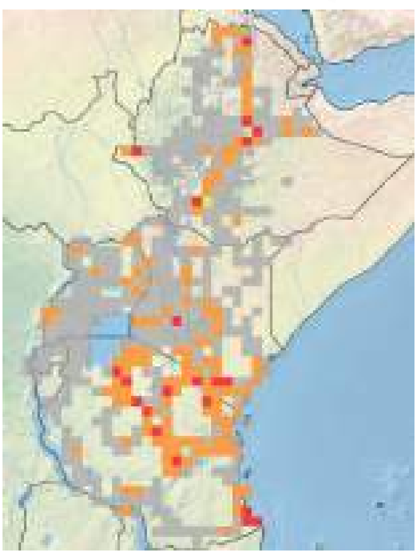
Notes: In East Africa, it is regarded as an "escape from cultivation, found in dry, rocky disturbed soils, on steep slopes, waste ground, river and lake banks and roadsides" (Edmonds, 2012). In Ethiopia, it has "escaped or naturalized in waste places and along roadsides" in the regions of Eritrea West, Tigray, Welo, Shewa and Harerge (Friis, 2006). It is widespread and locally abundant in many areas throughout the region, but more so north of Arusha, Tanzania, and between Maai Mahiu and Narok in Kenya. In these areas in has formed stands on roadsides and in floodplains.




Parkinsonia aculeata L.







FAMILY
Fabaceae; sub-family: Caesalpiniaceae

COMMON NAMES
English: horse bean, jelly bean tree, Jerusalem thorn, parkinsonian
Kenya: okwato, muk-bee

DESCRIPTION
Evergreen tree [2–6 (–10) m high]; stem smooth, hairless, greenish-yellow when young turning brown, branches zigzagged, armed with stout spines (3–20 mm long) below each leaf.

Bark: Greenish-yellow turning brown, smooth.

Leaves: Light green, once-divided in young plants becoming twice-divided in older plants with 1 or 2 (–3) pairs of very long, slender, drooping, flattened branchlets (20–40 cm long) each with 20–30 pairs of very small egg-shaped to somewhat elongated leaflets with almost parallel sides [1–4 (–10) mm long and 1–2 mm wide].

Flowers: Yellow and fragrant (2–3 cm across) with red or brown dots on the largest petal, in slender elongated clusters (5–20 cm long) arising from the leaf forks.

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning brown as they mature, narrow, elongated (3–13 cm long and 5–10 mm wide), swollen around each of the large seeds (9–15 mm long and 3–6 mm wide).

ORIGIN
Argentina, Bolivia, Galápagos Islands, Paraguay, Peru and Uruguay.

REASON FOR INTRODUCTION
Hedge/barrier, shade and ornament.

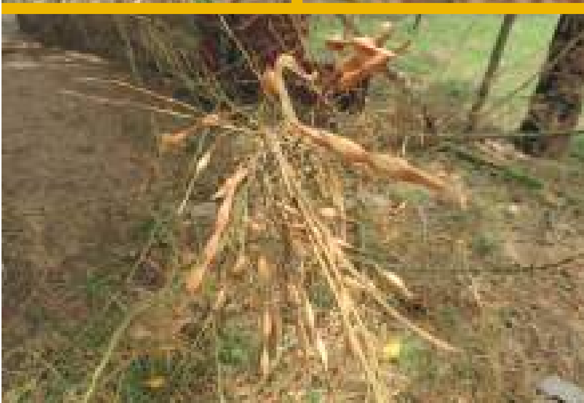
INVADES
Roadsides, disturbed land, drainage ditches, edges of irrigation channels, riversides, lowlands, floodplains, gullies and water courses.

IMPACTS

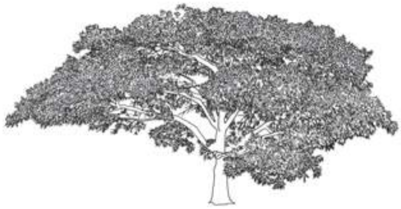
Forms large, impenetrable thickets, displacing native plant and animal species. According to Weber (2003), once it has become dominant it reduces species richness under stands. In Australia, this weed already occupies more than one million hectares, and has the potential to invade more than three-quarters of mainland Australia (Australian Weeds Committee, 2012). There, infestations have blocked or retarded water flows, increased erosion, lowered the water table, restricted access to land and to waterways, and blocked access by livestock to watering points. Dense stands of *P. aculeata* also harbour feral animals such as pigs – and contribute to additional mustering costs (Australian Weeds Committee, 2012). The livestock carrying capacities of pastures have been reduced. The spines on these trees/shrubs can cause injuries to people and to livestock and wild animals. In New Caledonia, *P. aculeata* has been described as one of the single biggest threats to productivity and profitability (Swarbrick, 1997).

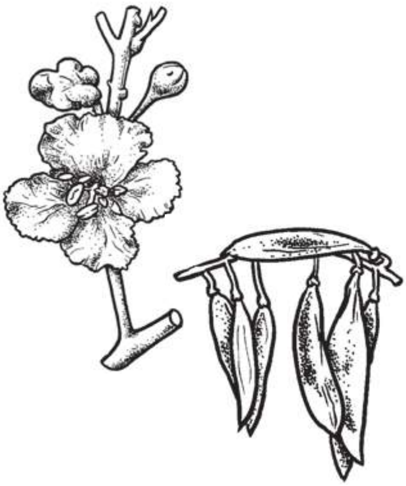
Notes: Cultivated in the Ethiopian regions of Eritrea East, Eritrea West, Tigray, Shewa, Harerge and Sidamo, it is naturalized in Eritrea West, Tigray and Harerge (Thulin, 1989). Almost 50 years ago, Brenan (1967) noted that it was cultivated in Uganda, Kenya and Tanzania, and that it "may become naturalized." This was confirmed by Beentje (1994) who found that it "has gone wild in places; often in riverine or swampy situations in dry areas" (Beentje, 1994). Birnie and Noad (2011) found that it was "showing signs of becoming naturalized". In Tanzania, it has the potential to become a serious weed (Mbuya *et al*., 1994). Our surveys found it to be locally abundant (invasive) at some sites, especially along roadsides and in low-lying areas.






Peltophorum pterocarpum (DC.) K. Heyne





PEA-FAMILY
Fabaceae; sub-family: Caesalpiniaceae

COMMON NAMES
English: copperpod, golden flamboyant, yellow flamboyant, yellow flame tree, yellow poinciana
Ethiopia: lugtoole

DESCRIPTION
Large tree [15–24 (–50) m tall], deciduous (sheds all or most of its leaves at the end of the growing season), with a trunk of diameter 50 (–100) cm; crown dense, spreading; tap-root deep.

Bark: Grey, smooth.

Leaves: Green, twice-divided (30–60 cm long), with 8–10 pairs of leaf branchlets each with 10–20 pairs of leaflets (0.8–2.5 cm long), leaflets elongated, with almost parallel sides, bases oblique.

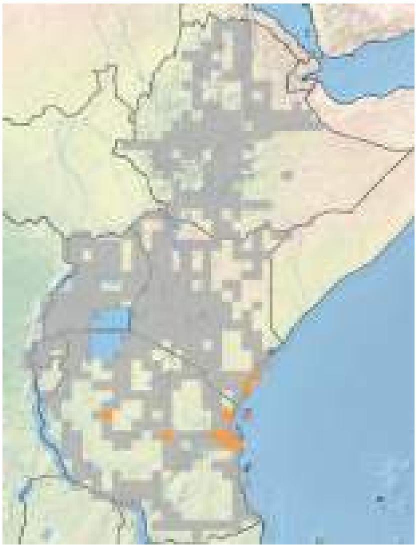
Flowers: Orange-yellow (2.5 cm across), fragrant, in terminal clusters with rust-coloured buds.

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning brown then black as they mature, flat, thin (5–10 cm long and 2.5 cm wide).

ORIGIN
Australia, Bangladesh, Cambodia, India, Indonesia, Malaysia, Myanmar, Papua New Guinea, Singapore, Sri Lanka, Thailand and Vietnam.

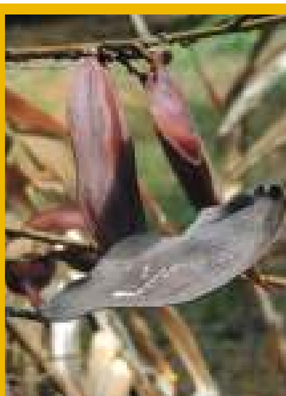
REASON FOR INTRODUCTION
Fuelwood, timber and ornament.

INVADES
Roadsides, disturbed areas, urban open spaces, gardens and savannahs.

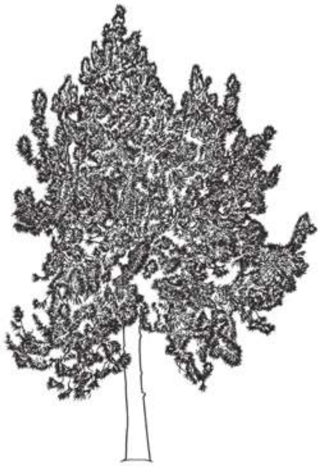


IMPACTS
Establishes dense localized infestations under or near mother plants, where it may displace native plant and animal species. In Hawaii, it appears to be in the early stages of naturalization on Maui (F. Starr, *pers*. *comm*., in PIER, 2010).

Notes: Widely grown as an ornamental throughout the region, especially in Tanzania. It has occasionally escaped cultivation and established stands under or near parent plants, especially along the Kenyan and Tanzanian coasts.

Pinus caribaea Morelet



FAMILY
Pinaceae

COMMON NAMES
Caribbean pine, pitch pine, Nicaragua pine

DESCRIPTION
Large evergreen coniferous tree [20–35 (–45) m tall] with a straight cylindrical trunk [50–80 (–100) cm in diameter]; crown rounded to pyramid-shaped; young twigs orange-brown; lower branches usually long, slender and drooping, with upper branches pointing upward.

Bark: Reddish-brown to greyish, deeply fissured.

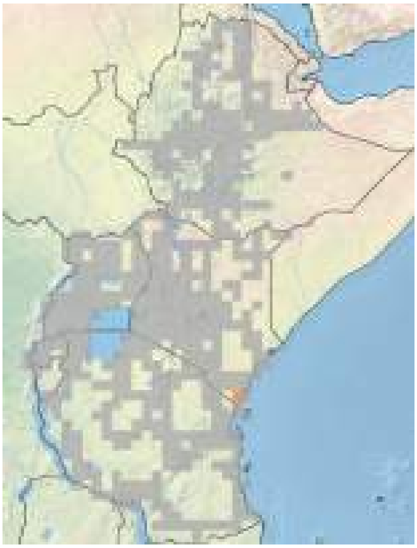
Leaves: Green needles in bundles of 2 or 3 (–4), (15–25 cm long and 1.5 mm wide), in whorls at the ends of the shoots.

Cones: Dark brown, on the inner surfaces of the scales, single, egg-shaped (4–14 cm long).

ORIGIN
Bahamas, Belize, Cuba, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Puerto Rico and Turks and Caicos Islands.

REASON FOR INTRODUCTION
Timber and paper and pulp production.

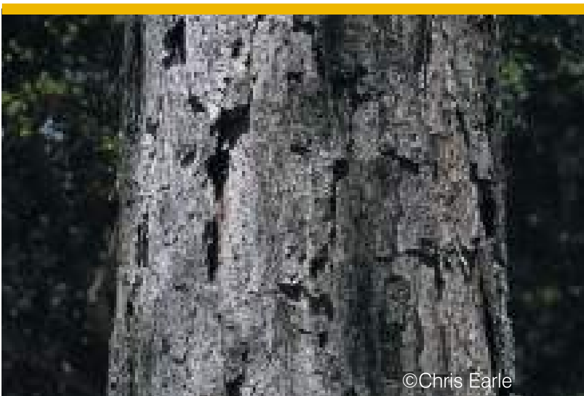
INVADES
Roadsides, disturbed areas, grasslands and forest edges/ gaps.



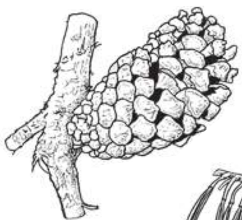
IMPACTS

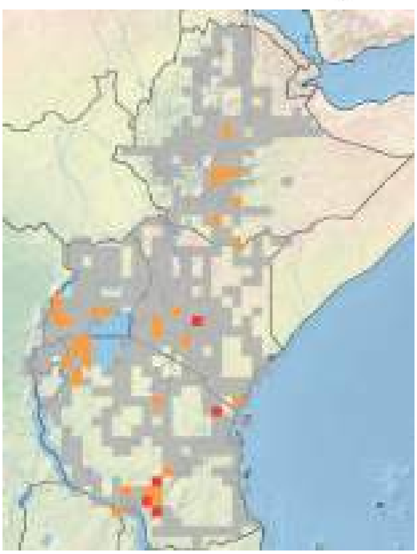
Has escaped cultivation and established populations in the wild which probably threaten native flora and fauna, especially in previously treeless landscapes. *P. caribaea* has escaped mainly from plantations, forming dense stands that exclude native vegetation and which alter hydrology, nutrient cycling, and fire regimes. Large amounts of litter under the trees result in the acidification of soils, making the understorey unsuitable for a host of native species (Richardson, 1998; Simberloff *et al.*, 2010). Infestations can also contribute to reductions in water supplies, while affecting recreation and altering the character of landscapes (Richardson, 1998). Conifer invasions in northwest Patagonia reduced the species richness of understorey vascular plants, beetles and birds (Paritsis and Aizen, 2008). Exotic pines invading local grasslands in the Argentinean pampas have displaced a number of endemic plant species (Zalba and Villamil, 2002) and contributed to changes in bird communities, including a decline of obligate grassland birds (Zalba, 2000). *P. caribaea* is invasive in Bangladesh, Brazil, Australia and a number of Pacific Islands (CABI, 2016).

Notes: Present in Shewa District of Ethiopia (Kelbessa, 2009), it has also been planted in Kenya, in Kwale District and on the Shimba Hills (Birnie and Noad, 2011), where it has become naturalized. Possibly naturalized elsewhere in East Africa. Due to difficulties distinguishing between various *Pinus* spp., *P. caribaea* is probably significantly more widespread and abundant than indicated.



Pinus patula Schiede ex Schltdl. & Cham.





FAMILY
Pinaceae

COMMON NAMES

English: patula pine. Mexican pine, Mexican weeping pine, weeping pine
Ethiopia: arzelibanos
Kenya: msindano, muchinda nugu
Rwanda: pinusi

DESCRIPTION
Large evergreen coniferous tree with drooping or 'weeping' foliage [12–20 (–40) m high]; straight cylindrical trunk (to 1.2 m in diameter), sometimes forked with two or more stems, conical when young but developing a dense, rounded canopy at maturity; often forking low down with branches almost horizontal and turning up at the ends.

Bark: Young bark reddish-orange and scaly, becoming grey to dark brown, vertically ridged.

Leaves: Grey-green to yellow-green needles in bundles of 3, occasionally 4 and rarely 5, slender and drooping (15–25 cm long).

Cones: Pale brown or yellowish-brown, shiny, woody, conical (7–10 cm long), single or in clusters of 2–5, sometimes eight, bent backwards on short stalks; cone scales with sunken centres.

ORIGIN
Mexico

REASON FOR INTRODUCTION
Timber, paper and pulp production.

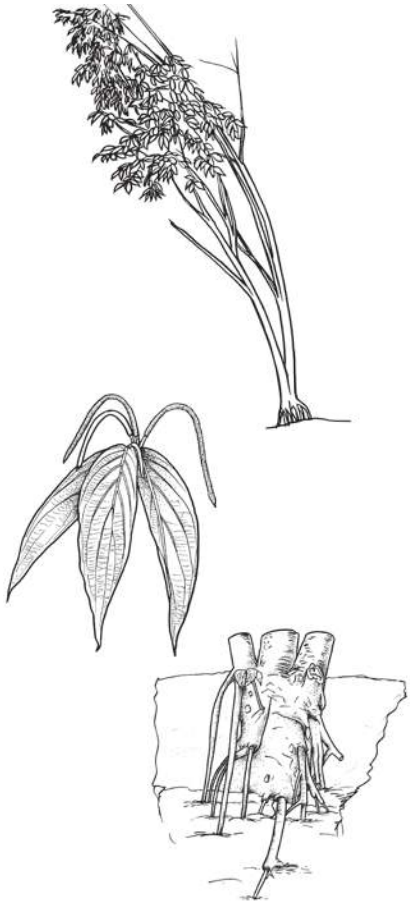
INVADES
Roadsides, disturbed areas, grasslands and forest edges/ gaps.

IMPACTS

P. patula has the ability to form dense stands, displacing native plant and animal species. In South Africa, *Pinus* spp. have invaded numerous conservation areas, displacing native plant species and reducing water run-off (Richardson *et al.*, 1992; Le Maitre *et al*., 1996; Richardson *et al.*, 1997; Richardson and Higgins, 1998; van Wilgen and van Wyk, 1999). Species richness and diversity among invertebrates has been found to be lower in pine plantations (which are similar to dense pine infestations) than in indigenous vegetation (Samways *et al.*, 1996). In terms of water-use, pine plantations on the Drakensberg in KwaZulu-Natal, South Africa, have reduced stream flows by 82% (Bosch, 1979), while in the Western Cape stream-flows from invaded fynbos water catchments have declined by 55%. In South Africa's Mpumalanga Province, the replacement of grassland catchment areas with pines and Eucalyptus spp. led, within 6–12 years, to the drying up of streams (van Lill *et al*., 1980). There, removal of dense stands of pines and wattles from river banks has resulted in a 120% increase in stream-flows (Dye and Poulter, 1995). *P. patula* is also invasive in Hawaii (USA), Zimbabwe, Botswana and Malawi (Haysom and Murphy, 2003), as well as in both Madagascar and New Zealand (Richardson and Rejmánek, 2004). In Zimbabwe, *P. patula* is considered to be one of the most aggressive invaders of afromontane forests, grasslands and miombo woodlands in localities above 1,600 metres above sea level where it is able to produce viable seed (Nyoka, 2003).

Notes: In Ethiopia, it is grown in woodlots in the regions of Shewa, Arsi, Kefa and Sidamo (Kelbessa, 2009). *P. patula* has also been recorded in the Kakamega Forest, Kenya (Fischer *et al*., 2010). *Pinus* spp. have also been reported as being invasive in the Southern Highlands of Tanzania (McKone and Walzzem, 1994). Due to difficulties in distinguishing between different *Pinus* spp., *P. patula* is probably significantly more abundant than indicated.

Piper aduncum L.



PEPPER FAMILY
Piperaceae

COMMON NAMES

English: bamboo piper, false matico, jointwood, piper
Kenya: dingon

DESCRIPTION
Evergreen shrub or small tree (6–8 m tall) with short stilt roots, often in thickets; branches erect, but with drooping twigs and swollen, purplish nodes; foliage and twigs aromatic.

Bark: Yellow-green, finely hairy stems with enlarged, ringed nodes.

Leaves: Green, softly hairy beneath, broadly sword- to oval-shaped (13–25 cm long and 3.5–8 cm wide), tapering into long tips with the base asymmetric, short leaf stalks.

Flowers: Yellowish, tiny, in long curving spikes opposite the leaves.

Fruits: Berries (fleshy fruits that do not open at maturity), green, small, egg-shaped, compressed into greyish, worm-like spikes.

ORIGIN
Belize, Brazil, Bolivia, Colombia, Costa Rica, Ecuador, El Salvador, French Guiana, Guatemala, Guyana, Honduras, Mexico, Nicaragua, Panama, Peru, Surinam, Venezuela and the Caribbean.

REASON FOR INTRODUCTION
Medicine, spice and ornament.

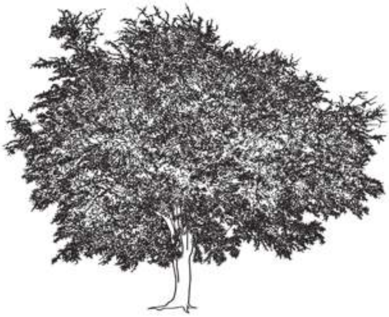
INVADES
Roadsides, disturbed land, fallow land, plantations, forest edges/gaps, lowlands and riparian zones.

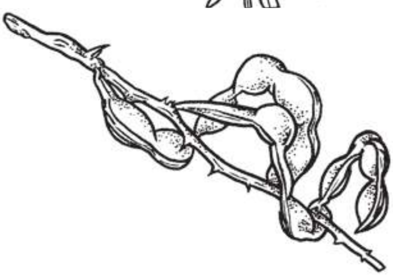
IMPACTS

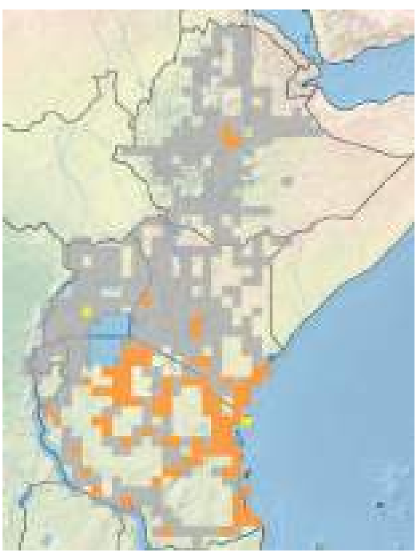
P. aduncum establishes dense stands which shade out native species and prevent forest regeneration. In field surveys in Papua New Guinea, it was found to be present in all garden plots, in 92% of riverine plots, in 80% of young secondary and 65% of old secondary forest plots, and in 75% of the gaps (Leps *et al.*, 2002). In some regenerating areas, *P. aduncum* attained a canopy cover of 75%, suppressing native species that local communities had utilized extensively in the past (Leps *et al.*, 2002). In the Pacific, it is accidentally harvested with kava (*Piper methysticum* G. Forst), an important crop, lowering its quality. It also competes with kava and other crops, and may act as a host for kava pests and pathogens (Plant Protection Service, 2001, in GISD, 2005). It uses large quantities of water, drying out the soil, and absorbs significant amounts of nutrients, to the detriment of crops. Also naturalized in Indonesia and Malaysia (Padmanaba and Sheil, 2014), and invasive in the Philippines (A.B.R. Witt, *pers. obs.*). According to Padmanaba and Sheil (2014) it may also become a very serious problem in natural forest areas in Borneo and elsewhere in the region, especially if the canopy is opened and there is a recurrence of major droughts and fires. Forest loss is often exacerbated when farmers abandon invaded land and clear virgin forest to plant crops.

Notes: *P. aduncum* is not present in Ethiopia (Gilbert, 2000b). In East Africa, where it is occasionally grown as an ornamental, it has been recorded as invasive only in the Amani Nature Reserve, East Usambaras, Tanzania (Dawson *et al.*, 2008), confirmed by our surveys.

Pithecellobium dulce (Roxb.) Benth.







FAMILY

Fabaceae; sub-family: Mimosaceae

COMMON NAMES

English: Manila tamarind, sweet inga
Ethiopia: madras
Kenya: mkwaju-wa-kihindi
Tanzania: mchongoma?

DESCRIPTION

Spiny tree (15–20 m high) with a short trunk (80–100 cm in diameter), usually with multiple stems, spreading in habit with irregular branches, pairs of straight spines (4–13 mm long) on shoots, but occasionally thornless.

Bark: Whitish grey, pale and smooth on young trees becoming rough, then furrowed.

Leaves: Deep green above, paler green-grey below, twice-divided, one pair of leaflet branchlets with single pair of obliquely oval or elongated-oval leaflets (25–46 mm long and 9–32 mm wide) per branchlet.

Flowers: White-greenish (1.0–1.5 mm across), in clusters of 20–30 at ends of branches, slightly fragrant.

Fruits: Pods (several-seeded dry fruits that split open at maturity), greenish-brown turning red or pinkish as they mature (10–15 cm long and 1–2 cm wide), irregular and flattened, in spirals of 1–3 whorls, containing about 10 black, shiny seeds, each with with red-and-white edible appendage.

ORIGIN

Argentina, Bolivia, Brazil, Colombia, Ecuador, French Guiana, Guyana, Mexico, Paraguay, Peru, Surinam, Uruguay, USA and Venezuela.

REASON FOR INTRODUCTION

Barrier/hedge, edible fruit and ornament.

INVADES

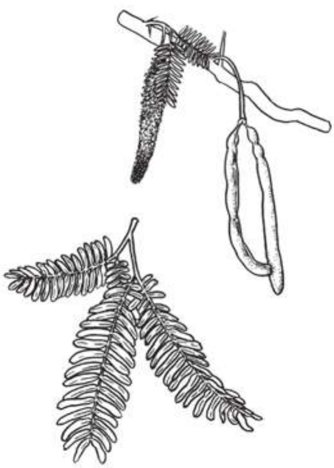
Roadsides, disturbed areas, urban open spaces, gardens and savannahs.

IMPACTS

Establishes dense, impenetrable stands which displace native flora and fauna. A fast-growing and highly adaptable species, it can grow in a wide range of soils and habitats in the tropics and sub-tropics. Being a nitrogen-fixing species, it alters nutrient cycling. It also has the ability to invade pasture, impacting negatively on livestock production. The sharp thorns can cause injuries to people and livestock, while the plant sap can cause skin welts and eye irritations. In Hawaii, it is naturalized (Wagner *et al*., 1999), having displaced other plants in dry pastures and disturbed natural areas (Motooka *et al.*, 2003). It is also naturalized in Fiji (Smith, 1985).

Notes: Widely planted as an ornamental and as a hedge in the Ethiopian regions of Eritrea East, Eritrea West, Harerge and Ilubabor (Thulin, 1989), it has the potential to become a weed in Ethiopia and Eritrea (Bekele-Tesemma *et al*., 1993; Bein, 1996). Brenan (1967) found it to be naturalized on the fringe of a woodland at Mazeras, in Kenya, almost 50 years ago. In Kenya, it has "gone wild on the coast and near Thika" (Beentje, 1994). KHS (1995) infers that Madras thorn is naturalized in Kenya by stating, "seedlings freely available near mature plants." It has the potential to become a weed in Uganda (Mbuya *et al*., 1994). Our surveys found it to be occasionally naturalized, but never invasive.

Prosopis juliflora (Sw.) DC.



PEA FAMILY
Fabaceae; sub-family: Mimosaceae

COMMON NAMES
English: algorroba, ironwood, mesquite
Ethiopia: prosopis
Kenya: eterai, mathenge, mathebe
Tanzania: ngezi

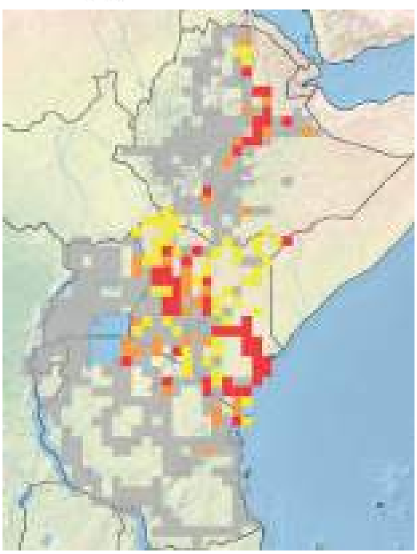
DESCRIPTION
Evergreen shrub or tree [3–5 (–15) m high] with thorns/spines; multi-stemmed but occasionally single-stemmed, twigs distinctively zigzagged.

Bark: Thick, rough grey-green, becoming scaly with age and armed with sharp thorns/spines (to 5 cm long).

Leaves: Dark green, hairless or hairy, twice-divided, 1–3 (–4) pairs of leaf branchlets (3–11 cm long), each with 11–15 pairs of leaflets, narrow, somewhat elongated with parallel sides (6–23 mm long and 1.6–5.5 mm wide), with smooth margins, no terminal leaflet, leaves grow alternately on the stems.

Flowers: Yellow, small, in cylindrical spikes (5–10 cm long and 1.5 cm side), solitary or in clusters near the leaf axils, fragrant.

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning yellow as they mature, flat, slightly curved (8–29 cm long and 9–17 mm wide), containing 10–20 oval seeds (2–8 mm long).



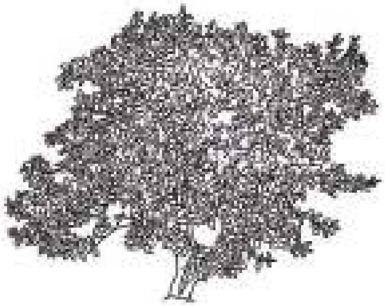
ORIGIN
Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama and Venezuela.

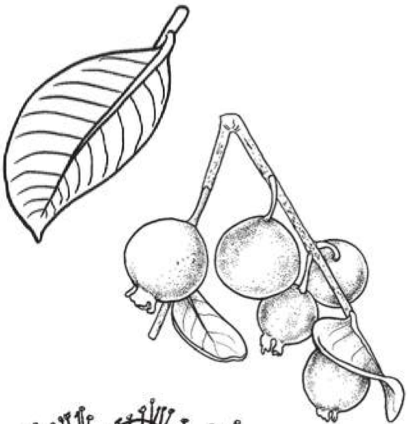
REASON FOR INTRODUCTION
Fuelwood, timber, fodder, tannin, landscape restoration, windbreaks, shade, hedge/barrier and ornament.

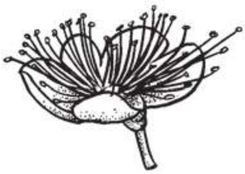
INVADES
Roadsides, disturbed land, wastelands, fallow land, drainage ditches, woodland edges/gaps, savannahs, riparian vegetation, floodplains, gullies and sandy stream beds.

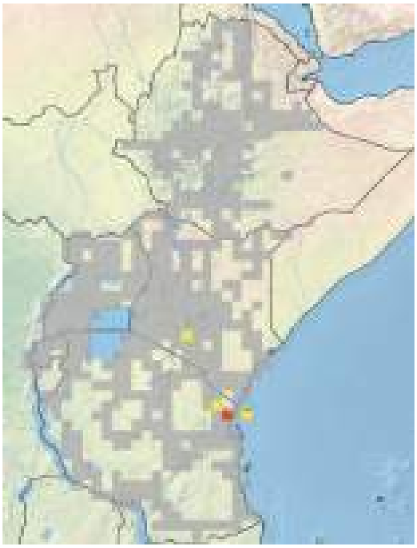
IMPACTS
Displaces native plant species and reduces the abundance and diversity of birds and other animal species. In Ethiopia, *P. juliflora* has reduced understorey basal cover for perennial grasses from 68% to 2%, and has reduced the number of grass species from seven to two (Kebede and Coppock, 2015). By transforming habitats and eliminating pasture species, *P. juliflora* is threatening the survival of Grévy's zebra (*Equus grevyi*) in invaded areas (Kebede and Coppock, 2015). *P. juliflora* also has a dramatic negative impact on underground water resources. Other negative impacts include encroachment on to paths, villages, homes, crop- and pasturelands, and injuries inflicted by the thorns (Mwangi and Swallow, 2008; Maundu *et al*., 2009). Infestations have contributed to the abandonment of agricultural land, and in some cases of homes and small villages as well. The pollen has been identified as a major allergen (Killian and McMichael, 2004). In semi-arid parts of Africa, *P. juliflora* has depleted the natural resources on which many thousands of people depend, spawning conflict between communities over the diminishing resources. In invaded areas of northeastern Brazil and the Caatinga biome, *P. juliflora* now reportedly accounts for around 87% of total ground cover, and has drastically altered the diversity and structure of native forests (Pegado *et al*., 2006). In invaded riparian areas in Bahia, the species accounts for 60.8% of all plant species in regenerating forests (P.C.F. Lima and L.H.P. Kiill, *unpubl*. *data*, in Zenni and Ziller, 2011).

Notes: It is grown in the Kasese District of Uganda (Katende *et al*., 1995). In the eastern parts of Ethiopia (Afar plains, eastern Welo, eastern Shoa and Harerge), it has become a noxious weed (Bekele-Tesemma *et al*., 1993). Our surveys found *P. juliflora* to be invasive across large parts of Ethiopia and Kenya, and to be locally abundant in parts of Tanzania. It has invaded roadsides, urban open spaces, savannahs and riparian vegetation. A congener, *Prosopis chilensis* (Molina) Stuntz, is abundant around Tesenei, Karora, Mahmimet and Massawa in Eritea, where it can become a weed (Bein *et al.*, 1996).









MYRTLE FAMILY
Myrtaceae

COMMON NAMES
English: cherry guava, Chinese guava, red guava, strawberry guava
Kenya: baddeeessaa, doqma, ocha, yino

DESCRIPTION
Small erect evergreen bush or tree [1–3 (–8) m tall]; younger stems rounded, hairless or sparsely hairy.

Bark: Grey to reddish-brown, peels readily.

Leaves: Dark green, shiny, leathery, hairless, oval to egg-shaped (4–8 cm long and 2.5–4.5 cm wide), tapering at the bases with short pointed tips, held opposite each other on the stems.

Flowers: White (15–25 mm across) on short stalks (3–7 mm long).

Fruits: Berries (fleshy fruits that open at maturity), green turning purplish-red as they mature, round, fleshy (2–3.5 cm across), crowned with some of the old flower parts.

ORIGIN
Brazil and Uruguay.

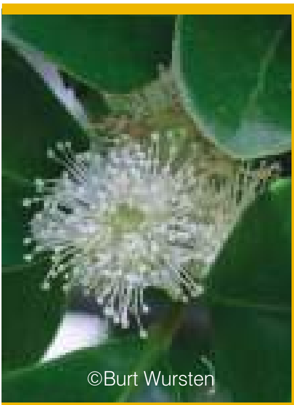
REASON FOR INTRODUCTION
Edible fruit and ornament.

INVADES
Roadsides, disturbed areas, urban open space, forest edges/gaps, forests and riparian vegetation.

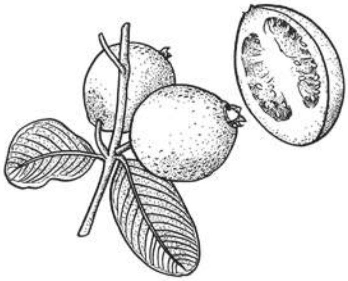
IMPACTS

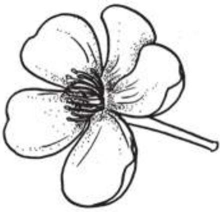
Forms dense thickets which displace native plant species, inhibiting their regeneration. *P. cattleianum* is a habitat-changing weed. It is shade-tolerant and as such is able to proliferate in forest understoreys, posing a major threat to the endemic flora of many natural habitats. Its leaf litter, being allelopathic, inhibits the germination and growth of native plant species (Smith, 1985). *P. cattleianum* has been identified, along with other introduced species, as one of the most serious threats to forests on the Seychelles (Fleischmann, 1997, 1999). It is also considered to be one of the most serious invaders on Réunion (MacDonald *et al*., 1991), and Mauritius (Lorence and Sussman, 1988), as well as in forests on Madagascar. In Hawaii, *P. cattleianum* is widespread in the rainforests of several protected areas. In the lower-elevation rainforest of Hawaii's Haleakala National Park, *P. cattleianum* has, together with *Paspalum conjugatum* Bergius (Poaceae), almost completely halted reproduction of *Antidesma platyphyllum* Mann (Phyllanthaceae) and of seven other rare flowering species (Vitousek *et al*., 1987). According to Tng *et al.* (2015), strawberry guava invasions have potentially dire consequences for regenerating native forests in the Australian Wet Tropics.

Notes: It is "widely cultivated in East Africa" (Verdcourt, 2001), and "not uncommon in Uganda" (Dale, 1953). Echoing this view, Greenway (undated in Verdcourt, 2001) found it to be "cultivated and regenerating freely, also spread by birds." It is considered to be invasive in the Amani Nature Reserve, Tanzania (Dawson *et al*., 2008). Other observations suggest that it may be significantly more widespread than indicated on the distribution map.



Psidium guajava L.





MYRTLE FAMILY
Myrtaceae

COMMON NAMES

English: Brazilian guava, common guava, guava, yellow guava
Ethiopia: zeitun, zeyiton, zeyitum, zeythun, zeytun, zeyitunnaa
Kenya: kivela, lipera, mapera, mbera, mpera, mupeera
Rwanda: guwawa, makepera
Tanzania: ipera, mpeya, mupela
Uganda: mupeera

DESCRIPTION
Evergreen tree or small shrub [1–6 (–10) m tall], stems smooth, young stems four-angled, green and hairy.

Bark: Reddish-brown, peels off in flakes giving the trunk a mottled appearance.

Leaves: Bronze turning light green, hairy undersides, egg-shaped, oval to elongated (7–15 cm long and 3–7 cm wide), often broad and rounded at both ends with a small, pointed tip, 10–20 pairs of very obvious veins on the underside, held opposite each other on the stems.

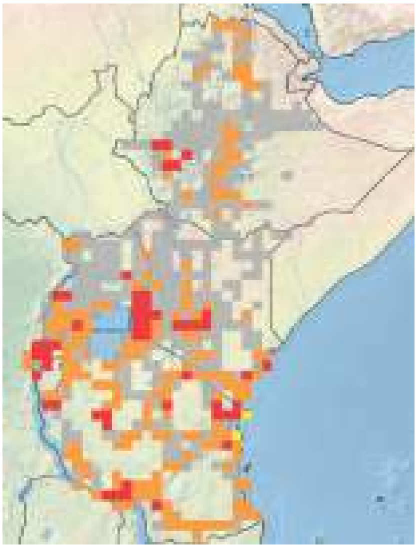
Flowers: White (about 25 mm across), held on hairy stalks (1–2.5 cm long) in groups of 1–3.

Fruits: Berries (fleshy fruits that open at maturity), green turning yellow as they mature, round to pear-shaped (2.5–10 cm long); flesh white, yellow or pink, with a strong odour.

ORIGIN
Argentina, Bolivia, Brazil, Colombia, Ecuador, French Guiana, Guyana, Mexico, Paraguay, Peru, Surinam, Venezuela and the Caribbean.

REASON FOR INTRODUCTION
Edible fruit.

INVADES
Roadsides, disturbed areas, wastelands, urban open space, forest, forest edges/gaps, woodland, woodland edges/gaps, savannah and riparian vegetation.



IMPACTS

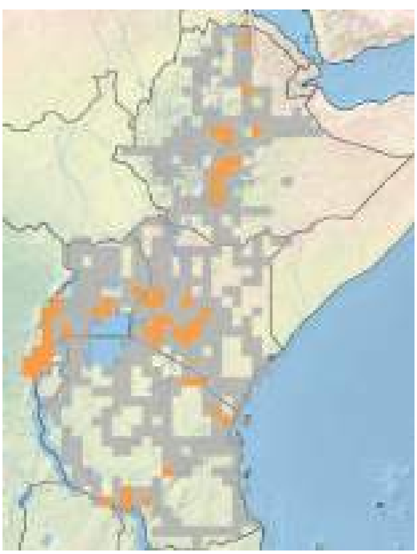
Establishes dense stands, displacing native plant and animal species. It is considered to be allelopathic (Smith, 1998), impacting negatively on seed germination and root growth in lettuce (*Lactuca sativa* L.) (Chapla and Campos, 2010). In Zimbabwe, *P. guajava* is invasive in lowland forest areas of the eastern highlands. On Costa Rica, *P. guajava* is a serious weed in pastures, where it is hard to eradicate and can lead to land degradation (Somarriba, 1995). On Hawaii, it has formed dense thickets in native *Acacia* forests (Smith, 1998; Cronk and Fuller, 1995). It is also a weed in agricultural areas of Puerto Rico (CABI, 2016), and is considered to be invasive on Bermuda and in Brazil (Ziller and Rosa, 2001). It is invasive in secondary forests on abandoned pasture in the Upper Paraná River Floodplain (Campos and Dickinson, 2005), where understoreys dominated by *P. guajava* support fewer native plant species (Chapla *et al.*, 2008). The species also covers large areas in the Galápagos archipelago where, together with quinine (*Cinchona pubescens* Vahl; Rubiaceae), it has turned previously treeless shrublands into highland forests (Jager *et al*., 2007; Watson *et al*., 2009). Invasions have resulted in 57–88% declines in endemic herb and grass species (Jager *et al.*, 2007). Invasive *P. guajava* stands provide an alternative host for introduced and native fruitfly species, so increasing damage to cultivated crops (Langeland and Burks, 1998).

Notes: In Ethiopia, it is planted in gardens and is locally naturalized in many regions (Friis, 1995). According to Verdcourt (2001), it is "widely grown throughout East Africa and has become wild in various places in Tanzania, especially along the coast and near habitations." In Tanzania, it is invasive in the Amani Nature Reserve, East Usambaras (Dawson *et al*., 2008), and "may become a weed on good sites elsewhere, often colonizing unused sites" (Mbuya *et al*., 1994). In Kenya, it "has spread extensively in the western parts of the country, particularly in humid parts of Western and Nyanza Provinces (Maundu and Tengnäs, 2005). Our surveys support these observations, in having found large infestations in many parts of Kenya, including areas within and adjoining Kakamega Forest.





Sambucus nigra L. ssp. *canadensis* (L.) R. Bolli



HONEYSUCKLE FAMILY
Adoxaceae (Caprifoliaceae)

SYNONYM
Sambucus canadensis L.

COMMON NAMES

English: American black elderberry, American elder, American elderberry, elderberry, sweet elder

DESCRIPTION
Shrub or small tree (to 6 m tall) with multiple stems, branching from the base; sometimes with a short rhizome.

Bark: Deeply fissured, grey on branches, with many lenticels.

Leaves: Green, hairless, variable from once- to twice-divided (10–30 cm long), 5–11 (–15) oval to egg-shaped leaflets (5–9 cm long and 2–3 cm wide) with broad and rounded or oblique bases tapering towards the apex, margins sharply toothed and hairy, held opposite each other on the stems; leaf stalks to 6 cm long.

Flowers: Yellowish or creamy white (6–8 mm across), in large dome-shaped clusters [12–24 (–30) cm wide], unpleasant smell.

Fruits: Drupes (fruits with a stony centre), berry-like, purple-black, hairless, round, small (6–8 mm across), containing 4–5 seeds (3 mm long).

ORIGIN
Eastern seaboard of North America from Nova Scotia, Canada, to South Florida and west to Texas, Mexico and southwards to Panama.

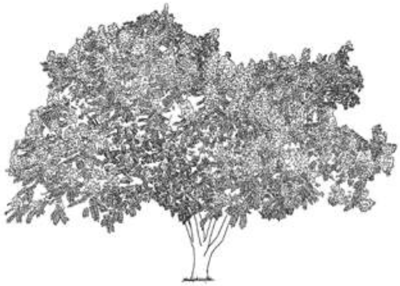
REASON FOR INTRODUCTION
Medicine and ornament.

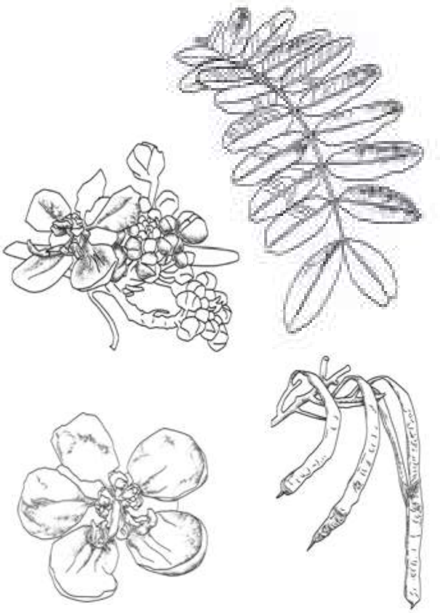
INVADES
Disturbed areas, urban open space, forest, forest gaps/ edges, floodplains and riparian zones.

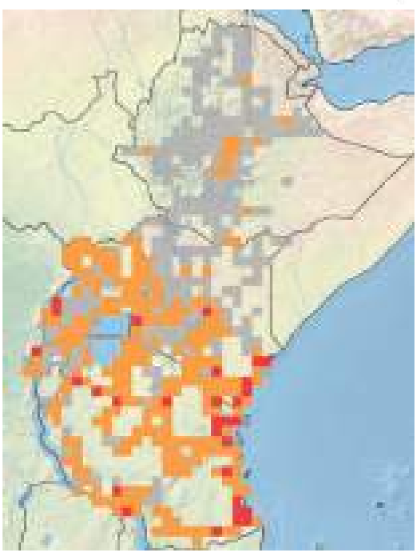
IMPACTS

There is little to no information available on the negative impacts of American elder. However, some research has been undertaken on the impacts of the European elderberry (*S. nigra* L. or *Sambucus nigra* L. ssp. *nigra*), which has become problematic outside of its natural range in Europe. *S. nigra* has the ability to form dense stands, especially along watercourses, where it may displace native plant and animal species, while impacting on the local hydrology. *S. nigra* easily colonizes natural forests, plantation forests and shrublands (Kollmann and Reiner, 1996). In the Baltic States, it is established in semi-natural habitats, such as dry and mesophilous pine forests (Gudžinskas, 1998; Laivinš, 2002). It can establish under a closed canopy (Gilbert, 1991, in Atkinson and Atkinson, 2002). *S. nigra* is toxic, and cases of poisoning have been reported in animals and also in people who have eaten the bark, leaves, berries, roots and stems (Cooper and Johnson, 1984, in Atkinson and Atkinson, 2002).

Notes: Plants identified as *S. canadensis* are present in the Ethiopian regions of Eritrea West, Shewa, Arsi and Sidamo (Kelbessa, 2003). These Ethiopian plants appear never to produce fruits, but they do spread vegetatively from suckers near the main stem (Kelbessa, 2003). Widely grown as an ornamental in East Africa, *S. canadensis* (now *Sambucus nigra* ssp. *canadensis*) has escaped cultivation and established in low-lying areas, especially along waterways. Not to be confused with the indigenous species *S. ebulus* L. ssp. *africana* (Engl.) R. Bolli.







PEA-FAMILY

Fabaceae; sub-family: Caesalpiniaceae

COMMON NAMES

English: Bombay blackwood, cassia, iron wood, Thailand shower, Siamese senna, yellow cassia
Ethiopia: boskobassha, hambhambo, jalelo, yeferenji digita
Kenya: igasha, ikengeta, mbengo, mjohoro, muchingiri, ndek owinu
Tanzania: nsongoma

DESCRIPTION

Evergreen medium-sized tree (10–12 (–30) m tall) with a short, straight trunk (to 30 cm in diameter); crown dense and round at first becoming irregular and spreading with age; shallow root system.

Bark: Grey or light brown, smooth, becoming slightly fissured longitudinally with age.

Leaves: Dark green, once-divided [10–) 15–30 (–35) cm long] with 6–14 pairs of oblong leaflets (3–7 cm long and 12–20 mm wide), rounded at both ends with tiny bristled tips, leaves arranged alternately on stems.

Flowers: Bright yellow (3 cm across), in upright, pyramidal-shaped clusters [20–30 (–60) cm long and 13 cm across] at the ends of the branches.

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning dark brown as they mature, long, narrow, flat (15–25 cm long and 12–20 mm wide), constricted between seeds; seeds bean-shaped, shiny, dark brown (8 mm long).

ORIGIN

Brunei, Cambodia, China, India, Indonesia, Laos, Malaysia, Myanmar, Thailand, Nepal, Philippines, Sri Lanka, Thailand and Vietnam.

REASON FOR INTRODUCTION

Ornament, shade, shelter, timber and fuelwood.

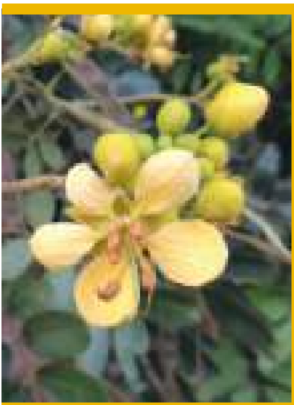
INVADES

Roadsides, disturbed areas, urbam open spaces, plantations and open woodlands.

IMPACTS

It has escaped cultivation in some areas, forming stands that may have a negative impact on native plant species. Contact with the wood shavings can irritate the skin. The leaves, pods and seeds are toxic to pigs and to poultry, and possibly to other species (CABI, 2016). The leaves are said to be poisonous to people.

Notes: Cultivated in the regions of Eritrea West, Eritrea East and Ilubabor and "no doubt elsewhere", it is not recorded as being naturalized or invasive in Ethiopia (Thulin, 1989). Widely planted throughout East Africa, it is naturalized and invasive in some areas, although infestations appear to be limited to areas around mother plants.



Senna spectabilis (DC.) H.S. Irwin & Barneby

PEA-FAMILY
Fabaceae; sub-family: Caesalpiniaceae

COMMON NAMES
English: calceolaria shower, cassia, pisabed, yellow shower
Ethiopia: gwefyya
Kenya: igasha, mhomba, muchingiri
Rwanda: cassiya
Tanzania: mjoholo-lua

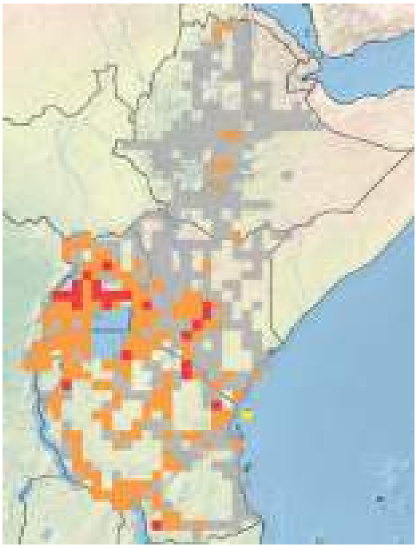
DESCRIPTION
Tree [7–10 (–15) m tall] with a spreading crown, deciduous (sheds most or all of its leaves at the end of the growing season), trunk to 30 cm in diameter.

Bark: Smooth, grey, with horizontal markings, of warts and short fissures, becoming rougher with age, with broad vertical bands of large lenticels.

Leaves: Green, usually softly hairy below, once-divided (to 40 cm long) with 4–15 (–19) pairs of leaflets, narrowly oval (to 7.5 cm long), tapering towards the tips.

Flowers: Yellow, held in large, branched erect terminal clusters [15–30 (–90) cm long], fragrant.

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning black as they mature, cylindrical or flattened (18–25 cm long), ending in a short, narrow point, hard, not splitting open or splitting only slightly on one side, with many cross walls (to 3 mm apart) between separate seed compartments; seeds 50–70, flattened, brown (about 5 mm wide).



ORIGIN
Antigua and Barbuda, Argentina, Bahamas, Barbados, Bolivia, Brazil, Chile, Colombia, Cuba, Dominica, Dominican Republic, Ecuador, French Guiana, Grenada, Guadeloupe, Guatemala, Guyana, Haiti, Honduras, Jamaica, Martinique, Mexico, Montserrat, Netherlands Antilles, Nicaragua, Panama, Paraguay, Peru, St Kitts and Nevis, St Lucia, St Vincent and the Grenadines, Surinam, Trinidad and Tobago, Uruguay and Venezuela.

REASON FOR INTRODUCTION
Fuelwood, boundary markers and ornament.

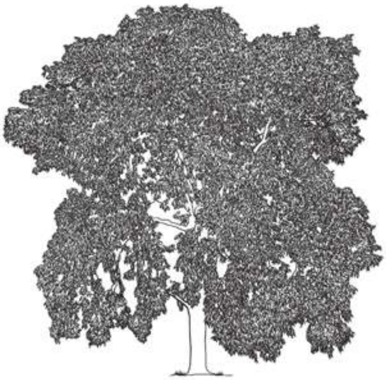
INVADES
Roadsides, disturbed areas, wastelands, urban open space, plantations, forest edges/gaps, woodlands, woodland edges/gaps and riparian vegetation.

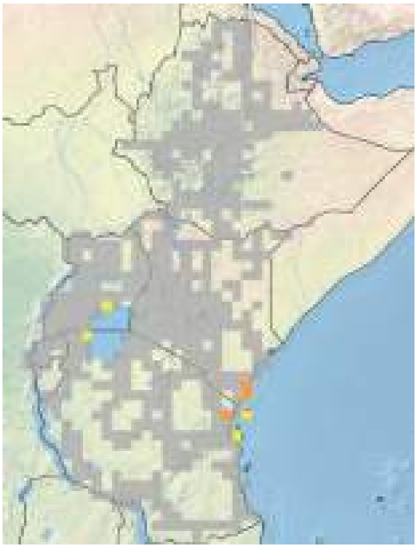
IMPACTS
S. spectabilis grows rapidly, dominating other species in the wild and displacing native flora, and in cultivated lands out-competing crops, causing reduced crop yields (Noordwijk *et al.*, 2004). Stands in the Mahale Mountains National Park, western Tanzania, now cover an estimated 225 ha. There, in areas where the species has been removed or killed, the abundance of native tree species has increased markedly. According to Wakibara and Mnaya (2002), *S. spectabilis* appears to have suppressed renewal among native trees in the Park, and its removal alone has been enough to encourage regeneration of degraded forest, without the need for artificial re-seeding. In India, infestations of *S. spectabilis* and of other invasive plant species (including *Lantana camara, Chromolaena odorata* and *Parthenium hysterophorus*) are posing a threat to wildlife and indigenous plants in the forest areas of the Nilgiri Biosphere Reserve, including the Wayanad Wildlife Sanctuary, a major habitat for the country's Asiatic elephants. Areas in this part of India invaded by *S. spectabilis* cover nearly 3,000 km^2, in the North and South Wayanad Forest Divisions and in the adjacent Muthumalai, Bandipur and Nagarhole Tiger Reserves, as well as in the Wayanad Wildlife Sanctuary. The resulting displacement of valuable forage plants may exacerbate "man-animal conflict" (Manoj, The Hindu, 2014; Rajeev, The Times of India, 2015).

Notes: *S. spectabilis* is naturalized and invasive at many localities in East Africa, including the Budongo Forest and the Kibale Forest National Park in Uganda and the Mahale Mountains National Park in Tanzania. Widely grown as an ornamental, it often escapes cultivation, especially in higher-rainfall areas. Often found as an escape in forest gaps and along the edges of forests and woodlands.




Syzygium cumini (L.) Skeels





MYRTLE FAMILY
Myrtaceae

COMMON NAMES

English: black plum tree, black plum, jambolan-plum, Java plum, jambolan, malabar plum
Kenya: eme, jamna, msambarau, zambarau
Tanzania: jambolan, mpemba, msamli, mzambarau

DESCRIPTION

Evergreen medium-sized tree [10–20 (–30) m tall] with a short trunk (40–100 cm in diameter), straight or crooked but usually multi-stemmed close to the ground; crown (to 11 m in diameter) irregular or round with many branches; twigs light green, becoming light grey and hairless; hanging, glossy foliage.

Bark: Brown or dark grey, thick, rough, cracked and flaking, but smooth higher up.

Leaves: Pinkish when young, older leaves with a dark green upper surface, lower surface yellowish and dull, mid-vein light yellow, hairless, thick, egg-shaped, oval or somewhat elongated (7–18 cm long and 3–9 cm wide), base triangular or rounded, apex blunt or tapering to a pointed tip, held opposite each other on stems, on slender stalks (1.5–2 cm long); turpentine-like smell.

Flowers: White, drying to pale orange-brown, small (7 mm long), in many-flowered clusters (2.5–10 cm long), slightly fragrant.

Fruits: Berries (fleshy fruits that do not open at maturity), green turning pink then purple-black as they mature, egg-shaped to somewhat elongated or oval [1–2.5 (–5) cm long], in clusters of 10–40; pulp greyish-yellow, white or pale violet, containing 1–5 seeds.

ORIGIN

India, Malaysia, Myanmar, Philippines, Sri Lanka and Thailand.

REASON FOR INTRODUCTION

Fuelwood, timber, edible fruit, bee forage and ornament.

INVADES

Roadsides, disturbed areas, urban open space and coastal vegetation.

IMPACTS

Where it has escaped from cultivation, it can form dense stands, to the detriment of biodiversity. In large monospecific stands, it excludes other species, preventing forest regeneration (Weber, 2003). The tree has the ability to grow in wet and well drained soils, and withstand prolonged flooding (Weber, 2003). It is invasive in Hawaii, on the Cook Islands and in French Polynesia, where it has prevented the re-establishent of lowland forest (PIER, 2016). Being allelopathic, it is able to prevent the establishment and growth of plants of other species (Medeiros *et al.*, 2015).

Notes: According to Beentje (1994), it is naturalized on the coast at Wundanyi, and at Muhoroni near Kericho. It is also present in Kakamega Forest, Kenya (Fischer *et al*., 2010), and is naturalized on Mombasa Island (Birnie and Noad, 2011). In Uganda, it has become "naturalized in secondary forests and scrub" (Katende *et al*., 1995). In East Africa, it occurs "on plantation edges, and in sea-shore and coastal bush and savannah habitats on coral rock, having more or less naturalized in some coastal areas" (Verdcourt, 2001).

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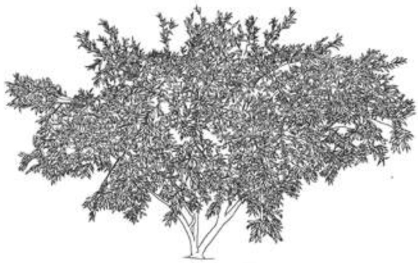
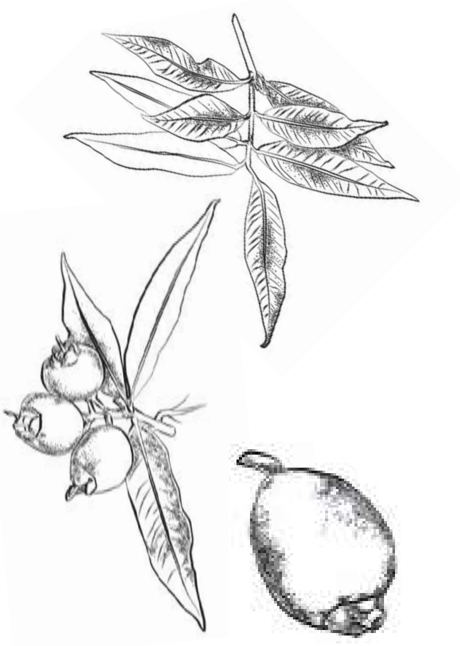
Syzygium jambos (L.) Alston





MYRTLE FAMILY
Myrtaceae

COMMON NAMES

English: plum rose, rose apple, malabar plum
Tanzania: mpemba, mvengi

DESCRIPTION
Evergreen large shrub or small tree (7.5–12 m tall) with a short trunk (to 50 cm in diameter) and a dense crown (to 20 m diameter) of slender, wide-spreading branches.

Bark: Brown, smooth but furrowed.

Leaves: Pinkish when young, mature leaves dark green above, lighter below, glossy, leathery, narrow or sword-shaped (10–22 cm long and 2.5–6.25 cm wide), triangular at base, tapering to a sharply pointed tip, held opposite each other on stems, on stalks [5–6 (–13) mm long].

Flowers: Creamy- or greenish-white, large (5–10 cm wide), in terminal clusters (5–10 cm long) of 4–5 flowers.

Fruits: Berries (fleshy fruits that do not open at maturity), green turning pale yellow or whitish as they mature sometimes pink as they mature, nearly round, oval or slightly pear-shaped (4–5 cm long); pulp dry to juicy, yellowish, sweet, containing 1–4 round seeds.

ORIGIN
Guatemala, Honduras, Malaysia, Panama, Puerto Rico, Virgin Islands (USA).

REASON FOR INTRODUCTION
Fuelwood, timber, medicine, edible fruit, bee forage and ornament.

INVADES
Roadsides, disturbed areas, forests, forest edges/gaps and coastal vegetation.

IMPACTS

Where it has escaped from cultivation, it can form dense monospecific stands, displacing native plant and animal species. The trees produce vegetative shoots, and juveniles are shade-tolerant, allowing the species to proliferate rapidly, even in forest understoreys (Huenneke and Vitousek 1990; Aide *et al*., 2000; Weber, 2003). On the Pitcairn Islands, it has displaced native trees, and has even suppressed other aggressive plant invaders such as *Lantana camara* (Diamond, 1994; Binggeli, 2001). A dense, shallow and spreading root system, coupled with the extensive, deep shade cast by the foliage of the trees, is deleterious to crop growth (Binggeli, 2001). In the Dominican Republic, it has become a serious weed of *Pinus occidentalis* Sw. (Pinaceae) forests, preventing their regeneration (Wadsworth, 1943). On the Comoros islands, it is one of the most damaging invasive plant species in the Kartala Forest (Yahaya Ibrahim and Mauremootoo, 2003). As an alternative host for various fruitfly species, *S. jambos* has increased the pest load on tropical and sub-tropical fruit trees. Dense stands can also contribute to increased erosion, resulting in the formation of deep gullies, extending right down to the bedrock in some areas on Pitcairn Island. The seeds and the roots are poisonous.

Notes: Specimens have been collected in Uganda and in the districts of Mwanza, Lushoto and Kilosa in Tanzania. It is naturalized on Zanzibar “in forest on loam over coral” (Verdcourt, 2001), and has spread from where it was originally planted in the Amani Botanical Gardens, East Usambaras, Tanzania (Dawson *et al.*, 2008). Not recorded as present in Ethiopia (Friis, 1995).

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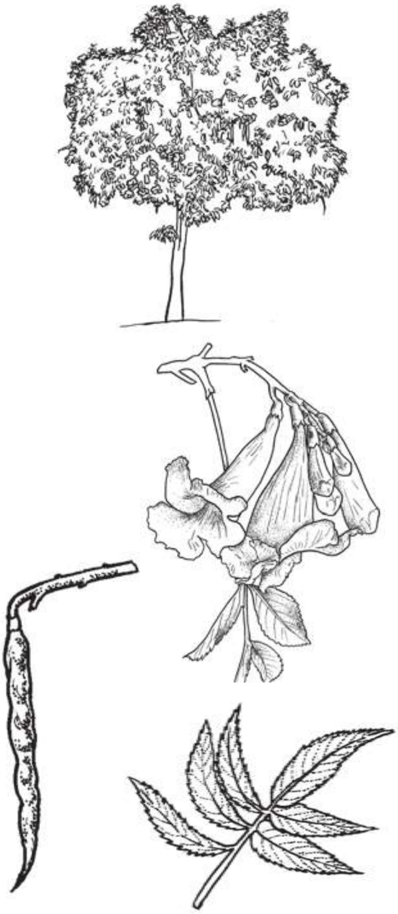


JACARANDA FAMILY
Bignoniaceae

COMMON NAMES
English: tecoma, trumpet flower, yellow bells, yellow elder, yellow trumpet flower
Tanzania: mtekoma

DESCRIPTION
Large shrub or small tree [1.5–5 (–10) m tall], much-branched; younger stems greenish, smooth, hairless, four-angled.

Bark: Light brown to pale grey, furrowed and rough in texture.

Leaves: Green, generally hairless, soft to the touch, once-divided (10–25 cm long) with 3–7 (–13) egg-shaped or elongated leaflets (25–100 mm long and 8–30 mm wide), terminal leaflet larger, margins sharply toothed with pointed tips; leaves on slender stalks (1–9 cm long).

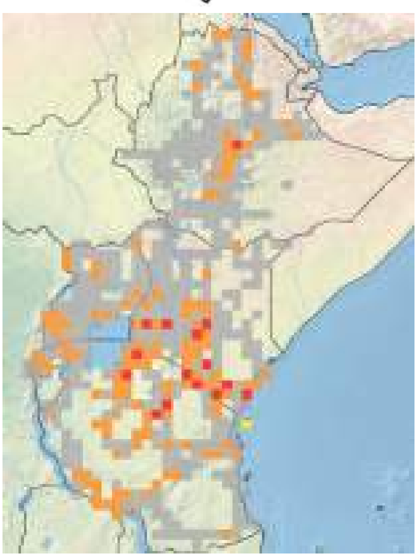
Flowers: Bright yellow, tubular or trumpet-shaped (50 mm long) with 5 rounded lobes, on short stalks in several-flowered clusters (5–15 cm long), showy.

Fruits: Capsules (dry fruits that split open at maturity), green turning brown as they mature, large, elongated and somewhat flattened (10–30 cm long and 5–20 mm wide), splitting open to release many papery seeds; the split capsules remain on the trees for months, in untidy clusters.

ORIGIN
Mexico, Ecuador, Peru, USA and the Caribbean.

REASON FOR INTRODUCTION
Ornament.

INVADES
Roadsides, waterways, riparian vegetation, open woodlands, grasslands, forest margins, waste areas and disturbed sites in tropical and sub-tropical environments.

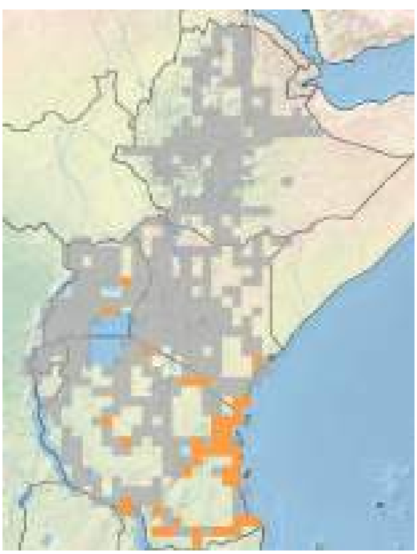


IMPACTS

Forms dense stands which may result in the displacement of native species. It forms dense monospecific thickets that restrict the regeneration of native species (GISD, 2016). Introduced into Brazil, it now occupies more than 10,000 ha of degraded Alto Paraná Atlantic Forests (Bredow *et al.*, 2004). Infestations there have also led to the abandonment of productive land, including pastures. Losses to the cattle industry alone reportedly amount to some US$ 7.5 million annually (Pedrosa-Macedo, 2004).

Notes: In Kenya and Tanzania, it is "often naturalized on roadsides, in grasslands and rocky places, and on sandy lakeshores" (Bidgood *et al.*, 2006). In Ethiopia, it is cultivated in the regions of Eritrea West, Shewa, Sidamo and Harerge, "becoming more or less naturalized in many areas" (Bidgood, 2006). Widely grown as an ornamental, it readily establishes in the wild, forming stands. Our surveys suggest that *T. stans* is likely to become increasingly problematic throughout the region.

Tectona grandis L.f.



VERBENA FAMILY
Verbenaceae

COMMON NAMES

English: common teak, Indian oak, teak, teak tree
Tanzania: majanimapana

DESCRIPTION
Medium-sized to large tree [25–50 m tall] with a straight trunk (1–2.5 m in diameter), fluted and buttressed in older trees; crown rounded and open.

Bark: Dark greyish-brown, ridged.

Leaves: Dark green, large (11–50 cm long and 37 cm wide), round or egg-shaped with narrower end at base, keeled mid-rib underneath, oppositely arranged, on short leaf stalks (6 cm long).

Flowers: Yellowish-white at tips of branches.

Fruits: Drupes (fruits with a stony centre), hard, woody, round (1.2–1.8 cm across) with 0–4 seeds; each drupe enclosed in an inflated, bladder-like covering, which is green at first turning brown.

ORIGIN
India, Laos, Myanmar and Thailand.

REASON FOR INTRODUCTION
Timber.

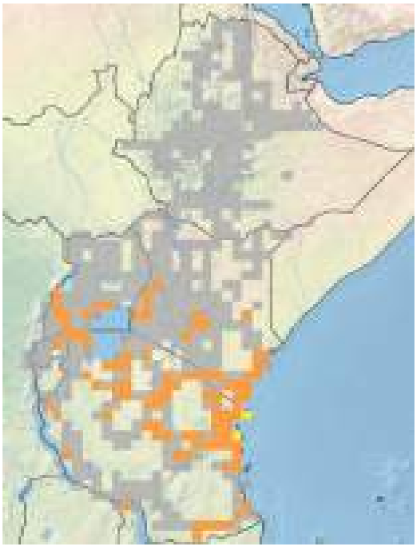
INVADES
Roadsides, disturbed areas, plantations, woodlands and forest edges/gaps.

IMPACTS

T. grandis has escaped from cultivation and has established populations in the wild, to the detriment of native biodiversity. Extracts from the leaves, which are allelopathic, have been found to inhibit germination and growth in tomatoes (*Lycopersicum esculentum* L.; Solanaceae); eggplants (*Solanum melongena* L.; Solanaceae); *Capsicum annuum* L. (Solanaceae), and other food crops (Krishna *et al.*, 2003; Evangeline *et al*., 2012), including peanuts and maize (Jayakumar *et al.*, 1987). Teak trees shade out native vegetation, inhibiting understorey growth and regeneration and increasing the erosion of soils. In teak plantations, there is often no significant understorey (Lamprecht, 1989; Evans, 1992).

Notes: In East Africa, *T. grandis* is often grown in woodlots, especially in Tanzania, where it is occasionally naturalized in the East Usambaras.

Terminalia catappa L.



ALMOND FAMILY
Combretaceae

COMMON NAMES
English: bastard almond, Indian almond, Malabar almond, Malay almond, sea almond
Kenya: mkungu, mwangati
Tanzania: mnenge, mtanga, ngezi

DESCRIPTION
Deciduous tree (sheds most or all of its leaves at the end of the growing season), [15–25 (–30) m tall], with a thick trunk (1–1.5 m in diameter), often buttressed at the base; whorls of nearly horizontal branches up the trunk.

Bark: Grey-brown, becoming rough with age.

Leaves: Dark green above, paler below, veins conspicuous, leathery, glossy, hairless, turning bright scarlet, dark red or yellow, egg-shaped (15–35 cm long and 10–19 cm wide) with narrower end at base, tips rounded or sharply pointed, held opposite or sub-opposite on stems, often clustered at branch tips; leaf stalks short.

Flowers: Greenish-white, tiny with no petals (5–6 mm wide), held in clusters (6–18 cm long).

Fruits: Drupes (fruits with a stony centre), green turning yellow and finally red as they mature, egg-shaped or oval (5–7 cm long and 3–5.5 cm wide) with two ridges, in clusters; containing a single cylindrical seed (3 cm long and 1 cm wide).

ORIGIN
Australia, Cambodia, India, Japan, Laos, Malaysia, Thailand and Vietnam.

REASON FOR INTRODUCTION
Fuelwood, tannins, edible fruit and ornament.

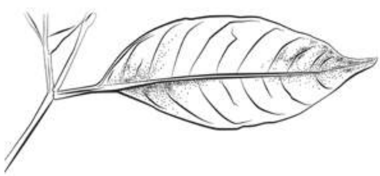
INVADES
Disturbed areas, urban open space, forest edges/gaps and coastal forests.

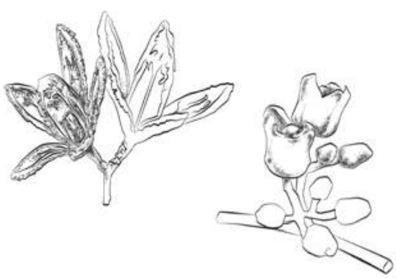
IMPACTS

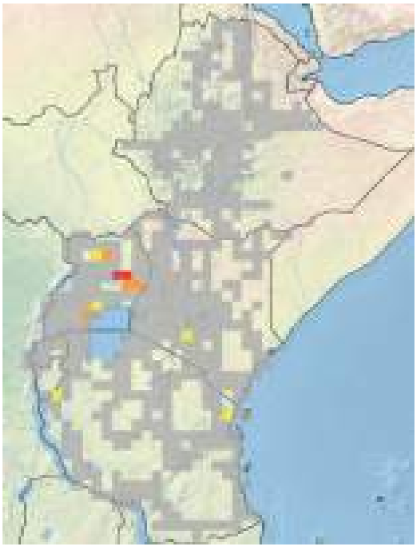
Has the ability to establish dense stands, to the detriment of native flora and fauna. It can tolerate well-drained soils and salt spray, which means it can establish readily in coastal regions. It is considered to be invasive in Florida, USA, in Brazil, and on several Caribbean Islands, including Montserrat, Puerto Rico and the Cayman Islands (CABI, 2016). In Kenya, it is a host for the invasive fruitfly *Bactrocera invadens* (Drew, Tsuruta & White; Tephritidae), allowing fly populations to remain high during the off-season when cultivated host plants are not fruiting (Rwomushana *et al.*, 2008).

Notes: Widely planted in Kenya, *T. catappa* "has gone wild on the coast" (Beentje, 1994), and is said to be naturalized in the Kenyan districts of Voi, Nairobi, Kisumu (Birnie and Noad, 2011) and Magadi (Maundu and Tengnäs, 2005). Widely grown throughout the region, our surveys found it to be naturalized at only a few sites, along the coast, including the Tana (Sabaki) River Delta.

Toona ciliata M. Roem.







MAHOGANY FAMILY
Meliaceae

COMMON NAMES

English: Australian red cedar, Burma cedar, Indian cedar, Indian mahogany, Queensland red cedar, red cedar

DESCRIPTION
Large tree [20–30 (–55) m tall], deciduous (sheds most or all of its leaves at the end of the growing season); trunk thick (1.8–3 m in diameter) with buttresses; crown spreading/rounded.

Bark: Dark grey or reddish-brown, initially smooth and later rough, with shallow reticulate cracks exfoliating in irregular woody scales.

Leaves: Green, hairy or sparsely hairy, once-divided (30–50 cm long) but on young trees to 90 cm long, with (9–) 11–17 (–29) sword- or egg-shaped leaflets (5–15 cm long and 2–6 cm wide), tapering to a sharp point with oblique bases, margins entire or wavy, leaflets opposite or alternate, on leaf stalks (0.3–1.3 cm long).

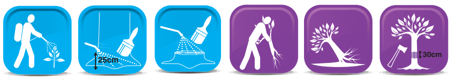
Flowers: Small, with creamy petals (part of a flower that is usually brightly coloured), small (5 mm long), in drooping or sub-erect densely-branched terminal panicles or clusters (25-35 cm long), sweetly scented; in *Cedrela odorata* the terminal panicles are much larger (to 90 cm long), unpleasant odour.

Fruits: Capsules (dry fruits that open at maturity), green turning dark brown as they mature, elongated, smooth (1.8–2.5 long and 0.5–0.8 cm wide), with five chambers; seeds pale brown, winged (1.3–1.5 cm long including the wing).

ORIGIN
Bangladesh, Cambodia, China, India, Indonesia, Laos, Malaysia, Myanmar, Nepal, Pakistan, Papua New Guinea, Philippines, Thailand and Vietnam.

REASON FOR INTRODUCTION
Timber, tannin and ornament.

INVADES
Roadsides, disturbed areas, forest edges/gaps and riparian vegetation.

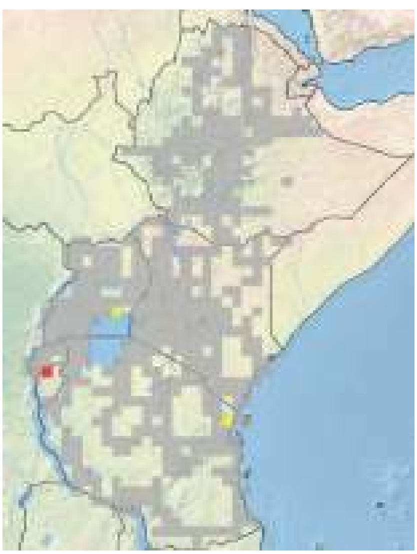


IMPACTS

Has the ability to form dense stands, displacing native plants and preventing their regeneration. It is considered to be "very aggressive and invasive, and unsuitable for planting in gardens or near food crops because of its shallow and aggressive root system" (Katende *et al*., 1995). A fast-growing, light-demanding pioneer species, it spreads rapidly in disturbed forests and cleared areas. In South Africa, it has out-competed indigenous species, particularly in forested areas and along river banks (ISSA, 2012). In Zimbabwe, it is widely cultivated in gardens and as a street tree, but is "frequently escaping into wild areas", often establishing along streams and riverbanks (Flora of Zimbabwe, 2015). Its spreading, superficial root system may have adverse effects on the growth of agricultural crops.

Notes: According to Maundu and Tegnäs (2005), it is naturalized in parts of Kenya. It is considered to be invasive in Uganda, where it is "capable of competing with local trees" (Katende *et al.*, 1995). Probably more widespread than indicated.

Toona sinensis (Juss.) M.Roem.



MAHOGANY FAMILY
Meliaceae

COMMON NAMES

English: Chinese mahogany, Chinese toon, red toon
Rwanda: isederera

DESCRIPTION
Deciduous tree (sheds all or most of its leaves at the end of the growing season), up to 25 (–40) m tall, with a buttressed trunk (to 70 cm in diameter), smelling of garlic and pepper when cut.

Bark: Brown and smooth becoming grey to dark brown, scaly to shaggy.

Leaves: Green, hairless, once-divided [(32–) 50–70 (–120) cm long and 30–40 cm wide) with 10–40 lance-shaped to narrow and long leaflets (9–15 cm long and 2.5–4 cm wide), margins entire or weakly toothed (only *Toona* spp. where the leaflets are sometimes toothed)main 'stem' of leaf often reddish; leaf stalk 5.5–20 cm long.

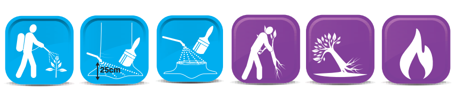
Flowers: White or pale pink, small (4–5 mm wide), in large clusters [30–50 (–100) cm long] at the ends of the branches.

Fruits: Capsules (dry fruits that open at maturity), green turning reddish to dark brown as they mature, smooth (2–3.5 cm long and 0.4–0.7 cm wide), containing many winged seeds (0.8–1.6 cm long and 3.5–6.2 mm wide).

ORIGIN
India and Nepal eastward through China, Burma, Thailand and Malaysia to Java.

REASON FOR INTRODUCTION
Medicine, timber and ornament.

INVADES
Roadsides, disturbed areas, plantations and forest gaps/edges.



IMPACTS

Can escape from cultivation and establish in the wild, to the possible detriment of native flora and fauna. Where mature trees have been cut down in the USA, seedlings have emerged from "vigorous root sprouts more than 15 m away from the original trees" (Brennan, 2011), prompting fears that the species may be invasive (Druse, 2011). Nevertheless, in California it is considered to be "less invasive" than some other introduced tree species (Grotkopp and Rejmanek, 2007). In Philadelphia, the species was removed from woodlands in Morris Park, after showing signs of "beginning to spread at an alarming rate" (Soloman and Dijois, 2011). In Japan, it has reportedly become established in the wild (Mito and Uesugi, 2004). In South Australia, its planting is "not recommended" in natural areas (DECD, 1999).

Notes: Seen only in Rwanda, where it is naturalized at a few sites, rarely invasive, but probably more widespread in the region.

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Useful Websites

African Convention on the Conservation of Nature and Natural Resources (**www.au.int**)

ASEAN Centre for Biodiversity (ACB) (**www.aseanbiodiversity.org**)

BioNET-EAFRINET Keys and Fact Sheets – Invasive Plants (**http://keys.lucidcentral.org/keys/v3/eafrinet/plants.htm**)

CABI Invasive Species Compendium (ISC) (**www.cabi.org/isc**)

Convention on Biological Diversity (CBD) (**www.cbd.int**)

Convention on the Establishment of the Lake Victoria Fisheries Organisation (**www.kenyalaw.org**)

Convention on Wetlands of International Importance (RAMSAR) (**www.ramsar.org**)

Environmental Weeds of Australia (**http://keyserver.lucidcentral.org/weeds/data/media/Html/index.htm#A**)

Forest Invasive Species Network for Africa (FISNA) (**www.fao.org/forestry/fisna/en**)

Global Invasive Species Database (GISD) (**www.iucngisd.org/gisd**)

International Plant Protection Convention (IPPC) (**www.ippc.int**)

New Partnership for Africa's Development (NEPAD) (**www.nepad.org**)

New South Wales Department of Primary Industries (**www.dpi.nsw.gov.au/agriculture/pests-weeds/weeds**)

New South Wales WeedWise (NSW WeedWise) (**http://weeds.dpi.nsw.gov.au/Weeds/Details/**)

Pacific Island Ecosystems at Risk (PIER) (**www.hear.org/pier**)

Phytosanitary Convention for Africa (**www.au.int**)

Scientific Committee on Problems of the Environment (SCOPE) (**www.icsu-scope.org**)

South African Working for Water Programme (WfW) (**http://dwaf.gov.za/wfw/**)

United States Department of Agriculture (USDA) National Invasive Species Information Center (**http://invasivespeciesinfo.gov/**)

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Appendix A

Summary table of plant species included in this Guide (terms used by various authors such as “wild” or “gone wild” or “weed” were assumed to indicate that the species was invasive)

Species	Family	Growth form	Cultivated use	Origin	Naturalized	Invasive
Brillantaisia lamium (Nees) Benth.	Acanthaceae	Herb	Ornament	Africa – tropical (Central and West)	Agnew and Agnew (1994); Vollesen (2008); Witt, *pers. obs.*	Witt, *pers. obs.*
Thunbergia grandiflora Roxb.	Acanthaceae	Climber	Ornament	Asia – tropical	Greenway (1934); Mosango *et al.* (2001); Dawson *et al.* (2008); Witt, *pers. obs.*	Mosango *et al.* (2001); Witt, *pers. obs.*
Sambucus nigra L. ssp. *canadensis* (L.) R. Bolli	Adoxaceae	Woody tree/shrub	Ornament	N. America – nth temperate	Witt, *pers. obs.*	?Witt, per obs.
Agave americana L.	Agavaceae	Succulent tree/shrub	Agricultural crop (fibre), barrier, ornament	America – tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Agave angustifolia Haw.	Agavaceae	Succulent tree/shrub	Agricultural crop (fibre), barrier, ornament	America – tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Agave sisalana Perrine	Agavaceae	Succulent tree/shrub	Agricultural crop (fibre), barrier, ornament	America – tropical	Pemba Island – Koenders (1992); Henderson (2002); Witt, *pers. obs.*	Henderson (2002); Witt, *pers. obs.*
Furcraea foetida (L.) Haw.	Agavaceae	Succulent tree/shrub	Agricultural crop (fibre), barrier, ornament	America – tropical	Brink and Achigan-Dako, 2012; Witt, *pers. obs.*	Witt, *pers. obs.*
Allium neapolitanum Cirillo	Alliaceae	Herb	Ornament	America – tropical	Smith and Stansbie (2003); Witt, *pers. obs.*	Smith and Stansbie (2003); Witt, *pers. obs.*
Foeniculum vulgare Mill.	Apiaceae	Herb	Agricultural crop (herb)	Mediterranean – nth temperate	Townsend (1989); Agnew and Agnew (1994); Hedberg and Hedberg (2003); Witt, *pers. obs.*	Witt, *pers. obs.*
Calotropis gigantea (L.) Dryand.	Apocynaceae	Woody tree/shrub	Barrier, medicinal, ornament	Asia – tropical	Beentje (1994); Luke (2005); Witt, *pers. obs.*	Witt, *pers. obs.*
Calotropis procera (Aiton) Dryand.	Apocynaceae	Woody tree/shrub	Barrier, medicinal, ornament	Africa – tropical	Blundell (1992); Pemba Island –Koenders (1992); Cochard and Bloesch (2007); Goyder *et al.* (2012); Witt, pers. obs	Witt, *pers. obs.*
Cascabela thevetia (L.) Lippold (Syn.: *Thevetia peruviana* (Pers.) K. Schum.	Apocynaceae	Woody tree/shrub	Barrier, medicinal, ornament	America – tropical	Mbuya *et al.* (1994); Omino (2002); Maundu and Tengnäs (2005); Witt, *pers. obs.*	Mbuya et al. (1994); Maundu and Tengnäs (2005); Witt, *pers. obs.*
Catharanthus roseus (L.) G. Don	Apocynaceae	Herb	Medicinal, ornament	Madagascar – tropical	Blundell (1992); Agnew and Agnew (1994); Omino (2002); Leeuwenberg (2003); Dharani and Yenesew (2010); Witt, *pers. obs.*	Dharani and Yenesew (2010); Witt, *pers. obs.*
Cryptostegia grandiflora Roxb. ex R. Br	Apocyncaeae	Woody tree/shrub	Ornament	Madagascar – tropical	Goyder *et al.* (2003), Witt, *pers. obs.*	Witt, *pers. obs.*

Species	Family	Growth form	Cultivated use	Origin	Naturalized	Invasive
Cryptostegia madagascariensis Bojer ex Decne.	Apocyncaeae	Woody tree/shrub	Ornament	Madagasca: tropical	Goyder *et al.* (2012); Witt, *pers. obs.*	
Vinca major L. (see narrative for possible confusion with *V. minor*)	Apocynaceae	Climber	Ornament	Mediterranean and N. Africa – nth temperate	Witt, *pers. obs.*	Witt, *pers. obs.*
Pistia stratiotes L.	Araceae	Aquatic	Ornament	?America – tropical (see narrative for additional information on possible origin)	Mayo (1985); Agnew and Agnew (1994); Riedl (1997); Macdonald *et al.* (2003); Cochard and Bloesch (2007); CABI (2016); Witt, *pers. obs.*	Agnew and Agnew (1994); Macdonald *et al.* (2003); Cochard and Bloesch (2007);CABI (2016); Witt, *pers. obs.*
Areca catechu L.	Arecaceae	Palm	Agricultural crop (dye, narcotic), ornament	Asia – tropical	Greenway (1934); Pemba Island – Koenders (1992); Beentje (1994); Zanzibar Island – Nakonyo *et al.* (2002); Maundu and Tengnäs (2005); Dawson *et al.* (2008); TBA (2010); Witt, *pers. obs.*	?Beentje (1994); Zanzibar Island – Nakonyo *et al.* (2002); TBA (2010)
Arenga pinnata (Wurmb) Merr.	Arecaceae	Palm	Agricultural crop (food, fibre, beverage); ornament	Asia – tropical	Greenway (1934); Dawson *et al.* (2008); TBA (2010); Witt, *pers. obs.*	Greenway (1934); Dawson *et al.* (2008); TBA (2010); Witt, *pers. obs.*
Elaeis guineensis Jacq.	Arecaceae	Palm	Agricultural crop (oil), ornament	Africa – tropical	Greenway (1934); Williams (1949); Pemba Island – Koenders (1992); Dawson *et al.* (2008); TBA (2010); GISD (2016); Witt, *pers. obs.*	Greenway (1934); Dawson *et al.* (2008); TBA (2010); GISD (2016); Witt, *pers. obs.*
Aristolochia littoralis Parodi (Syn.: *Aristolochia elegans* Mast.)	Aristolochiaceae	Climber	Ornament	America – tropical	Verdcourt (1986); Beentje (1994); KHS (1995); Mosango *et al.* (2001)	Verdcourt (1986); Beentje (1994); KHS (1995); Mosango *et al.* (2001)
Ageratina adenophora (Spreng.) R.M. King & H. Rob.	Asteraceae	Herb/sub-shrub	Ornament	America – tropical	Beentje *et al.* (2005); CABI (2016); Witt, *pers. obs.*	CABI (2016); Witt, *pers. obs.*
Ageratum conyzoides L.	Asteraceae	Herb	Ornament	America – tropical	Engler (1895a); Williams (1949); Terry and Michieka (1987); Pemba Island – Koenders (1992); Agnew and Agnew (1994); Henderson (2002); Tadesse (2004); Beentje *et al.* (2005); CABI (2016); GISD (2016); Witt, *pers. obs.*	Williams (1949); Terry and Michieka (1987); Agnew and Agnew (1994); Henderson (2002); Tadesse (2004); Beentje *et al.* (2005); CABI (2016); GISD (2016); Witt, *pers. obs.*

Species	Family	Growth form	Cultivated use	Origin	Naturalized	Invasive
Ageratum houstonianum Mill.	Asteraceae	Herb	Ornament	America – tropical	Agnew and Agnew (1994); Henderson (2002); Tadesse (2004); Beentje *et al.* (2005); Witt, *pers. obs.*	Henderson (2002); Beentje *et al.* (2005); Witt, *pers. obs.*
Chromolaena odorata (L.) R.M. King & H. Rob.	Asteraceae	Woody tree/shrub	?Ornament	America – tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Cirsium vulgare (Savi) Ten.	Asteraceae	Herb	Agricultural crop (bee forage)	Eurasia – nth temperate	Blundell (1992); Agnew and Agnew (1994); Beentje (2000); Tadesse (2004); Witt, *pers. obs.*	Agnew and Agnew (1994); Tadesse (2004); Witt, *pers. obs.*
Dahlia imperialis Roezl ex Ortgies	Asteraceae	Herb	Ornament	America – tropical	Beentje *et al.* (2005); Witt, *pers. obs.*	Witt, *pers. obs.*
Erigeron karvinskianus DC. (unresolved)	Asteraceae	Herb	Ornament	*America – tropical*	Blundell (1992); Beentje (2002); Witt, *pers. obs.*	Blundell (1992); Witt, *pers. obs.*
Euryops chrysanthemoides (DC.) B. Nord.	Asteraceae	Woody tree/shrub	Ornament	Southern Africa – sth temperate	Henderson (2002); Beentje *et al.* (2005); Witt, *pers. obs.*	Henderson (2002); Witt, *pers. obs.*
Helianthus anuum L.	Asteraceae	Herb	None	America – tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Montanoa hibiscifolia Benth.	Asteraceae	Woody tree/shrub	Ornament	America – tropical	Beentje *et al.* (2005); Dawson *et al.* (2008); Witt, *pers. obs.*	Witt, *pers. obs.*
Parthenium hysterophorus L.	Asteraceae	Herb	None	America – tropical	Lyons and Miller (1999), Tadesse (2004); Beentje *et al.* (2005); CABI (2016); Witt, *pers. obs.*	Lyons and Miller (1999); Tadesse (2004); Beentje *et al.* (2005); CABI (2016); Witt, *pers. obs.*;
Senecio madagascariensis Poir.	Asteraceae	Herb	None	Southern Africa – sth temperate	Agnew and Agnew (1994); Witt, *pers. obs.*	Witt, *pers. obs.*
Sphagneticola trilobata (L.) Pruski	Asteraceae	Herb	Cover/binder, ornament	America – tropical	KHS (1995); Witt, *pers. obs.*	Witt, *pers. obs.*
Tithonia diversifolia (Hemsl.) A. Gray	Asteraceae	Woody tree/shrub	Agricultural crop (green manure); barrier, ornament	America – tropical	Greenway (1934); Williams (1949); Blundell (1992); Pemba Island – Koenders (1992); Agnew and Agnew (1994); Beentje (1994); Beentje *et al.* (2005); Maundu and Tengnäs (2005); Dawson *et al.* (2008); Fischer *et al.* (2010);TBA (2010); Witt, *pers. obs.*	Beentje (1994); Beentje *et al.* (2005); Maundu and Tengnäs (2005); TBA (2010); Witt, *pers. obs.*
Tithonia rotundifolia (Mill.) S.F. Blake	Asteraceae	Woody tree/shrub	Agricultural crop (bee forage), barrier, ornament	America – tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Xanthium spinosum L.	Asteraceae	Herb	Medicinal	America – tropical	Tadesse (2004); Witt, *pers. obs.*	Tadesse (2004); Witt, *pers. obs.*
Xanthium strumarium L.	Asteraceae	Herb	Medicinal	America – tropical	Tadesse (2004); Beentje *et al.* (2005); Fischer *et al.* (2010); Witt, *pers. obs.*	Tadesse (2004); Beentje *et al.* (2005); Witt, *pers. obs.*

Species	Family	Growth form	Cultivated use	Origin	Naturalized	Invasive
Zinnia peruviana (L.) L	Asteraceae	Herb	Ornament	America – tropical	Tadesse (2004); Witt, *pers. obs.*	Tadesse (2004); Witt, *pers. obs.*
Azolla filiculoides Lam. (see narrative for issues around identification of *Azolla* spp.)	Azollaceae	Aquatic	Ornament	America – tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Anredera cordifolia (Ten.) Steenis.	Basellaceae	Climber	Ornament	America – tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Dolichandra unguis-cati (L.) L.G. Lohmann	Bignoniaceae	Climber	Ornament	America – tropical	Greenway (1934); Bidgood *et al.* (2006); Dawson *et al.* (2008); GISD (2016); Witt, *pers. obs.*	Greenway (1934); GISD (2016); Witt, *pers. obs.*
Jacaranda mimosifolia D. Don	Bignoniaceae	Woody tree/shrub	Agricultural crop (bee forage), barrier, domestic, ornament	America – tropical	Birnie and Noad (2011); Witt, *pers. obs.*	Witt, *pers. obs.*
Tecoma stans (L.) Juss. ex Kunth	Bignoniaceae	Woody tree/shrub	Barrier, ornament	America – tropical	Bidgood *et al.* (2006); Witt, *pers. obs.*	Witt, *pers. obs.*
Cordia alliodora (Ruiz & Pav.) Oken	Boraginaceae	Woody tree/shrub	Domestic, ornament, silvicultural crop	America – tropical	Greenway (1934); Pemba Island – Koenders (1992); Dawson *et al.* (2008); TBA (2010); Witt, *pers. obs.*	Greenway (1934); Dawson *et al.* (2008); TBA (2010); Witt, *pers. obs.*
Echium plantagineum L.	Boraginaceae	Herb	Agricultural crop (bee forage), ornament	Eurasia – nth temperate	Verdcourt (1991); Agnew and Agnew (1994); Riedl and Edwards (2006); Witt, *pers. obs.*	Verdcourt (1991); Witt, *pers. obs.*
Austrocylindropuntia subalata (Muelenpf.) Backeb.	Cactaceae	Succulent tree/shrub	Barrier, ornament	America – tropical	Hunt (1968); Witt, *pers. obs.*	Hunt (1968); Witt, *pers. obs.*
Cereus jamacaru DC. (see narrative regarding identification of *Cereus* spp.)	Cactaceae	Succulent tree/shrub	Barrier, ornament	America – tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Cylindropuntia imbricata (Haw.) F.M. Knuth	Cactaceae	Succulent tree/shrub	Barrier, ornament	America – tropical	Witt, *pers. obs.*	
Hylocereus undatus (Haw.) Britton & Rose	Cactaceae	Succulent climber	Ornament	America – tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Opuntia cochenillifera (L.) Mill.	Cactaceae	Succulent tree/shrub	Barrier, ornament	America – tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Opuntia elatior Mill.	Cactaceae	Succulent tree/shrub	Barrier, ornament	America – tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Opuntia engelmannii Salm-Dyck ex Engelm.	Cactaceae	Succulent tree/shrub	Barrier, ornament	N. America – nth temperate	Witt, *pers. obs.*	Witt, *pers. obs.*
Opuntia ficus-indica (L.) Mill.	Cactaceae	Succulent tree/shrub	Agricultural crop (fodder, food), barrier, ornament	America – tropical	Hunt (1968); Agnew and Agnew (1994); Bein *et al.* (1996); Luke (2005); Obiri (2011); Witt, *pers. obs.*	Hunt (1968); Bein *et al.* (1996);Obiri (2011); Witt, *pers. obs.*
Opuntia microdasys (Lehm.) Pfeiff.	Cactaceae	Succulent tree/shrub	Barrier, ornament	America – tropical	Witt, *pers. obs.*	

Species	Family	Growth form	Cultivated use	Origin	Naturalized	Invasive
Opuntia monacantha (Willd.) Haw.	Cactaceae	Succulent tree/shrub	Agricultural crop (food), barrier	America – tropical	Hunt (1968); Blundell (1992); Agnew and Agnew (1994); Luke (2005); Cochard and Bloesch (2007); Witt, *pers. obs.*	Hunt (1968); Witt, *pers. obs.*
Opuntia stricta (Haw.) Haw.	Cactaceae	Succulent tree/shrub	Barrier, ornament	America – tropical	Williams (1949); Hunt (2000); Witt, *pers. obs.*	Hunt (2000); Witt, *pers. obs.*
Peniocereus serpentinus (Lag. & Rodr.) N.P.Taylor]	Cactaceae	Succulent tree/shrub	Barrier, ornament	America – tropical	Witt, *pers. obs.*	
Pereskia aculeata Mill.	Cactaceae	Climber	Barrier, ornament	America – tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Canna × generalis L.H. Bailey & E.Z. Bailey	Cannaceae	Herb	Ornament	America – tropical	Lye (1997); Witt, *pers. obs.*	Witt, *pers. obs.*
Canna indica L.	Cannaceae	Herb	Ornament	America – tropical	Engler (1895b); Williams (1949); Pemba Island – Koenders (1992); Lock (1993); Lye (1997); Henderson (2002); Cochard and Bloesch (2007); Witt, *pers. obs.*	Lock (1993); Henderson (2002); Williams (1949); Lye (1997); Witt, *pers. obs.*
Casuarina cunninghamiana Miq.	Casuarinaceae	Woody tree/shrub	Barrier, cover/binder, domestic, ornament, silvicultural crop	Australia – tropical	S. Mathias, TAFORI, *pers. comm.*	S. Mathias, TAFORI, *pers. comm.*
Casuarina equisetifolia L.	Casuarinaceae	Woody tree/shrub	Barrier, cover/binder, domestic, ornament, silvicultural crop	Asia – tropical	Mbuya *et al.* (1994); Maundu and Tengnäs (2005); Bekele-Tesemma (2007); Witt, *pers. obs.*	Witt, *pers. obs.*
Terminalia catappa L.	Combretaceae	Woody tree/shrub	Agricultural crop (food, tannins), domestic, ornament	Asia and Australia – tropical	Pemba Island – Koenders (1992); Beentje (1994); Dharani (2002); Maundu and Tengnäs (2005); Cochard and Bloesch (2007); Birnie and Noad (2011); Dharani (2011)	Beentje (1994), ?Cochard and Bloesch (2007)
Callisia fragrans (Lindl.) Woodson	Commelinaceae	Herb	Ornament	America – tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Callisia repens (Jacq.) L.	Commelinaceae	Herb	Ornament	America – tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Tradescantia fluminensis Vell.	Commelinaceae	Herb	Ornament	America – tropical	Faden (2012)	
Tradescantia pallida (Rose) D.R. Hunt	Commelinaceae	Herb	Ornament	America – tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Tradescantia spathacea Sw.	Commelinaceae	Herb	Ornament	America – tropical		
Tradescantia zebrina Bosse	Commelinaceae	Herb	Ornament	America – tropical	Agnew and Agnew (1994); Mosango *et al.* (2001); Faden (2012); Witt, *pers. obs.*	Mosango *et al.* (2001); Faden (2012); Witt, *pers. obs.*

Species	Family	Growth form	Cultivated use	Origin	Naturalized	Invasive
Convolvulus arvensis L.	Convolvulaceae	Climber	None, ?Ornament	Europe and Asia – nth temperate	Verdcourt (1963); Agnew and Agnew (1994); Mosango *et al.* (2001); Demissew (2006); CABI (2016); Witt, *pers. obs.*	Verdcourt (1963); Mosango *et al.* (2001); Demissew (2006); CABI (2016)
Cuscuta campestris Yunck.	Convolvulaceae	Climber	None	N. America – nth temperate	Verdcourt (1963); Agnew and Agnew (1994); Aweke and Edwards (2006); CABI (2016); Witt, *pers. obs.*	Verdcourt (1963); Agnew and Agnew (1994); Aweke and Edwards (2006); CABI (2016)
Ipomoea alba L.	Convolvulaceae	Climber	Ornament	America – tropical	Verdcourt (1963); Demissew (2006); Agnew and Agnew (1994); Witt, *pers. obs.*	Verdcourt (1963)
Ipomoea cairica (L.) Sweet	Convolvulaceae	Climber	Ornament	Africa and Asia – tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Ipomoea carnea Jacq. ssp. *fistulosa* (Mart. ex Choisy)	Convolvulaceae	Woody tree/shrub	Barrier, ornament	America – tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Ipomoea hederifolia L.	Convolvulacese	Climber	Ornament	America – tropical	Verdcourt (1963); Witt, *pers. obs.*	
Ipomoea hildebrandtii Vatke	Convolvulaceae	Woody tree/shrub	None	Africa – tropical	Mworia *et al.* (2008); Bosco *et al.* (2015); Witt, *pers. obs.*	Mworia *et al.* (2008); Bosco *et al.* (2015); Witt, *pers. obs.*
Ipomoea indica (Burm.) Merr.	Convolvulaceae	Climber	Ornament	America – tropical	Verdcourt (1963); Agnew and Agnew (1994); Demissew (2006); Witt, *pers. obs.*	Witt, *pers. obs.*
Ipomoea nil (L.) Roth	Convolvulaceae	Climber	Ornament	America – tropical	Verdcourt (1963); Demissew (2006); Witt, *pers. obs.*	
Ipomoea purpurea (L.) Roth	Convolvulaceae	Climber	Ornament	America – tropical	Verdcourt (1963); Mosango *et al.* (2001); Agnew and Agnew (1994); Demissew (2006); Witt, *pers. obs.*	Mosango *et al.* (2001); Witt, *pers. obs.*
Bryophyllum daigremontianum Raym.-Hamet & H. Perrier) A. Berger	Crassulaceae	Succulent herb	Ornament	Madagascar – sth temperate	Witt, *pers. obs.*	
Bryophyllum delagoense (Eckl. & Zeyh.) Druce	Crassulaceae	Succulent herb	Ornament	Madagascar – sth temperate	Wickens (1987); Witt, *pers. obs.*	Witt, *pers. obs.*
Bryophyllum fedtschenkoi (Raym.-Hamet & H. Perrier) Lauz.-March	Crassulaceae	Succulent herb	Ornament	Madagascar – sth temperate	Wickens (1987); Witt, *pers. obs.*	Witt, *pers. obs.*
Bryophyllum pinnatum (Lam.) Oken	Crassulaceae	Succulent herb	Ornament	Madagascar – tropical	Bally (1942); Agnew and Agnew (1994); Witt, *pers. obs.*	
Bryophyllum proliferum Bowie ex Hook.	Crassulaceae	Succulent herb	Ornament	Madagascar – tropical	Wickens (1987); Gilbert (1989); Fischer *et al.* (2010); Witt, *pers. obs.*	Witt, *pers. obs.*
Crassula sarmentosa Harv.	Crassulaceae	Succulent herb	Ornament	Africa – sth temperate	Witt, *pers. obs.*	Witt, *pers. obs.*
Kalanchoe beharensis Drake	Crassulaceae	Succulent herb	Ornament	Madagascar – sth temperate	Witt, *pers. obs.*	

Species	Family	Growth form	Cultivated use	Origin	Naturalized	Invasive
Hevea brasiliensis (Willd. ex A. Juss.) Müll. Arg.	Euphorbiaceae	Woody tree/shrub	Agricultural crop (rubber); domestic; silvicultural crop	America – tropical	Greenway (1934); Hamilton and Bensted-Smith (1989); Sheil (1994); Mosango *et al.* (2001); Haysom and Murphy (2003); Dawson *et al.* (2008); TBA (2010); Witt, *pers. obs.*	?Hamilton and Bensted-Smith (1989); Mosango *et al.* (2001); TBA (2010)
Hovenia dulcis Thunb.	Rhamnaceae	Woody tree/shrub	Agricultural crop (food); medicine; ornament	Asia – nth temperate	Dawson *et al.* (2008); Witt, *pers. obs.*	Dawson *et al.* (2008); Witt, *pers. obs.*
Hura crepitans L.	Euphorbiaceae	Woody tree/shrub	Ornament, silvicultural crop	America – tropical	Greenway (1934); Hamilton and Bensted-Smith (1989); Dawson *et al.* (2008); TBA (2010); Witt, *pers. obs.*	?Hamilton and Bensted-Smith (1989); TBA (2010)
Jatropha curcas L.	Euphorbiaceae	Woody tree/shrub	Agricultural crop (oil), barrier, medicinal, ornament	America – tropical	Greenway (1941a); Agnew and Agnew (1994); Beentje (1994); Gilbert (1995); Maundu and Tengnäs (2005); Dharani and Yenesew (2010), Witt, *pers. obs.*	Beentje (1994)
Jatropha gossypiifolia L.	Euphorbiaceae	Woody tree/shrub	Agricultural crop (oil); barrier, medicinal, ornament	America – tropical	Radcliff-Smith (1987); Witt, *pers. obs.*	Witt, *pers. obs.*
Ricinus communis L.	Euphorbiaceae	Woody tree/shrub	Agricultural crop (oil), medicinal, ornament	?Africa – tropical	Smith (1987); Blundell (1992); Sheil (1994); Gilbert (1995); Lyons and Miller (1999); Henderson (2002); CABI (2016); Witt, *pers. obs.*	Lyons and Miller (1999); Henderson (2002); CABI (2016); Witt, *pers. obs.*
Acacia auriculiformis Benth.	Fabaceae	Woody tree/shrub	Domestic, ornament	Australia – sth temperate	Zanzibar Island – Kotiluoto *et al.* (2009)	Zanzibar Island – Kotiluoto *et al.* (2009)
Acacia colei Maslin & L.A.J. Thomson	Fabaceae	Woody tree/shrub	Agricultural crop (food); domestic, ornament	Australia – sth temperate	Witt, *pers. obs.*	Witt, *pers. obs.*
Acacia mearnsii De Wild	Fabaceae	Woody tree/shrub	Agricultural crop (bee forage, tannins), barrier, domestic, ornament, silvicultural crop	Australia – sth temperate	Brenan (1959); Henderson (2002); Maundu and Tengnäs (2005); Spanhove and Lehouck (2008); Birnie and Noad (2011); Dharani (2011); Obiri (2011); CABI (2016); GISD (2016); Witt, *pers. obs.*	Brenan (1959); Henderson (2002); Spanhove and Lehouck (2008); Obiri (2011); CABI (2016); GISD (2016); Witt, *pers. obs.*
Acacia melanoxylon R. Br	Fabaceae	Woody tree/shrub	Barrier, domestic, ornament, silvicultural crop	Australia – sth temperate	Maundu and Tengnäs (2005); CABI (2016); GISD (2016); Witt, *pers. obs.*	CABI (2016); GISD (2016); Witt, *pers. obs.*
Acacia podalyriifolia G. Don	Fabaceae	Woody tree/shrub	Barrier, ornament	Australia – sth temperate	Birnie and Noad (2011); Dharani (2011); Witt, *pers. obs.*	Witt, *pers. obs.*

Species	Family	Growth form	Cultivated use	Origin	Naturalized	Invasive
Acacia saligna Wendl	Fabaceae	Woody tree/shrub	Agricultural crop (tannins) barrier, cover/ binder, domestic, ornament, silvicultural crop	Australia – sth temperate	Witt, *pers. obs.*	Witt, *pers. obs.*
Acrocarpus fraxinifolius Arn.	Fabaceae	Woody tree/shrub	Agricultural crop (bee forage), barrier, domestic, ornament, silvicultural crop	Asia – tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Adenanthera pavonina L.	Fabaceae	Woody tree/shrub	Domestic, ornament, silvicultural crop	Asia – tropical	Mbuya *et al.* (1994); Maundu and Tengnäs (2005)	
Albizia lebbeck (L.) Benth	Fabaceae	Woody tree/shrub	Agricultural crop (fodder, green manure), domestic, ornament	Asia – tropical	Brenan (1959); Thulin (1989); Pemba Island – Koenders (1992); Maundu and Tengnäs (2005); Birnie and Noad (2011); Dharani (2011); Witt, *pers. obs.*	
Albizia saman (Jacq.) Merr.	Fabaceae	Woody tree/shrub	Domestic, ornament	America – tropical	Beentje (1994); Maundu and Tengnäs (2005).	Beentje (1994)
Bauhinia monandra Kurz	Fabaceae	Woody tree/shrub	Domestic, ornament	Madagascar – tropical		
Bauhinia purpurea L.	Fabaceae	Woody tree/shrub	Domestic, ornament	Asia – tropical	Thulin (1989)	
Bauhinia variegata L.	Fabaceae	Woody tree/shrub	Domestic, ornament	Asia – tropical	Thulin (1989); Mosango *et al.* (2001); Witt, *pers. obs.*	Mosango *et al.* (2001); Witt, *pers. obs.*
Caesalpinia decapetala (Roth) Alston	Fabaceae	Climber	Agricultural crop (bee forage), barrier, ornament	Asia – tropical	Brenan (1967); Blundell (1992); Thulin (1989); Beentje (1994); Mbuya *et al.* (1994); Katende *et al.* (1995); Dharani (2002); Henderson (2002); Maundu and Tengnäs (2005); Dawson *et al.* (2008); Birnie and Noad (2011); Dharani (2011); Obiri (2011); CABI (2016); GISD (2016); Witt, *pers. obs.*	Beentje (1994); Mbuya *et al.* (1994); Katende *et al.* (1995); Henderson (2002); Maundu and Tengnäs (2005); Birnie and Noad (2011); Obiri (2011); CABI (2016); GISD (2016); Witt, *pers. obs.*
Calliandra houstoniana (Mill.) Standl. var. *calothyrsus* (Meisn.) Barneby (Syn.: *Calliandra calothyrsus* Meisn.)	Fabaceae	Woody tree/shrub	Agricultural crop (fodder), barrier, domestic, ornament	America – tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Delonix regia (Hook.) Raf.	Fabaceae	Woody tree/shrub	Ornament	Madagascar – tropical	Witt, *pers. obs.*	

Species	Family	Growth form	Cultivated use	Origin	Naturalized	Invasive
Desmodium uncinatum (Jacq.) DC.	Fabaceae	Herb or climber	Agricultural crop (fodder, nitrogen-fixation); cover/binder	America – tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Gliricidea sepium (Jacq.) Walp.	Fabaceae	Woody tree/shrub	Agricultural crop (nitrogen-fixation, support for vanilla), domestic, ornament	America – tropical	Witt, *pers. obs.*	
Leucaena leucocephala (Lam.) de Wit	Fabaceae	Woody tree/shrub	Agricultural crop (fodder, nitrogen-fixation), barrier, cover/ binder, domestic, ornament	America – tropical	Williams (1949); Brenan (1967); Pemba Island – Koenders (1992); Beentje (1994); Thulin (1989); Mbuya *et al.* (1994); Sheil (1994); Lyons and Miller (1999); Katende *et al.* (1995); Haysom and Murphy (2003); Macdonald *et al.* (2003); Maundu and Tengnäs (2005); CABI (2016); GISD (2016); Witt, *pers. obs.*	Maundu and Tegnas (2005); Haysom and Murphy (2003); Macdonald *et al.* (2003); Lyons and Miller (1999); Beentje (1994); Mbuya *et al.* (1994); Katende *et al.* (1995); CABI (2016); GISD (2016); Witt, *pers. obs.*
Mimosa diplotricha Sauvalle	Fabaceae	Woody tree/shrub	Barrier, cover/binder, ornament	America – tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Mimosa pigra L.	Fabaceae	Woody tree/shrub	Agricultural crop (green manure, nitrogen-fixation), barrier, ornament	America – tropical	Agnew and Agnew (1994); Thulin (1989); Lyons and Miller (1999); CABI (2016); GISD (2016); Witt, *pers. obs.*	Lyons and Miller (1999); CABI (2016); GISD (2016); Witt, *pers. obs.*
Mimosa pudica L.	Fabaceae	Herb	Cover/binder, ornament	America – tropical	Greenway (1934); Blundell (1992); Pemba Island – Koenders (1992); Agnew and Agnew (1994); Dawson *et al.* (2008); TBA (2010); CABI (2016); Witt, *pers. obs.*	Pemba Island – Koenders (1992); TBA (2010); CABI (2016); Witt, *pers. obs.*
Parkinsonia aculeata L.	Fabaceae	Woody tree/shrub	Agricultural crop (bee forage, fodder), barrier, ornament	America – tropical	Blundell (1992); Beentje (1994); Mbuya *et al.* (1994); Thulin (1989); Dharani (2002); Maundu and Tengnäs (2005); Birnie and Noad (2011); Dharani (2011); CABI (2016); Witt, *pers. obs.*	Beentje (1994); Mbuya *et al.* (1994); CABI (2016)
Peltophorum pterocarpum (DC.) K. Heyne	Fabaceae	Woody tree/shrub	Domestic, ornament	America – tropical	Witt, *pers. obs.*	
Pithecellobium dulce (Roxb.) Benth.	Fabaceae	Woody tree/shrub	Barrier, domestic, ornament	America – tropical	Brenan (1967); Beentje (1994); Mbuya *et al.* (1994); Dharani (2002); Haysom and Murphy (2003); Maundu and Tengnäs (2005); Dharani (2011)	Beentje (1994); Mbuya *et al.* (1994).

Species	Family	Growth form	Cultivated use	Origin	Naturalized	Invasive
Prosopis juliflora (Sw.) DC.	Fabaceae	Woody tree/shrub	Agricultural crop (bee forage, food, fodder), barrier, cover/ binder, domestic, ornament	America – tropical	Maundu and Tengnäs (2005); Lyons and Miller (1999); Bekele-Tesemma *et al.* (1993); Mbuya *et al.* (1994); Katende *et al.* (1995); Obiri (2011); CABI (2016); GISD (2016); Witt, *pers. obs.*	Bekele-Tesemma *et al.* (1993); Maundu and Tengnäs (2005); Lyons and Miller (1999); Mbuya *et al.* (1994); Obiri (2011); CABI (2016); GISD (2016), Witt, *pers. obs.*
Senna alata (L.) Roxb.	Fabaceae	Woody tree/shrub	Ornament, medicinal	America – tropical	Williams (1949); Brenan (1967); Thulin (1989); Pemba Island – Koenders (1992); Thulin (1989); Dharani (2002); Dharani and Yenesew (2010); Dharani (2011); Witt, *pers. obs.*	Williams (1949); Brenan (1967); Dharani (2002); Dharani and Yenesew (2010); Witt, *pers. obs.*
Senna bicapsularis (L.) Roxb.	Fabaceae	Climber	Barrier, ornament	America – tropical	Brenan (1967); Blundell (1992); Agnew and Agnew (1994); Beentje (1994); Cochard and Bloesch (2007); Witt, *pers. obs.*	Agnew and Agnew (1994); Beentje (1994); Cochard and Bloesch (2007); Witt, *pers. obs.*
Senna didymobotrya (Fresen.) H.S. Irwin & Barneby	Fabaceae	Woody tree/shrub	Barrier, medicinal, ornament	Africa – tropical	Thulin (1989); Blundell (1992); Henderson (2002); Cochard and Bloesch (2007); Witt, *pers. obs.*	Thulin (1989); Henderson (2002); Cochard and Bloesch (2007); Witt, *pers. obs.*
Senna hirsuta H.S. Irwin & Barneby	Fabaceae	Woody tree/shrub	Ornament	America – tropical	Brenan (1967); Witt, *pers. obs.*	Witt, *pers. obs.*
Senna obtusifolia (L.) H.S. Irwin & Barneby	Fabaceae	Woody tree/shrub	Medicine, ornament	America – tropical	Brenan (1967); Thulin (1989); Pemba Island – Koenders (1992); Agnew and Agnew (1994); Witt, *pers. obs.*	Brenan (1967); Thulin (1989); Agnew and Agnew (1994); Witt, *pers. obs.*
Senna occidentalis (L.) Link	Fabaceae	Woody tree/shrub	Domestic, medicinal, ornament	America – tropical	Engler (1895a); Williams (1949); Brenan (1967); Thulin (1989); Blundell (1992); Pemba Island – Koenders (1992); Agnew and Agnew (1994); Cochard and Bloesch (2007); Dawson *et al.* (2008); Dharani and Yenesew (2010); CABI (2016); Witt, *pers. obs.*	Williams (1949); Brenan (1967); Thulin (1989); Agnew and Agnew (1994); Cochard and Bloesch (2007); Dharani and Yenesew (2010); CABI (2016); Witt, *pers. obs.*

Species	Family	Growth form	Cultivated use	Origin	Naturalized	Invasive
Senna septemtrionalis (Viv.) H.S. Irwin & Barneby	Fabaceae	Woody tree/shrub	Ornament	America – tropical	Thulin (1989); Agnew and Agnew (1994); Beentje (1994); Witt, *pers. obs.*	Agnew and Agnew (1994); Witt, *pers. obs.*
Senna siamea (Lam.) H.S. Irwin & Barneby	Fabaceae	Woody tree/shrub	Domestic, ornament	Asia – tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Senna spectabilis (DC.) H.S. Irwin & Barneby	Fabaceae	Woody tree/shrub	Barrier, domestic, ornament	America – tropical	Lyons and Miller (1999); Haysom and Murphy (2003); Fischer *et al.* (2010); Obiri (2011); Witt, *pers. obs.*	Lyons and Miller (1999); Obiri (2011); Witt, *pers. obs.*
Tephrosia vogelli Hook. f.	Fabaceae	Woody tree/shrub	Agricultural crop (nitrogen-fixation), domestic, medicine	?Africa – tropical	Thulin (1989); Mkenda *et al.* (2015); Witt, *pers. obs.*	Mkenda *et al.* (2015)
Myriophyllum aquaticum (Vell.) Verdc.	Haloragaceae	Aquatic	Ornament	America – tropical	Verdcourt (1973); Agnew and Agnew (1994); Witt, *pers. obs.*	Agnew and Agnew (1994); Witt, *pers. obs.*
Myriophyllum spicatum L.	Haloragaceae	Aquatic	Ornament	?Eurasia – nth temperate	Verdcourt (2000)	Verdcourt (2000)
Gmelina arborea Roxb.	Lamiaceae	Woody tree/shrub	Domestic	America – tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Hyptis suaveolens (L.) Poit.	Lamiaceae	Herb	None	America – tropical	Paton *et al.* (2009); Witt, *pers. obs.*	Paton *et al.* (2009); Witt, *pers. obs.*
Salvia coccinea Buc'hoz ex Etl.	Lamiaceae	Herb	Ornament	America – tropical	Blundell (1992); Agnew and Agnew (1994); Demissew (2006); Paton *et al.* (2009); Witt, *pers. obs.*	?Paton *et al.* (2009); Witt, *pers. obs.*
Salvia leucantha Cav.	Lamiaceae	Herb	Ornament	America – tropical	Demissew (2006); Paton *et al.* (2009); Witt, *pers. obs.*	
Cinnamomum camphora (L.) J. Presl	Lauraceae	Woody tree/shrub	Agricultural crop (oils), ornament	Asia: nth temperate	Greenway (1934); Dawson *et al*. (2008); Spanhove and Lehouck (2008); TBA (2010); CABI (2016)	TBA (2010); CABI (2016)
Cinnamomum verum J. Presl	Lauraceae	Woody tree/shrub	Agricultural crop (oil), medicinal, ornament	Asia – tropical	Greenway (1934); Williams (1949); Zanzibar Island – Faulkner, in Verdcourt (1996); Dawson *et al.* (2008)	Zanzibar Island – Faulkner, in Verdcourt (1996)
Clidemia hirta (L.) D. Don	Melastomataceae	Woody tree/shrub	Ornament	America – tropical	Wickens (1975); Hamilton and Bensted-Smith (1989); Sheil (1994); Luke (2005); Dawson *et al.* (2008); TBA (2010); GISD (2016); Witt, *pers. obs.*	Wickens (1975); Hamilton and Bensted-Smith (1989); TBA (2010); GISD (2016), Witt, *pers. obs.*

Species	Family	Growth form	Cultivated use	Origin	Naturalized	Invasive
Azadirachta indica A. Juss.	Meliaceae	Woody tree/shrub	Agricultural crop (bee forage, insecticide), barrier, domestic, medicine, ornament	Asia – nth temperate	Styles and White (1991); Mbuya *et al.* (1994); Katende *et al.* (1995); Luke (2005); Maundu and Tengnäs (2005); KHS (1995); Cochard and Bloesch (2007); CABI (2016); Witt, *pers. obs.*	Styles and White (1991); Mbuya *et al.* (1994); Katende *et al.* (1995); Luke (2005); KHS (1995); Cochard and Bloesch (2007); CABI (2016); Witt, *pers. obs.*
Cedrela odorata L.	Meliaceae	Woody tree/shrub	Ornament, silvicultural crop	America – tropical	Greenway (1934); Hamilton and Bensted-Smith (1989); Pemba Island – Koenders (1992); Sheil (1994); Haysom and Murphy (2003); Dawson *et al.* (2008); TBA (2010); Flecks *et al.* (2012); Witt, *pers. obs.*	Greenway (1934); ?Hamilton and Bensted-Smith (1989); Dawson *et al.* (2008); TBA (2010); Flecks *et al.* (2012); Witt, *pers. obs.*
Melia azedarach L.	Meliaceae	Woody tree/shrub	Agricultural crop (bee forage, medicine), domestic, ornament	Australasia – tropical	Styles and White (1991); Hamilton and Bensted-Smith (1989); Sheil (1994); Katende *et al.* (1995); Haysom and Murphy (2003); CABI (2016); Witt, *pers. obs.*	Hamilton and Bensted-Smith (1989); CABI (2016)
Toona ciliata M. Roem.	Meliaceae	Woody tree/shrub	Barrier, domestic, medicinal, ornament, silvicultural crop	Asia – tropical	Greenway (1934); Katende *et al.* (1995); Mosango *et al.* (2001); Haysom and Murphy (2003); Maundu and Tengnäs (2005); Dawson *et al.* (2008); Witt, *pers. obs.*	Greenway (1934); Katende *et al.* (1995); Mosango *et al.* (2001); Maundu and Tengnäs (2005); Dawson *et al.* (2008); Witt, *pers. obs.*
Toona sinensis (Juss.) M. Roem.	Meliaceae	Woody tree/shrub	Barrier, domestic, ornament, silvicultural crop	Asia – tropical	Witt, *pers. comm.*	
Artocarpus heterophyllus Lam.	Moraceae	Woody tree/shrub	Agricultural crop (food, fodder), domestic, medicine	Asia – tropical	Greenway (1934); Sheil (1994); Mosango *et al.* (2001); Dharani (2002); Haysom and Murphy (2003); Maundu and Tengnäs (2005); Nyambo *et al.* (2005); Dawson *et al.* (2008); Dharani (2011); Witt, *pers. obs.*	Mosango *et al.* (2001); Nyambo *et al.* (2005)
Broussonetia papyrifera (L.) L'Her.ex Vent.	Moraceae	Woody tree/shrub	Ornament, silvicultural crop	Asia – nth temperate	Lyons and Miller (1999); Haysom and Murphy (2003); Dawson *et al.* (2008); CABI (2016); Witt, *pers. obs.*	Lyons and Miller (1999); Haysom and Murphy (2003); CABI (2016); Witt, *pers. obs.*

Species	Family	Growth form	Cultivated use	Origin	Naturalized	Invasive
Castilla elastica Cerv.	Moraceae	Woody tree/shrub	Agricultural crop (rubber), ornament	America – tropical	Greenway (1934); Dawson *et al.* (2008); TBA (2010); Witt, *pers. obs.*	Greenway (1934); Dawson *et al.* (2008); TBA (2010)
Psidium cattleianum Afzel. ex Sabine	Myrtaceae	Woody tree/shrub	Agricultural crop (food), domestic, ornament	America – tropical	Greenway (1934); Dawson *et al.* (2008); TBA (2010); Witt, *pers. obs.*	Greenway (1934); Dawson *et al.* (2008); TBA (2010); Witt, *pers. obs.*
Psidium guajava L.	Myrtaceae	Woody tree/shrub	Agricultural crop (food), domestic, ornament	America – tropical	Greenway (1934); Mbuya *et al.* (1994); Friis (1995); Verdcourt (2001); Dharani (2002); Haysom and Murphy (2003); Maundu and Tengnäs (2005); Nyambo *et al.* (2005); Dawson *et al.* (2008); Fischer *et al.* (2010); TBA (2010); Dharani (2011); Obiri (2011); CABI (2016); GISD (2016); Witt, *pers. obs.*	Greenway (1934); Mbuya *et al.* (1994); Verdcourt (2001); Nyambo *et al.* (2005); Dawson *et al.* (2008); TBA (2010); Obiri (2011); CABI (2016); GISD (2016); Witt, *pers. obs.*
Syzygium cumini (L.) Skeels	Myrtaceae	Woody tree/shrub	Agricultural crop (bee forage, food) domestic, medicinal, ornament	Asia – tropical	Pemba Island – Koenders (1992); Beentje (1994); Mosango *et al.* (2001); Verdcourt (2001); Luke (2005); Maundu and Tengnäs (2005); Cochard and Bloesch (2007); Dharani and Yenesew (2010); Birnie and Noad (2011); Dharani (2011)	Zanzibar Island – Greenway (1994); Mosango *et al.* (2001)
Syzygium jambos (L.) Alston	Myrtaceae	Woody tree/shrub	Agricultural crop (bee forage, food), domestic, ornament	Asia: tropical	Greenway (1934); Zanzibar Island – Verdcourt (2001); Dawson *et al.* (2008)	Greenway (1934); Dawson *et al.* (2008)
Mirabilis jalapa L.	Nyctaginaceae	Herb	Ornament	S. America – sth temperate	Williams (1949); Pemba Island – Koenders (1992); Agnew and Agnew (1994); Whitehouse (1996); Gilbert (2000); Mosango *et al.* (2001); Dharani and Yenesew (2010); Cochard and Bloesch (2007); Witt, *pers. obs.*	Gilbert (2000); Mosango *et al.* (2001); Witt, *pers. obs.*
Fraxinus pennsylvanica Marshall	Oleaceae	Woody tree/shrub	Domestic, ornament, silvicultural crop	N. America – nth temperate	Mullah *et al.* (2014)	Mullah *et al.* (2014)
Lonicera japonica Thunb.	Oleaceae	Climber	Barrier, ornament	Asia – nth temperate	Blundell (1992)	Blundell (1992)

Species	Family	Growth form	Cultivated use	Origin	Naturalized	Invasive
Argemone mexicana L.	Papaveraceae	Herb	None	America – tropical	Williams (1949); Lucas (1962); Blundell (1992); Pemba Island – Koenders (1992); Terry and Michieka (1987); Agnew and Agnew (1994); Demissew (2000); Henderson (2002); Macdonald *et al.* (2003); Cochard and Bloesch (2007); CABI (2016); Witt, *pers. obs.*	Lucas (1962); Terry and Michieka (1987); Agnew and Agnew (1994); Demissew (2000); Henderson (2002); Macdonald *et al.* (2003); Cochard and Bloesch (2007); CABI (2016); Witt, *pers. obs.*
Argemone ochroleuca Sweet	Papaveraceae	Herb	None	America – tropical	Henderson (2002); Witt, *pers. obs.*	Henderson (2002); Witt, *pers. obs.*
Passiflora caerulea L.	Passifloraceae	Climber	Ornament	America – tropical	KHS (1995); Witt, *pers. obs.*	
Passiflora edulis Sims	Passifloraceae	Climber	Agricultural crop (food), ornament	America: tropical	De Wilde (1975); Sheil (1994); de Wilde and Gilbert (1995); Mosango *et al.* (2001); Witt, *pers. obs.*	De Wilde (1975); Mosango *et al.* (2001); Witt, *pers. obs.*
Passiflora foetida L.	Passifloraceae	Climber	Ornament	America – tropical	De Wilde (1975); Witt, *pers. obs.*	
Passiflora suberosa L.	Passifloraceae	Climber	Ornament	America – tropical	De Wilde (1975); KHS (1995), Witt, *pers. obs.*	Witt, *pers. obs.*
Passiflora subpeltata L.	Passifloraceae	Climber	Ornament	America – tropical	De Wilde, 1975; Blundell (1992); Agnew and Agnew (1994); Sheil (1994); Witt, *pers. obs.*	De Wilde (1975); Witt, *pers. obs.*
Passiflora tarminiana Coppens & V.E. Barney (see narrative for issues regarding identification)	Passifloraceae	Climber	Ornament	America – tropical	De Wilde (1975); Beentje (1994)	De Wilde (1975); Beentje (1994)
Rivina humilis L.	Phytolaccaceae	Herb	Ornament	America -tropical	Polhill (1971); Mosango *et al.* (2001); Witt, *pers. obs.*	Polhill (1971); Mosango *et al.* (2001); Witt, *pers. obs.*
Pinus caribaea Morelet	Pinaceae	Woody tree/shrub	Barrier, ornament, silvicultural crop	America -tropical	Luke (2005); Witt, *pers. obs.*	
Pinus patula Schiede ex Schltdl. & Cham.	Pinaceae	Woody tree/shrub	Barrier, domestic, ornament, silvicultural crop	America – tropical	Lyons and Miller (1999); CABI (2016); Witt, *pers. obs.*	Lyons and Miller (1999); CABI (2016); Witt, *pers. obs.*
Piper aduncum L.	Piperaceae	Woody tree/shrub	Agricultural crop (spice), medicinal, ornament	America: tropical	Greenway (1934); Dawson *et al.* (2008); Witt, *pers. obs.*	Greenway (1934); Dawson *et al.* (2008)

Species	Family	Growth form	Cultivated use	Origin	Naturalized	Invasive
Antigonon leptopus Hook. & Arn.	Polygonaceae	Climber	Ornament	America – tropical	Graham (1958); Hedberg (2000); Witt, *pers. obs.*	Witt, *pers. obs.*
Eichhornia crassipes (Mart.) Solms	Pontederiaceae	Aquatic	Ornament	America – tropical	Verdcourt (1968); Agnew and Agnew (1994); Aweke (1997); Lyons and Miller (1999); Macdonald *et al.* (2003); CABI (2016); GISD (2016); Witt, *pers. obs.*	Verdcourt (1968); Agnew and Agnew (1994); Aweke (1997); Lyons and Miller (1999); Macdonald *et al.* (2003); CABI (2016); GISD (2016); Witt, *pers. obs.*
Pontederia cordata L.	Pontederiaceae	Aquatic	Ornament	America – tropical	Witt, *pers. obs.*	
Grevillea robusta A. Cunn. ex R. Br.	Proteaceae	Woody tree/shrub	Agricultural crop (bee forage), barrier, domestic, ornament	Australia – sth temperate	Birnie and Noad (2011), Witt, *pers. obs.*	
Hovenia dulcis Thunb.	Rhamnaceae	Woody tree/shrub	Agricultural crop (rubber), ornament	Asia: nth temperate	Greenway (1934); Hamilton and Bensted-Smith (1989); Dawson *et al.* (2008); TBA (2010); Witt, *pers. obs.*	Greenway (1934); Hamilton and Bensted-Smith (1989); Dawson *et al.* (2008); TBA (2010); Witt, *pers. obs.*
Maesopsis eminii Engl.	Rhamnaceae	Woody tree/shrub	Domestic, ornament, silvicultural crop	West and Central Africa -tropical	Greenway (1934); Hamilton and Bensted-Smith (1989); Pemba Island – Koenders (1992); Sheil (1994); Lyons and Miller (1999); Haysom and Murphy (2003); Macdonald *et al.* (2003); Dawson *et al.* (2008); Spanhove and Lehouck (2008); TBA (2010); Witt, *pers. obs.*	Greenway (1934); Hamilton and Bensted-Smith (1989); Lyons and Miller (1999); Haysom and Murphy (2003); Macdonald *et al.* (2003); Dawson *et al.* (2008); TBA (2010); Witt, *pers. obs.*
Eriobotrya japonica (Thunb.) Lindl.	Rosaceae	Woody tree/shrub	Agricultural crop (food), domestic, ornament	Asia – nth temperate	Witt, *pers. obs.*	
Rubus niveus Thunb.	Rosaceae	Woody tree/shrub	Agricultural crop (food), barrier, ornament	Asia – tropical	Beentje (1994); Hamilton and Bensted-Smith (1989); Hedberg (1989); Sheil (1994); Dawson *et al.* (2008); Witt, *pers. obs.*	Hamilton and Bensted-Smith (1989); Beentje (1994); Witt, *pers. obs.*

Species	Family	Growth form	Cultivated use	Origin	Naturalized	Invasive
Rubus rosifolius Sm.	Rosaceae	Woody tree/shrub	Agricultural crop (food), barrier, ornament	Asia and Australia – tropical	Greenway (1934); Graham (1960); Hamilton and Bensted-Smith (1989); Hedberg (1989); Agnew and Agnew (1994); Sheil (1994); Nyambo *et al.* (2005); Dawson *et al.* (2008); Fischer *et al.* (2010); TBA (2010); Witt, *pers. obs.*	Greenway (1934); Hamilton and Bensted-Smith (1989); Agnew and Agnew (1994); Nyambo *et al.* (2005); Dawson *et al.* (2008); TBA (2010); Witt, *pers. obs.*
Dovyalis caffra (Hook.f. & Harv.) Sim	Salicaceae	Woody tree/shrub	Agricultural crop (fruit), barrier, ornament	Southern Africa: sth temperate	Birnie and Noad (2011); Witt, *pers. obs.*	Witt, *pers. obs.*
Salvinia molesta D.S. Mitch.	Salviniaceae	Aquatic	Ornament	America – tropical	Agnew and Agnew (1994); Lyons and Miller (1999); Verdcourt (2000); CABI (2016); GISD (2016); Witt, *pers. obs.*	Agnew and Agnew (1994); Lyons and Miller (1999); Verdcourt (2000); CABI (2016); GISD (2016); Witt, *pers. obs.*
Cardiospermum grandiflorum Sw.	Sapindaceae	Climber	Ornament	America – tropical	Mosango *et al.* (2001); Witt, *pers. obs.*	Mosango *et al.* (2001); Witt, *pers. obs.*
Brugmansia suaveolens (Humb. & Bonpl. ex Willd.) Bercht. & J. Presl	Solanaceae	Woody tree/shrub	Ornament	America -tropical	Katende *et al.* (1995); Mosango *et al.* (2001); Dawson *et al.* (2008); Edmonds (2012); Witt, *pers. obs.*	Mosango *et al.* (2001); Witt, *pers. obs.*
Capsicum annuum L. (Syn.: Capsicum frutescens L.)	Solanaceae	Herb	Agricultural crop (food), ornament	America – tropical	Mosango *et al.* (2001); *C. frutescens* - Luke (2005); Witt, *pers. obs.*	Mosango *et al.* (2001)
Cestrum aurantiacum Lindl.	Solanaceae	Woody tree/shrub	Barrier, ornament	America – tropical	Blundell (1992); Fischer *et al.* (2010); Edmonds (2012); Witt, *pers. obs.*	Witt, *pers. obs.*
Cestrum elegans (Brongn. ex Neumann) Schltdl.	Solanaceae	Woody tree/shrub	Barrier, ornament	America – tropical	Friis (2006); Edmonds (2012); Witt, *pers. obs.*	Witt, *pers. obs.*
Cestrum nocturnum L.	Solanaceae	Woody tree/shrub	Barrier, ornament	America – tropical	Pemba Island – Koenders (1992); Mosango *et al.* (2001); Friis (2006); Edmonds (2012); Witt, *pers. obs.*	Mosango *et al.* (2001)
Cestrum parqui (Lam.) L'Hér.	Solanaceae	Woody tree/shrub	Barrier, ornament	America – tropical	Edmonds (2012)	
Datura ferox L.	Solanaceae	Herb	None	America – tropical	Edmonds (2012), Witt, *pers. obs.*	Witt, *pers. obs.*
Datura innoxia Mill.	Solanaceae	Herb	None	America – tropical	Friis (2006); Edmonds (2012); Witt, *pers. obs.*	Friis (2006); Edmonds (2012); Witt, *pers. obs.*

Species	Family	Growth form	Cultivated use	Origin	Naturalized	Invasive
Datura stramonium L.	Solanaceae	Herb	Ornament	America: tropical	Terry and Michieka (1987); Blundell (1992); Agnew and Agnew (1994); Henderson (2002); Friis (2006); Dharani and Yenesew (2010); Edmonds (2012); CABI (2016); Witt, *pers. obs.*	Terry and Michieka (1987); Agnew and Agnew (1994); Henderson (2002); Friis (2006); Dharani and Yenesew (2010); Edmonds (2012); CABI (2016); Witt, *pers. obs.*
Nicotiana glauca Graham	Solanaceae	Woody tree/shrub	Medicinal, ornament	South America – sth temperate	Blundell (1992); Agnew and Agnew (1994); Friis (2006); Edmonds (2012); Witt, *pers. obs.*	Edmonds (2012); Witt, *pers. obs.*
Physalis peruviana L.	Solonaceae	Herb	Agricultural crop (food)	America – tropical	Agnew and Agnew (1994); Mosango *et al.* (2001); Nyambo *et al.* (2005); Friis (2006); Witt, *pers. obs.*	Mosango *et al.* (2001); Nyambo *et al.* (2005); Witt, *pers. obs.*
Solanum campylacanthum Hochst. ex A. Rich.	Solanaceae	Woody tree/shrub	Medicinal	?Africa – tropical	Terry and Michieka (1987); Blundell (1992); Agnew and Agnew (1994), Beentje (1994); Henderson (2002); Friis (2006); Witt, *pers. obs.*	Terry and Michieka (1987); Agnew and Agnew (1994); Beentje (1994); Henderson (2002); Friis (2006); Witt, *pers. obs.*
Solanum mauritianum Scop.	Solanaceae	Woody tree/shrub	Ornament	America – tropical	Dharani (2002); Haysom and Murphy (2003); Edmonds (2012); CABI (2016); Witt, *pers. obs.*	Dharani (2002); Haysom and Murphy (2003); Edmonds (2012); CABI (2016); Witt, *pers. obs.*
Solanum seaforthianum Andrews	Solanaceae	Climber	Ornament	America – tropical	Edmonds (2012); KHS (1995); Witt, *pers. obs.*	Edmonds (2012); Witt, *pers. obs.*
Solanum torvum Sw.	Solanaceae	Woody tree/shrub	Ornament	America – tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Duranta erecta L.	Verbenaceae	Woody tree/shrub	Barrier, ornament	America – tropical	Hutchins (1909); Greenway (1934); Verdcourt (1992); Sheil (1994); Dawson *et al.* (2008); Fischer *et al.* (2010); Witt, *pers. obs.*	Verdcourt (1992); Beentje (1994); Cochard and Bloesch (2007)

Species	Family	Growth form	Cultivated use	Origin	Naturalized	Invasive
Lantana camara L.	Verbenaceae	Woody tree/shrub	Barrier, medicinal, ornament	America – tropical	Williams (1949); Terry and Michieka (1987); Blundell (1992); Verdcourt (1992); Beentje (1994);), Lyons and Miller (1999); Dharani (2002); Henderson (2002); Luke (2005); Demissew (2006); Cochard and Bloesch (2007); Dawson *et al.* (2008); Fischer *et al.* (2010); Dharani and Yenesew (2010); TBA (2010); Birnie and Noad (2011); Dharani (2011); Obiri (2011); CABI (2016); GISD (2016); Witt, *pers. obs.*	Terry and Michieka (1987); Blundell (1992); Verdcourt (1992); Beentje (1994); Lyons and Miller (1999); Dharani (2002); Henderson (2002); Cochard and Bloesch (2007); Dharani and Yenesew (2010); TBA (2010); Birnie and Noad (2011); Dharani (2011); Obiri (2011); CABI (2016); GISD (2016); Witt, *pers. obs.*
Stachytarpheta jamaciensis (L.) Vahl	Verbeaceae	Herb	Ornament	America – tropical	Blundell (1992); Verdcourt (1992); Witt, *pers. obs.*	Witt, *pers. obs.*
Tectona grandis L. f.	Verbenaceae	Woody tree/shrub	Ornament, silvicultural crop	Asia – tropical	Witt, *pers. obs.*	
Verbena bonariensis L.	Verbenaceae	Herb	Ornament	America – tropical	Blundell (1992); Verdcourt (1992); Agnew and Agnew (1994); Henderson (2002); Witt, *pers. obs.*	Verdcourt (1992); Agnew and Agnew (1994); Henderson (2002); Witt, *pers. obs.*
Verbesina encelioides (Cav.) Benth. & Hook. f. ex A. Gray	Verbenaceae	Herb	Ornament	America – tropical	Tadesse (2004); Witt, *pers. obs.*	Tadesse (2004); Witt, *pers. obs.*
Hedychium coronarium J. Koenig	Zingiberaceae	Herb	Ornament	Asia – nth temperate	Pemba Island – Koenders (1992); Witt, *pers. obs.*	Witt, *pers. obs.*
Hedychium flavescens Carey ex Roscoe	Zingiberaceae	Herb	Ornament	Asia – nth temperate	Witt, *pers. obs.*	Witt, *pers. obs.*
Hedychium gardnerianum Sheppard ex Ker Gawl.	Zingiberaceae	Herb	Ornament	Asia – nth temperate		

? = uncertainty as to classification as naturalized or invasive or origin

Appendix B

Biological control agents that have established in eastern Africa or elsewhere on some of the species of plants included in this Field Guide (Winston *et al*., 2014 and R.L. Winston, *pers. comm*.)

Species	Plant family	Agent family	Agent species	Country/countries established
Cryptostegia grandiflora Roxb. ex R. Br.	Apocynaceae	Crambidae	*Euclasta whalleyi* Popescu-Gorj & Constantinescu	Australia
		Pucciniales	*Maravalia cryptostegiae* (Cummins) Ono	Australia
Pistia stratiotes L.	Araceae	Curculionidae	*Neohydronomus affinis* Hustache	Australia, Benin, Botswana, Cote d'Ivoire, Ghana, Kenya, Morocco, Mozambique, Nigeria, Papua New Guinea, Puerto Rico*, Republic of Congo, Republic of South Africa, République Togolaise, Senegal, United States of America, Vanuatu, Zambia, Zimbabwe,
		Noctuidae	*Spodoptera pctinicornis* (Hampson)	Thailand
Ageratina adenophora (Spreng.) R.M. King & H. Rob.	Asteraceae	Pterophoridae	*Oidaematophorus benefices* Yano & Heppner	Hawaii USA
		Capnodiales	*Passalora ageratinae* Crous & A.R. Wood	Australia, Hawaii USA, India, Nepal, New Zealand, People's Republic of China, Republic of South Africa
		Tephritidae	*Procecidochares utilis* Stone	Australia, Hawaii USA, India, Nepal, New Zealand, People's Republic of China, Republic of South Africa, Thailand
Chromolaena odorata (L.) R.M. King & H. Rob.	Asteraceae	Eriophyidae	*Acalitus adoratus* Keifer	Bangladesh, Federated States of Micronesia, Guam, India, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, Northern Mariana Islands, Palau, Papua New Guinea, People's Republic of China, Philippines, Singapore, Taiwan, Thailand, Timor Leste, Vietnam
		Nymphalidae	*Actinote anteas* (Doubleday)	Indonesia
			Actinote thalia pyrrha Fabricius	Indonesia
			Actinote thalia thalia Keifer	Indonesia
		Agromyzidae	*Calycomyza eupatorivora* Spencer	Republic of South Africa
		Tephritidae	*Cecidochares connexa* Macquart	Cote d'Ivoire, Federated States of Micronesia, Ghana, Guam, India, Indonesia, Northern Mariana Islands, Palau, Papua New Guinea, Philippines, Tanzania*, Thailand, Thailand, Timor Leste
		Tortricidae	*Dichrorampha odorata* Brown & Zachariades	Republic of South Africa
		Curculionidae	*Lixus aemulus* Petri	Republic of South Africa*
		Erebidae	*Pareuchaetes insulata* (Walker)	Republic of South Africa
		Erebidae	*Pareuchaetes pseudoinsulata* Rego Barros	Benin, Brunei, Cote d'Ivoire, Federated States of Micronesia, Ghana, Guam, India, Indonesia, Malaysia, Nigeria, Northern Mariana Islands, Papua New Guinea, Philippines, Republic of South Africa, Sri Lanka

Species	Plant family	Agent family	Agent species	Country/countries established
Cirsium vulgare (Savi) Ten.	Asteraceae	Syrphidae	*Cheilosia grossa* (Fallén)	United States of America
		Curculionidae	*Rhinocyllus conicus* (Frölich)	Australia, Canada, Republic of South Africa, United States of America
		Curculionidae	*Trichosirocalus horridus* (Panzer)	Australia, United States of America
		Tephiritidae	*Urophora stylata* (Fabricius)	Australia, Canada, New Zealand, United States of America
Parthenium hysterophorus L.	Asteraceae	Bucculatricidae	*Bucculatrix pathenica* Bradley	Australia
		Sesiidae	*Carmenta* sp. nr *ithacae* (Beutenmüller)	Australia
		Curculionidae	*Conotrachelus albocinereus* Fiedler	Australia
		Tortricidae	*Epiblema strenuana* (Walker)	Australia
		Curculionidae	*Listronotus setosipennis* (Hustache)	Australia, Republic of South Africa*
		Tortricidae	*Platphalonidia mystica* (Razowski & Becker)	Australia
		Pucciniales	*Puccinia abrupta* Dietel & Holw. var. *partheniicola* (H.S. Jacks.) Parmelee	Australia, Ethiopia, India, Kenya, Mauritius, Nepal, People's Republic of China, Republic of South Africa, Tanzania
		Pucciniales	*Puccinia xanthii* Schwein. var *parthenii-hysterophorae* Seier, H. C. Evans & Á. Romero.	Australia, Republic of South Africa
		Curculionidae	*Smicronyx lutulentus* Dietz	Australia
		Delphacidae	*Stobaera concinna* (Stål)	Australia
		Chrysomelidae	*Zygogramma bicolorata* Pallister	Australia, Ethiopia*, India, Nepal, Pakistan, Republic of South Africa*, Tanzania*, Vanuatu*
Xanthium spinosum L.	Asteraceae	Incertae sedis	*Colletorichum orbiculare* (Berk.) Arx	Australia
		Tephritidae	*Euaresta bullans* (Wiedemann)	Australia, Republic of South Africa
Xanthium strumarium L.	Asteraceae	Tortricidae	*Epiblema strenuana* (Walker)	Australia
		Tephritidae	*Euaresta aequalis* Loew	Australia
		Cerambycidae	*Mecas cana* ssp. *satumina* (LeConte)	Australia*
		Cerambycidae	*Nupserha vexator* (Pascoe)	Australia
		Chrysomelidae	*Ophraella communa* LeSage	Japan
		Pucciniales	*Puccinia xanthii* Schweinitz	Australia
Azolla filiculoides Lam.	Azollaceae	Erirhinidae	*Stenopelmus rufinasus* Gyllenhal	Belgium, England, France, Germany, Hungary, Italy, Mozambique, Netherlands, Northern Ireland, Portugal, Republic of Ireland, Republic of South Africa, Slovakia, Spain, Ukraine, Wales, Zimbabwe
Anredera cordifolia (Ten.) Steenis	Basellaceae	Chrysomelidae	*Plectonycha correntina* Lacordaire	Australia
Dolichandra unguis-cati (L.) L.G. Lohmann	Bignoniaceae	Tingidae	*Carvalhotingis hollandi* Drake	Republic of South Africa,
			Carvalhotingis visenda Drake & Hambleton	Australia, Republic of South Africa

Species	Plant family	Agent family	Agent species	Country/countries established
		Chrysomelidae	*Charridotis auroguttata* Boheman	Republic of South Africa
		Buprestidae	*Hylaeogena jureceki* Obenberger	Australia*, Republic of South Africa
		Pyralidae	*Hypocosmia pyrochroma* Jones	Australia*, Republic of South Africa*
Echium plantagineum L.	Boraginaceae	Gracillariidae	*Dialectica scalariella* (Zeller)	Australia
		Chrysomelidae	*Longitarsus echii* (Koch)	Australia
		Nitidulidae	*Meligethes planiusculus* (Heer)	Australia
		Curculionidae	*Mogulones geopraphicus* (Goeze)	Australia
			Mogulones larvatus (Schultze)	Australia
		Cerambycidae	*Opsilia coerulescens* (Scopoli)	Australia
Cereus jamacaru DC.	Cactaceae	Pseudococcidae	*Hypogeococcus festerianus* (Lizer y Trelles)	Republic of South Africa
		Cerambycidae	*Nealcidion cereicola* (Fisher)	Republic of South Africa
Cylindropuntia imbricata (Haw.) F.M. Knuth	Cactaceae	Dactylopiidae	*Dactylopius tomentosus* (Lamark)	Australia, Republic of South Africa
		Dryophthridae	*Metamasius spinoalae* (Gyllenhal)	Republic of South Africa
Opuntia elatior Mill.	Cactaceae		*Dactylopius opuntiae* (Cockerell)	India, Indonesia
Opuntia engelmannii Salm-Dyck ex Engelm.	Cactaceae	Pyralidae	*Cactoblastis cactorum* (Berg)	Antigua, Republic of South Africa
		Dactylopiidae	*Dactylopius opuntiae* (Cockerell)	Republic of South Africa
Opuntia ficus-indica (L.) Mill.	Cactaceae	Pyralidae	*Cactoblastis cactorum* (Berg)	Cuba, Hawaii USA, Puerto Rico, Republic of South Africa, U.S. Virgin Islands
		Dactylopiidae	*Dactylopius opuntiae* (Cockerell)	Hawaii USA, Republic of South Africa, Spain
		Hypocreales	*Fusarium oxysporum* Schlecktendahl	Hawaii USA
		Cerambycidae	*Lagocheirus funestus* Thomson	Hawaii USA, Republic of South Africa
		Dryophthoridae	*Metamasius spinolae* (Gyllenhal)	Republic of South Africa
Opuntia monacantha (Willd.) Haw.	Cactaceae	Pyralidae	*Cactoblastis cactorum* (Berg)	Cuba, Mauritius
		Dactylopiidae	*Dactylopius ceylonicus* (Green)	Australia, India, Mauritius, Republic of South Africa, Sri Lanka
			Dactylopius confusus (Cockerell)	Australia
		Dactylopiidae	*Dactolopius opuntiae* (Cockerell)	Mauritius
Opuntia stricta (Haw.) Haw.	Cactaceae	Pyralidae	*Cactoblastis cactorum* (Berg)	Antigua, Australia, Bahamas, Cayman Islands, Cuba, Federation of St Kitts and Nevis, Guadeloupe, Jamaica, Montserrat, New Caledonia, Puerto Rico, Republic of South Africa, U.S. Virgin Islands
		Coreidae	*Chelinidea tabulata* (Burmeister)	Australia

Species	Plant family	Agent family	Agent species	Country/countries established
			Chelinidea vittiger Uhler	Australia*
		Dactylopiidae	*Dactylopius confusus* Cockerell	Australia
			Dactolopius opuntiae (Cockerell)	Australia, Federation of St Kitts and Nevis, India, Kenya, Republic of South Africa, Sri Lanka
		Cerambycidae	*Moneilema blapsides* (Newman) ssp. *ulkei* Horn	Australia
		Cerambycidae	*Moneilema variolare* Thomson	Australia
		Pyralidae	*Olycella junctolineella* (Hulst)	Australia
Pereskia aculeata Mill.	Cactaceae	Coreidae	*Catorhintha schaffneri* Brailovsky & Garcia	Republic of South Africa*
		Chrysomelidae	*Phenrica guerini* Bechyné	Republic of South Africa
Tradescantia fluminensis Vell.	Commelinaceae	Chrysomelidae	*Neolema ogloblini* (Monros)	New Zealand*
Convolvulus arvensis L.	Convolvulaceae	Eriophyidae	*Aceria malherbae* Nuzzaci	Canada, United States of America
		Chrysomelidae	*Charidotella purpurata* (Boheman)	Canada
		Noctuidae	*Tyta luctuosa* (Denis & Schiffermüller)	United States of America
Cuscuta campestris Yunck.	Convolvulaceae	Pleosporales	*Alternaria cuscutacidae* Rudakov	Russia
Acacia mearnsii De Wild.	Fabaceae	Agaricales	*Cylindrobasidium laeve* (Pers.)	Republic of South Africa
		Cecidomyiidae	*Dasineura rubiformis* Kolesik	New Zealand, Republic of South Africa,
		Curculionidae	*Melanterius maculatus* Lea	Republic of South Africa
Acacia melanoxylon R. Br.	Fabaceae	Curculionidae	*Melanterius acaciae* Lea	Republic of South Africa
Acacia podalyriifolia G. Don	Fabaceae	Curculionidae	*Melanterius maculatus* Lea	Republic of South Africa
Acacia saligna Labill. Wendl.	Fabaceae	Curculionidae	*Melanterius compactus* Lea	Republic of South Africa
		Pucciniales	*Uromycladium tepperianum* (Sacc.)	Republic of South Africa
Caesalpinia decapetala (Roth) Alston	Fabaceae	Chrysomelidae	*Sulcobruchus subsuturalis* (Pic)	Republic of South Africa
Leucaena leucocephala (Lam.) de Wit	Fabaceae	Chrysomelidae	*Acanthoscelides macrophthalmus* Schaeffer	Australia, Benin, India, Japan, People's Republic of China, Republic of Cyprus, Republic of South Africa, République Togolaise, Senegal, Taiwan, Thailand, Vietnam
Mimosa diplotricha Sauvalle	Fabaceae	Psyllidae	*Heteropsylla spinulosa* Muddiman, Hodkinson & Hollis	American Samoa, Australia, Cook Islands, Federated States of Micronesia, Fiji, Guam, Niue, Northern Mariana Islands, Northern Mariana Islands, Palau, Papua New Guinea, Samoa, Solomon Islands, Timor Leste, Tonga, Vanuatu
Mimosa pigra L.	Fabaceae	Chrysomelidae	*Acanthoscelides puniceus* Johnson	Australia, Indonesia, Lao People's Democratic Republic, Malaysia, Malaysia, Myanmar, Myanmar, Papua New Guinea*, Singapore, Thailand, Vietnam

Species	Plant family	Agent family	Agent species	Country/countries established
			Acanthoscelides quadridentatus (Schaeffer)	Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, Myanmar, Papua New, Guinea*, Singapore, Thailand, Vietnam
		Sesiidae	*Carmenta mimosa* Eichlin & Passoa	Australia, Malaysia, Vietnam
		Curculionidae	*Chalcodermus serripes* Fåhraeus	Australia
		Chrysomelidae	*Chlamisus mimosa* Karren	Australia, Thailand*, Vietnam*
		Brentidae	*Coelocephalapion pigrae* Kissinger	Australia
		Pucciniales	*Diabole cubensis* (Arthur & J. R. Johnst.) Arthur	Australia
		Geometridae	*Leuciris fimbriaria* (Stoll)	Australia
			Macaria pallidata (Warren)	Australia,
		Chrysomelidae	*Malacorhinus irregularis* Jacoby	Australia
			Nesaecrepida infuscata (Schaeffer)	Australia
		Gracillariidae	*Neurostrota gunniella* (Busck)	Australia
		Cerambycidae	*Rhytiphora piperitia* Hope	Australia
Parkinsonia aculeata L.	Fabaceae	Chrysomelidae	*Mimosestes ulkei* (Horn)	Australia*
		Chrysomelidae	*Penthobruchus germaini* (Pic)	Australia
		Miridae	*Rhinacloa callicrates* Herring	Australia
Prosopis juliflora (Sw.) DC.	Fabaceae	Chrysomelidae	*Algarobius bottimeri* Kingsolver	Australia
		Chrysomelidae	*Algarobius prosopis* (Le Conte)	Ascension Island, Australia, Botswana, Egypt, Namibia, Oman, Republic of South Africa, Saudi Arabia, United Arab Emirates, Yemen
		Gelechiidae	*Evippe* sp. # 1	Australia
		Psyllidae	*Heteropsylla reducta* Caldwell & Martorell	Ascension Island
		Chrysomelidae	*Neltumius arizonensis* (Schaeffer)	Ascension Island, Botswana, Namibia, Republic of South Africa
		Psyllidae	*Prosopidopsylla flava* Burckhardt	Australia
		Miridae	*Rhinocloa* sp.	Ascension Island
Myriophyllum aquaticum (Vell.) Verdc.	Haloragaceae	Chrysomelidae	*Lysathia* sp.	Republic of South Africa, Zimbabwe
Myriophyllum spicatum L.	Haloragaceae	Crambidae	*Acentria ephemerella* (Denis & Schiffermüller)	Canada*, United States of America
		Curculionidae	*Euhrychiopsis lecontei* (Dietz)	United States of America
		Leptoceridae	*Triaenodes tarda* Milne	Canada
Clidemia hirta (L.) D. Don	Melastomataceae	Erebidae	*Antiblemma acclinalis* Hübner	Hawaii USA
		Crambidae	*Ategumia matutinalis* (Guenée)	Hawaii USA

Species	Plant family	Agent family	Agent species	Country/countries established
		Incertae sedis	*Colletotrichum clidemiae* B. Weir & P. R. Johnst.	Hawaii USA
		Phlaeothripidae	*Liothrips urichi* Karny	American Samoa, Fiji, Hawaii USA, Palau
		Buprestidae	*Lius poseidon* Napp	Hawaii USA
		Momphidae	*Mompha trithalama* Meyrick	Hawaii USA
Psidium cattleianum Afzel. ex Sabine	Myrtaceae	Eriococcidae	*Tectococcus ovatus* Hempel	Hawaii USA
Passiflora tarminiana Coppens & V.E. Barney	Passifloraceae	Crambidae	*Pyrausta perelegans* Hampson	Hawaii USA
		Capnodiales	*Septoria passiflorae* Sydenham	Hawaii USA
Eichhornia crassipes (Mart.) Solms	Pontederiaceae	Hypocreales	*Acremonium zonatum* (Sawada) W. Gams	Mexico
		Pleosporales	*Alternaria eichhorniae* Nag Raj & Ponnappa	Egypt, Republic of South Africa
		Noctuidae	*Bellura densa* (Walker)	United States of America
		Capnodiales	*Cercospora piaropi* Tharp	Mexico, United States of America, Republic of South Africa
		Acrididae	*Cornops aquaticum* Bruner	South Africa*
		Miridae	*Eccritotarsus catarinensis* (Carvalho)	Ghana, Malawi, Republic of South Africa
		Delphacidae	*Megamelus scutellaris* Berg	Republic of South Africa, United States of America,
		Erirhinidae	*Neochetina bruchi* Hustache	Argentina, Australia, Benin, Bolivia, Burkina Faso, Cote d'Ivoire, Cuba, Egypt, Ghana, Honduras, India, Indonesia, Kenya, Malawi, Malaysia, Mali, Mexico, Mozambique, Niger Republic*, Nigeria, Panama*, Papua New Guinea, People's Republic of China, Philippines*, Republic of Congo, Republic of South Africa, République Togolaise, Rwanda, South Sudan, Sri Lanka, Sudan, Tanzania, Thailand, Uganda, United States of America, Vanuatu, Vietnam, Zambia, Zimbabwe
		Erirhinidae	*Neochetina eichhorniae* Warner	Australia, Benin, Bolivia, Burkina Faso, Cote d'Ivoire, Cuba, Egypt, Fiji, Ghana, Honduras, India, Indonesia, Kenya, Malawi, Malaysia, Mali, Mexico, Mozambique, Myanmar, Nauru*, Niger Republic, Nigeria, Papua New Guinea, People's Republic of China, Philippines*, Republic of Congo, Republic of South Africa, République Togolaise, Rwanda, Solomon Islands, South Sudan, Sri Lanka, Sudan, Tanzania, Thailand, Uganda, United States of America, Vanuatu, Vietnam*, Zambia, Zimbabwe
		Crambidae	*Niphograpta albiguttalis* (Warren)	Australia, Benin, Cuba, Ghana, Kenya, Malawi*, Malaysia, Mexico, Nigeria, Panama*, Puerto Rico, Republic of South Africa, South Sudan, Thailand, United States of America, Zimbabwe

Species	Plant family	Agent family	Agent species	Country/countries established
		Galumnidae	*Orthogalumna terebrantis* Wallwork	Cuba, India, Jamaica, Malawi, Mozambique, Republic of South Africa, United States of America, Zambia, Zimbabwe
		Crambidae	*Xubida infusella* (Walker)	Australia, Papua New Guinea*, Thailand
Salvinia molesta D.S. Mitch.	Salviniaceae	Erirhinidae	*Cyrtobagous salviniae* Calder & Sands	Australia, Botswana, Cote d'Ivoire, Fiji, Ghana, India, Indonesia, Kenya, Malaysia, Mali, Mauritania, Namibia, Papua New Guinea, Philippines, Republic of Congo, Republic of South Africa, République Togolaise, Senegal, Sri Lanka, Zambia, Zimbabwe
			Cyrtobagous singularis Hustache	Botswana, Fiji, Zambia, Zimbabwe
		Pauliniidae	*Paulinia acuminata* (De Geer)	Fiji, Mozambique, Zambia, Zimbabwe
		Crambidae	*Samea multiplicalis* (Guenée)	Australia, Fiji
Cardiospermum grandiflorum Sw.	Sapindaceae	Curculionidae	*Cissoanthonomus tuberculipennis* Hustache	Republic of South Africa*
Solanum mauritianum Scop.	Solanaceae	Curculionidae	*Anthonomus santacruzi* Hustache	Republic of South Africa
		Tingidae	*Gargaphia decoris* Drake	New Zealand, Republic of South Africa
Lantana camara L.	Verbenaceae	Eriophyidae	*Aceria lantanae* (Cook)	Australia*, Republic of South Africa, United States of America
		Membracidae	*Aconophora compressa* Walker	Australia
		Agromyzidae	*Calycomyza lantanae* (Frick)	Australia, Benin, Cambodia, Ethiopia, Federated States of Micronesia, Fiji, Guam, Indonesia, Kenya, La Réunion, Madagascar, Malaysia, Palau, Papua New Guinea, Philippines, Republic of South Africa, Singapore, Solomon Islands, Sri Lanka, Swaziland, Taiwan, Tanzania, Thailand, Timor Leste, Uganda, Vanuatu, Vietnam, Zimbabwe
		Brentidae	*Coelocephalapion camarae* Kissinger	Republic of South Africa
		Gracillariidae	*Cremastobombycia lantanella* Busck	Hawaii USA
		Torticidae	*Crocidosema lantana* Busck	Australia, Federated States of Micronesia, Guam, Hawaii USA, India, Marshall Islands, Northern Mariana Islands, Palau, Republic of South Africa, Sri Lanka, Vanuatu, Zimbabwe
		Noctuidae	*Diastema tigris* Guenée	Mauritius
		Tephritidae	*Eutreta xanthochaeta* Aldrich	Hawaii USA
		Miridae	*Falconia intermedia* (Distant)	Australia, Republic of South Africa
		Erebidae	*Hypena laceratalis* Walker	Australia, Cape Verde Islands, Federated States of Micronesia, Fiji, Guam, Hawaii USA, Mauritius, New Caledonia, Northern Mariana Islands, Papua New Guinea, Philippines, Republic of South Africa, Taiwan*, Vanuatu

Species	Plant family	Agent family	Agent species	Country/countries established
		Pterophoridae	*Lantanophaga pusillidactyla* (Walker)	Australia, Federated States of Micronesia, Guam, Hawaii USA, Hong Kong, India, Israel, Italy, Morocco, Myanmar, New Zealand, Northern Mariana Islands, Palau, Papua New Guinea, People's Republic of China, Philippines, Portugal, Republic of South Africa, Spain, Sri Lanka, Taiwan, Thailand, Timor Leste, Zambia, Zimbabwe
		Tingidae	*Leptobyrsa decora* Drake	Australia, Cook Islands*, Hawaii USA, Tonga*
		Chrysomelidae	*Longitarus bethae* Savini & Escalona	Republic of South Africa
		Noctuidae	*Neogalea sunia* (Guenée)	Australia, Hawaii USA, New Caledonia
		Chrysomelidae	*Octotoma championi* Baly	Australia
			Octotoma scabripennis Guérin-Méneville	Australia, Ghana, Guam, Hawaii USA, India, New Caledonia, Republic of South Africa, Solomon Islands*, Swaziland
		Agromyzidae	*Ophiomyia camarae* Spencer	Argentina, Ethiopia, Kenya, Madagascar, Mozambique, Swaziland, Tanzania, Zimbabwe,
			Ophiomyia lantanae (Froggatt)	Argentina, Australia, Benin, Cook Islands* Ethiopia, Federated States of Micronesia, Fiji, French Polynesia, Ghana, Guam, Hawaii USA, Hong Kong, India, Indonesia, Kenya, La Réunion, Madagascar, Malaysia, Mozambique, Myanmar, New Caledonia, Northern Mariana Islands, Palau, Papua New Guinea, Philippines, Republic of South Africa, Samoa, Singapore, Sri Lanka, Swaziland, Taiwan, Tanzania, Thailand, Timor Leste, Tonga, Vanuatu, Vietnam, Zambia, Zimbabwe
		Ortheziidae	*Orthezia insignis* Browne	Ascension Island, Cape Verde Islands, Ethiopia, Hawaii USA, India, Kenya, La Réunion, Mauritius, Republic of South Africa, Sri Lanka, St Helena, Swaziland
		Capnodiales	*Passalora lantanae* var. *lantanae* (Chupp) U. Braun	Sri Lanka
		Pseudococcidae	*Phenacoccus parvus* Morrison	Australia
		Cerambycidae	*Plagiohammus spinipennis* (Thomson)	Australia
		Pucciniales	*Prospodium tuberculatum* (Spegazzini) Arthur	Australia
		Crambidae	*Salbia haemorrhoidalis* Guenée	Australia, Benin, Federated States of Micronesia, Fiji, Hawaii USA, Mauritius, Republic of South Africa, Uganda, Zambia
		Capnodiales	*Septoria* sp.	Hawaii USA
		Lycaenidae	*Strymon bazochii* (Godart)	Fiji, Hawaii USA*

Species	Plant family	Agent family	Agent species	Country/countries established
		Tingidae	*Teleonemia scrupulosa* Stål	Ascension Island, Australia, Benin, Botswana, Federated States of Micronesia, Fiji, French Polynesia, Ghana, Guam, Hawaii USA, India, Indonesia, Kenya, La Réunion, Madagascar, Malaysia, Mauritius, Namibia, New Caledonia, Niue, Northern Mariana Islands, Palau Papua New Guinea, Philippines, Republic of South Africa, Samoa, Samoa, Solomon Islands, Sri Lanka, St Helena, Swaziland, Tanzania, Thailand, Timor Leste, Tonga, Uganda, Vanuatu, Zambia, Zimbabwe
		Lycaenidae	*Tmolus echion* (L.)	Hawaii USA
		Chrysomelidae	*Uroplata fulvopustulata* Baly	Australia
			Uroplata girardi Pic	Ascension Island, Australia, Cook Islands, Ethiopia, Federated States of Micronesia, Fiji, Ghana, Guam, Hawaii USA, India, Mauritius, New Caledonia, Niue, Northern Mariana Islands, Palau, Papua New Guinea, Philippines, Republic of South Africa, Samoa, Solomon Islands, St Helena*, Tanzania, Tonga, Trinidad and Tobago*, Uganda, Vanuatu, Zambia

*Released but establishment not yet confirmed

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Appendix C

Herbicides registered or permissible with minor or emergency use permits in Australia by the Australian Pesticides and Veterinary Medicines Authority against some of the plant species included in this Field Guide (Joseph Vitelli; Department of Agriculture and Fisheries; Queensland Government; Australia; *pers. comm*.).

(Abbreviations used: g/L = grams/litre; g/kg = grams per kilogram)

Species	Family	Active constituent	Active constituent with concentration	A.I. (grams) per Litre	Method of Application
Brillantaisia lamium (Nees) Benth.	Acanthaceae	Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.5g/L + 0.5g/L + 0.04g/L water + wetter	Foliar
Thunbergia grandiflora (Roxb. ex Rottl.) Roxb.	Acanthaceae	Imazapyr	Imazapyr (250g/L)	0.25 g/L water	Cut stump ("V" shape cut 2mls/cut)
		Imazapyr	Imazapyr (250g/L)	1.875 g/L water	Foliar
		Imazapyr + Glyphosate	Imazapyr (150g/L) + Glyphosate (150g/L)	1.875 + 1.875 g/L water	Foliar
Agave americana L.	Agavaceae	Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.12g/L water + wetter	Foliar
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g+2g/L diesel	Foliar
Agave angustifolia Haw.	Agavaceae	Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g+2g/L diesel	Foliar
Agave sisalana Perrine	Agavaceae	Fluroxypyr	Fluroxypyr (333g/L)	6g/L diesel	Foliar
		Imazapyr	Imazapyr (250g/L)	1.25g/L water	Foliar
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g+2g/L diesel	Foliar
Furcraea foetida (L.) Haw.	Agavaceae	Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.12g/L water + wetter	Foliar
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Foliar
Cananga odorata (Lam.) Hook.f. & Thomson	Annonaceae	Fluroxypyr	Fluroxypyr (333g/L)	3.0g/L diesel	Basal bark
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Basal bark/ Cut stump
		Glyphosate	Glyphosate (360g/L)	1.8 g/L water	Cut stump
		Triclopyr + Picloram	Triclopyr (200 g/L) + Picloram (100 g/L)	20.0g+10.0g/L water	Stem injection
		Imazapyr	Imazapyr (250g/L)	2.0g/L water	Foliar
Calotropis gigantea (L.) Dryand.	Apocynaceae	See *Calotropis procera*			
Calotropis procera (Aiton) Dryand.	Apocynaceae	Fluroxypyr	Fluroxypyr (333g/L)	10.0g/L diesel	Basal bark
		Imazapyr	Imazapyr (250g/L)	1.25g/L water	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.12g /L water + wetter	Foliar
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Basal bark/ Cut stump
		Picloram + Aminopyralid	Picloram (43g/Kg) + Aminopyralid (4.3g/Kg)	Neat – 3 to 5 mm layer	Cut stump
		Glyphosate	Glyphosate (360g/L)	360 g/L water	Cut stump
		Tebuthiuron	Tebuthiuron (200g/L)	0.2g per meter square of soil around plant	Spot ground application
Cascabela thevetia (L.) Lippold	Apocynaceae	Fluroxypyr	Fluroxypyr (333g/L)	3.0g/L diesel	Basal bark
		Glyphosate	Glyphosate (360g/L)	1.2 g/L water	Cut stump
		Triclopyr + Picloram	Triclopyr (200 g/L) + Picloram (100 g/L)	50.0g+25.0g/L water	Stem injection

Species	Family	Active constituent	Active constituent with concentration	A.I. (grams) per Litre	Method of Application
		Glyphosate	Glyphosate (360g/L)	1.8 g/L water	Stem injection
		Fluroxypyr	Fluroxypyr (333g/L)	1.0g/L water	Foliar
Catharanthus roseus (L.) G.Don	Apocynaceae	Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.12g/L water + wetter	Foliar
		Triclopyr + Picloram	Triclopyr (300g/L) + Picloram (100g/L)	3.5g + 0.35g/L water	Foliar
Pistia stratiotes L.	Araceae	Diquat	Diquate (200g/L)	0.67g/L water	Foliar
		Flumioxazin	Flumioxazin (500g/L)	0.7g/L water	Foliar
		Glyphosate	Glyphosate (360g/L)	4.68g/L water	Foliar
Aristolochia littoralis Parodi	Aristolochiaceae	Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Basal bark/ Cut stump
Cryptostegia grandiflora Roxb. ex R.Br.	Asclepiadaceae	2,4-D + Picloram	2,4-D (300g/L) + Picloram (75g/L)	3.9g + .098g/L water	Foliar
		Aminopyralid + Metsulfuron	Aminopyralid (375g/kg) + Metsulfuron (300g/kg)	0.056g + 0.045g/L water + wetter	Foliar
		Imazapyr	Imazapyr (250g/L)	1.0g/L water	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.09g /L water + wetter	Foliar
		Tebuthiuron	Tebuthiuron (200g/L)	0.3g per meter square of soil around plant	Spot ground application
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.5g/L + 0.5g/L + 0.04g/L water + wetter	Foliar
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Basal bark/ Cut stump
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.03g /L water + wetter	Cut stump
Cryptostegia madagascariensis Bojer ex Decne.	Asclepiadaceae	See *Cryptostegia grandiflora*			
Ageratina adenophora (Spreng.) R.M. King & H. Rob.	Asteraceae	2,4-D + Picloram	2,4-D (300g/L) + Picloram (75g/L)	1.95g + 0.49g/L water + wetter	Foliar
		Aminopyralid + Fluroxypyr	Aminopyralid (10g/L) + Fluroxypyr (140g/L)	0.07g/L + 0.98g/L water + wetter	Foliar
		Aminopyralid + Metsulfuron	Aminopyralid (375g/kg) + Metsulfuron (300g/kg)	0.1125g + 0.09g/L water + wetter	Foliar
		Fluroxypyr	Fluroxypyr (333g/L)	1.0g/L water	Foliar
		Glyphosate	Glyphosate (360g/L)	1.8g/L water + wetter	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.09g/L water + wetter	Foliar
		Triclopyr + Metsulfuron	Triclopyr (75g/L) + Metsulfuron (28g/L)	0.28g + 0.11g/L water + wetter	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.5g + 0.5g + 0.04g/L water	Splatter gun
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.05g + 0.35g + 0.028g/L water	Foliar
Ageratum conyzoides (L.) L.	Asteraceae	Fluroxypyr	Fluroxypyr (333g/L)	0.25g/L water	Foliar
		Glufosinate ammonium	Glufosinate ammonium (200g/L)	1g/L water	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.06g/L water + wetter	Foliar

Species	Family	Active constituent	Active constituent with concentration	A.I. (grams) per Litre	Method of Application
Ageratum houstonianum Mill.	Asteraceae	See *A. conyzoides*			
Chromolaena odorata (L.) R.M. King & H. Rob.	Asteraceae	Aminopyralid + Fluroxypyr	Aminopyralid (10g/L) + Fluroxypyr (140g/L)	0.05g + 0.7g/L water	Foliar
		Aminopyralid + Fluroxypyr	Aminopyralid (10g/L) + Fluroxypyr (140g/L)	1.42g +20.0g/L water	Splatter gun
		Fluroxypyr	Fluroxypyr (333g/L)	0.7g/L water	Foliar
		Picloram + Aminopyralid	Picloram (43g/Kg) + Aminopyralid (4.3g/Kg)	Neat – 3 to 5 mm layer	Cut stump
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.0g + 0.35g + 0.028/L water	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	15g + 5g + 0.4/L water	Splatter gun
Cirsium vulgare (Savi) Ten.	Asteraceae	Glyphosate	Glyphosate (360g/L)	3.6 g/L water	Foliar
Dahlia imperialis Roezl ex Ortgies	Asteraceae	Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Basal bark/ Cut stump
Euryops chrysanthemoides (DC.) B. Nord.	Asteraceae	2,4-D + Picloram	2,4-D (300g/L) + Picloram (75g/L)	1.95g + 0.49g/L water + wetter	Foliar
Montanoa hibiscifolia Benth	Asteraceae	See *Tithonia* spp.			
Parthenium hysterophorus L.	Asteraceae	2,4-D	2,4-D Amine (500g/L)	2.0g/L water	Foliar
		2,4-D + Picloram	2,4-D (300g/L) + Picloram (75g/L)	0.6g + 0.15g/L water	Foliar
		Aminopyralid + Metsulfuron	Aminopyralid (375g/kg) + Metsulfuron (300g/kg)	0.375g + 0.09g/L water + wetter	Foliar
		Dicamba	Dicamba (500g/L)	2.75g/L water	Foliar
		Hexazinone	Hexazinone (250g/L)	0.175g/L water per 2 square meters	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.03g/L water	Foliar
		Triclopyr + Metsulfuron	Triclopyr (75g/L) + Metsulfuron (28g/L)	0.15g + 0.06g/L water + wetter	Foliar
Senecio madagascariensis Poir	Asteraceae	Aminopyralid + Fluroxypyr	Aminopyralid (10g/L) + Fluroxypyr (140g/L)	.05g/L + 0.7g/L water + wetter	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.05g/L + 0.35g/L + 0.028g/L water + wetter	Foliar
Sphagneticola trilobata (L.) Pruski	Asteraceae	Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.09g/L water + wetter	Foliar
Tithonia diversifolia (Hemsl.) A.Gray	Asteraceae	Aminopyralid + Metsulfuron	Aminopyralid (375g/kg) + Metsulfuron (300g/kg)	0.075g + 0.06g/L water + wetter	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.06g/L water + wetter	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.05g + 0.35g + 0.028g/L water	Foliar
Tithonia rotundifolia (Mill.) S.F. Blake	Asteraceae	See *Tithonia diversifolia*			
Xanthium strumarium L.	Asteraceae	2,4-D	2,4-D Amine (625g/L)	1.9 g/L water	Foliar
		2,4-D + Picloram	2,4-D Amine (300g/L) + Picloram (75g/L)	200g + 50 g/L water	Foliar

Species	Family	Active constituent	Active constituent with concentration	A.I. (grams) per Litre	Method of Application
		Aminopyralid + Metsulfuron	Aminopyralid (375g/kg) + Metsulfuron (300g/kg)	0.0525g + 0.042g/L water + wetter	Foliar
		Dicamba	Dicamba (500g/L)	3.0 g/L water	Foliar
		Fluroxypyr	Fluroxypyr (333g/L)	0.15g/L water	Foliar
		Imazapyr	Imazapyr (250g/L)	0.625 g/L water	Foliar
		MCPA	MCPA (500g/L)	1.33g/L water	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.038g/L water + wetter	Foliar
		Triclopyr + Metsulfuron	Triclopyr (75g/L) + Metsulfuron (28g/L)	0.15g + 0.06g/L water + wetter	Foliar
Xanthium spinosum L.	Asteraceae	2,4-D	2,4-D Amine (625g/L)	1.9 g/L water	Foliar
		MCPA	MCPA (500g/L)	1.33g/L water	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.038g/L water + wetter	Foliar
		Fluroxypyr	Fluroxypyr (333g/L)	0.15g/L water	Foliar
Azolla filiculoides Lam.	Azollaceae	Calcium dodecyl benzene sulfonate	Calcium dodecyl benzene sulfonate (300 g/L)	15g/L kerosene per 100m2	Foliar
		Diquat	Diquat (200g/L)	1.67g/L water	Foliar
Anredera cordifolia (Ten.) Steenis	Basellaceae	Fluroxypyr	Fluroxypyr (200g/L)	1.0g/L water	Foliar
		Glyphosate	Glyphosate (360g/L)	360g/L water	Cut stump; immerse both cut ends of the vine into the prepared herbicide solution and leave until solution is no longer being absorbed
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.5g + 0.5g + 0.04g/L water	Foliar
Dolichandra unguis-cati (L.) L.G. Lohmann	Bignoniaceae	Glyphosate	Glyphosate (360g/L)	30.0 g/L water	Cut stump
		Glyphosate	Glyphosate (360g/L)	3.6 g/L water	Foliar
Cordia alliodora (Ruiz & Pav.) Oken	Boragnaceae	Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Basal bark/ Cut stump
Austrocylindropuntia cylindrica (Lam.) Backeb.	Cactaceae	MCMA	MSMA (800g/Kg)	18g/L water + wetter	Foliar
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g +2g/L diesel	Foliar
Cereus jamacaru DC.	Cactaceae	Imazapyr	Imazapyr (250g/L)	Neat – Holes 2.5cm apart with 1mls per hole	Stem injection
		MSMA	MSMA (800g/Kg)	18g/L water +wetter	Foliar
		MSMA	MSMA (800g/Kg)	360g/L water-Holes 2.5cm apart with 2mls per hole	Stem injection
Cylindropuntia imbricata (Haw.) F.M. Knuth	Cactaceae	Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.12g/L water + wetter	Foliar
		MSMA	MSMA (800g/Kg)	18g/L water +wetter	Foliar

Species	Family	Active constituent	Active constituent with concentration	A.I. (grams) per Litre	Method of Application
		Picloram + Fluroxypyr + Polysiloxane	Picloram (240g/L) + Fluroxypyr (333g/L) + 1020 (g/L) Polysiloxane	0.5g + 0.42g + 1.7g/L water	Foliar
Opuntia elatior Mill.	Cactaceae	Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g +2g/L diesel	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.5g + 0.5g + 0.04g/L water	Foliar
Opuntia engelmannii Salm-Dyck ex Engelm.	Cactaceae	Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.5g + 0.5g + 0.04g/L water	Foliar
Opuntia ficus-indica (L.) Mill.	Cactaceae	Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.5g + 0.5g + 0.04g/L water	Foliar
Opuntia microdasys (Lehm.) Pfeiff.	Cactaceae	Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.5g + 0.5g + 0.04g/L water	Foliar
Opuntia monacantha (Willd.) Haw.	Cactaceae	Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.5g + 0.5g + 0.04g/L water	Foliar
Opuntia stricta (Haw.) Haw.	Cactaceae	Amitrole + Ammonium Thiocyanate	Amitrole (250g/L) + Ammonium Thiocyanate (220g/L)	10g/L + wetter	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.12g/L water + wetter	Foliar
		MSMA	MSMA (800g/Kg)	18g/L water + wetter	Foliar
		Picloram + Fluroxypyr + Polysiloxane	Picloram (240g/L) + Fluroxypyr (333g/L) + 1020 (g/L) Polysiloxane	0.5g + 0.42g + 1.7g/L water	Foliar
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (200g/L) + Picloram (100g/L) + Aminopyralid (25g/L)	5g + 2.5g + 0.625/L water	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.5g + 0.5g + 0.04g/L water	Foliar
Peniocereus serpentinus (Lag. & Rodr.) N.P. Taylor	Cactaceae	MSMA	MSMA (800g/Kg)	18g/L water + wetter	Foliar
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Foliar
Canna indica L.	Cannaceae	Glyphosate	Glyphosate (360g/L)	3.6 g/L + wetter	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.06 g/L + wetter	Foliar
		Picloram + Aminopyralid	Picloram (43g/Kg) + Aminopyralid (4.3g/Kg)	Neat – 3 to 5 mm layer	Cut stump
Casuarina cunninghamiana Miq	Casuarinaceae	Tebuthiuron	Tebuthiuron (200g/L)	0.2g per meter square of soil around plant	Spot ground application
		Glyphosate	Glyphosate (360g/L)	1.8 g/L water	Foliar (seedlings)

Species	Family	Active constituent	Active constituent with concentration	A.I. (grams) per Litre	Method of Application
Casuarina equisetifolia L.	Casuarinaceae	Tebuthiuron	Tebuthiuron (200g/L)	0.2g per meter square of soil around plant	Spot ground application
		Glyphosate	Glyphosate (360g/L)	1.8 g/L water	Foliar (seedlings)
Callisia fragrans (Lindl.) Woodson	Commelinaceae	Glyphosate	Glyphosate (360g/L)	7.2 g/L water	Foliar
Callisia repens (Jacq.) L.	Commelinaceae	Glyphosate	Glyphosate (360g/L)	7.2 g/L water	Foliar
Tradescantia zebrina Bosse	Commelinaceae	Fluroxypyr	Fluroxypyr (333g/L)	3 g/L water	Foliar
		Glyphosate	Glyphosate (360g/L)	7.2 g/L water	Foliar
Convolvulus arvensis L.	Convolvulaceae	2,4-D + Picloram	2,4-D (300g/L) + Picloram (75g/L)	3.9g + .098g/L water	Foliar
		Glufosinate ammonium	Glufosinate ammonium (200g/L)	0.6g/L water	Foliar
Cuscuta campestris Yunck.	Convolvulaceae	Aminopyralid + Metsulfuron	Aminopyralid (375g/kg) + Metsulfuron (300g/kg)	0.0075g + 0.006g/L water + wetter	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.006 g/L + wetter	Foliar
Ipomoea cairica (L.) Sweet	Convolvulaceae	2,4-D	2,4-D Amine (625g/L)	2.5 g/L water	Foliar
		Dicamba	Dicamba (500g/L)	2.5 g/L water	Foliar
Ipomoea carnea Jacq.	Convolvulaceae	Flumioxazin	Flumioxazin (500g/L)	0.35g/L water	Foliar
Bryophyllum daigremontianum (Raym.-Hamet & Perrier) A. Berger	Crassulaceae	Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.12g/L water + wetter	Foliar
Bryophyllum delagoense (Eckl. & Zeyh.) Druce	Crassulaceae	Fluroxypyr	Fluroxypyr (333g/L)	1.2g/L water + wetter	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.12g/L water + wetter	Foliar
		Metsulfuron-methyl + Glyphosate	Metsulfuron-methyl (600g/kg) + Glyphosate (360g/L)	0.06g/L + 0.72g/L water + wetter	Foliar
		Triclopyr + Picloram	Triclopyr (300 g/L) + Picloram (100 g/L)	1.5g/L + 0.5g/L water + wetter	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.5g/L + 0.5g/L + 0.04g/L water + wetter	Foliar
Bryophyllum fedtschenkoi (Raym.-Hamet & H. Perrier) Lauz.-March.	Crassulaceae	Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.12g/L water + wetter	Foliar
Bryophyllum pinnatum (Lam.) Oken	Crassulaceae	Fluroxypyr	Fluroxypyr (333g/L)	1.2g/L water + wetter	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.12g/L water + wetter	Foliar
		Metsulfuron-methyl + Glyphosate	Metsulfuron-methyl (600g/kg) + Glyphosate (360g/L)	0.06g/L + 0.72g/L water + wetter	Foliar
		Triclopyr + Picloram	Triclopyr (300 g/L) + Picloram (100 g/L)	1.5g/L + 0.5g/L water + wetter	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.5g/L + 0.5g/L + 0.04g/L water + wetter	Foliar

Species	Family	Active constituent	Active constituent with concentration	A.I. (grams) per Litre	Method of Application
Bryophyllum proliferum Bowie ex Hook.	Crassulaceae	Fluroxypyr	Fluroxypyr (333g/L)	1.2g/L water + wetter	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.12g/L water + wetter	Foliar
Crassula multicava Lem.	Crassulaceae	Glyphosate	Glyphosate (360g/L)	7.2g/L water + wetter	Foliar
Crassula sarmentosa Harv.	Crassulaceae	Carfentrazone-ethyl + MCPA	Carfentrazone-ethyl (240g/L) + MCPA (500g/L)	0.02g + 0.21g/L water	Foliar
		Glufosinate ammonium	Glufosinate ammonium (200g/L)	0.25g/L water	Foliar
Kalanchoe beharensis Drake	Crassulaceae	Fluroxypyr	Fluroxypyr (333g/L)	1.2g/L water + wetter	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.12g/L water + wetter	Foliar
		Metsulfuron-methyl + Glyphosate	Metsulfuron-methyl (600g/kg) + Glyphosate (360g/L)	0.06g/L + 0.72g/L water + wetter	Foliar
Jatropha curcas L.	Euphorbiaceae	See *J. gossypifolia*			
Jatropha gossypiifolia L.	Euphorbiaceae	Fluroxypyr	Fluroxypyr (333g/L)	1.0 g/L water	Foliar
		Fluroxypyr	Fluroxypyr (333g/L)	1.0 g/L water	Foliar
		Glyphosate	Glyphosate (360g/L)	3.6 g/L water	Foliar
		Glyphosate	Glyphosate (360g/L)	3.6 g/L water	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.09 g/L water + wetter	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.09 g/L water + wetter	Foliar
		Metsulfuron-methyl + Aminopyralid	Metsulfuron-methyl (300g/kg) + Aminopyralid (375g/L)	0.06g + 0.075g/L water + wetter	Foliar
		Metsulfuron-methyl + Aminopyralid	Metsulfuron-methyl (300g/kg) + Aminopyralid (375g/L)	0.06g + 0.075g/L water + wetter	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.05g + 0.35g + 0.028g/L water + wetter	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.05g + 0.35g + 0.028g/L water + wetter	Foliar
Ricinus communis L.	Euphorbiaceae	2,4-D	2,4-D Amine (625g/L)	1.76g/L water	Foliar
		Picloram + Aminopyralid	Picloram (43g/Kg) + Aminopyralid (4.3g/Kg)	Neat – 3 to 5 mm layer	Cut stump
		Triclopyr	Triclopyr (600g/L)	10g/L diesel	Basal bark/ Cut stump
Acacia auriculiformis Benth.	Fabaceae	Aminopyralid + Fluroxypyr	Aminopyralid (10g/L) + Fluroxypyr (140g/L)	0.07g +1.0g/L water	Foliar
		Clopyralid	Clopyralid (600g/L)	1.5g/L water	Foliar
		Fluroxypyr	Fluroxypyr (333g/L)	2.0g/L water	Foliar
		Picloram + Aminopyralid	Picloram (43g/Kg) + Aminopyralid (4.3g/Kg)	Neat – 3 to 5 mm layer	Cut stump
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Basal bark/ Cut stump
Acacia colei Maslin & L.A.J. Thomson	Fabaceae	Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Basal bark/ Cut stump
Acacia mearnsii De Wild.	Fabaceae	Aminopyralid + Fluroxypyr	Aminopyralid (10g/L) + Fluroxypyr (140g/L)	.07g/L + 0.98g/L water + wetter	Foliar

Species	Family	Active constituent	Active constituent with concentration	A.I. (grams) per Litre	Method of Application
		Fluroxypyr	Fluroxypyr (333g/L)	2.0g/L water + wetter	Foliar
		Triclopyr	Triclopyr (600g/L)	10g/L diesel	Basal bark/ Cut stump
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Basal bark/ Cut stump
Acacia melanoxylon R. Br.	Fabaceae	Aminopyralid + Fluroxypyr	Aminopyralid (10g/L) + Fluroxypyr (140g/L)	.07g/L + 0.98g/L water + wetter	Foliar
		Fluroxypyr	Fluroxypyr (333g/L)	2.0g/L water + wetter	Foliar
		Picloram + Aminopyralid	Picloram (43g/Kg) + Aminopyralid (4.3g/Kg)	Neat – 3 to 5 mm layer	Cut stump
		Triclopyr	Triclopyr (600g/L)	10g/L diesel	Basal bark/ Cut stump
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g+2g/L diesel	Basal bark/ Cut stump
Acacia podalyriifolia G. Don	Fabaceae	Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Basal bark/ Cut stump
		Triclopyr	Triclopyr (600g/L)	10g/L diesel	Basal bark/ Cut stump
Acacia saligna (Labill.) Wendl.	Fabaceae	Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Basal bark/ Cut stump
		Triclopyr	Triclopyr (600g/L)	10g/L diesel	Basal bark/ Cut stump
Acrocarpus fraxinifolius Arn.	Fabaceae	Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Basal bark/ Cut stump
		Triclopyr	Triclopyr (600g/L)	10g/L diesel	Basal bark/ Cut stump
Adenanthera pavonina L.	Fabaceae	Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Basal bark/ Cut stump
		Triclopyr	Triclopyr (600g/L)	10g/L diesel	Basal bark/ Cut stump
Albizia lebbeck (L.) Benth.	Fabaceae	Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Basal bark/ Cut stump
Albizia saman (Jacq.) Merr.	Fabaceae	Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Basal bark/ Cut stump
Artocarpus heterophyllus Lam.	Fabaceae	Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Basal bark/ Cut stump
Bauhinia monandra Kurz	Fabaceae	Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Basal bark/ Cut stump
Bauhinia purpurea L.	Fabaceae	Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Basal bark/ Cut stump
Bauhinia variegata L.	Fabaceae	Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g +2g/L diesel	Basal bark/ Cut stump
Caesalpinia decapetala (Roth) Alston	Fabaceae	Aminopyralid + Metsulfuron	Aminopyralid (375g/ kg) + Metsulfuron (300g/kg)	0.075g + 0.06g/L water + wetter	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.06g /L water + wetter	Foliar
		Metsulfuron-methyl + Aminopyralid	Metsulfuron-methyl (300g/kg) + Aminopyralid (375g/L)	0.06g + 0.075g/L water + wetter	Foliar
		Picloram + Aminopyralid	Picloram (43g/Kg) + Aminopyralid (4.3g/Kg)	Neat – 3 to 5 mm layer	Cut stump
		Triclopyr + Metsulfuron	Triclopyr (75g/L) + Metsulfuron (28g/L)	0.19g + 0.07g/L water + wetter	Foliar
Calliandra houstoniana (Mill.) Standl. var. *calothyrsus* (Meisn.) Barneby	Fabaceae	Picloram + Aminopyralid	Picloram (43g/Kg) + Aminopyralid (4.3g/Kg)	Neat – 3 to 5 mm layer	Cut stump

Species	Family	Active constituent	Active constituent with concentration	A.I. (grams) per Litre	Method of Application
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Basal bark/ Cut stump
Delonix regia (Hook.) Raf.	Fabaceae	Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Basal bark/ Cut stump
Leucaena leucocephala (Lam.) de Wit	Fabaceae	Picloram + Aminopyralid	Picloram (43g/Kg) + Aminopyralid (4.3g/Kg)	Neat – 3 to 5 mm layer	Cut stump
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Basal bark/ Cut stump
Mimosa diplotricha Sauvalle	Fabaceae	Dicamba	Dicamba (500g/L)	2.0g/L water	Foliar
		Fluroxypyr	Fluroxypyr (333g/L)	1.0g/L water	Foliar
		Glufosinate ammonium	Glufosinate ammonium (200g/L)	1.0g/L water	Foliar
Mimosa pigra L.	Fabaceae	Aminopyralid + Metsulfuron	Aminopyralid (375g/kg) + Metsulfuron (300g/kg)	0.11g + 0.09g/L water + wetter	Foliar
		Fluroxypyr	Fluroxypyr (333g/L)	1.0g/L water	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.09g/L water + wetter	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	1.2g/L water + wetter	Cut stump
		Tebuthiuron	Tebuthiuron (200g/L)	0.2g per meter square of soil around plant	Spot ground application
Mimosa pudica L.	Fabaceae	Dicamba	Dicamba (500g/L)	2.0g/L water	Foliar
		Fluroxypyr	Fluroxypyr (333g/L)	1.0g/L water	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	0.6g + 0.2g + 0.016/L water	Foliar
Parkinsonia aculeata L.	Fabaceae	Hexazinone	Hexazinone (250g/L)	1.0g per spot per tree applied to the soil for trees > 1m tall	Spot ground application
		Hexazinone	Hexazinone (250g/L)	0.25g per spot per tree applied to the soil for trees up to 1m tall	Spot ground application
		Tebuthiuron	Tebuthiuron (200g/L)	0.3g per meter square of soil around tree	Spot ground application
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Basal bark/ Cut stump
		Triclopyr + Picloram	Triclopyr (300 g/L)+ Picloram (100 g/L)	1.0g + 0.35g/L water	Foliar
Prosopis juliflora (Sw.) DC.	Fabaceae	Picloram + Aminopyralid	Picloram (43g/Kg) + Aminopyralid (4.3g/Kg)	Neat – 3 to 5 mm layer	Cut stump
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Basal bark/ Cut stump
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.05g/L + 0.35g/L + 0.028g/L water + wetter	Foliar
Senna alata (L.) Roxb.	Fabaceae	2,4-D + Picloram	2,4-D (300g/L) + Picloram (75g/L)	0.9g + 0.225g/L water + wetter	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.05g/L + 0.35g/L + 0.028g/L water + wetter	Foliar
Senna bicapsularis (L.) Roxb.	Fabaceae	See other *Senna* spp.			

Species	Family	Active constituent	Active constituent with concentration	A.I. (grams) per Litre	Method of Application
Senna didymobotrya (Fresen.) H.S. Irwin & Barneby	Fabaceae	2,4-D + Picloram	2,4-D (300g/L) + Picloram (75g/L)	0.9g + 0.225g/L water + wetter	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.05g/L + 0.35g/L + 0.028g/L water + wetter	Foliar
Senna hirsuta (L.) H.S. Irwin & Barneby	Fabaceae	See other *Senna* spp.			
Senna obtusifolia (L.) H.S. Irwin & Barneby	Fabaceae	2,4-D + Picloram	2,4-D (300g/L) + Picloram (75g/L)	0.9g + 0.225g/L water + wetter	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.05g/L + 0.35g/L + 0.028g/L water + wetter	Foliar
Senna occidentalis (L.) Link	Fabaceae	2,4-D + Picloram	2,4-D (300g/L) + Picloram (75g/L)	0.9g + 0.225g/L water + wetter	Foliar
		2,4-D + Picloram	2,4-D (300g/L) + Picloram (75g/L)	0.9g + 0.225g/L water + wetter	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.05g/L + 0.35g/L + 0.028g/L water + wetter	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.05g/L + 0.35g/L + 0.028g/L water + wetter	Foliar
Senna septemtrionalis (Viv.) H.S. Irwin & Barneby	Fabaceae	2,4-D + Picloram	2,4-D (300g/L) + Picloram (75g/L)	0.9g + 0.225g/L water + wetter	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.05g/L + 0.35g/L + 0.028g/L water + wetter	Foliar
Dovyalis caffra (Hook.f. & Harv.) Sim	Flacourtiaceae	Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Basal bark/ Cut stump
Myriophyllum aquaticum (Vell.) Verdc.	Haloragaceae	Flumioxazin	Flumioxazin (500g/L)	0.35g/L water + wetter	Foliar
Hyptis suaveolens (L.) Poit.	Lamiaceae	2,4-D	2,4-D Amine (625g/L)	8.75 g/L water	Foliar (ideally before flowering)
		2,4-D + Picloram	2,4-D (300g/L) + Picloram (75g/L)	0.375g + 0.09g/L water + wetter	Foliar
		Fluroxypyr	Fluroxypyr (333g/L)	0.42 g/L water	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.01 g/L water + wetter	Foliar
		Triclopyr	Triclopyr (600g/L)	0.5 g/L water	Foliar
		Triclopyr + Picloram	Triclopyr (300 g/L)+ Picloram (100 g/L)	0.25g + 0.08g/L water + wetter	Foliar
Salvia leucantha Cav.	Lamiaceae	2,4-D	2,4-D Amine (625g/L)	1.87g/L water	Foliar
		Fluroxypyr	Fluroxypyr (333g/L)	1.67g/L water	Foliar
		Glufosinate ammonium	Glufosinate ammonium (200g/L)	1.0g/L water	Foliar
		Glyphosate	Glyphosate (360g/L)	2.52g/L water	Foliar
		Imazapyr	Imazapyr (250g/L)	0.83g/L water	Foliar
		MCPA	MCPA (500g/L)	0.84g/L water	Foliar
Cinnamomum camphora (L.) J. Presl	Lauraceae	Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Basal bark/ Cut stump

Species	Family	Active constituent	Active constituent with concentration	A.I. (grams) per Litre	Method of Application
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.5g/L + 0.5g/L + 0.04g/L water + wetter	Foliar
		Glyphosate	Glyphosate (360g/L)	1.8 g/L water	Stem injection
Cinnamomum verum J. Presl	Lauraceae	Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Basal bark/ Cut stump
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.5g/L + 0.5g/L + 0.04g/L water + wetter	Foliar
		Glyphosate	Glyphosate (360g/L)	1.8 g/L water	Stem injection
Clidemia hirta (L.) D. Don	Melastomataceae	Metsulfuron-methyl + Fluroxypyr	Metsulfuron-methyl (600g/kg) + Fluroxypyr (333g/L)	0.012g + 0.3g/L water + wetter	Foliar
		Triclopyr	Triclopyr (600g/L)	0.63g/L water + wetter	Foliar
Azadirachta indica A. Juss.	Meliaceae	Glyphosate	Glyphosate (360g/L)	180g/L water	Cut stump
		Glyphosate	Glyphosate (360g/L)	180g/L water	Stem injection
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g +2g/L diesel	Basal bark/ Cut stump
		Triclopyr + Picloram + Aminopyralid	Triclopyr (200g/L) + Picloram (100g/L) + Aminopyralid (25g/L)	50g + 25g + 6.25g/L water	Stem injection
Cedrela odorata L.	Meliaceae	Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Basal bark/ Cut stump
Melia azedarach L.	Meliaceae	See *Azadirachta indica*			
Toona ciliata M. Roem.	Meliaceae	See *Cedrela odorata*			
Broussonetia papyrifera (L.) L'Hér. ex Vent.	Moraceae	Glyphosate	Glyphosate (360g/L)	180g/L water	Cut stump
		Picloram + Aminopyralid	Picloram (43g/Kg) + Aminopyralid (4.3g/Kg)	Neat – 3 to 5 mm layer	Cut stump
		Triclopyr	Triclopyr (600g/L)	20g/L diesel	Basal bark
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Basal bark/ Cut stump
		Triclopyr + Picloram + Aminopyralid	Triclopyr (200g/L) + Picloram (100g/L) + Aminopyralid (25g/L)	50g + 25g + 6.25g/L water	Stem injection
Castilla elastica Cerv.	Moraceae	Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Basal bark/ Cut stump
Psidium cattleianum Afzel. ex Sabine	Myrtaceae	See *Psidium guajava*			
Psidium guajava L.	Myrtaceae	Triclopyr	Triclopyr (600g/L)	300g/L diesel	Cut stump
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	8g + 4g/L diesel	Basal bark/ Cut stump
Mirabilis jalapa L.	Nyctaginaceae	Glyphosate	Glyphosate (360g/L)	1.6g/L water	Foliar
Areca catechu L.	Palmae	Glyphosate	Glyphosate (360g/L)	180g/L water	Stem injection
		Imazapyr	Imazapyr (250g/L)	2.5g/L water	Foliar
Arenga pinnata (Wurmb) Merr.	Palmae	Glyphosate	Glyphosate (360g/L)	180g/L water	Stem injection
Elaeis guineensis Jacq.	Palmae	See *Arenga pinnata*			
Argemone mexicana L.	Papaveraceae	2,4-D	2,4-D (625g/L)	0.73g/L water	Foliar
		2,4-D + Picloram	2,4-D (300g/L) + Picloram (75g/L)	0.25g + 0.06g/L water	Foliar
		Glyphosate	Glyphosate (360g/L)	0.45g/L water	Foliar
Argemone ochroleuca Sweet	Papaveraceae	See *Argemone mexicana*			
Passiflora caerulea L.	Passifloraceae	See other *Passiflora* spp.			
Passiflora edulis Sims	Passifloraceae	Glyphosate	Glyphosate (360g/L)	7.2g/L water	Foliar

Species	Family	Active constituent	Active constituent with concentration	A.I. (grams) per Litre	Method of Application
Passiflora foetida L.	Passifloraceae	Fluroxypyr	Fluroxypyr (200g/L)	4.5g/L water	Foliar
		Glyphosate	Glyphosate (360g/L)	180g/L water	Cut stump
		Triclopyr + Picloram	Triclopyr (200 g/L) + Picloram (100 g/L)	10g + 5g/L water	Cut stump
		Triclopyr + Picloram	Triclopyr (200 g/L) + Picloram (100 g/L)	2g + 1g/L water	Foliar
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Basal bark
Passiflora suberosa L.	Passifloraceae	Glyphosate	Glyphosate (360g/L)	180g/L water	Cut stump
		Glyphosate	Glyphosate (360g/L)	7.2g/L water	Foliar
Passiflora subpeltata Ortega	Passifloraceae	See other *Passiflora* spp.			
Passiflora tarminiana Coppens & V.E. Barney	Passifloraceae	See other *Passiflora* spp.			
Piper aduncum L.	Piperaceae	Picloram + Aminopyralid	Picloram (43g/Kg) + Aminopyralid (4.3g/Kg)	Neat – 3 to 5 mm layer	Cut stump
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Basal bark/ Cut stump
Antigonon leptopus Hook. & Arn.	Polygonaceae	Fluroxypyr	Fluroxypyr (333g/L)	1.2g/L water + wetter	Foliar
		Glyphosate	Glyphosate (360g/L)	3.6 g/L + wetter	Foliar
		MCPA + Dicamba	MCPA (340g/L) + Dicamba (80g/L)	1.6g/L + 0.38g/L water + wetter	Foliar
		Triclopyr + Picloram	Triclopyr (300g/L) + Picloram (100g/L)	1.5g/L + 0.5g/L water + wetter	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.5g/L + 0.5g/L + 0.04g/L water + wetter	Foliar
Eichhornia crassipes (Mart.) Solms	Pontederiaceae	Amitrole + Ammonium Thiocyanate	Amitrole (250g/L) + Ammonium Thiocyanate (220g/L)	0.7g + 0.62g/L water	Foliar
		Glyphosate	Glyphosate (360g/L)	4.68g/L + wetter	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.06g/L water	Foliar
Maesopsis eminii Engl.	Rhamnaceae	Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g +2g/L diesel	Basal bark/ Cut stump
Salvinia molesta D.S. Mitch.	Salviniaceae	Diquat	Diquat (200g/L)	1.67g/L water	Foliar
		Flumioxazin	Flumioxazin (500g/L)	0.35g/L water	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.06g/L water + wetter	Foliar
Cardiospermum grandiflorum Sw	Sapindacaeae	Glyphosate	Glyphosate (360g/L)	240 g/L water	Cut stump
		Fluroxypyr	Fluroxypyr (333g/L)	1.0g/L water	Foliar
Brugmansia suaveolens (Humb. & Bonpl. ex Willd.) Bercht. & J.Presl	Solanaceae	Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.05g + 0.35g + 0.028g/L water	Foliar
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g +2g/L diesel	Basal bark/ Cut stump
		Picloram + Aminopyralid	Picloram (43g/Kg) + Aminopyralid (4.3g/Kg)	Neat – 3 to 5 mm layer	Cut stump
Cestrum aurantiacum Lindl.	Solanaceae	Glyphosate	Glyphosate (360g/L)	360g/L water	Cut stump
		Glyphosate	Glyphosate (360g/L)	360g/L water	Stem scrape
		Picloram + Aminopyralid	Picloram (43g/Kg) + Aminopyralid (4.3g/Kg)	Neat – 3 to 5 mm layer	Cut stump
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Basal bark/ Cut stump

Species	Family	Active constituent	Active constituent with concentration	A.I. (grams) per Litre	Method of Application
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.2g + 0.4g + 0.032/L water	Foliar
Datura ferox L.	Solanaceae	Fluroxypyr	Fluroxypyr (333g/L)	1.0g/L water	Foliar
		Glyphosate	Glyphosate (360g/L)	2.7g/L water	Foliar
Datura inoxia Mill.	Solanaceae	Fluroxypyr	Fluroxypyr (333g/L)	1.0g/L water	Foliar
		Glyphosate	Glyphosate (360g/L)	2.7g/L water	Foliar
Datura stramonium L.	Solanaceae	2,4-D	2,4-D Amine (625g/L)	0.58g/L water	Foliar
		Glyphosate	Glyphosate (360g/L)	2.7g/L water	Foliar
Nicotiana glauca Graham	Solanaceae	2,4-D + Picloram	2,4-D (300g/L) + Picloram (75g/L)	1.95g + 0.49g/L water + wetter	Foliar
		Glyphosate	Glyphosate (360g/L)	7.2g/L water + wetter	Foliar
		Imazapyr	Imazapyr (250g/L)	2.5g/L water	Foliar
		Imazapyr	Imazapyr (250g/L)	50.0g/L water	Cut stump
		Picloram + Aminopyralid	Picloram (43g/Kg) + Aminopyralid (4.3g/Kg)	Neat – 3 to 5 mm layer	Cut stump
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Basal bark/ Cut stump
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.5g + 0.5g + 0.04g/L water	Foliar
Solanum campylacanthum Hochst.	Solanaceae	2,4-D + Picloram	2,4-D (300g/L) + Picloram (75g/L)	1.95g + 0.49g/L water + wetter	Foliar
		Fluroxypyr	Fluroxypyr (333g/L)	1.0g/L water	Foliar
		Glyphosate	Glyphosate (360g/L)	7.2g/L water + wetter	Foliar
		Imazapyr	Imazapyr (250g/L)	50.0g/L water	Cut stump
		Imazapyr	Imazapyr (250g/L)	2.5g/L water	Foliar
		Picloram + Aminopyralid	Picloram (43g/Kg) + Aminopyralid (4.3g/Kg)	Neat – 3 to 5 mm layer	Cut stump
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Basal bark/ Cut stump
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.5g + 0.5g + 0.04g/L water	Foliar
Solanum mauritianum Scop.	Solanaceae	2,4-D + Picloram	2,4-D (300g/L) + Picloram (75g/L)	1.95g + 0.49g/L water + wetter	Foliar
		Glyphosate	Glyphosate (360g/L)	7.2g/L water + wetter	Foliar
		Imazapyr	Imazapyr (250g/L)	2.5g/L water	Foliar
		Imazapyr	Imazapyr (250g/L)	50.0g/L water	Cut stump
		Picloram + Aminopyralid	Picloram (43g/Kg) + Aminopyralid (4.3g/Kg)	Neat – 3 to 5 mm layer	Cut stump
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Basal bark/ Cut stump
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.5g + 0.5g + 0.04g/L water	Foliar
Solanum seaforthianum Andrews	Solanaceae	2,4-D + Picloram	2,4-D (300g/L) + Picloram (75g/L)	1.95g + 0.49g/L water + wetter	Foliar
		Fluroxypyr	Fluroxypyr (333g/L)	1.0g/L water	Foliar
		Glyphosate	Glyphosate (360g/L)	7.2g/L water + wetter	Foliar
		Imazapyr	Imazapyr (250g/L)	2.5g/L water	Foliar
		Imazapyr	Imazapyr (250g/L)	50.0g/L water	Cut stump

Species	Family	Active constituent	Active constituent with concentration	A.I. (grams) per Litre	Method of Application
		Picloram + Aminopyralid	Picloram (43g/Kg) + Aminopyralid (4.3g/Kg)	Neat – 3 to 5 mm layer	Cut stump
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Basal bark/ Cut stump
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.5g + 0.5g + 0.04g/L water	Foliar
Solanum torvum Sw.	Solanaceae	2,4-D + Picloram	2,4-D (300g/L) + Picloram (75g/L)	1.95g + 0.49g/L water + wetter	Foliar
		Glyphosate	Glyphosate (360g/L)	7.2g/L water + wetter	Foliar
		Imazapyr	Imazapyr (250g/L)	2.5g/L water	Foliar
		Imazapyr	Imazapyr (250g/L)	50.0g/L water	Cut stump
		Picloram + Aminopyralid	Picloram (43g/Kg) + Aminopyralid (4.3g/Kg)	Neat – 3 to 5 mm layer	Cut stump
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Basal bark/ Cut stump
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.5g + 0.5g + 0.04g/L water	Foliar
Duranta erecta L.	Verbenaceae	2,4-D + Picloram	2,4-D (300g/L) + Picloram (75g/L)	3.0g + 0.75g/L water + wetter	Foliar
		Fluroxypyr	Fluroxypyr (333g/L)	2g/L water	Foliar
		Fluroxypyr	Fluroxypyr (333g/L)	7.0g/L diesel	Basal bark
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.06g/L water + wetter	Foliar
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g +2g/L diesel	Basal bark/ Cut stump
Lantana camara L.	Verbenaceae	2,4-D + Picloram	2,4-D (300g/L) + Picloram (75g/L)	1.95g/L + 0.49g/L water + wetter	Foliar
		Aminopyralid + Fluroxypyr	Aminopyralid (10g/L) + Fluroxypyr (140g/L)	.07g/L + 0.98g/L water + wetter	Foliar
		Aminopyralid + Fluroxypyr	Aminopyralid (10g/L) + Fluroxypyr (140g/L)	1.0g/L + 14.0g/L water + wetter	Splatter gun
		Fluroxypyr	Fluroxypyr (200g/L)	2.0g/L water + wetter	Foliar
		Glyphosate	Glyphosate (360g/L)	3.6g/L water + wetter	Foliar
		Glyphosate	Glyphosate (360g/L)	36g/L water + wetter	Splatter gun
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	1.2g/L water + wetter	Splatter gun
		Picloram + Aminopyralid	Picloram (43g/Kg) + Aminopyralid (4.3g/Kg)	Neat – 3 to 5 mm layer	Cut stump
		Triclopyr	Triclopyr (600g/L)	10g/L diesel	Basal bark/ Cut stump
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g +2g/L diesel	Basal bark/ Cut stump
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	2.25g + 0.75g + 0.06g/L water + wetter	Foliar
Stachytarpheta jamaicensis (L.) Vahl	Verbenaceae	2,4-D	2,4-D Amine (500g/L)	1.0g/L water	Foliar
		Fluroxypyr	Fluroxypyr (333g/L)	1.5g/L water	Foliar
Verbena bonariensis L.	Verbenaceae	2,4-D	2,4-D Amine (625g/L)	1.8 g/L water	Foliar
		Imazapyr	Imazapyr (250g/L)	2.0 g/L water	Foliar
		MCPA	MCPA (500g/L)	2.35 g/L water	Foliar

Species	Family	Active constituent	Active constituent with concentration	A.I. (grams) per Litre	Method of Application
Hedychium coronarium J. Koenig	Zingiberaceae	Imazapyr	Imazapyr (250g/L)	125g/L water + wetter	Cut stump
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.12g/L water + wetter	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.6g/L water + wetter	Cut stump (Spring and Summer application)
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	3.6g/L water + wetter	Cut stump (Winter application)
		Picloram + Aminopyralid	Picloram (43g/Kg) + Aminopyralid (4.3g/Kg)	Neat – 3 to 5 mm layer	Cut stump
		Triclopyr	Triclopyr (600g/L)	20g/L diesel	Basal bark
Hedychium flavescens Carey ex Roscoe	Zingiberaceae	Picloram + Aminopyralid	Picloram (43g/Kg) + Aminopyralid (4.3g/Kg)	Neat – 3 to 5 mm layer	Cut stump
		Imazapyr	Imazapyr (250g/L)	125g/L water	Cut stump
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	3.6g/L + wetter	Cut stump
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.15g/L + wetter	Foliar
Hedychium gardnerianum Sheppard ex Ker Gawl.	Zingiberaceae	Imazapyr	Imazapyr (250g/L)	125g/L water + wetter	Cut stump
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.12g/L water + wetter	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.6g/L water + wetter	Cut stump (Spring and Summer application)
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	3.6g/L water + wetter	Cut stump (Winter application)
		Picloram + Aminopyralid	Picloram (43g/Kg) + Aminopyralid (4.3g/Kg)	Neat – 3 to 5 mm layer	Cut stump
		Triclopyr	Triclopyr (600g/L)	20g/L diesel	Basal bark

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Appendix D

Additional information on the herbicides registered for use in Australia by the Australian Pesticides and Veterinary Medicines Authority, together with useful information on their modes of application, against some of the plant species included in this Field Guide (verbatim from the "Noxious and Environmental Weed Control Handbook" by Ensbey, 2011).

(Abbreviations used: g/L = grams/litre; g/kg = grams per kilogram; L = litre; /ha = per hectare)

Species	Family	Chemical and concentration	Rate	Comments
Cryptostegia grandiflora Roxb. ex R. Br.	Apocynaceae	Metsulfuron-methyl 600g/kg	15 g per 100 L of water	Hand gun application. Do not apply to bushes more than 3 m tall. Apply October to April, ensuring thorough spray coverage of all foliage.
		Triclopyr 240g/L + Picloram 120g/L	1.0 L per 60 L of diesel	Basal bark and cut stump application.
		Triclopyr 600g/L	1.0 L per 60 L of diesel	Basal bark and cut stump application.
		Picloram 100g/L + Triclopyr 300g/L + Aminopyralid 8g/L	350 or 500m L in 100 L of water	Hand gun application
Pistia stratiotes L.	Araceae	Diquat 200g/L	400m L per 100 L of water	Add Agral 600 wetter, use clean water for best results. Observe withholding period.
		Diquat 200g/L	5.0–10.0 L/ha	Add Agral 600 wetter, use clean water for best results. Observe withholding period.
		Glyphosate 360g/L Only products registered for aquatic use	1.0–1.3 L in 100 L of water	Best results are obtained from mid-summer through to winter. Use higher rate on dense infestations.
		2,4-D 300g/L	1 L in 200 L of water	Avoid causing submersion of sprayed plants. Coverage: 200 L spray solution per 1000 square metres.
		Metsulfuron-methyl 600 g/kg	10 g in 100 L of water	Handgun application, add wetter, synertrol oil at 200 mL in 100 L of water, avoid broadcasting spray over the water.
Xanthium spinosum L.	Asteraceae	2,4-D amine 625g/L	80–110 mL per 150 L water	Spot spray. Seedlings only, actively growing.
		MCPA 500g/L	1–2 L/ha	Apply at seedling stage.
		Fluroxypyr 200g/L	75 mL per 100 L of water	Apply to actively growing plants.
		Fluroxypyr 333g/L	45 mL per 100 L water	Apply to actively growing plants.
		2,4-D 300g/L + Picloram 75g/L	1 L per Hectare	Boom spray application.
		2,4-D LV ester 680g/L	1.7 to 3.3 L/ha.	Boom spray application, use higher rates on mature plants.
Ageratina adenophora (Spreng.) R.M. King & H. Rob.	Asteraceae	Picloram 100g/L + Triclopyr 300g/L + Aminopyralid 8g/L Grazon	350 mL in 100 L of water	Spring to autumn. Spray all foliage to point of run-off. Actively growing plants.
		Triclopyr 300g/L + Picloram 100g/L	350 mL per 100 L of water	Spring to autumn. Spray all foliage to point of run-off. Actively growing plants.
		Fluroxypyr 333g/L	300 mL in 100 L of water	Apply to actively growing seedlings and young plants up to flowering.
		Fluroxypyr 200g/L	500 mL per 100 L of water	Apply to actively growing seedlings and young plants up to flowering.
		Fluroxypyr 140g/L + Aminopyralid 10g/L	700 mL in 100 L of water	Spot spray application. Apply to actively growing plants from October to April
		Fluroxypyr 140g/L + Aminopyralid 10g/L	1.5 L/ha	Boom spray application. Apply to actively growing plants from October to April.

Species	Family	Chemical and concentration	Rate	Comments
		Metsulfuron-methyl 300g/kg + Aminopyralid 375g/kg	30 g per 100 L of water	Folia spray to thoroughly wet the plants.
		MCPA 340g/L + Dicamba 80g/L	190–270 mL per 100 L of water	Spray during active growth. For use in grass pastures.
		MCPA 340g/L + Dicamba 80g/L	2.8–4.0 L/ha	Spray during active growth. For use in grass pastures.
		2,4-D 300g/L + Picloram 75g/L	650 mL per 100 L of water	For use in grass pasture when weed is actively growing.
		Glyphosate 360 g/L	500 mL per 100 L of water	Actively growing plants with full foliage.
		Metsulfuron-methyl 600g/kg	15 g per 100 L of water	Add surfactant. Thoroughly wet all foliage to point of run-off up to bud stage to prevent seed set.
		Triclopyr 300g/L + Picloram 100g/L	500 mL per 10 L of water	Gas gun/Splatter gun application. Apply to actively growing bushes.
Senecio madagascariensis Poir.	Asteraceae	Bromoxynil 200g/L	1.4 L/ha	Boom spray. Seedling application. In pastures apply with low volume boom spray during autumn/winter when weeds are young and actively growing. Observe withholding period.
		Bromoxynil 200g/L	2.8 L/ha	Boom spray. Early flowering application. In pastures apply with low volume boom spray during autumn/winter when weeds are young and actively growing. Observe withholding period.
		Picloram 100g/L + Triclopyr 300g/L + Aminopyralid 8g/L	350 mL in 100 L of water	Apply as a thorough foliar spray.
		Fluroxypyr 140g/L + Aminopyralid 10g/L	500 mL in 100 L of water	Apply to flowering plants up to 30 cm tall.
		Fluroxypyr 140g/L + Aminopyralid 10g/L	1.5 L/ha	Treat seedling plants up to flowering.
		2,4-D amine 62 g/L	2–2.5 L/ha	Boom spray application.
		Metsulfuron-methyl 600g/kg	10 g in 100 L of water	Spot spray application.
		Metsulfuron-methyl 600g/kg	40 g/ha	Boom spray.
Tithonia diversifolia (Hemsl.) A. Gray	Asteraceae	Picloram 100g/L + Triclopyr 300g/L + Aminopyralid 8 g/L	500 mL in 100 L of water	Apply from late spring to early autumn. Any regrowth and seedlings must be resprayed when 1 m high.
		Triclopyr 300g/L + Picloram 100g/L	500 mL per 100 L of water	Apply from late spring to early autumn. Any regrowth and seedlings must be resprayed when 1 m high.
		Triclopyr 240g/L + Picloram 120g/L	1.0 L per 60 L of diesel	Basal bark application.
		2,4-D 300g/L + Picloram 75g/L	650 mL per 100 L of water	Handgun application on actively growing bushes in full leaf.
		Amitrole 250g/L + Ammonium thiocyanate 220g/L	1.1 L per 100 L of water	Handgun application on active growth, before flowering.
		Triclopyr 600g/L	170 mL per 100 L of water	Retreat regrowth the next season.
		Picloram 44.7g/L + Aminopyralid 4.47g/L	Undiluted	Cut stump application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm .
		Glyphosate 360g/L	1 part glyphosate to 1.5 parts water	Cut, scrape and paint.

Species	Family	Chemical and concentration	Rate	Comments
		Glyphosate 360g/L	1 part glyphosate to 50 parts water	Spot spray.
		Triclopyr 600g/L	1.0 L per 30 L of diesel	Basal bark application. DO NOT over treat as excessive run- off might affect adjacent trees and shrubs through root absorption.
Parthenium hysterophorus L.	Asteraceae	Dicamba 500g/L	40 mL per 100 L of water	Spot spray.
		Dicamba 50 g/L	600 mL/ha	Boom spray. Apply to young, actively growing plants.
		2,4-D 300g/L + Picloram 75g/L	125 mL per 100 L of water	Spot spray. Rosette stage when plants are actively growing.
		2,4-D 300g/L + Picloram 75g/L	3.0 L/ha	Boom application.
		Metsulfuron-methyl 600g/kg	5 g per 100 L of water	Thoroughly wet all foliage to the point of run-off.
		Hexazinone 250g/L	70 mL per 100 L of water	Apply uniformly over the area. When spraying single plants treat soil for 1 m around. Do not use near desirable trees.
		Atrazine 900g/kg	3.3 L/ha	Protects against emerging seedlings.
		Metsulfuron-methyl 300g/kg + Aminopyralid 375g/kg	10 g per 100 L of water	Hand gun application.
Chromolaena odorata (L.) R.M. King & H. Rob.	Asteraceae	Picloram 44.7 g/L + Aminopyralid 4.47 g/L	Undiluted	Cut stump application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm.
		Fluroxypyr 333 g/L	210 mL in 100 L of water	Handgun application
Sphagneticola trilobata (L.) Pruski	Asteraceae	Glyphosate 360 g/L	200 mL per 10 L of water	Spot spray. Foliar application.
		Glyphosate 360 g/L	200 mL glyphosate plus 1.5 g metsulfuron-methyl per 10 L water	Spot spray application.
Azolla spp.	Azollaceae	Diquat 200 g/L	5.0–10.0 L/ha	Spray to wet all foliage thoroughly. Observe withholding period.
		Orange oil 55.2 g/kg	1 part product per 100 parts water	Spray on to free-floating plants.
Anredera cordifolia (Ten.) Steenis	Basellaceae	Fluroxypyr 333g/L	300 mL in 100 L of water	Apply at times of active growth. Avoid drift on to desirable plants.
		Fluroxypyr 200g/L	500 mL in 100 L of water	Apply at times of active growth. Avoid drift on to desirable plants.
		Picloram 44.7g/L + Aminopyralid 4.47g/L	Undiluted	Cut stump application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm .
		Glyphosate 360g/L	Undiluted glyphosate	Stem scraping application.
		Glyphosate 360g/L	100 mL glyphosate per 10 L of water	Spot spray for seedling control. Add a surfactant.
		Glyphosate 360g/L	200 mL glyphosate plus 1.5 g metsulfuron-methyl in 10 L of water	Spot spray for seedling control.

Species	Family	Chemical and concentration	Rate	Comments
		Picloram 100g/L + Triclopyr 300g/L + Aminopyralid 8g/L	400 mL in 100L of water	Handgun application
		Triclopyr 300g/L + Picloram 100g/L	400 mL in 100L of water	Handgun application.
Dolichandra unguis-cati (L.) L.G. Lohmann	Bignoniaceae	Picloram 44.7g/L + Aminopyralid 4.47g/L	Undiluted	Cut stump application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm.
		Glyphosate 360g/L	1 part glyphosate to 50 parts water	Spray to kill regrowth.
		Glyphosate 360g/L	1 part glyphosate to 1.5 parts water	Cut stump/scrape stem/inject.
		Triclopyr 300g/L + Picloram 100g/L	400 mL product per 100 L water.	Hand gun spray vines on ground.
Tecoma stans (L.) Juss. ex Kunth	Bignoniaceae	Triclopyr 240g/L + Picloram 120g/L	1.0 L in 60 L of diesel	Basal bark/cut stump application.
		Picloram 44.7g/L + Aminopyralid 4.47g/L	Undiluted	Cut stump application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm.
		Glyphosate 360g/L	1.0 L in 50 L of water	Spray seedlings.
		Glyphosate 360g/L	1 part per 1.5 parts of water	Stem injection or cut stem application.
Echium plantagineum L.	Boraginaceae	Picloram 100g/L + Triclopyr 300g/L + Aminopyralid 8g/L	250 mL in 100 L of water	Spot spray from rosette to flowering plants.
		2,4-D amine 625g/L	170–220 mL in 150 L of water	Spot spray. Young rosettes.
		2,4-D amine 625g/L	1.7–2.2 L/ha	Boom spray.
		2,4-D 300g/L + Picloram 75g/L	150 mL in 100 L of water	Spot spray. Rosettes to pre-flowering.
		Glyphosate 360g/L	500–700 mL in 100 L of water	Spot spray. Actively growing plants.
		Glyphosate 360g/L	2.0–3.0 L/ha	Boom application
		Metsulfuron-methyl 600g/kg	5 g in 100 L of water	Apply to rosettes after full leaf expansion but before head emergence. Do not spray after emergence of first flowers, as seed set has occurred.
		Metsulfuron-methyl 600g/kg	10–15 g/ha	Apply to rosettes after full leaf expansion but before head emergence. Do not spray after emergence of first flowers, as seed set has occurred.
		MCPA 500g/L	1.0–1.5 L/ha	Apply at early rosette stage
		Dicamba 500g/L	280 mL per 100 L of water.	Spot spray.
		Dicamba 500g/L	4.0 L/ha	Boom spray. Apply prior to flowering. Add wetting agent.
		Metsulfuron-methyl 300g/kg + Aminopyralid 375g/kg	10 g per 100 L of water	Hand gun application.
Opuntia stricta (Haw.) Haw.	Cactaceae	Triclopyr 600g/L	1.0 L in 75 L of distillate.	Apply as a thorough foliar spray.
		Triclopyr 600g/L	3.0 L in 100 L of water	Apply as a thorough foliar spray.

Species	Family	Chemical and concentration	Rate	Comments
		Picloram 100g/L + Triclopyr 300g/L + Aminopyralid 8g/L	500 mL in 100 L of water	Apply as a thorough foliar spray.
		Triclopyr 300g/L + Picloram 100g/L	500 mL in 100 L of water	Apply as a thorough foliar spray.
		Triclopyr 240g/L + Picloram 120g/L	1.0 L in 60 L of distillate	Foliar application; thoroughly wet plants.
Opuntia monacantha (Willd.) Haw.	Cactaceae	Triclopyr 600g/L	1.0 L per 75 L of distillate	Apply thoroughly as a foliar spray.
		Picloram 100g/L + Triclopyr 300g/L + Aminopyralid 8g/L	500 mL in 100 L of water	Apply as a thorough foliar spray.
		Triclopyr 300g/L + Picloram 100g/L	500 mL per 100 L of water	Common pear and smooth tree pear, with active phyllode (leaf) growth.
Canna indica L.	Cannaceae	Picloram 44.7g/L + Aminopyralid 4.47g/L	Undiluted	Cut stump application. Apply a 3–5 mm layer of gel across the cut surface on the rhizome.
		Glyphosate 360g/L	1 part glyphosate to 50 parts water	Spot spay. Apply as foliar application. Spray regrowth after slashing.
Lonicera japonica Thunb.	Caprifoliaceae	Glyphosate 360g/L	400 mL in 600 mL of water	Cut stump application.
		Metsulfuron-methyl 600g/kg	10–20 g in 100 L of water	Spot spray application, add a surfactant
Tradescantia fluminensis Vell.	Commelinaceae	Fluroxypyr 333g/L	900 mL in 100 L of water	Foliar application. Re-treatment necessary. Young plants up to and including flowering.
		Fluroxypyr 200g/L	1.5 L in 100 L of water	Foliar application. Re-treatment necessary. Young plants up to and including flowering.
		Picloram 44.7g/L + Aminopyralid 4.47g/L	Undiluted (16 g/m2)	Use a long-handled paint roller or similar making sure the foliage has been completely flattened during application.
		Glyphosate 360g/L	200 mL per 10 L of water	Treat in winter or early spring. For best results, add a surfactant. Apply two sprays, 6–8 weeks apart. Repeat treatments are essential.
		Picloram 100g/L + Triclopyr 300g/L + Aminopyralid 8g/L	50 mL/10 L water	Knapsack. Spray thoroughly.
Cuscuta spp.	Convolvulaceae	Picloram 44.7g/L + Aminopyralid 4.47g/L	Undiluted	Cut stump application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm.
		Fluroxypyr 200g/L	35 mL per 1 L of diesel	Basal bark application.
		Glyphosate 360g/L	1 part glyphosate to 1.5 parts water	Cut stump/ stem injection.
Ipomoea cairica (L.) Sweet	Convolvulaceae	Picloram 44.7g/L + Aminopyralid 4.47g/L	Undiluted	Cut stump application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm.
		Dichlorprop 600g/L	1 L in 200 L of water	Completely wet all leaves and stem of target plants.
		Glyphosate 360g/L	200 mL per 10 L of water	Spot-spray for seedling control.
		Glyphosate 360g/L	1 part glyphosate per 1.5 parts water	Stem scraping application.

Species	Family	Chemical and concentration	Rate	Comments
		Glyphosate 360g/L	200 mL glyphosate plus 1.5g of metsulfuron-methyl in 10 L water	Spot spray application.
		Picloram 100g/L + Triclopyr 300g/L + Aminopyralid 8g/L	50 mL/10 L water	Spot spray application.
		Triclopyr 300 g/L + Picloram 100g/L	50 mL/10 L water	Spot spray application.
Ipomoea indica (Burm.) Merr.	Convolvulaceae	Picloram 44.7g/L + Aminopyralid 4.47g/L	Undiluted	Cut stump application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm.
		Dichlorprop 600g/L	1 L in 200 L of water	Completely wet all leaves and stem of target plants.
		Glyphosate 360g/L	200 mL per 10 L of water	Spot-spray for seedling control.
		Glyphosate 360g/L	1 part glyphosate per 1.5 parts water	Stem scraping application.
		Glyphosate 360g/L	200 mL glyphosate plus 1.5 g of metsulfuron-methyl in 10 L water	Spot spray application.
		Picloram 100g/L + Triclopyr 300g/L + Aminopyralid 8g/L	50 mL/10 L water	Spot spray application.
		Triclopyr 300g/L + Picloram 100g/L	50 mL/10 L water	Spot spray application.
Bryophyllum spp.	Crassulaceae	Picloram 100g/L + Triclopyr 300g/L + Aminopyralid 8g/L	500 mL in 100 L of water	Apply at flowering, add a surfactant.
		Triclopyr 300g/L + Picloram 100g/L	500 mL per 100 L of water	Apply at flowering, add a surfactant.
		2,4-D 300g/L	70 mL in 10 L of water	Thorough even coverage of leaves.
		2,4-D amine 625g/L	400 mL per 100 L of water	Thorough, even coverage of leaves and plantlets is necessary. Add a wetting agent.
		Fluroxypyr 333g/L	360 mL in 100 L of water	Apply to actively growing seedlings and young plants before flowering.
		Fluroxypyr 200g/L	600 mL per 100 L of water	Actively growing seedlings and young plants before flowering.
		Glyphosate 360g/L	10 g metsulfuron-methyl plus 200 mL glyphosate in 100 L of water	Apply just prior to flowering, add a surfactant.
Jatropha gossypiifolia L.	Euphorbiaceae	Fluroxypyr 333g/L	300 mL in 100 L of water	Spot spray application.
Ricinus communis L.	Euphorbiaceae	Triclopyr 600g/L	1.0 L per 60 L of diesel	Basal bark application for plants up to 5 cm basal diameter. Cut stump application for plants with larger basal diameter.
		Picloram 44.7g/L + Aminopyralid 4.47g/L	Undiluted	Cut stump application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm.

Species	Family	Chemical and concentration	Rate	Comments
		2,4-D amine 625g/L	340 mL per 150 L of water, or 3.4 L/Ha	Apply to young, actively growing plants.
		Glyphosate 360g/L	1 part glyphosate to 50 parts water	Spray seedlings and coppice shoots.
		Glyphosate 360g/L	1 part glyphosate to 1.5 parts water	Cut stump/scrape stem application for saplings. Stem injection application large trees and shrubs.
Leucaena leucocephala (Lam.) de Wit	Fabaceae	Triclopyr 240 g/L + Picloram 120 g/L	1.0 L in 60 L of diesel	Cut stump/basal bark application.
Prosopis spp.	Fabaceae	Picloram 100g/L + Triclopyr 300g/L + Aminopyralid 8g/L	350 mL in 100 L of water	Controls seedlings, plants in full leaf and flowering before podding. Thoroughly wet all foliage, stems and soil around the base of the plants. Add a wetting agent to increase efficacy. Do not spray plants bearing pods.
		Triclopyr 300g/L + Picloram 100g/L	350 mL in 100 L of water	Controls seedlings, plants in full leaf and flowering before podding. Thoroughly wet all foliage, stems and soil around the base of the plants. Add a wetting agent to increase efficacy. Do not spray plants bearing pods.
		Triclopyr 240g/L + Picloram 120g/L	1.0 L in 60 L of diesel	Basal bark application of plants up to 5 cm in diameter. Cut stump for plants over 5 cm.
		Picloram 44.7g/L + Aminopyralid 4.47g/L	Undiluted	Cut stump application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm.
Caesalpinia decapetala (Roth) Alston	Fabaceae	Metsulfuron-methyl 600g/kg	10 g per 100 L of water	Spray to thoroughly wet all foliage, but not to cause run off. Apply to actively growing plants before flowering. Add wetting agent.
		Picloram 44.7g/L + Aminopyralid 4.47g/L	Undiluted	Cut stump application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm.
		Metsulfuron-methyl 300g/kg + Aminopyralid 375g/kg	20 g per 100 L of water	Hand gun application.
Parkinsonia aculeata L.	Fabaceae	Triclopyr 240g/L + Picloram 120g/L	1.0 L in 60 L of diesel	Basal bark or cut stump application.
		Hexazinone 250g/L	4 mL per spot	One spot per bush up to 5 m tall.
		Hexazinone 250g/L	1 mL per spot	One spot per bush up to 1 m tall. Do not use near desirable plants.
		Picloram 44.7g/L + Aminopyralid 4.47g/L	Undiluted	Cut stump application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm.
Cinnamomum camphora (L.) J. Presl	Lauracaceae	Picloram 100g/L + Triclopyr 300g/L + Aminopyralid 8g/L	350 or 500 mL per 100 L water	Use higher rate on trees over 2 m tall. Apply as a thorough foliar spray.
		Triclopyr 300g/L + Picloram 100g/L	350 or 500 mL per 100 L of water	Use higher rate on trees over 2 metres tall. Apply as a thorough foliage spray.
		Triclopyr 240g/L + Picloram 120g/L	1 L per 60 L of diesel	Basal bark application for basal diameter less than 10 cm or cut stump application for greater than 10 cm.
		Triclopyr 200g/L + Picloram 100g/L	1 part per 4 parts water	Stem injection application.
		Triclopyr 600g/L	170 mL per 100 L of water	Seedling to three metres tall.

Species	Family	Chemical and concentration	Rate	Comments
		Glyphosate 360g/L	1 part glyphosate to 1 part water, 2 mL per cut	Stem injection for basal diameter up to 25 cm.
		Glyphosate 360g/L	Undiluted, 2 mL per cut	Stem injection for basal diameter 25 cm to 60 cm.
		Picloram 44.7g/L + Aminopyralid 4.47g/L	Undiluted	Cut stump application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm.
		Triclopyr 300g/L + Picloram 100g/L	500 mL per 10 L of water	Gas gun/Splatter gun application. Apply to actively growing bushes.
		Glyphosate 360g/L	1 part glyphosate to 50 parts water	Spray seedlings and coppice shoots.
		Glyphosate 360g/L	1 part glyphosate to 1.5 parts water	Cut stump/scrape stem application for saplings. Stem injection application large trees and shrubs.
		Glyphosate 360g/L	Undiluted	4 mL per drill hole/axe cut
Broussonetia papyrifera (L.) L'Hér. ex Vent.	Moraceae	Picloram 44.7g/L + Aminopyralid 4.47g/L	Undiluted	Cut stump application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm.
		Glyphosate 360g/L	400 mL of glyphosate in 600 mL of water	Cut stump application.
Psidium cattleianum Afzel. ex Sabine	Myrtaceae	Picloram 44.7g/L + Aminopyralid 4.47g/L	Undiluted	Cut stump application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm.
		Fluroxypyr 200g/L	35 mL per 1 L of diesel	Basal bark application.
		Glyphosate 360g/L	1 part glyphosate to 1.5 parts water	Cut stump/stem injection.
Eichhornia crassipes (Mart.) Solms	Pontederiaceae	Diquat 200g/L	400 mL per 100 L of water	Add Agral 600 wetter; use clean water for best results. Observe withholding period.
		Diquat 200g/L	5.0 to 10.0 L/ha	Add Agral 600 wetter; use clean water for best results. Observe withholding period.
		Amitrole 250g/L	280 mL to 100 L of water	Apply prior to flowering.
		Glyphosate 360g/L Only products registered for aquatic use	1.0–1.3 L in 100 L of water	Apply when actively growing, at or beyond the early bloom stage. Use higher rate on dense infestations.
		Glyphosate 360g/L Only products registered for aquatic use	6.0–9.0 L/ha	Apply when actively growing, at or beyond the early bloom stage. Use higher rate on dense infestations.
		2,4-D 300g/L	1 L in 200 L of water	Avoid causing submersion of sprayed plants.
		Metsulfuron-methyl 600g/kg	10 g in 100 L of water	Hand gun application, add synertrol oil at 200 mL in 100 L of water. Avoid broadcasting the spray over the water.
Rubus niveus Thunb.	Rosaceae	Picloram 44.7g/L + Aminopyralid 4.47g/L	Undiluted	Cut stump application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm.

Species	Family	Chemical and concentration	Rate	Comments
		Glyphosate 360g/L	2 L of Glyphosate plus 15 g of Brush-off in 100 L of water	Spot spray application, plus add a wetter.
Salvinia molesta D.S. Mitch.	Salviniaceae	Orange oil 55.2g/kg	1.0 L per 100 L of water	Spray on to free-floating plants.
		Diquat 200g/L	400 mL per 100 L of water	Spot spray to wet all foliage thoroughly, add Agral 600. Observe withholding period.
		Diquat 200g/L	5.0–10.0 L/ha	Boom spray to wet all foliage thoroughly, add Agral 600. Observe withholding period.
		Glyphosate 360g/L Only products registered for aquatic use	1.0 L per 100 L of water	Overall spray. Follow directions on specific permits.
		Glyphosate 360g/L Only products registered for aquatic use	1 L in 100 L of water	Hand gun application, follow directions on the permit.
		Metsulfuron-methyl 600g/kg	10 g in 100 L of water	Hand gun application, add wetter, synertrol oil at 200 mL/100 L, avoid broadcast spraying over the water.
Cardiospermum grandiflorum Sw.	Sapindaceae	Picloram 44.7g/L + Aminopyralid 4.47g/L	Undiluted	Cut stump application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm.
		Glyphosate 360g/L	1 part glyphosate to 50 parts water	Spot spray. Spray regrowth up to 0.5 m only.
		Glyphosate 360g/L	1 part glyphosate to 1.5 parts water	Cut stump. Retreatment necessary.
		Glyphosate 360g/L	200 mL of glyphosate plus 1.5 g of metsulfuron-methyl in 10 L of water	Spot spray application.
Cestrum parqui (Lam.) L'Hér.	Solanaceae	Picloram 100g/L + Triclopyr 300g/L + Aminopyralid 8g/L	500 mL in 100 L of water	Apply from late spring to early autumn. Any regrowth and seedlings must be resprayed when 1 m high.
		Triclopyr 300g/L + Picloram 100g/L	500 mL per 100 L of water	Apply from late spring to early autumn. Any regrowth and seedlings must be resprayed when 1 m high.
		Triclopyr 240g/L + Picloram 120g/L	1.0 L per 60 L of diesel	Basal bark application.
		2,4-D 300g/L + Picloram 75g/L	650 mL per 100 L of water	Handgun application on actively growing bushes in full leaf.
		Amitrole 250g/L + Ammonium thiocyanate 220g/L	1.1 L per 100 L of water	Handgun application on active growth, before flowering.
		Triclopyr 600g/L	170 mL per 100 L of water	Retreat regrowth the next season.
		Picloram 44.7g/L + Aminopyralid 4.47g/L	Undiluted	Cut stump application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm.
		Glyphosate 360g/L	1 part glyphosate to 1.5 parts water	Cut, scrape and paint.

Species	Family	Chemical and concentration	Rate	Comments
		Glyphosate 360g/L	1 part glyphosate to 50 parts water	Spot spray.
		Triclopyr 600g/L	1.0 L per 30 L of diesel	Basal bark application. DO NOT over treat as excessive run- off might affect adjacent trees and shrubs through root absorption.
Solanum mauritianum Scop.	Solanaceae	Picloram 100g/L + Triclopyr 300g/L + Aminopyralid 8g/L	350 mL in 100 L of water	Foliar application from spring to autumn for plants up to 2m tall
		Triclopyr 240g/L + Picloram 120g/L	1.0 L in 60 L of diesel	Cut stump application.
		Triclopyr 300g/L + Picloram 100g/L	350 mL in 100 L of water	Foliar application from spring to autumn for plants up to 2m tall
		Picloram 44.7g/L + Aminopyralid 4.47g/L	Undiluted	Cut stump application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm.
		Triclopyr 300g/L + Picloram 100g/L	500 mL per 10 L of water	Gas gun/Splatter gun application. Apply to actively growing bushes.
		Glyphosate 360g/L	200 mL glyphosate per 10 L of water	Foliar application for seedlings.
		Glyphosate 360g/L	1 part per 1.5 parts of water	Cut stump/injection application.
Lantana spp.	Verbenaceae	Picloram 100g/L + Triclopyr 300g/L + Aminopyralid 8g/L	350 mL or 500 mL in 100 L of water	Wet thoroughly, use higher rate on large bushes, 1–2 m tall. Low rates for bushes up to 1 m tall. Apply from summer to autumn.
		Triclopyr 300g/L + Picloram 100g/L	350 or 500 mL per 100 L of water	Wet thoroughly, use higher rate on large bushes, 1–2 m tall. Low rates for bushes up to 1 m tall. Apply from summer to autumn.
		Fluroxypyr 333g/L	300–600 mL per 100 L of water	Apply to actively growing bushes from October to April. Use lower rate on seedlings or bushes to 1.2 m high, higher rate on bushes over 1.2 m.
		Fluroxypyr 200g/L	500 mL or 1.0 L per 100 L of water	Apply to actively growing bushes from October to April. Use lower rate on seedlings or bushes to 1.2 m high, higher rate on bushes over 1.2 m.
		Fluroxypyr 140g/L + Aminopyralid 10g/L	500 mL per 100 L of water	Seedlings and regrowth 0.5–1.2 m height. Apply to actively growing plants.
		Fluroxypyr 140g/L + Aminopyralid 10g/L	700 mL per 100 L of water	Mature plants and regrowth 1.2–2.0 m. Apply to actively growing plants.
		Metsulfuron-methyl 300g/kg + Aminopyralid 375g/kg	20 g in 100 L of water	Hand gun application.
		Triclopyr 600g/L	1.0 L per 60 L of diesel	Basal bark application for basal diameter less than 5 cm or cut stump application above 5 cm.
		Glyphosate 360g/L	10 g metsulfuron-methyl plus 200 mL glyphosate per 100 L of water	Apply to bushes up to 2 m high. Thoroughly wet all foliage and stems. Add organosilicone penetrant.
		Metsulfuron-methyl 600g/kg	10 g per 100 L of water	Apply to bushes up to two metres tall. Spray to wet all foliage and stems. Re-treatment will be necessary.
		2,4-D amine 625g/L	320 mL in a 100 L of water	Apply to actively growing bushes.

Species	Family	Chemical and concentration	Rate	Comments
		Picloram 44.7g/L + Aminopyralid 4.47g/L	Undiluted	Cut stump application. Apply a 3–5 mm layer of gel for stems less than 20 mm. Apply 5 mm layer on stems above 20 mm.
		Glyphosate 360g/L	1 part per 9 parts water	Gas gun/Splatter gun application. Apply 2 x 2 mL doses per 0.5 m of bush height
		Triclopyr 240g/L + Picloram 120g/L	1.0 L per 60 L of diesel	Basal bark or cut stump application.
		Glyphosate 835g/kg + Metsulfuron- methyl 10g/kg	1 measured pack (173 g) per 100 L of water	Apply when actively growing, thoroughly wet all foliage and stems. Do not apply during stress periods.
		Glyphosate 360g/L	1.0 L per 100 L of water	Actively growing with full foliage. Avoid summer stress.
		2,4-D 300g/L + Picloram 75g/L	650 mL per 100 L of water	High volume spot spray. Thoroughly wet foliage and soil around the base of plant during March to May.
		Dichlorprop 600g/L	1.0 L per 200 L of water	Spot spray application, completely wet all leaves and stems.
Hedychium gardnerianum Sheppard ex Ker Gawl.	Zingiberaceae	Glyphosate 360g/L	200 mL of glyphosate plus 1.5 g of Metsulfuron methyl in 10 L of water	Spot spray application, add a surfactant.

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Appendix E

Registered and minor-use* herbicides applied in South Africa for the control of some of the plant species included in this Field Guide with herbicide concentrations/volumes based on weed densities of closed stands (100% cover) [South Africa Department of Environment Affairs (DEA): Environmental Programmes (EP): Natural Resource Management (NRM) and XACT Information (2005)]. Please note that “lopping/pruning” and “cut and spray” applications use a similar methodology as that of “cut-stump,” as explained elsewhere.

(Abbreviations used: cm = centimetre; EC = emulsifiable concentrate; g/kg = grams per kilogram; g/l = grams per litre; ha = hectare; kg = kilogram; l = litre; m = metre; m^2 = square metre; ME = micro-emulsion; ml = millilitre; mm = millimetre; SC = suspension concentrate; SL = solution; WG = water dispensable granule; WP = wettable powder)

Species	Active constituent with concentration	Age	Dosage (ml/g)	Wetter /dye	A.I, (L/kg)	Mix (L)	% mix	Estimated product (L/ha or kg/ha)	Vol. of mix	Method of application
Agave americana L. (Agavaceae)	MSMA 720 g/L SL	All ages	10000		10	10	100	50	50	Stem inject
	Glyphosate (as sodium salt) 500g/ kg WG	Young	200		0.2	10	2	6	300	Foliar spray
	Glyphosate (as isopropylamine salt) 480 g/L SL	Young	200		0.2	10	2	6	300	Foliar spray
Agave sisalana Perrine (Agavaceae)	MSMA 720 g/L SL	All ages	10000		10	10	100	50	50	Stem inject
			Use 2 ml concentrate per plant and inject into the sisal bole. Burn after plants have died and leaves have dried out.							
	Glyphosate (as sodium salt) 500g/ kg WG	Young	200		0.2	10	2	6	300	Foliar spray
	Glyphosate (as isopropylamine salt) 480 g/L SL	Young	200		0.2	10	2	6	300	Foliar spray
Furcraea foetida (L.) Haw. (Agavaceae)	Glyphosate (as isopropylamine salt) 360 g/L SL	Adult	2200		0.22	10	2.2	1.1	50	Stem inject
	MSMA 720 g/L SL		200		2	100	2	10	500	Stem inject
Ageratum conyzoides (L.) L. (Asteraceae)	2.4D (as dimethylamine salt) 480 g/L SL	Young	150	0.10%	0.15	10	1.5	2.25	150	Foliar spray
	Glyphosate (as isopropylamine salt) 480 g/L SL		150		0.15	10	1.5	4.5	300	Foliar spray

Species	Active constituent with concentration	Age	Dosage (ml/g)	Wetter /dye	A.I, (L/kg)	Mix (L)	% mix	Estimated product (L/ha or kg/ha)	Vol. of mix	Method of application
Chromolaena odorata (L.) R.M. King & H. Rob. (Asteraceae)	Clopyralid 90 + Triclopyr (as amine salt) 270 g/L SL	Young	50	0.50%	0.05	10	0.5	1.5	300	Foliar spray
			Use 50 ml mineral oil /10 l water. Apply as a full cover spray to actively growing plants. Plants to high should be slashed and regrowth sprayed.							
	Fluroxypyr 80 + Picloram 80 g/L ME		75	0.50%	0.075	10	0.75	2.25	300	Foliar spray
			Use 75 ml/10 l water+ 50 ml mineral oil. Apply to actively growing plants.							
	Glyphosate (as ammonium salt) 680 g/kg WG		80	0.10%	0.08	10	0.8	2.4	300	Foliar spray
			Use 80g/10 l water. Slash established plants and apply as a full cover spray when regrowth is 0.5 – 1.2 m high.							
	Glyphosate (as isopropylamine salt) 360 g/L SL		100	0.10%	0.1	10	1	3	300	Foliar spray
			Use 100 ml/10 l water. Slash established plants and apply as full cover spray when regrowth is 0.5 – 1.2 m high							
	Glyphosate (as potassium salt) 450g/L SL		120	0.10%	0.12	10	1.2	3.6	300	Foliar spray
			Use 120 ml/10 l water. Slash established plants and spray regrowth at 0.5 – 1.2 m high.							
	Glyphosate (as isopropylamine salt) 480 g/L SL		110	0.10%	0.11	10	1.1	3.3	300	Foliar spray
			Use 110 ml/10 l water. Apply to regrowth of slashed plants.							
	Glyphosate (as potassium salt) 500 SL		70	0.10%	0.07	10	0.7	2.1	300	Foliar spray
			Use 70 ml/10 l water. Slash rank growth in winter and apply to regrowth in summer.							
	Glyphosate (as sodium salt) 500g/kg WG		75	0.50%	0.075	10	0.75	2.25	300	Foliar spray
			Use 75 g/10 l water. Slash plants and apply to regrowth as a full cover spray.							
	Metsulfuron methyl 600g/kg WP		25	0.10%	0.25	100	0.25	0.75	300	Foliar spray
			Use 2.5 g/10 l water and add a surfactant. Apply to actively growing plants between 50 cm and 75 cm high. Taller plants should be slashed and regrowth treated.							
	Triclopyr (as butoxy ethyl ester) 240 g/L EC		75	0.10%	0.075	10	0.75	2.25	300	Foliar spray
			Use 75 ml + 50 ml mineral oil/10 l water. Apply as a full cover spray to actively growing plants. Taller plants must be slashed and regrowth treated.							
	Triclopyr (as butoxy ethyl ester) 480 g/L EC		37.5	0.50%	0.0375	10	0.375	1.125	300	Foliar spray
			Use 37.5 ml + 50 ml mineral oil/10 l water. Apply as a full cover spray to actively growing plants. Plants too high should be slashed and regrowth sprayed when 0.5 m high.							
	Triclopyr (as triethyl ammonium) 120 g/L + Aminopyralid 12 g/L		75	0.50%	0.075	10	0.75	2.25	300	Foliar spray

Species	Active constituent with concentration	Age	Dosage (ml/g)	Wetter /dye	A.I, (L/kg)	Mix (L)	% mix	Estimated product (L/ha or kg/ha)	Vol. of mix	Method of application
	Clopyralid 90 + Triclopyr (as amine salt) 270 g/L SL	Adult	200	0.50%	0.2	10	2	4	200	Cut and spray
			Use 200 ml + 50 ml mineral oil/10 l water. Apply to cut surface of low cut stems within 3 hours of felling.							
	Fluroxypyr 80 + Picloram 80 g/L ME		75	0.50%	0.075	10	0.75	1.5	200	Cut and spray
			Use 75 ml + 50 ml mineral oil/10 l water. Apply to cut surface of low cut stems.							
	Imazapyr 100 g/L SL		200		0.2	10	2	4	200	Cut and spray
			Use 200 ml/10 l water. Apply to freshly cut stumps. Use at least 10 ml per 10 cm of stump diameter.							
	Picloram (as potassium salt) 240g/L SL		100	0.50%	0.1	10	1	2	200	Cut and spray
			Use 100 ml + 50 ml mineral oil /10 l water. Apply to cut surface of low cut stems within 3 hours of felling							
	Triclopyr (as butoxy ethyl ester) 240 g/L EC		200	0.10%	0.2	10	2	4	200	Cut and spray
			Use 200 ml/10 l diesel. Apply to cut surface, all exposed bark and root crown of low cut stems							
	Triclopyr (as amine salt) 360 g/L SL		200	0.10%	0.2	10	2	4	200	Cut and spray
			Use 200 ml + 50 ml mineral oil /100 l water. Apply to the cut surface of low cut stumps.							
	Triclopyr (as butoxy ethyl ester) 480 g/L EC		100		0.1	10	1	2	200	Cut and spray + diesel
			Use 100 ml/10 l diesel. Apply to cut surface, all exposed bark and root crown of low cut stumps.							
Cirsium vulgare (Savi) Ten. (Asteraceae)	Clopyralid 90 + Triclopyr (as amine salt) 270 g/L SL	Young	75	0.50%	0.075	10	0.75	2.25	300	Foliar spray
	Fluroxypyr 80 + Picloram 80 g/L ME		75	0.50%	0.075	10	0.75	2.25	300	Foliar spray
	Picloram (as potassium salt) 240g/L SL		50	0.50%	0.05	10	0.5	1.5	300	Foliar spray
Montanoa hibiscifolia Benth (Asteraceae)	Glyphosate (as sodium salt) 500g/kg WG*	Young	220		0.22	10	2.2	6.6	300	Foliar spray
Parthenium hysterophorus L. (Asteraceae)	Glyphosate (as potassium salt) 500 SL	Young	200	0.10%	0.2	10	2	6	300	Foliar spray
	Picloram (as potassium salt) 240g/L SL		50	0.50%	0.05	10	0.5	1.5	300	Foliar spray
	Glyphosate (as isopropylamine salt) 480 g/L SL		150		0.15	10	1.5	4.5	300	Foliar spray
Xanthium spinosum L. (Asteraceae)	2.4D (as dimethylamine salt) 480g/L SL	Young	150	0.10%	0.15	10	1.5	2.25	150	Foliar spray

Species	Active constituent with concentration	Age	Dosage (ml/g)	Wetter /dye	A.I, (L/kg)	Mix (L)	% mix	Estimated product (L/ha or kg/ha)	Vol. of mix	Method of application
Xanthium strumarium L. (Asteraceae)	2.4D (as dimethylamine salt) 480g/L SL	Young	150	0.10%	0.15	10	1.5	2.25	150	Foliar spray
	Chlorimuron ethyl (as sulfonyl urea) 500g/kg WP		17.5	0.10%	0.0175	10	0.175	0.525	300	Foliar spray
Anredera cordifolia (Ten.) Steenis (Basselaceae)	Clopyralid 90 + Triclopyr (as amine salt) 270 g/L SL	Young	100	0.10%	0.1	10	1	4	400	Foliar spray
	Fluroxypyr 80 + Picloram 80 g/L ME		50	0.10%	0.05	10	0.5	2	400	Foliar spray
	Triclopyr (as butoxy ethyl ester) 240 g/L EC		100	0.10%	0.1	10	1	4	400	Foliar spray
			Use 100 ml/10 l water. Apply as a full cover spray.							
	Triclopyr (as butoxy ethyl ester) 480 g/L EC		50	0.10%	0.05	10	0.5	2	400	Foliar spray
			Use 50 ml/10 l water. Apply as a full cover spray							
	Triclopyr (as butoxy ethyl ester) 480 g/L EC	Adult	100	0.10%	0.1	10	1	2	200	Cut and spray
	Triclopyr (as butoxy ethyl ester) 480 g/L EC		100		0.1	10	1	2	200	Basal bark + diesel
Dolichandra unguis-cati (L.) L.G. Lohmann (Bignoniaceae)	Glyphosate (as isopropylamine salt) 360 g/L SL	Young	250	0.10%	0.25	10	2.5	7.5	300	Foliar spray
	Glyphosate (as isopropylamine salt) 360 g/L SL	Adult	2		0.002	10	0.02	0.04	200	Cut and spray
	Imazapyr 100 g/L SL		800	0.10%	0.8	10	8	16	200	Cut and spray
Jacaranda mimosifolia D. Don (Bignoniaceae)	Imazapyr 100 g/L SL	Young	1000		1	10	10	20	200	Lopping/ pruning
	Imazapyr 100 g/L SL	Adult	1000		1	10	10	20	200	Cut stump/frill
			Use 1 l/10 l water. Apply to the cut surface of freshly cut stumps. Use at least 10 ml per 10 cm of stump diameter							
Echium plantagineum L. (Boraginaceae)	Glyphosate (as phosponic acid) 480g/L SL	Young	200	0.50%	0.2	10	2	8	400	Foliar spray
	Picloram (as potassium salt) 240g/L SL		35	0.50%	0.035	10	0.35	1.4	400	Foliar spray
Cereus jamacaru DC. (Cactaceae)	MSMA 720 g/L SL	All ages	10000		10	10	100	50	50	Stem inject
			Use1 l/2 l water. Apply one injection/stem shorter than 2.5 m and twoinjections/stem higher than 2.5 m into pre-made holes (2 ml per hole).							
Hylocereus undatus (Haw.) Britton & Rose (Cactaceae)	Glyphosate (as ammonium salt) 680 g/kg WG*	Adult	1800	0.10%	1.8	10	18	9	50	Cut and spray
Opuntia engelmannii Salm-Dyck ex Engelm. (Cactaceae)	Glyphosate (as isopropylamine salt) 360 g/L SL*	Adult	4800		4.8	10	48	24	50	Stem inject

Species	Active constituent with concentration	Age	Dosage (ml/g)	Wetter /dye	A.I, (L/kg)	Mix (L)	% mix	Estimated product (L/ha or kg/ha)	Vol. of mix	Method of application
Opuntia ficus-indica (L.) Mill. (Cactaceae)	Glyphosate (as ammonium salt) 680 g/kg WG	All	1800	0.10%	1.8	10	18	9	50	Stem inject
			Use 1.8 kg/10 l water. Inject 2 ml in pre-made holes in the stem of the plant (4 – 12 pre-made holes for plants with 20 – 250 cladodes).							
	Glyphosate (as isopropylamine salt) 360 g/L SL		3300	0.10%	3.3	10	33	16.5	50	Stem inject
			Use 3.3 l/10 l water. Apply 2 ml into each of 4 – 12 pre-made holes in the stem of plants with 20 – 250 cladodes.							
	Glyphosate (as potassium salt) 450g/L SL		1800	0.10%	1.8	10	18	9	50	Stem inject
	Glyphosate (as potassium salt) 500 SL		2200	0.10%	2.2	10	22	11	50	Stem inject
			Use 2.2 l/10 l water. For plants with 20 – 250 cladodes drill 4 – 12 holes in stem and inject 3 ml/hole							
Opuntia microdasys (Lehm.) Pfeiff. (Cactaceae)	Glyphosate (as isopropylamine salt) 360 g/L SL*	Adult	4800		4.8	10	48	24	50	Stem inject
Pereskia aculeata Mill. (Cactaceae)	Triclopyr (as butoxy ethyl ester) 240 g/L EC	Adult	100	0.10%	0.1	10	1	3	300	Cut and spray
			Use 100 ml + 50 ml mineral oil/10 l water. Apply as high volume spray. Plants should be reduced to a height of 2 m. After treatment remove dead top growth e.g. by controlled burn.							
	Triclopyr (as butoxy ethyl ester) 480 g/L EC		50	0.10%	0.05	10	0.5	1.5	300	Cut and spray
			Use 50 ml + 50 ml mineral oil/10 l water. Apply as a high volume spray. Plants should be reduced to a height of 2 m. After treatment remove dead top growth e.g. by controlled burn.							
Lonicera japonica Thunb. (Caprifoliaceae)	Glyphosate (as isopropylamine salt) 360 g/L SL	Young	250	0.10%	0.25	10	2.5	7.5	300	Foliar spray
Casuarina cunninghamiana Miq (Casuarinaceae)	Triclopyr (as butoxy ethyl ester) 240 g/L EC	Young	200	0.10%	0.2	10	2	4	200	Lopping/ pruning
	Triclopyr (as butoxy ethyl ester) 480 g/L EC		300	0.10%	0.3	10	3	6	200	Looping/ pruning
	Triclopyr (as butoxy ethyl ester) 240 g/L EC	Adult	200	0.10%	0.2	10	2	4	200	Cut stump/frill
	Triclopyr (as butoxy ethyl ester) 480 g/L EC		300	0.10%	0.3	10	3	6	200	Cut stump/frill
Casuarina equisetifolia L. (Casuarinaceae)	Triclopyr (as butoxy ethyl ester) 240 g/L EC	Young	200	0.10%	0.2	10	2	4	200	Foliar spray
	Triclopyr (as butoxy ethyl ester) 480 g/L EC		300	0.50%	0.3	10	3	6	200	Foliar spray
	Triclopyr (as butoxy ethyl ester) 480 g/L EC	Adult	100	0.50%	0.1	10	1	2	200	Cut and spray + diesel
			Use 100 ml/10 l diesel or 150–300 ml/10 l water, Apply to the cut surface of low cut stumps.							

Species	Active constituent with concentration	Age	Dosage (ml/g)	Wetter /dye	A.I, (L/kg)	Mix (L)	% mix	Estimated product (L/ha or kg/ha)	Vol. of mix	Method of application
Convolvulus arvensis L. (Convolvulaceae)	Glyphosate (as isopropylamine salt) 360 g/L SL	Young	300		0.3	10	3	9	300	Foliar spray
			Use 300 ml/10 l water. Apply in summer at onset of flowering.							
	Glyphosate (as sodium salt) 500g/kg WG		220		0.22	10	2.2	6.6	300	Foliar spray
	Glyphosate (as sodium salt) 700g/kg WG		78		0.078	10	0.78	2.34	300	Foliar spray
	Glyphosate (as sodium salt) 500g/kg WG		100		0.1	10	1	3	300	Foliar spray
			Use 200 g/10 l water. Apply in summer at onset of flowering.							
Ipomoea alba L. (Convolvulaceae)	Glyphosate (as isopropylamine salt) 360 g/L SL*	Young	200		0.2	10	2	6	300	Foliar spray
Ipomoea carnea Jacq. (Convolvulaceae)	Glyphosate (as isopropylamine salt) 480 g/L SL*	All	200	0.10%	0.2	10	2	6	300	Spray from boat/shoreline
Ipomoea indica (Burm.) Merr. (Convolvulaceae)	Glyphosate (as isopropylamine salt) 360 g/L SL*	Young	200		0.2	10	2	6	300	Foliar spray
Ipomoea purpurea (L.) Roth (Convolvulaceae)	Glyphosate (as isopropylamine salt) 360 g/L SL	Young	200		0.2	10	2	6	300	Foliar spray
	Glyphosate (as phosponic acid) 480g/L SL		220		0.22	10	2.2	6.6	300	Foliar spray
	Glyphosate (as potassium salt) 500 SL		130		0.13	10	1.3	3.9	300	Foliar spray
	Tebuthiuron 250g/L + Bromacil 250g/L SC	All	150		0.15	10	1.5	22.5	1500	Soil
Ricinus communis L. (Euphorbiaceae)	Clopyralid 90 + Triclopyr (as amine salt) 270 g/L SL	Adult	2000	0.50%	2	10	20	40	200	Cut and spray
			Use 200 ml + 50 ml mineral oil/10 l water. Apply to the surface of low cut stumps within three hours of felling.							
	Fluroxypyr 80 + Picloram 80 g/L ME		100	0.50%	0.1	10	1	2	200	Cut and spray
			Use 100 ml + 50 ml mineral oil/10 l water. Apply to cut surface of low cut stumps within three hours of felling.							
	Imazapyr 100 g/L SL		300		0.3	10	3	6	200	Cut and spray
			Use 300 ml/10 l water. Apply to freshly cut stumps. Apply at least 10 ml per 10 cm of stump diameter.							

Species	Active constituent with concentration	Age	Dosage (ml/g)	Wetter /dye	A.I, (L/kg)	Mix (L)	% mix	Estimated product (L/ha or kg/ha)	Vol. of mix	Method of application
	Fluroxypyr 80 + Picloram 80 g/L ME	Young	200	0.50%	0.2	10	2	4	200	Lopping/ pruning
	Imazapyr 100 g/L SL		1000		1	10	10	20	200	Lopping/ pruning
	Picloram (as potassium salt) 240g/L SL		150	0.50%	0.15	10	1.5	3	200	Lopping/ pruning
	Triclopyr (as amine salt) 360 g/L SL		300	0.50%	0.3	10	3	6	200	Lopping/ pruning
	Triclopyr (as triethyl ammonium) 120 g/L + Aminopyralid 12 g/L		200	0.50%	0.2	10	2	4	200	Lopping/ pruning
	Fluroxypyr 80 + Picloram 80 g/L ME	Adult	200	0.50%	0.2	10	2	4	200	Cut stump/frill
	Imazapyr 100 g/L SL		1000		1	10	10	20	200	Cut stump/frill
			Use 1 l/10 l of water. Apply to freshly cut stumps. Apply at least 10 ml per 100 mm of stump diameter.							
	Picloram (as potassium salt) 240g/L SL		150	0.50%	0.15	10	1.5	3	200	Cut stump/frill
			Use 600 ml + 200 ml mineral oil/10 ml water. Apply sufficient mixture to fill the frill.							
	Triclopyr (as amine salt) 360 g/L SL		300	0.50%	0.3	10	3	6	200	Cut stump/frill
			Use 300 ml + 50 ml mineral oil/10 l water. Apply to the cut surface of low cut stumps.							
	Triclopyr (as triethyl ammonium) 120 g/L + Aminopyralid 12 g/L		200	0.50%	0.2	10	2	4	200	Cut stump/frill
	Cylindrobasidium laeve		1 sachet / 400ml sunflower oil					200		Cut stump/frill
	Picloram (as potassium salt) 240g/L SL		600	2.00%	0.6	10	6	12	200	Frill
			Use 150 ml + 50 ml mineral oil/10 l water. Apply to the cut surface of low cut stumps within 3 hours of felling.							
	Triclopyr (as butoxy ethyl ester) 480 g/L EC		200		0.2	10	2	4	200	Basal stem + diesel
			Use 200 ml/10 l of diesel for plants with a stem diameter of up to 10 cm. Ensure wetting of the root crown, exposed roots and stem up to a height of 25 cm.							

Species	Active constituent with concentration	Age	Dosage (ml/g)	Wetter /dye	A.I, (L/kg)	Mix (L)	% mix	Estimated product (L/ha or kg/ha)	Vol. of mix	Method of application
Acacia mearnsii De Wild. (Fabaceae)	Clopyralid 90 + Triclopyr (as amine salt) 270 g/L SL		40	0.50%	0.04	10	0.4	1.2	300	Foliar spray
			Use 30-50 ml + 50 ml mineral oil/10 ml water. Apply the lower rate on seedlings and the higher rate on saplings as a full cover spray.							
	Fluroxypyr 200 g/L EC		12.5	0.50%	0.0125	10	0.125	0.375	300	Foliar spray
			Use 12.5 ml + 50 ml of mineral oil/ 10 l water. Apply as a full cover spray on young, actively growing plants up to 1 m high.							
	Glyphosate (as ammonium salt) 680 g/kg WG		80	0.50%	0.08	10	0.8	2.4	300	Foliar spray
			Use 80 g/10 l water. Apply to plants up to 1 m high.							
	Glyphosate (as isopropylamine salt) 360 g/L SL		150	0.10%	0.15	10	1.5	4.5	300	Foliar spray
			Use 150 ml/10 l water. Apply in summer to plants up to 1 m high.							
	Glyphosate (as potassium salt) 450g/L SL		120	0.10%	0.12	10	1.2	3.6	300	Foliar spray
			Use 120 ml/10 l water. Spray plants up to 1 m high.							
	Glyphosate (as isopropylamine salt) 480 g/L SL		110	0.10%	0.11	10	1.1	3.3	300	Foliar spray
			Use 110 ml/10 l of water. Spray plants up to 1 m high.							
	Glyphosate (as sodium salt) 500g/kg WG		110	0.10%	0.11	10	1.1	3.3	300	Foliar spray
			Use 100 g/10 l water to young trees up to 1 m high.							
	Triclopyr (as butoxy ethyl ester) 240 g/L EC	Seedling	50	0.10%	0.05	10	0.5	1.5	300	Foliar spray
			Use 50-150 ml + 50 ml mineral oil/10 l water. Apply as a full cover spray to actively growing plants. Use lower rate on seedlings (smaller than 50 cm high) and higher rate on seedlings.							
	Triclopyr (as triethyl ammonium) 120 g/L + Aminopyralid 12 g/L		50	0.50%	0.05	10	0.5	1.5	300	Foliar spray
	Triclopyr (as butoxy ethyl ester) 480 g/L EC		25	0.50%	0.025	10	0.25	0.75	300	Foliar spray
			Use 25 – 75 ml+ 50 ml mineral oil/10 l water. Apply as a full cover spray to actively growing plants. Use lower rate on seedlings (smaller than 50 cm high) and higher rate on seedlings.							
	Triclopyr (as butoxy ethyl ester) 240 g/L + Aminopyralid 30 g/L		25	0.50%	0.025	10	0.25	0.75	300	Foliar spray
	Clopyralid 90 + Triclopyr (as amine salt) 270 g/L SL		50	0.50%	0.05	10	0.5	1.5	300	Foliar spray
	Fluroxypyr 80 + Picloram 80 g/L ME		75	0.50%	0.075	10	0.75	2.25	300	Foliar spray
			Use 75 ml + 50 ml mineral oil/10 l water. Apply as a full cover spray on actively growing plants.							
	Glyphosate (as potassium salt) 500 SL		100	0.10%	0.1	10	1	3	300	Foliar spray
			Use 100 ml/10 l water. Apply in summer to young trees 1-2 m high.							
	Triclopyr (as butoxy ethyl ester) 240 g/L EC		150	0.10%	0.15	10	1.5	4.5	300	Foliar spray
	Triclopyr (as butoxy ethyl ester) 480 g/L EC		75	0.10%	0.075	10	0.75	2.25	300	Foliar spray

Species	Active constituent with concentration	Age	Dosage (ml/g)	Wetter /dye	A.I, (L/kg)	Mix (L)	% mix	Estimated product (L/ha or kg/ha)	Vol. of mix	Method of application
Acacia melanoxylon R.Br. (Fabaceae)	Clopyralid 90 + Triclopyr (as amine salt) 270 g/L SL		70	0.50%	0.07	10	0.7	2.1	300	Foliar spray
			Use 70 ml + 50 ml mineral oil/10 l water. Apply to young actively growing saplings up to 2 m high.							
	Fluroxypyr 200 g/L EC		12.5	0.10%	0.0125	10	0.125	0.375	300	Foliar spray
			Use 12.5 ml + 50 ml mineral oil/10 l water. Apply as a full cover spray to young actively growing plants up to 1 m high.							
	Triclopyr (as butoxy ethyl ester) 480 g/L EC	Seedling	75	0.50%	0.075	10	0.75	2.25	300	Foliar spray
			Use 75 ml + 50 ml mineral oil/10 l water. Apply to young actively growing plants up to 2 m high.							
	Triclopyr (as triethyl ammonium) 120 g/L + Aminopyralid 12 g/L		100	0.50%	0.1	10	1	3	300	Foliar spray
	Triclopyr (as butoxy ethyl ester) 240 g/L + Aminopyralid 30 g/L		50	0.50%	0.05	10	0.5	1.5	300	Foliar spray
			Use 150 ml + 50 ml mineral oil/10 l water. Apply as a full cover spray to young actively growing trees up to 2 m high.							
	Clopyralid 90 + Triclopyr (as amine salt) 270 g/L SL		400	0.50%	0.4	10	4	8	200	Lopping/ pruning
	Triclopyr (as amine salt) 360 g/L SL	Young	600	0.50%	0.6	10	6	12	200	Lopping/ pruning
	Triclopyr (as triethyl ammonium) 120 g/L + Aminopyralid 12 g/L		400	0.50%	0.4	10	4	8	200	Lopping/ pruning
	Clopyralid 90 + Triclopyr (as amine salt) 270 g/L SL		400	0.50%	0.4	10	4	8	200	Cut stump/frill
			Use 400 ml + 50 ml mineral oil/10 l water. Apply to cut surface of low cut stumps within 3 hours of felling.							
	Triclopyr (as amine salt) 360 g/L SL		600	0.50%	0.6	10	6	12	200	Cut stump/frill
		Adult	Use 600 ml + 50 ml mineral oil/10 l water. Apply to cut surface of low cut stumps within 3 hours of felling.							
	Triclopyr (as triethyl ammonium) 120 g/L + Aminopyralid 12 g/L		400	0.50%	0.4	10	4	8	200	Cut stump/frill
	Triclopyr (as butoxy ethyl ester) 480 g/L EC		200		0.2	10	2	4	200	Basal stem + diesel
			Use 200 ml/10 l diesel for plants with a stem diameter of up to 10 cm. Ensure wetting of the root crown, exposed roots and stem up to a height of 25 cm.							
Acacia podalyriifolia G. Don (Fabaceae)	Triclopyr (as butoxy ethyl ester) 480 g/L EC*	Young	300	0.50%	0.3	10	3	6	200	Lopping / pruning
	Triclopyr (as butoxy ethyl ester) 480 g/L EC*	Adult	300	0.50%	0.3	10	3	6	200	Cut stump / Frill
	Triclopyr (as butoxy ethyl ester) 480 g/L EC*		300	0.50%	0.3	10	3	6	200	Basal stem + diesel

Species	Active constituent with concentration	Age	Dosage (ml/g)	Wetter /dye	A.I, (L/kg)	Mix (L)	% mix	Estimated product (L/ha or kg/ha)	Vol. of mix	Method of application
Acacia saligna (Labill.) Wendl. (Fabaceae)	Clopyralid 90 + Triclopyr (as amine salt) 270 g/L SL	Seedling	70	0.50%	0.07	10	0.7	2.1	300	Foliar spray
			Use 70 ml + 50 ml mineral oil/10 l water. Apply to young actively growing saplings up to 2 m high.							
	Fluroxypyr 200 g/L EC		25	0.50%	0.025	10	0.25	0.75	300	Foliar spray
			Use 25 ml + 50 ml mineral oil/10 l water. Apply as a full cover spray on actively growing plants up to 0.5 m high. Buffer the mixture to obtain pH 5-6.							
	Glyphosate (as ammonium salt) 680 g/kg WG		80	0.10%	0.08	10	0.8	2.4	300	Foliar spray
			Use 80 g/10 l water. Apply to plants up to 0.6 m high.							
	Glyphosate (as isopropylamine salt) 360 g/L SL		150	0.10%	0.15	10	1.5	4.5	300	Foliar spray
			Use 120 ml/10 l water. Apply to seedlings up to 60 cm high.							
	Glyphosate (as potassium salt) 450g/L SL		120	0.10%	0.12	10	1.2	3.6	300	Foliar spray
	Glyphosate (as isopropylamine salt) 480 g/L SL		110	0.10%	0.11	10	1.1	3.3	300	Foliar spray
			Use 110 ml/10 l water for plants in the twice-divided stage and 150 ml/10 l for plants up to 60 cm high.							
	Glyphosate (as potassium salt) 500 SL		100	0.10%	0.1	10	1	3	300	Foliar spray
			Use 100 ml/10 l water. Apply in autumn or spring to seedlings up to 60 cm high.							
	Glyphosate (as sodium salt) 500g/ kg WG		150	0.50%	0.15	10	1.5	4.5	300	Foliar spray
			Use 150 g/10 l water in the 1-12 leaf stage, 300 g/10 l water in the 12+ leaf to pre-flowering stage and 220g/10 l water in the flowering stage.							
	Triclopyr (as butoxy ethyl ester) 480 g/L EC		50	0.50%	0.05	10	0.5	1.5	300	Foliar spray
			Use 50 ml + 50 ml mineral oil/10 l water. Apply as a full cover spray to young actively growing trees up to 2 m high.							
	Triclopyr (as butoxy ethyl ester) 240 g/L + Aminopyralid 30 g/L		37.5	0.50%	0.0375	10	0.375	1.125	300	Foliar spray
			Use 100 ml + 50 ml mineral oil/10 l water. Apply as a full cover spray to young actively growing trees up to 2 m high.							
	Triclopyr (as triethyl ammonium) 120 g/L + Aminopyralid 12 g/L		75	0.50%	0.075	10	0.75	2.25	300	Foliar spray
	Glyphosate (as isopropylamine salt) 180 g/l SL		400	0.50%	0.4	10	4	12	300	Foliar spray

Species	Active constituent with concentration	Age	Dosage (ml/g)	Wetter /dye	A.I, (L/kg)	Mix (L)	% mix	Estimated product (L/ha or kg/ha)	Vol. of mix	Method of application
	Clopyralid 90 + Triclopyr (as amine salt) 270 g/L SL		250	0.50%	0.25	10	2.5	5	200	Lopping/ pruning
	Glyphosate (as ammonium salt) 680 g/kg WG		265	0.50%	0.265	10	2.65	5.3	200	Lopping/ pruning
	Picloram (as potassium salt) 240g/L SL	Young	200	0.10%	0.2	10	2	4	200	Lopping/ pruning
	Triclopyr (as triethyl ammonium) 120 g/L + Aminopyralid 12 g/L		200	0.50%	0.2	10	2	4	200	Lopping/ pruning
	Triclopyr (as amine salt) 360 g/L SL		300	0.50%	0.3	10	3	6	200	Lopping/ pruning
			Use 300 ml + 50 ml mineral oil/10 l water. Apply to the cut surface of low cut stumps within 3 hours of felling.							
	Clopyralid 90 + Triclopyr (as amine salt) 270 g/L SL		250	0.50%	0.25	10	2.5	5	200	Cut stump/Frill
			Use 250 ml + 50 ml mineral oil/10 l water. Apply to cut surface of low cut stumps within 3 hours of felling.							
	Glyphosate (as ammonium salt) 680 g/kg WG in plastic capsules		265	0.10%	0.265	10	2.65	5.3	200	Cut stump/Frill
		Adult	Cut trees 10 cm above ground level and knock Ecoplugs with a hammer into punched or drilled holes (28 – 35 mm deep) in the stem and exposed roots. Number of plugs depends on stump diameter.							
	Picloram (as potassium salt) 240g/L SL		200	0.50%	0.2	10	2	4	200	Cut stump/Frill
			Use 200 ml + 50 ml mineral oil/10 l water. Apply to cut surface of low cut stumps within 3 hours of felling.							
	Triclopyr (as triethyl ammonium) 120 g/L + Aminopyralid 12 g/L		200	0.50%	0.2	10	2	4	200	Cut stump/Frill
	Triclopyr (as amine salt) 360 g/L SL		300	0.50%	0.3	10	3	6	200	Cut stump/Frill

Species	Active constituent with concentration	Age	Dosage (ml/g)	Wetter /dye	A.I, (L/kg)	Mix (L)	% mix	Estimated product (L/ha or kg/ha)	Vol. of mix	Method of application
Caesalpinia decapetala (Roth) Alston (Fabaceae)	Glyphosate (as ammonium salt) 680 g/kg WG	Young	80	0.10%	0.08	10	0.8	2.4	300	Foliar spray
			Use 10 g/10 l water. Apply to plants up to 1 m high.							
	Glyphosate (as isopropylamine salt) 360 g/L SL		150	0.10%	0.15	10	1.5	4.5	300	Foliar spray
			Use 150 ml/10 l water. Apply to plants up to 1 m high.							
	Glyphosate (as potassium salt) 450g/L SL		120	0.10%	0.12	10	1.2	3.6	300	Foliar spray
	Glyphosate (as isopropylamine salt) 480 g/L SL		110	0.10%	0.11	10	1.1	3.3	300	Foliar spray
			Use 110 ml/10 l water. Apply to plants up to 1 m high.							
	Glyphosate (as potassium salt) 500 SL		100	0.10%	0.1	10	1	3	300	Foliar spray
			Use 100 ml/10 l water. Apply in summer.							
	Glyphosate (as sodium salt) 500g/kg WG		110	0.50%	0.11	10	1.1	3.3	300	Foliar spray
	Triclopyr (as butoxy ethyl ester) 240 g/L EC		100	0.10%	0.1	10	1	3	300	Foliar spray
			Use 100 ml + 50 ml mineral oil/10 l water. Apply as a full cover spray to actively growing plants up to 3 m high. Taller plants must be cut back and regrowth treated.							
	Triclopyr (as butoxy ethyl ester) 480 g/L EC		50	0.50%	0.05	10	0.5	1.5	300	Foliar spray
			Use 50 ml + 50 ml mineral oil/10 l water. Apply as a full cover spray to actively growing plants up to 3 m high. Taller plants must be cut back and regrowth treated.							
	Triclopyr (as amine salt) 360 g/L SL	Adult	300	0.10%	0.3	10	3	6	200	Cut and spray
Leucaena leucocephala (Lam.) de Wit (Fabaceae)	Triclopyr (as butoxy ethyl ester) 480 g/L EC*	Young	100		0.1	10	1	2	200	Basal stem + diesel
	Triclopyr (as butoxy ethyl ester) 480 g/L EC	Adult	100		0.1	10	1	2	200	Basal stem + diesel
Mimosa pigra L. (Fabaceae)	Glyphosate (as isopropylamine salt) 360 g/L SL	Young	300		0.3	10	3	9	300	Foliar spray
			Use 300 ml/10 l water with knapsack sprayer or 400 ml/10 l water with mistblower. Apply as a full cover spray in summer to autumn.							
	Glyphosate (as sodium salt) 500g/kg WG		220		0.22	10	2.2	6.6	300	Foliar spray
	Glyphosate (as sodium salt) 700g/kg WG		157		0.157	10	1.57	4.71	300	Foliar spray
Senna didymobotrya (Fresen.) H.S. Irwin & Barneby (Fabaceae)	Imazapyr 100 g/L SL*	Adult	500		0.5	10	5	10	200	Cut and spray

Species	Active constituent with concentration	Age	Dosage (ml/g)	Wetter /dye	A.I, (L/kg)	Mix (L)	% mix	Estimated product (L/ha or kg/ha)	Vol. of mix	Method of application
Senna hirsuta (L.) H.S. Irwin & Barneby (Fabaceae)	Imazapyr 100 g/L SL*	Adult	500		0.5	10	5	10	200	Cut and spray
Senna occidentalis (L.) Link (Fabaceae)	Imazapyr 100 g/L SL*	Adult	500		0.5	10	5	10	200	Cut and spray
Senna septemtrionalis (Viv.) H.S. Irwin & Barneby (Fabaceae)	Imazapyr 100 g/L SL*	Adult	500		0.5	10	5	10	200	Cut and spray
Prosopis glandulosa Torr. (Fabaceae)	Clopyralid 90 + Triclopyr (as amine salt) 270 g/L SL		150	0.50%	0.15	10	1.5	4.5	300	Foliar spray
			Use 100-150 ml + 50 ml mineral oil/10 l water. Apply as a full cover spray. Plants to high should be slashed and regrowth sprayed.							
	Glyphosate (as potassium salt) 500 SL		500	0.10%	0.5	10	5	15	300	Foliar spray
			Use 350-660 ml/10 l water. Apply to seedlings and regrowth.							
	Triclopyr (as triethyl ammonium) 120 g/L + Aminopyralid 12 g/L		300	0.50%	0.3	10	3	9	300	Foliar spray
	Clopyralid 90 + Triclopyr (as amine salt) 270 g/L SL		400	0.50%	0.4	10	4	8	200	Lopping/ pruning
	Triclopyr (as butoxy ethyl ester) 240 g/L EC		800	0.10%	0.8	10	8	16	200	Lopping/ pruning
	Triclopyr (as amine salt) 360 g/L SL		500	2.00%	0.5	10	5	10	200	Lopping/ pruning
	Clopyralid 90 + Triclopyr (as amine salt) 270 g/L SL		400	0.50%	0.4	10	4	8	200	Cut stump/frill
			Use 400 ml + 50 ml mineral oil/10 l water. Apply to cut surface of low cut stumps within 3 hours of felling,							
	Triclopyr (as butoxy ethyl ester) 240 g/L EC		800	0.10%	0.8	10	8	16	200	Cut stump/frill
			Use 800 ml/10 l diesel. Apply to the cut surface and all bark and root crown of low cut stumps.							
	Triclopyr (as amine salt) 360 g/L SL		500	2.00%	0.5	10	5	10	200	Cut stump/frill
			Use 500 ml + 200 ml mineral oil/10 l water. Apply to the cut surface of low cut stumps within three hours of felling.							
	Picloram (as potassium salt) 54g/kg + Triclopyr (as triethylamine) 36g/kg		Paint directly onto stumps 10g/10mm stump			200				Cut stump/frill
	Triclopyr (as butoxy ethyl ester) 480 g/L EC		400	0.50%	0.4	10	4	8	200	Cut stump/frill
	Glyphosate (as potassium salt) 500 SL		500	0.50%	0.5	10	5	20	400	Aerial application

Species	Active constituent with concentration	Age	Dosage (ml/g)	Wetter /dye	A.I, (L/kg)	Mix (L)	% mix	Estimated product (L/ha or kg/ha)	Vol. of mix	Method of application
Myriophyllum aquaticum (Vell.) Verdc (Haloragaceae)	Diquat dibromide (as dibromide salt) 200g/L SL	All	7500	0.10%	7.5	10	75	37.5	50	Spray from boat/shoreline
	Glyphosate (as isopropylamine salt) 480 g/L SL		300	0.10%	0.3	10	3	9	300	Spray from boat/shoreline
	Glyphosate (as sodium salt) 500g/kg WG		300	0.10%	0.3	10	3	9	300	Spray from boat/shoreline
	Glyphosate (as sodium salt) 700g/kg WG		200	0.10%	0.2	10	2	6	300	Spray from boat/shoreline
Myriophyllum spicatum L. (Haloragaceae)	Diquat dibromide (as dibromide salt) 200g/L SL	All	50	0.10%	0.05	10	0.5	0.25	50	Spray from boat/shoreline
Melia azedarach L. (Meliaceae)	Clopyralid 90 + Triclopyr (as amine salt) 270 g/L SL	Young	300	0.50%	0.3	10	3	6	200	Lopping/ pruning
	Fluroxypyr 80 + Picloram 80 g/L ME		150	0.50%	0.15	10	1.5	3	200	Lopping/ pruning
	Imazapyr 100 g/L SL		300		0.3	10	3	6	200	Lopping/ pruning
	Picloram (as potassium salt) 240g/L SL		200	0.50%	0.2	10	2	4	200	Lopping/ pruning
	Triclopyr (as amine salt) 360 g/L SL		300	0.50%	0.3	10	3	6	200	Lopping/ pruning
	Clopyralid 90 + Triclopyr (as amine salt) 270 g/L SL	Adult	300	0.50%	0.3	10	3	6	200	Cut stump/frill
	Fluroxypyr 80 + Picloram 80 g/L ME		150	0.50%	0.15	10	1.5	3	200	Cut stump/frill
	Imazapyr 100 g/L SL		300		0.3	10	3	6	200	Cut stump/frill
			Use 300 ml/10 l water. Apply to freshly cut stumps. Apply at least 10 ml per 10 cm of stump diameter.							
	Picloram (as potassium salt) 240g/L SL		200	0.50%	0.2	10	2	4	200	Cut stump/frill
			Use 200 ml + 50 ml mineral oil/10 l water. Apply to the cut surface of low cut stumps within three hours of felling.							
	Triclopyr (as amine salt) 360 g/L SL		300	0.50%	0.3	10	3	6	200	Cut stump/frill
			Use 300 ml + 50 ml mineral oil/10 l water. Apply to the cut surface of low cut stumps within 3 hours of felling.							
	Triclopyr (as butoxy ethyl ester) 480 g/L EC		2000		2	10	20	40	200	Basal bark + diesel
			Use 200 ml/10l diesel for plants with a stem diameter up to 10 cm. Ensure wetting of the root crown, exposed roots and stem up to a height of 25 cm.							
Psidium cattleianum Afzel. ex Sabine (Myrtaceae)	Fluroxypyr 80 + Picloram 80 g/L ME*	Young	150	0.50%	0.15	10	1.5	4.5	300	Foliar spray

Species	Active constituent with concentration	Age	Dosage (ml/g)	Wetter /dye	A.I, (L/kg)	Mix (L)	% mix	Estimated product (L/ha or kg/ha)	Vol. of mix	Method of application
Psidium guajava L. (Myrtaceae)	Fluroxypyr 80 + Picloram 80 g/L ME	Seedling	150	0.50%	0.15	10	1.5	4.5	300	Foliar spray
			Use 150 ml + 50 ml mineral oil /10 l water. Apply as a full cover spray on actively growing plants.							
	Imazapyr 100 g/L SL	Young	1250		1.25	10	12.5	25	200	Lopping/ pruning
	Imazapyr 100 g/L SL	Adult	1250		1.25	10	12.5	25	200	Cut stump/frill
			Use 1.25 l/10 l water. Apply to the cut surface of low cut stumps. Apply at least 10 ml per 100 mm of stump diameter.							
Mirabilis jalapa L. (Nyctaginaceae)	Glyphosate (as sodium salt) 500g/ kg WG*	Young	220		0.22	10	2.2	6.6	300	Foliar spray
Argemone mexicana L. (Papaveraceae)	Glyphosate (as isopropylamine salt) 180 g/l SL	Young	150		0.15	10	1.5	6	400	Foliar spray
	Glyphosate (as sodium salt) 500g/ kg WG		220		0.22	10	2.2	8.8	400	Foliar spray
	Tebuthiuron 250g/L + Bromacil 250g/L SC	All	600		0.6	10	6	90	1500	Soil
Argemone ochroleuca Sweet (Papaveraceae)	Glyphosate (as isopropylamine salt) 180 g/l SL	Young	150		0.15	10	1.5	6	400	Foliar spray
	Glyphosate (as sodium salt) 500g/ kg WG		220		0.22	10	2.2	8.8	400	Foliar spray
	Tebuthiuron 250g/L + Bromacil 250g/L SC*	All	600		0.6	10	6	90	1500	Soil
Passiflora caerulea L. (Passifloraceae)	Glyphosate (as isopropylamine salt) 360 g/L SL*	Young	150	0.10%	0.15	10	1.5	6	400	Foliar spray
Passiflora edulis Sims (Passifloraceae)	Glyphosate (as isopropylamine salt) 360 g/L SL*	Young	150	0.10%	0.15	10	1.5	6	400	Foliar spray
Passiflora suberosa L. (Passifloraceae)	Glyphosate (as isopropylamine salt) 360 g/L SL*	Young	150	0.10%	0.15	10	1.5	6	400	Foliar spray
Passiflora subpeltata Ortega (Passifloraceae)	Glyphosate (as isopropylamine salt) 360 g/L SL*	Young	150	0.10%	0.15	10	1.5	6	400	Foliar spray
Rivina humilis L. (Phytolaccaceae)	Glyphosate (as isopropylamine salt) 480 g/L SL*	Young	150	0.10%	0.15	10	1.5	4.5	300	Foliar spray
	Glyphosate (as isopropylamine salt) 480 g/L SL*		300	0.10%	0.3	10	3	9	300	Foliar spray

Species	Active constituent with concentration	Age	Dosage (ml/g)	Wetter /dye	A.I, (L/kg)	Mix (L)	% mix	Estimated product (L/ha or kg/ha)	Vol. of mix	Method of application
Eichhornia crassipes (Mart.) Solms (Pontederiaceae)	Glyphosate (as sodium salt) 700g/kg WG		220	0.50%	0.22	10	2.2	6.6	300	Spray from boat/shoreline
	Glyphosate (as isopropylamine salt) 480 g/L SL		220	0.10%	0.22	10	2.2	6.6	300	Spray from boat/shoreline
			Use 220ml/10 l water with a pressurized or knapsack sprayer and 300 ml/10 l with a mistblower. Apply when maximum exposure of leaves is visible.							
	Glyphosate (as sodium salt) 500g/kg WG		220		0.22	10	2.2	6.6	300	Spray from boat/shoreline
	Glyphosate (as potassium salt) 500 SL	All	450		0.45	10	4.5	13.5	300	Spray from boat/shoreline
			Use 200-265 ml/10 l water. Apply in summer on actively growing plants.							
	Glyphosate (as phosponic acid) 480g/L SL		225		0.225	10	2.25	6.75	300	Spray from boat/shoreline
	Diquat dibromide (as dibromide salt) 200g/L SL		500		0.5	10	5	2.5	50	Aerial
			Use 7.5-10 l + 1.5 l wetting agent – 40 l water/ha. Apply on actively growing plants.							
	Glyphosate (as potassium salt) 500 SL		450		0.45	10	4.5	4.5	100	Aerial
			Use 4-5.3 l/30 l water/ha. Apply in summer on actively growing plants.							
Pontederia cordata L. (Pontederiaceae)	Glyphosate (as isopropylamine salt) 480 g/L SL		300	0.10%	0.3	10	3	9	300	Spray from boat/shoreline
	Glyphosate (as sodium salt) 500g/kg WG	All	300	0.10%	0.3	10	3	9	300	Spray from boat/shoreline
	Glyphosate (as sodium salt) 700g/kg WG		200	0.10%	0.2	10	2	6	300	Spray from boat/shoreline
Rubus niveus Thunb (Rosaceae)	Glyphosate (as phosponic acid) 480g/L SL		450	0.10%	0.45	10	4.5	13.5	300	Foliar spray
	Glyphosate (as isopropylamine salt) 360 g/L SL		300	0.10%	0.3	10	3	9	300	Foliar spray
		Young	Use 300 ml/10 l water. Slash rank growth in winter and apply when growth is 0.5 m high.							
	Glyphosate (as sodium salt) 500g/kg WG		215	0.50%	0.215	10	2.15	6.45	300	Foliar spray
Salvinia molesta D.S. Mitch. (Salviniaceae)	Glyphosate (as sodium salt) 500g/kg WG		300	0.10%	0.3	10	3	9	300	Spray from boat/shoreline
	Glyphosate (as sodium salt) 700g/kg WG		300	0.10%	0.3	10	3	9	300	Spray from boat/shoreline
	Glyphosate (as isopropylamine salt) 480 g/L SL	All	200	0.10%	0.2	10	2	6	300	Spray from boat/shoreline
	Diquat dibromide (as dibromide salt) 200g/L SL		500	0.10%	0.5	10	5	2.5	50	Aerial
			Use 7.5 – 10 l + 1.5 l Agral 90/ha. Apply in 35 – 40 l water/ha.							

Species	**Active constituent with concentration**	**Age**	**Dosage (ml/g)**	**Wetter /dye**	**A.I, (L/kg)**	**Mix (L)**	**% mix**	**Estimated product (L/ha or kg/ha)**	**Vol. of mix**	**Method of application**
Cardiospermum grandiflorum Sw (Sapindaceae)	Glyphosate (as isopropylamine salt) 360 g/L SL	Adult	150	0.10%	0.15	10	1.5	3	200	Cut and spray
Cestrum aurantiacum Lindl. (Solanaceae)	Imazapyr 100 g/L SL	Adult	150		0.15	10	1.5	3	200	Cut and spray
Datura ferox L. (Solanaceae)	Chlorimuron ethyl (as sulfonyl urea) 500g/kg WP	Young	17.5	0.10%	0.0175	10	0.175	0.35	200	Foliar spray
	Metsulfuron methyl 600g/kg WP		10	0.10%	0.11	110	0.1	0.2	200	Foliar spray
	Glyphosate (as sodium salt) 500g/kg WG		110		0.11	10	1.1	2.2	200	Foliar spray
	2.4D (as dimethylamine salt) 480g/L SL		440	0.10%	0.44	10	4.4	6.6	150	Foliar spray
	Glyphosate (as isopropylamine salt) 180 g/l SL		150		0.15	10	1.5	3	200	Foliar spray
Datura innoxia Mill. (Solanaceae)	Chlorimuron ethyl (as sulfonyl urea) 500g/kg WP*	Young	17.5	0.10%	0.0175	10	0.175	0.35	200	Foliar spray
Datura stramonium L. (Solanaceae)	2.4D (as dimethylamine salt) 480g/L SL	Young	150	0.10%	0.15	10	1.5	2.25	150	Foliar spray
	Chlorimuron ethyl (as sulfonyl urea) 500g/kg WP		17.5	0.10%	0.0175	10	0.175	0.35	200	Foliar spray
	Glyphosate (as sodium salt) 500g/kg WG		110		0.11	10	1.1	2.2	200	Foliar spray
	Glyphosate (as isopropylamine salt) 180 g/l SL		150		0.15	10	1.5	3	200	Foliar spray
	Tebuthiuron 250g/L + Bromacil 250g/L SC	All	150		0.15	10	1.5	3	200	Soil
Nicotiana glauca Graham (Solanaceae)	Glyphosate (as isopropylamine salt) 360 g/L SL*	Young	300	0.10%	0.3	10	3	12	400	Foliar spray
Solanum mauritianum Scop. (Solanaceae)	Glyphosate (as isopropylamine salt) 360 g/L SL		50	0.50%	0.05	10	0.5	1.5	300	Foliar spray
			Use 150 ml/10 l water. Slash tall plants and apply when regrowth is 1 m high. Use 50 ml/10 l water on saplings less than 1 m high.							

Species	Active constituent with concentration	Age	Dosage (ml/g)	Wetter /dye	A.I, (L/kg)	Mix (L)	% mix	Estimated product (L/ha or kg/ha)	Vol. of mix	Method of application
	Clopyralid 90 + Triclopyr (as amine salt) 270 g/L SL		600	0.50%	0.6	10	6	18	300	Foliar spray
			Use 600 ml + 50 ml mineral oil/100 l water. Apply to actively growing plants. Plants too high for good coverage should be slashed and the regrowth sprayed when 0.5 m high.							
	Fluroxypyr 200 g/L EC		12.5	0.50%	0.0125	10	0.125	0.375	300	Foliar spray
			Use 12.5 ml + 50 ml mineral oil/10 l water on young actively growing plants up to 1 m high.							
	Fluroxypyr 80 + Picloram 80 g/L ME		25	0.50%	0.025	10	0.25	0.75	300	Foliar spray
			Use 25 ml + 50 ml mineral oil10 l water. Apply as a full cover spray on actively growing plants.							
	Glyphosate (as ammonium salt) 680 g/kg WG		80	0.10%	0.08	10	0.8	2.4	300	Foliar spray
			Use 80 g/10 l water for seedlings up to 1 m high. Slash tall plants and spray regrowth at 0.5 m high.							
	Glyphosate (as isopropylamine salt) 360 g/L SL		150	0.10%	0.15	10	1.5	4.5	300	Foliar spray
			Use 150 ml/10 l water. Slash tall plants and apply when regrowth is 1 m high. Use 50 ml/10 l water on saplings less than 1 m high.							
	Glyphosate (as potassium salt) 450g/L SL		40	0.10%	0.04	10	0.4	1.2	300	Foliar spray
	Glyphosate (as isopropylamine salt) 480 g/L SL		40	0.10%	0.04	10	0.4	1.2	300	Foliar spray
		Young	Use 40 ml/10 l water. Spray seedling up to 1m high.							
	Glyphosate (as potassium salt) 500 SL		100	0.10%	0.1	10	1	3	300	Foliar spray
			Use 100 ml/10 l water. Apply to sapling in spring or summer. Cut large trees and apply when regrowth is more than 500 mm.							
	Glyphosate (as sodium salt) 500g/kg WG		36	0.10%	0.036	10	0.36	1.08	300	Foliar spray
	Glyphosate (as sodium salt) 700g/kg WG		103		0.103	10	1.03	3.09	300	Foliar spray
	Imazapyr 100 g/L SL		63	0.10%	0.063	10	0.63	1.89	300	Foliar spray
			Use 63 ml per 10 l water. Apply as a full cover spray to regrowth 0.5 to 1.0 m high.							
	Triclopyr (as butoxy ethyl ester) 240 g/L EC		100	0.10%	0.1	10	1	3	300	Foliar spray
			Use 100 ml + 50 ml mineral oil /10 l water. Apply to young actively growing plants. Plants higher than 1.5 m should be slashed and regrowth treated when 0.5 m high.							
	Triclopyr (as butoxy ethyl ester) 480 g/L EC		50	0.10%	0.05	10	0.5	1.5	300	Foliar spray
			Use 50 ml + 50 ml mineral oill/10 l water. Apply to young actively growing plants. Plants higher than 1.5 m should be slashed and regrowth treated when 0.5 m high.							
	Triclopyr (as butoxy ethyl ester) 240 g/L + Aminopyralid 30 g/L		37.5	0.50%	0.0375	10	0.375	1.125	300	Foliar spray

Species	Active constituent with concentration	Age	Dosage (ml/g)	Wetter /dye	A.I, (L/kg)	Mix (L)	% mix	Estimated product (L/ha or kg/ha)	Vol. of mix	Method of application
	Glyphosate (as ammonium salt) 680 g/kg WG in plastic capsules	Adult	265	0.10%	0.265	10	2.65	7.95	300	Cut and spray
			Cut trees 10 cm above ground level and knock Ecoplugs with a hammer into punched or drilled holes (28 – 35 mm deep) in the stem and exposed roots. Number of plugs depends on stump diameter.							
	Picloram (as potassium salt) 54g/kg + Triclopyr (as triethylamine) 36g/kg		Paint directly onto stumps 10g/10mm stump					200		Cut and spray
	Glyphosate (as isopropylamine salt) 480 g/L SL		110	0.10%	0.11	10	1.1	2.2	200	Cut and spray
			Use 110 ml/10 l water for regrowth of large trees of which the stems have been cut back to a height of 5 – 20 cm.							
	Imazapyr 100 g/L SL		200		0.2	10	2	4	200	Cut and spray
			Use 200 ml/10 l water. Apply to freshly cut stumps. Use at least 10 ml per 10 cm of stump diameter.							
	Picloram (as potassium salt) 240g/L SL		100	0.50%	0.1	10	1	2	200	Cut and spray
			Use 100 ml + 50 ml mineral oil/10 l water. Apply to the cut surface of low cut stumps within three hours of felling.							
	Triclopyr (as amine salt) 360 g/L SL		300	0.50%	0.3	10	3	6	200	Cut and spray
			Use 300 ml + 50 ml mineral oil/10 l water. Apply to the cut surface of low cut stumps within three hours of felling.							
	Glyphosate (as sodium salt) 500g/kg WG		75	0.50%	0.075	10	0.75	1.5	200	Cut and spray
	Triclopyr (as butoxy ethyl ester) 480 g/L EC		2000		2	10	20	40	200	Basal stem + diesel
			Use 200 ml/10 l diesel for plants with a stem diameter up to 10 cm ensure wetting of the root crown, exposed roots and stem up to a height of 25 cm.							
	Fluroxypyr 200 g/L EC		100		0.1	10	1	2	200	Basal stem + diesel
			Use 100 ml/10 l diesel. Ensure wetting of all bark, root crown and stem up to a height of 1.25 m.							

Species	Active constituent with concentration	Age	Dosage (ml/g)	Wetter /dye	A.I, (L/kg)	Mix (L)	% mix	Estimated product (L/ha or kg/ha)	Vol. of mix	Method of application
Solanum seaforthianum Andrews (Solanaceae)	Triclopyr (as butoxy ethyl ester) 480 g/L EC*	Young	50		0.05	10	0.5	1.5	300	Foliar spray
Lantana camara L. (Verbenaceae)	Fluroxypyr 80 + Picloram 80 g/L ME		150	0.50%	0.15	10	1.5	4.5	300	Foliar spray
			Use 150 ml + 50 ml mineral oil/10 l water. Apply as a full cover spray on actively growing plants.							
	Glyphosate (as ammonium salt) 680 g/kg WG		160	0.10%	0.16	10	1.6	4.8	300	Foliar spray
			Use 160 g/10 l water with knapsack sprayer or 200 g/10 l water with mistblower. Apply as a full cover spay.							
	Glyphosate (as isopropylamine salt) 360 g/L SL		300	0.10%	0.3	10	3	9	300	Foliar spray
			Use 300 ml/10 l water with knapsack sprayer or 400 ml/10 l water with mistblower. Apply as a full cover spray in summer to autumn.							
	Glyphosate (as potassium salt) 450g/L SL		240	0.10%	0.24	10	2.4	7.2	300	Foliar spray
	Glyphosate (as isopropylamine salt) 480 g/L SL	Young	220	0.10%	0.22	10	2.2	6.6	300	Foliar spray
			Use 220 ml/10 l water with knapsack sprayer and 300 ml/10 l with a mistblower.							
	Glyphosate (as potassium salt) 500 SL		200	0.10%	0.2	10	2	6	300	Foliar spray
			Use 200 ml/10 l water. Slash large bushes in winter and apply to regrowth in summer.							
	Glyphosate (as sodium salt) 500g/kg WG		220	0.50%	0.22	10	2.2	6.6	300	Foliar spray
	Imazapyr 100 g/L SL		200		0.2	10	2	6	300	Foliar spray
			Use 200 ml/10 l water. Apply as a full cover spray when regrowth is 0.5 to 1 m high.							
	Picloram (as potassium salt) 240g/L SL		100	0.50%	0.1	10	1	3	300	Foliar spray
			Use 75–100 ml + 50 ml mineral oil/10 l water. For high volume application use 50 ml/10 l water and add a foaming agent. Apply as a full cover spray. Use higher rate for previously slashed plants with big stumps.							
	Fluroxypyr 80 + Picloram 80 g/L ME		150	0.50%	0.15	10	1.5	3	200	Cut and spray
			Use 150 ml + 50 ml mineral oil/10 l water. Apply to cut surface of low cut stumps within three hours of felling.							
	Imazapyr 100 g/L SL	Adult	200		0.2	10	2	4	200	Cut and spray
			Use 200 ml/10 l water. Apply to the cut surface of freshly cut stumps. Use at least 10 ml per 10 cm of stump diameter.							
	Picloram (as potassium salt) 240g/L SL		100	0.50%	0.1	10	1	2	200	Cut and spray
			Use 100 ml + 50 ml mineral oil/10 l water. Apply to the cut surface of low cut stumps within three hours of felling.							

Species	Active constituent with concentration	Age	Dosage (ml/g)	Wetter /dye	A.I, (L/kg)	Mix (L)	% mix	Estimated product (L/ha or kg/ha)	Vol. of mix	Method of application
Verbena bonariensis L. (Verbenaceae)	Glyphosate (as isopropylamine salt) 360 g/L SL	Young	300		0.3	10	3	9	300	Foliar spray
	Metsulfuron methyl 600g/kg WP		25		0.25	100	0.25	0.75	300	Foliar spray
			Use 2.5 g/10 l water and add a surfactant. Apply to actively growing plants during the later summer.							
Hedychium coronarium J. Koenig (Zingiberaceae)	Imazapyr 100 g/L SL*	Adult	200		0.2	10	2	4	200	Cut and spray
Hedychium flavescens Carey ex Roscoe (Zingiberaceae)	Imazapyr 100 g/L SL*	Adult	200		0.2	10	2	4	200	Cut and spray
Hedychium gardnerianum Sheppard ex Ker Gawl. (Zingiberaceae)	Imazapyr 100 g/L SL*	Adult	200		0.2	10	2	4	200	Cut and spray

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Glossary
(verbatim from Environmental Weeds of Australia, 2016)

A

Achene: a small, dry, one-seeded fruit that does not open at maturity

Acute: pointed, having a sharp tip

Alien: occurring in, and/or naturalized in, a region to which it is not native or indigenous

Allelopathic: chemicals released by a plant that inhibit the growth of other plants

Alternately arranged: leaves arranged or held singly at each node

Annual: a plant which completes its life cycle within one year and then dies after flowering

Apex: the tip or end of a structure

Aquatic: living or growing in, near, or on water

Areole: a small light to dark coloured bump found on the modified stems of cacti (cladodes), out of which grow clusters of spines; used to identify species in the cactus family

Aril: a small fleshy appendage that is attached to a seed

Aromatic: having a distinctive smell or aroma

Ascending: growing on a slant at first, but becoming upright

Axil: the upper angle between a leaf stalk and the stem that bears it

Axillary: located or occurring in an axil

B

Basal: located at or near the base of a particular plant part

Berry: a fleshy fruit, without a hard centre, that does not open at maturity

Biennial: a plant that lives longer for one year but less than two years

Biodiversity: the number and variety of organisms found at a site or within a specified geographic region

Biological control: the use of natural enemies to reduce the damage caused by a weed or other pest population

Bipinnate: twice-divided; consisting of parts that are already compound

Blade: the expanded, usually flattened, part of a leaf or other plant structure

Bract: a small leaf-like structure usually found underlying another plant structure

Branchlet: a very small or very young branch; the smallest subdivision of a branch

Broadleaf: refers to a member of the group of plants known as the dicotyledons; having broad or relatively broad leaves

Bulb: a plant storage organ found below ground, which is usually surrounded and protected by dead leaf tissues

Bulbil: a small bulb that may be produced below ground, in the leaf axils, or in the seed-head

Burr: a structure consisting of the seeds or fruits of plants, usually surrounded by a prickly outer covering

C

Capsule: a dry fruit that opens at maturity, releasing its contents

Catkin: an elongated cluster of unisexual flowers that lack petals

Cladode: a flattened stem which resembles, and functions as, a leaf

Climber: a vine or climbing plant that grows up over a supporting structure or other plants

Cone: the reproductive structure of certain non-flowering plants such as pine trees, consisting of a central axis around which are arranged a compact group of scales

Conical: cone-shaped; having a shape that tapers from a wide base to a point at the apex

Conifer: a gymnosperm that bears its reproductive structures in cones

Coppice: forming shoots or sprouts from a stump

Cordate: heart-shaped in outline

Corky: woody stems at least partially made up of a light, soft, water-resistant, protective tissue

Corm: an underground storage and propagative structure similar to a bulb, but formed from a swollen underground stem

Corrugated: shaped into folds; with parallel and alternating ridges and grooves

Cosmopolitan: widely distributed; occurring in many parts of the world or in many habitats

Creeper: a plant with a low-growing or creeping habit

Creeping: to grow or spread over the ground surface or over other ground-dwelling plants

Culm: the upright stem of a grass or similar plant; the flowering stem of a grass plant

Cuneate: wedge-shaped; triangular, but narrower at the base and wider at the tip

Cylindrical: cylinder-shaped; elongated and round in cross-section

D

Deciduous: describing a plant that sheds most or all of its leaves at the end of the growing season

Deflexed: bent backwards and downwards at a sharp angle

Dicotyledon: a flowering plant with two seed leaves or cotyledons that usually appear at germination

Digitate: having distinct parts or finger-like projections branching from a common point

Domatium: a small, rounded projection that is often located on or near the midrib of a leaf

Drupe: a fruit with a stony centre (which contains a single seed) surrounded by a fleshy layer and a skin that does not open at maturity

Drupelet: a small drupe; a segment of an aggregate fruit (e.g. blackberry)

E

Ellipsoid: shaped like an oval or ellipse, and solid or three-dimensional

Elongated: being significantly longer than wide

Emarginate: with a broad shallow notch at the tip

Endemic: native to a particular locality, region, state or country

Entire margin: a leaf margin that is uniform

Evergreen: having leaves throughout the year; not deciduous

Exotic: not native; from another part of the world

F

Fern: a plant that does not flower or produce seeds, is made up of roots, stems, and fronds and reproduces by spores

Fibrous roots: roots that are small, thin, bunched, and resemble a group of fibres

Flower-head: another name for a head or capitulum; an inflorescence of densely packed small flowers that is mostly found in the daisy family

Follicle: a dry fruit which has one compartment and opens only along one side at maturity

G

Glabrous: hairless; without hairs or similar structures

Gland: a structure that is usually minute and globular which often secretes oily, resinous or gummy substances

Globular: rounded; shaped like a sphere, ball or globe

Glochids: barbed hairs or bristles

H

Habitat: a location where, or environment in which, an organism commonly grows

Head: a flower-head; an inflorescence of densely packed small flowers that is mainly found in the daisy family

Hispid: covered in short stiff hairs, rough hairs or bristles

I

Imparipinnate: a pinnate leaf with an odd number of leaflets (i.e. with a single terminal leaflet)

Indigenous: native; originating or occurring naturally in a region or environment; not introduced

Inflorescence: a term that describes the arrangement of flowers as a group or cluster on the flowering part of a plant; the seed-head

Internode: the part of the stem between two nodes or joints

J

Juvenile: not fully grown or developed

L

Lanceolate: lance-shaped, narrow and tapering to a point at the apex

Latex: a milky sap or juice that is exuded from plant parts when they are broken

Leaflet: part of a larger compound leaf that itself resembles a small leaf

Lenticel: a corky spot or pore on the stem or branch of a woody plant

Linear: long and narrow

Lobed: having deeply indented margins and forming sections that are not completely separated from one another

M

Mericarp: a dry single-seeded fruit that is derived from a carpel and splits off from the remains of the ovary at maturity

Midrib: the central and principle vein of a leaf; the midvein

Monocotyledon: any of the large group of flowering plants having a single cotyledon in the seed (e,g. grasses, sedges, orchids and lilies)

Monoculture: a population made up of a single species; a site or area totally dominated by a species to the exclusion of any other species

N

Node: the joint on a stem from which other structures such as leaves arise

Nut: a one-seeded and hard-shelled fruit that does not open at maturity

O

Oblanceolate: lance-shaped (i.e. lanceolate), but with the pointed end at the base

Oblong: somewhat elongated (i.e. longer than broad) and with approximately parallel sides, but flattened or two-dimensional

Obovate: egg-shaped in outline, but with the narrower end at the base

Obovoid: egg-shaped and solid, butt with the narrower end at the base

Obtuse: with a blunt or rounded tip

Oppositely arranged: arranged in pairs and arising from the same level along a plant stem

Orbicular: circular in shape

Origin: the place where the weed came from

Ornamental: a plant deliberately grown or cultivated for its beauty or decorative value

Ovate: egg-shaped and flat; broader and rounded at the base and tapering toward the end

Ovoid: egg-shaped and solid or three-dimensional

P

Palmate: a compound leaf divided into leaflets that radiate from one point and resemble the finders of a hand

Panicle: an inflorescence or flower cluster that is divided into branches, each bearing several flowers

Pappus: a ring of hairs, bristles or scales found at the top of many fruit belong to the daisy plant family

Parapinnate: once-compound but with an even number of leaflets

Peduncle: the stem or stalk that supports a solitary flower; or the main stalk that supports an inflorescence or flower cluster

Pendulous: hanging downwards or drooping

Perennial: a plant which requires more than two years to complete its life cycle; living far longer than two years

Petal: the part of a flower that is usually brightly coloured and forming the inner whorl of the perianth

Petiole: a leaf stalk; a stalk attaching the leaf blade to the stem

Phyllode: a flattened and expanded leaf stalk that takes on the appearance and function of a leaf blade; a leaf-like petiole

Pinna: one of the branchlets of a twice-compound (i.e. bipinnate) leaf on which the leaflets are borne; one of the leaflets of a once-compoun (i.e. pinnate) leaf

Pinnate: a once-compound leaf having several leaflets arranged on each side of a stem or rachis

Plantlet: a small plant, often formed on the tips of leaves or creeping stems

Pod: a several-seeded dry fruit that splits open at maturity; the fruit of a leguminous plant; the fruit of a member of the pea plant family

Prickle: a small sharp outgrowth on the stem or leaf; a small thorn

Propagule: a structure that gives rise to a new plant (e.g. seed, spore, etc.)

Prostrate: growing or lying flat along the ground

R

Raceme: an unbranched inflorescence with several flowers, each flower having a stalk or pedicel

Rachis: the main stem of a branched inflorescence (i.e. flower cluster); the main stem of a compound leaf

Reticulate: marked with a network of lines; with the pattern of a network; net-like

Rhizome: a horizontal, root-like stem usually found underground and often with short internodes

Ribbed: having ridges or raised features on the surface

Riparian: relating to or located on the banks of a river or stream; growing or located near waterways

Runner: a creeping or trailing stem that roots at the nodes and at intervals along its length forming new plants; a stolon

S

Savannah: an ecological community made up of grassland with scattered trees that is found in tropical and sub-tropical regions

Scale: a much-reduced leaf or a small leaf-like structure; a small, thin, and often disc-shaped structure that protects a flower bud or is present on a fruit

Scalloped: edged with a series of curved projections; crenate

Shizocarp: a dry indehiscent fruit that splits into one-seeded segments (i.e. mericarps) at maturity

Scrambler: a plant that grows over low obstacles, structures or other low-growing plants; a plant that climbs almost horizontally

Scrambling: growing over low obstacles, structures or low-growing plants; climbing almost horizontally

Seed: a propagative plant part, or propagule, produced in a flower; a ripened plant ovule, usually consisting of an embryo and endosperm covered with a seed coat, and often also with accessory structures

Semi-deciduous: partially deciduous; describes a plant that sheds some of its leaves at the end of the growing season

Sepal: a part of the calyx, or outer whorl of a flower, that is often green and leaf-like in appearance

Septum: a thin partition or wall that separates two cavities, especially one that separates the compartments of an ovary or fruit

Serrate: edged with sharp projections or teeth that are forward-pointing

Sessile: stalkless; without a stalk and attached directly at the base

Sheath: an almost tubular structure such as the base of a leaf that surrounds or clasps the stem

Shrub: a many-stemmed, woody plant or relatively low height; a bush

Spathulate: spoon-shaped; with a long, narrow, base an d rounded tip

Specimen: an individual of a species; a representative sample

Spike: an unbranched inflorescence with stalkless (i.e. sessile) flowers arranged directly on the stem

Spikelet: a unit of the inflorescence in the grasses and sedges having one to many reduced flowers; s small flower spike

Sprawling: growing or spreading in different directions in a straggling or disorderly manner

Stamen: a male reproductive organ of a flower consisting of a pollen-bearing anther and its stalk

Sterile: incapable of producing seed, fruit or other reproductive propagules

Stolon: a creeping or trailing stem that grows above ground and roots at the nodes; a runner

Sub-acute: almost acute; somewhat pointed

Sub-cordate: almost cordate; somewhat heart-shaped

Submerged: growing under the water surface; below the water surface; under water

Sub-obtuse: almost obtuse; somewhat rounded

Sub-opposite: almost oppositely arranged; almost paired

Sub-shrub: a small or low growing shrub

Subterranean: underground or below the soil surface

Succulent: describing a leaf or stem that is thick and fleshy or juicy in appearance and has water-storing capacity; a plant with juicy leaves or stems that is adapted to semi-arid conditions

Sucker: a shoot produced from below-ground (i.e. from the roots or base of the stem) that can give rise to a new plant

Synonym: an alternative, usually previously used, scientific name

T

Taproot: the main root of a plant which grows directly downwards to a considerable depth

Temperate: a climate that is mild (i.e. warm in summer and cool in winter); the geographic area between the tropics and the frigid zones

Tendril: a slender, usually twisting, structure found on the stems or leaves of some plants that aids climbing by clinging to its objects and thereby providing support.

Terminal: growing or present at the end of a plant structure (e.g. branch, stalk, leaf, fruit, etc.)

Terrestrial: living or growing on land

Tomentose: densely covered with short matted hairs; densely covered with matted woolly hairs

Toxic: poisonous (i.e. capable of causing injury or death)

Tree: a woody plant of considerable size when fully grown and usually with a single main trunk in evidence

Trifoliate: describing a compound leaf with three leaflets

Tropical: a climate characterized by hot temperatures and high humidity; the climatic zone either side of the equator

Truncate: appearing to abruptly terminate as if cut off squarely at the tip or base

Tuber: a swollen underground stem that functions as a food storage organ or as a means of vegetative reproduction; a projection or swelling on a stem

Tubular: shaped like a tube or hollow cylinder

Twiner: a climbing plant that winds, twists or coils around objects or plants for support

V

Variegated: having different coloured markings (e.g. spots, blotches, streaks or patches)

Vine: a climbing or creeping plant that is weak-stemmed and supported by other objects

W

Whorl: three or more leaves or other appendages arranged around a stem at the same level, usually at a node

Wing: a thin or membranous extension that is attached to one of a variety of plant structures (e.g. seed, fruit, stem)

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GUIDE TO THE NATURALIZED AND INVASIVE PLANTS OF

EASTERN AFRICA

Arne Witt, CABI, co-author Quentin Luke

Eastern Africa is home to a tremendous variety of plant and animal species, including iconic wildlife species such as chimpanzees, gorillas, lions, rhinos and elephants, and hosts one of the largest wildlife migrations on Earth. The region is also home to millions of people who largely depend on its bountiful natural resources for their survival. Yet this extraordinary biodiversity and the livelihoods of people who depend on it are threatened by, among other factors, the uncontrolled spread of invasive alien species (IAS).

One of the major barriers to effective management is the lack of information on the presence, impact and management of IAS. This Field Guide has been developed to help address this issue. Only those species that we consider to be threatening biodiversity and livestock production have been included.

- The Guide includes information on 200 naturalized, nearly naturalized or invasive plant species, with descriptive text and more than 1000 line drawings and colour images for easy identification.
- The text provides additional information on the origin and impact of each plant species.
- The introductory section provides a general overview of the threats posed by invasive plants and options with regard to their control.
- The appendices provide detailed information on herbicide use and biological control.

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