

Artemisia

Artemisia (/ˈɑːrtemiːziə/)[3] is a large, diverse genus of plants belonging to the daisy family Asteraceae, with between 200 and 400 species. Common names for various species in the genus include mugwort, wormwood, and sagebrush.

Artemisia comprises hardy herbaceous plants and shrubs, which are known for the powerful chemical constituents in their essential oils. Artemisia species grow in temperate climates of both hemispheres, usually in dry or semiarid habitats. Notable species include *A. vulgaris* (common mugwort), *A. tridentata* (big sagebrush), *A. annua* (sagewort), *A. absinthium* (wormwood), *A. dracunculus* (tarragon), and *A. abrotanum* (southernwood). The leaves of many species are covered with white hairs.

Most species have strong aromas and bitter tastes from terpenoids and sesquiterpene lactones, which discourage herbivory, and may have had a selective advantage.[4] The small flowers are wind-pollinated.[4] Artemisia species are used as food plants by the larvae of a number of Lepidoptera species.

Some botanists split the genus into several genera, but DNA analysis[5] does not support the maintenance of the genera *Crossostephium*, *Filifolium*, *Neopallasia*, *Seriphidium*, and *Sphaeromeria*; three other segregate genera — *Stilnolepis*, *Elachanthemum*, and *Kaschgaria* — are maintained by this evidence. Occasionally, some of the species are called sages, causing confusion with the *Salvia* sages in the family Lamiaceae.

The genus was erected by Carl Linnaeus in 1753. The name Artemisia derives from the Greek goddess Artemis (Roman Diana), the namesake of Greek Queens Artemisia I and II.[6] A more specific reference may be to Artemisia II of Caria, a botanist and medical researcher (also a queen and naval commander), who died in 350 BC.[7][8]

As of November 2020[update], Plants of the World Online accepted almost 470 species, including:[9]

Classification of Artemisia is difficult.[4] Divisions of Artemisia prior to 2000 into subgenera or sections have not been backed up by molecular data,[5] but much of the molecular data, as of 2006, are not especially strong.[4] The following identified groups do not include all the species in the genus.

Subgenera Artemisia and Absinthium are sometimes, but not always, considered the same. Subgenus Artemisia (originally Abrotanum Besser) is characterized by a heterogamous flower head with female outer florets and hermaphrodite central florets, and a fertile, glabrous receptacle. Absinthium DC, though sometimes merged with subgenus Artemisia is characterized by heterogamous flower head with female outer florets and hermaphrodite central florets, and a fertile, hairy receptacle. Generally, previously proposed monotypic and non-monophyletic subgenera have been merged with the subgenus Artemisia due to molecular evidence. For example, in 2011 using ribosomal DNA analysis of their own and a review of molecular data (such as ITS sequence analysis) of others, S. Garcia and colleagues argued that it was logical to rename several *Sphaeromeria* and *Picrothamnus* (formerly designated sister genera to Artemisia) species as Artemisia, as well as to revert some *Sphaeromeria* species back to Artemisia, where they had been categorized

previously.[12] Part of this was due to research by Watson and colleagues, who found that the four subgenera were not monophyletic except for *Dracunculus*, after analyzing and matching the internal transcribed spacers of nuclear ribosomal DNA from many *Seriphidium* and *Artemisia* species, and the related genera *Arctanthemum* and *Dendranthema*. The authors concluded that inflorescence morphology is not alone reliable for categorizing the genus or some subgenera, as qualities that previously demarcated them (such as homogamous, discoid, ray-less inflorescences) seemed to have undergone paralleled evolution up to seven times.[5] *Picrothamnus* Nutt. ("bud sage"), now considered *Artemisia spinescens* and *Sphaeromeria* Nutt. ("chicken sage") are some examples, both endemic to North America.[12]

Section *Tridentatae* consists of eleven to thirteen species of coarse shrubs often known colloquially as "sagebrushes", which are very prominent parts of the flora in western North America.[13] In some classifications, they have previously been considered part of the genus or subgenus *Seriphidium*, although recent studies have contested this lineage to Old World species.[5] *Tridentatae* was first articulated as a section by Rydberg in 1916, and it was not until McArthur et al. in 1981 that *Tridentatae* was elevated to a separate subgenus from *Seriphidium*. The principal motive for their separation was geographical distribution, chemical makeup, and karyotype.[14] Much of the debate surrounding *Tridentatae* is phytogeographic, thus habitat and geography are frequently cited when understanding the evolution of this endemic North American subgenus. Evolutionary cycles of wet and dry climates encouraged "diploid and polyploid races which are morphologically similar if not indistinguishable" (McArthur 598).

Autopolyploidy among plants is not uncommon, however *Tridentatae* exhibits a remarkable amount of chromosomal differences at the population level, rather than the taxon level. This contributes to the difficulty in determining *Tridentatae*'s phylogeny. The subgenus' relative homogeneity within ploidies has enabled it to habitually hybridize and backcross, resulting in a high degree of genetic variation at the population level rather than the taxon level.[15] For instance, some articles suggest that to be monophyletic, section *Tridentatae* should exclude *Artemisia bigelovii* and *Artemisia palmeri*. [5][13] and include *Artemisia pygmaea* and *Artemisia rigida*. [16] These results were supported by extensive chloroplast DNA (cpDNA) and nrDNA sequencing which departed from prior morphological, anatomical, and behavioral data.

Traditional lineages within *Tridentatae* were proposed on the basis of leaf morphology, habitat preference, and the ability to leaf-sprout, among other morphological and behavioral characteristics.[13] For instance, sagebrush in the *Artemisia tridentata* lineage have tridentate leaves, live in especially arid habitats, and are unable to root-sprout.[13] This method of delimitation is problematic for species that do not fully adhere to the characteristics of a given lineage. The dry habitat and the presence of interxylary cork has often made the case for *Tridentatae* as a subgenus of its own,[17] and there is some ribosomal molecular evidence of a "*Tridentatae* core" group for the subgenus.[18] In 2011, Garcia and colleagues proposed enlarging *Tridentatae* and organized it into the sections *Tridentatae*, *Nebulosae*, and *Filifoliae* based on previous research establishing relationships via ribosomal and nuclear DNA.[19][12]

Intergrading forms are particularly common in recently radiated subgenera such as *Tridentatae*, given their frequent reversals and convergent evolution. Global reviews of *Artemisia* using ITS analysis support the hypothesis that *Tridentatae* has independent origins from Old World *Seriphidium*[5] These findings were compared with capitula morphology,

challenging past assumptions based on floral characteristics. To better understand the rapid diversification and radiation relative to Old World *Artemisia*, a closer study of Beriginian or Arctic species may provide missing links.[20]

Section *Tridentatae* includes above species with exception of *Artemisia longiloba*, which is treated as a subspecies of *Artemisia arbuscula*. Section *Nebulae* includes *Artemisia californica*, *Artemisia nesiotica*, and *Artemisia filifolia*. [21]

The Old World species which different classifications put into the genus or subgenus *Seriphidium* consist of about 125 species native to Europe and temperate Asia, with the largest number of species in Central Asia.[22] Some classifications, such as that of the Flora of North America, exclude any New World plants from *Seriphidium*. [4] They are herbaceous plants or small shrubs.[22]

Seriphidium Besser was morphologically categorized by a homogamous flower head with all hermaphrodite florets and fertile and glabrous receptacle. *Tridentatae* was originally categorized as within *Seriphidium* due to floral, inflorescence, and leaf morphological similarities, until McArthur et al.'s analysis in 1981, which explained these similarities as convergent evolution.[23] Old World *Seriphidium*, with 125 species native to Europe and temperate Asia, was a previous classification of *Seriphidium*. North American or "New World" *Seriphidium* and Old World *Seriphidium*. [clarification needed] North American *Seriphidium* were later placed into *Tridentatae* Rydb due to geographical distribution, growth habit, and karyotypic and chemotaxonomic similarities (such as presence of certain terpenols). [24]

One group which is well-supported by molecular data is subgenus *Dracunculus*. It consists of 80 species found in both North America and Eurasia,[4] of which the best-known is perhaps *Artemisia dracunculus*, the spice tarragon.

Dracunculus Besser. has historically been characterized morphologically by a heterogamous flower head with female outer florets and hermaphrodite central florets, but with a female-sterile, glabrous receptacle. *Dracunculus* is the most supported and resolved subgenus of *Artemisia*, which includes *Artemisia dracunculus* L., known as the cooking spice tarragon. Chloroplast and ribosomal DNA sequence analysis in 2011 supported monophyly with two clades, one of which includes some North American endemic species as well as most species of Europe and Asia, while the second clade includes just *A. salsoloides* and *A. Tanaitica*, found in Eastern Europe and Siberia to the Western Himalayas.[25] This study places *Dracunculus* as one of the more recent subgenera within *Artemisia*, situating *A. Salisoides* more basally on the tree, with North American endemic groups such as the sagebrushes having derived on the other end of a split from a common ancestor with *Dracunculus*. Formerly proposed genera *Mausolea*, *Neopallasia* and *Turaniphytum* are now argued to be within the subgenus *Dracunculus* due to ribosomal and chloroplast DNA evidence, with further species resolved as sister groups to *Dracunculus* due to phytochemical relationships.[25][26]

The aromatic leaves of some species are used for flavouring. Most species have an extremely bitter taste. *A. dracunculus* (tarragon) is widely used as a culinary herb, particularly important in French cuisine.

Artemisia vulgaris (mugwort) was used to repel midges (mug > midge), fleas and moths, intestinal worms, and in brewing (mugwort beer, mugwort wine) as a remedy against hangovers and nightmares.

Artemisia absinthium is used to make the highly potent spirit absinthe. Malört also contains wormwood. The aperitif vermouth (derived from the German word Wermut, "wormwood") is a wine flavored with aromatic herbs, but originally with wormwood.

Artemisia arborescens (tree wormwood, or sheeba in Arabic) is an aromatic herb indigenous to the Middle East used in tea, usually with mint.

A few species are grown as ornamental plants, the fine-textured ones used for clipped bordering. All grow best in free-draining sandy soil, unfertilized, and in full sun.

Artemisia stelleriana is known as Dusty Miller, but several other species bear that name, including *Jacobaea maritima* (syn. *Senecio cineraria*), *Silene coronaria* (syn. *Lychnis coronaria*), and *Centaurea cineraria*.

The largest collection of living *Artemisia* species, subspecies and cultivars is held in the National Collection of *Artemisia* in Sidmouth, Devon, UK, which holds about 400 taxa. The National Collection scheme is administered by Plant Heritage (formerly National Council for Conservation of Plants and Gardens, NCCPG) in the British Isles.[27]

Artemisinin (from *Artemisia annua*) and derivatives are a group of compounds used to treat malaria.[28][29] Treatments containing an artemisinin derivative (artemisinin-combination therapies) are now standard treatment worldwide for malaria caused by *Plasmodium falciparum*. [28] Administering *Artemisia annua* as dried whole leaves may cause resistance to develop more slowly than if it is administered as pure artemisinin.[30]

Tu Youyou received the 2015 Nobel Prize in Physiology or Medicine for her discovery of the semisynthetic derivatives. She conducted research on traditional Chinese medicine and potential contributions to cures for malaria,[31] on the basis of folk medicine and ancient Chinese texts.[32] Before Tu and her team discovered artemisinin, 240,000 compounds had already been tested for use in potential antimalaria drugs, none of which had worked.[33] From reviewing ancient Chinese texts, they found that the compound artemisinin was optimally extracted at lower temperatures, as high temperature water poured over sweet wormwood leaves destroyed essential treatment properties.

The World Health Organization does not support the promotion or use of *Artemisia* plant material in any form for the prevention or treatment of malaria. They note that the plant form of medication has several problems. These include a lack of consistent *Artemisia* content, the content being low enough that recurrence of malaria often occurs, that the use of the plant may contribute to widespread artemisinin resistance, and that the plant form is not effective in malaria prevention.[34][35]

As of June 2020, there is no evidence that *Artemisia* can treat or prevent COVID-19.[36]

Artemisia has been mentioned and used in popular culture for centuries. A few examples are:

Artemisia species are found on every continent except Antarctica,[38] and have become part of many ecosystems around the world as a result. Below is currently a partial view of the importance of *Artemisia* species in ecosystems around the world.

In North America, several species of *Artemisia* have become important parts of local environments, with wide adaptability. *Artemisia papposa* described by S.F.Blake & Arthur

Cronquist can grow in the harsh, dry expanses of alkali flats, but also adapts to meadowlands.[39]

Sagebrushes like *A. papposa* (of the *Tridentae* subgenus) in general are found in the north and southwest areas of the North American continent. In the Intermountain West, in a habitat known as Sagebrush Steppe, *A. tridentata*, *A. tripartite*, and *A. arbuscula* grow alongside various grasses and species of bitter bush, creating an important environment for mule deer, pygmy rabbits, antelopes, and the sage grouse.[40] Understanding the phylogenetic relationships among the sagebrushes has been helpful in understanding the relationships among these plants and their environments, as well as learning more about how these plants formed these communities over long stretches of time.[12] Sagebrushes, which include *A. ludoviciana* and *A. tridentata* among others, can often also be found growing near junipers, particularly in the Elkhorn Mountain region, where the Juniper Woodlands form an ecosystem which provide cover for many animal species in both summer and winter months and storms. Because the habitat should burn only every 400–600 years,[41] with sagebrush shrubs living as long as 200 years (though potentially typically 88), this particular combination of *Artemisia* with other flora form an enduring habitat.[24] As it often goes, however, governments and farming businesses have often cleared sagebrush-juniper communities to create land for cow and domestic animal feedcrops, and *Artemisia* species may be declining due to this and invasive species such as cheatgrass.[42] Destabilization of the vegetation creates higher risk of fires, causing concern among the local conservation and wildlife groups.[40][42]

Due to their often extensive rhizome systems and other potential characteristics, however, some *Artemisia* species are often resilient to mowing or pulling, giving some species of *Artemisia* the ability to easily become invasive if introduced to comfortable, though non-native habitats.

