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## FURTHER DEVELOPMENTS OF THE FLORA AND FAUNA OF THE WILDLIFE GARDEN AT THE NATURAL HISTORY MUSEUM, LONDON: TWENTY YEARS OF SPECIES RECORDING

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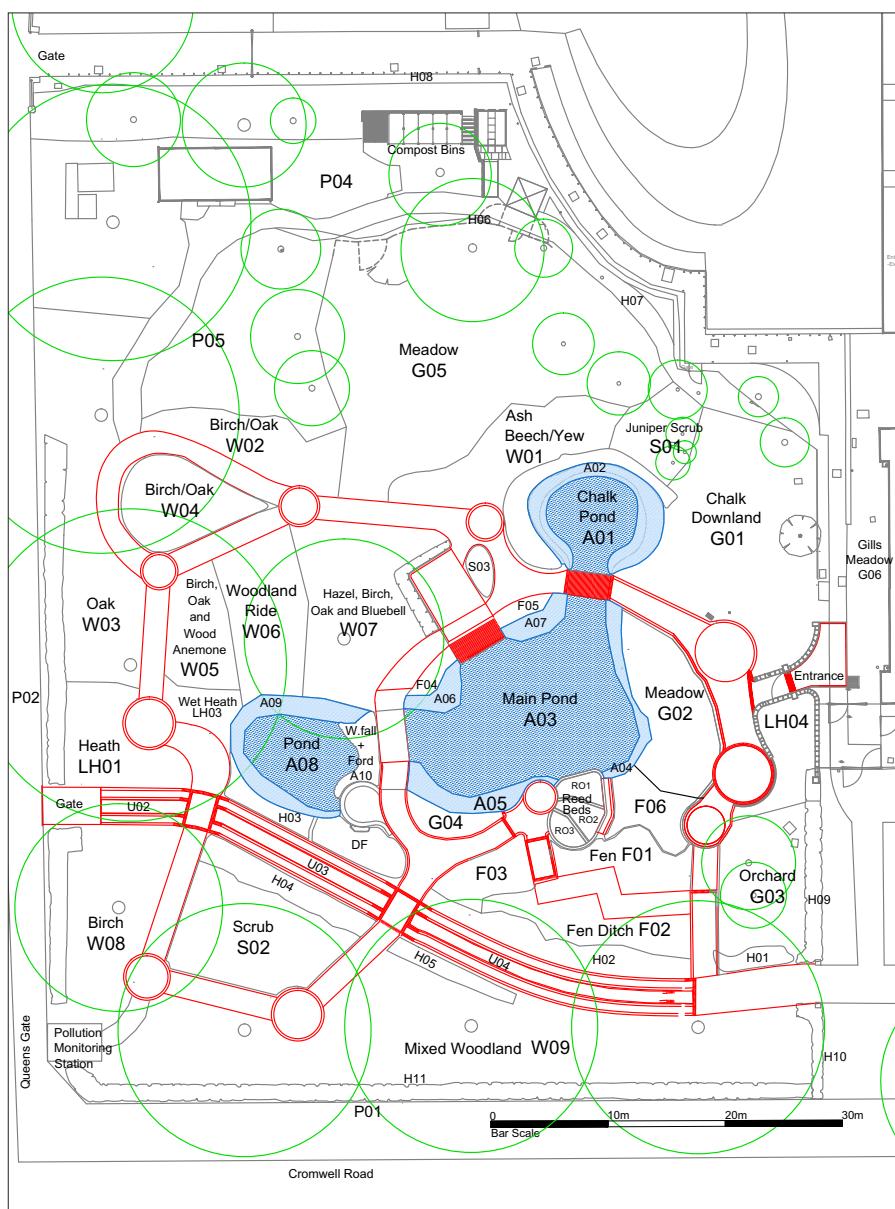


Figure 1: Plan of Wildlife Garden with habitat areas and codes from 2012 onwards

## ABSTRACT

This paper presents the latest results of a long-term study of the Wildlife Garden in the grounds of the Natural History Museum, South Kensington. The current study tracks further developments in the Wildlife Garden and its colonization by several rare and unusual species as well as more commonly encountered species. It follows the publication of the results from the Garden's opening in 1995 through to 1998 in *The London Naturalist* No. 77 (1998) and No. 78 (1999) and from 1999 to 2003 in *The London Naturalist* No. 82 (2003). The records show changes in species' composition and abundance within the groups recorded. Populations of many species have increased, whilst others have decreased or disappeared. The list of recorded species since 1995 stands at over 2,700 of which two moths were new sightings to Britain. The list includes 34 Notable species and 8 UK Red Data Book for the groups discussed below.

## INTRODUCTION

### Background and aims of report

The background and aims of the Natural History Museum's Wildlife Garden have been fully described (Honey *et al.* 1998: 17-20). In summary, the aims are to illustrate successful habitat creation and wildlife conservation, to provide an educational resource for schools and Museum visitors, and provide research opportunities for Museum scientists and other naturalists and students. It is now over twenty years since the opening of the Museum's Wildlife Garden (henceforth the garden) and it is useful to look back on the aims and aspirations in 1995 and compare them with those of today.

The press release of the day - 10 July 1995 - celebrated the garden's opening as a flagship event for the European Nature Conservation Year 1995 - a year of action co-ordinated by English Nature (now Natural England).

The then Secretary of State for the Environment, John Gummer, said "The garden is a symbol of what can be done to help and protect our wildlife, even in a small and crowded area in the centre of London ..... a central theme of *Biodiversity: the UK Action Plan 1994* is raising public awareness in conserving wildlife, an aim this garden will carry out." For the Museum's then Director, Sir Neil Chalmers, "Our wildlife garden symbolizes a unique interaction between two important elements which underpin our work: science and education. It creates for the first time an outdoor classroom combined with a living laboratory".

Now, more than twenty years on, we can report that by introducing and managing a diversity of plants in a mosaic of habitats, overall biodiversity of the local area has been increased, illustrating how wildlife conservation can be successfully achieved and sustained in the inner city. This has been recognized by the Royal Borough of Kensington and Chelsea (RBKC) and the site was upgraded to a Site of Nature Conservation Importance, Borough grade II, in 2010. The garden was awarded the London in Bloom Environment Award in 2004 and contributed to the London in Bloom Biodiversity Award for the borough in 2014 and 2015. The garden has also been acknowledged by awards within the borough's Brighter Kensington and Chelsea Scheme with awards of best Wildlife Garden, the Princess Athlone Environment Award and the Overall Prize Winner's Trophy.

Biological recording started as the garden was being created. It was one of the

stipulations of the grant provided by English Nature at the time and was embedded in the aims of the garden (Honey *et al.* 1998: 17–18). Museum scientists, amateur naturalists, scientists and conservationists from other academic institutions and many other volunteers continue to contribute records to the Museum's long-term study of flora and fauna within the garden. The reports published in 1998 (Honey *et al.*) and 1999 (Ware) provided baseline data on species of plants and animals introduced and initially colonizing the garden followed by data of further developments in 2003 (Leigh and Ware). The purpose of this report is to describe the development of the garden during the years 2003 to 2015 and to report and discuss species colonization and changes over the years. We include data for the same groups of plants and animals reported on in 2003, supplemented with information on groups not previously covered, such as Orthoptera, Hemiptera, Hymenoptera and Acari.

### Habitat management and development since 2003

Habitat management has focused on consolidating and enhancing plant communities within each habitat (see Figure 1) whilst maintaining a distinction between the different habitats in a relatively small area. Woodland management includes tree-thinning with coppicing and pollarding to prevent over-shading of non-woodland habitats and to demonstrate sustainable woodland management to our visitors. Sheep grazing, introduced in 1999, continues as the preferred management of the meadow and chalk downland habitats in late summer and autumn. Their presence is also popular with our visitors. To minimize the use of electric fencing, chestnut posts and rails were installed south of meadow (G05) in 2003, south of chalk downland (G01) in 2004 and around orchard grassland (G03) in 2012. The rails were made from sweet chestnut *Castanea sativa* harvested from mixed coppiced woodland in Kent. The use of power-driven machinery is kept to a minimum but a shredder/chipper is an essential aid in recycling the leaves from London planes *Platanus x hispanica* that border the garden on two sides and for shredding small wood and twigs for composting. Further details of habitat management can be found in the current Wildlife Garden management plan – available from the authors on request.

The most significant development during this period was the new entrance to the garden, created in 2012 to improve visitor access from the Darwin Centre, and the restoration of the garden's heathland habitat. Since 2012, the number of visitors enjoying the garden has increased, though access has been curtailed from the front of the Museum, and the complaint by many is still: "We didn't know the wildlife garden was here".

Signage, publicity and access need to be further improved without detriment to the visitor's experience of this living exhibition. The possibility of public access throughout the year is being considered.

The new heathland habitat (LH04), now in a more open part of the garden (replacing the former 'urban' habitat) was made possible thanks to a donation of £23,000 from Western Riverside Environmental Fund (WREF) and sponsorship in kind from Bournemouth Airport, Dorset County Council (DCC) and landscape architect Adams Loxton partnership. The work, including the new entrance, took place between November 2011 and April 2012. The heathland was created using turves lifted from Merritown Heath, near Bournemouth, Dorset, in February 2012 under the supervision of DCC Senior Ecologist, Danny Alder. The primary reason for the turf lifting on Merritown Heath, as recommended



*Wildlife Garden, Natural History Museum - view from main pond. © The Trustees of the Natural History Museum, London*

in the condition assessment of the heathland SSSI by Natural England, was 'to increase the area of open bare-ground to benefit species such as the sand lizard which requires open basking and egg-laying sites within exposed sand and to accommodate a broader assemblage of invertebrates and associated early successional heathland plants' (D. Alder, pers. comm.). A small proportion of cut turves were donated to the Museum for educational

purposes. Raising public awareness of the threats to heathland - as with all lowland habitats - is crucial to its ongoing conservation in the UK which is home to 20% of Europe's lowland heathland.

A dry stone wall was built to contain the new heathland substrate. Far more robust than intended, the garden team has been working to distress this wall (by applying a mixture of yogurt and peat on the surface and cutting back the over-hanging stone) to encourage conditions for colonising algae, mosses and lichens. Early colonisers include green algae and lichens such as *Xanthoria parietina* and *Phaeophyscia nigricans*. The bryophyte *Grimmia pulvinata* appeared in mid-2015. Holes were also drilled into the wall to create areas for mining bees to colonise.

With the change in entrance and restoration of heathland on the east side of the garden, the urban habitat U01 no longer appears. However many of the plants were transplanted to the working and plant nursery area P04.

The iron railings on the north east boundary were removed to further open up the garden and the chalk downland habitat was extended from the eastern slope to the path (approximately 142 sq. m.) using chalk quarried from Monksherborne, near Basingstoke, Hampshire, and sown with 500 grams of Emorsgate seed mix: EM6 - Meadow mixture for chalk and limestone soils. A discrete area of chalk (approximately 20 sq. m.) was left unsown and monitored for self-colonising plants. The strip of grassland alongside the west wing of the Waterhouse building, previously maintained as closely mown lawn, was included in the expansion and the predominantly fescue lawn was planted with meadow plants in memory of Dr Gillian Stevens (1965-2011), Head of Angela Marmont Centre for UK Biodiversity 2009-2011. This is now G06 on the plan (Figure 1).

The strip of lawn directly in front of the south side of the west wing of the Waterhouse building was taken on as a project by the Wildlife Garden team in spring 2012. Seventy three species of flowering plants were recorded in 2012 including corn parsley *Petroselinum segetum* which has not been seen in this area since 1930. The grass is unmown between March and October and lightly grazed by sheep in September/October. The total area of grassland managed sustainably in and around the Wildlife Garden is now 1,645 sq. m.

In 2010 a new hedge of native mixed species was planted along the boundary of the newly created Darwin Centre 'courtyard' to contain the sheep within the Wildlife Garden. In the same period the recycling area - unchanged since 1997 - was expanded with new purpose-built compost bins. A new greenhouse was bought, part-funded by money raised through a sponsored walk organised by volunteer Dr Rama Sarkhel and a generous donation from Mrs Joan Gilbey. The greenhouse and adjacent space have provided a very useful wild flower nursery area.

The principle of sustainable management was extended by creating green roofs on small sheds. In 2009, wildlife gardener/ecologist Chris McGaw created a green turf roof on a small tool shed, using meadow turf, kindly donated by RBKC Ecology Centre. This was further developed by Nicky Reilly after the shed's relocation with the addition of a log store in 2012. Two years later, a green roof was created on the sheep shed by Larissa Cooper, using shingle and coastal plants. For further details see: <http://www.nhm.ac.uk/natureplus/blogs/wildlife-garden/2014/08/13/extending-our-boundaries>.

Other changes included relining the waterfall and upper pond (A09-A10) in 2006 to resolve problems of leakage in the waterfall area. The improved flow in water resulting

from this repair, although visually attractive, had a significant effect on some of the aquatic biodiversity.

Since 2009 the water used to top up the ponds has been sourced from the Museum's borehole, replacing the mains supply. This changed the chemistry of the water supply but we have yet to fully analyse and determine the extent of the changes on the ponds' flora and fauna.

Minor changes to individual habitats are mentioned in the discussion below.

## AN EDUCATIONAL RESOURCE

### Schools

The garden is regarded as a highly valuable and excellent learning space for school pupils, not just because of its links to popular classroom topics such as habitats and minibeasts, but also because of the opportunity it provides for children who may have had very limited contact with nature. It is particularly rewarding for pupils to experience plants and insects within the setting of a mosaic of different habitats, including a variety of ponds and water features, enabling them to have as realistic an encounter with nature as is possible in urban surroundings.

The combination of indoor and outdoor activities and exhibitions makes a well-structured day of variety and interest for pupils and teachers, e.g. combining a Wildlife Garden workshop looking at pond invertebrates with a visit to the Creepy Crawlies Gallery. It is a hugely popular space - during summer term 2014, over 2,000 school pupils (Foundation, and Key Stage 1 and 2) attended our core garden workshops, with over 3,000 children attending in 2015 (A. Tinkler pers. comm.). The garden accommodates groups of children in a safe and secluded natural environment away from the busy galleries and visitor queues.

### Training in biological recording and species identification

With over 400 species of vascular plants, the garden provides an excellent training ground for wild flower identification. Courses for volunteers, visitors and Museum members are run each year and include: Introduction to Wild Flowers, Grass Identification, Winter Tree Identification and Introduction to Mosses. Training and workshops in other taxa also take place including: Introduction and Identification of Woodlice, Identification of Fresh Water Invertebrates and Moth and Bat evenings.

The process of recording and species identification is also used to train students, young scientists, amateur naturalists and other visitors. The Wildlife Garden is an important resource for Citizen Science and supports the Angela Marmont Centre for Biodiversity in its mission to champion UK biodiversity.

*An educational resource - Big Nature Day 2011. © The Trustees of the Natural History Museum, London*





Above: An educational resource - Sue Kidger introducing rescue hedgehogs to visitors during Hedgerow Harvest 2014. © The Trustees of the Natural History Museum, London

Below: An educational resource - Nettle Weekend 2014. © The Trustees of the Natural History Museum, London



In addition to formal learning, special events for visitors and volunteers take place throughout the year including themed weekends linked to the Museum's public offer and to national and international dates (e.g. National Insect Week, International Bat Night, Be Nice to Nettles Week and London Garden Open Squares Weekend). Events such as Spring Wildlife, Nettle Weekend, Insect Weekend, Bat Festival and Hedgerow Harvest, include workshops with displays and opportunities for visitors to meet Museum scientists as well as other conservation trusts, societies and groups. These events provide an opportunity for visitors to learn further about the Museum's work and its collections and to find out more about biodiversity in an urban context including the importance of biological recording in the garden. Such events also encourage visitors to actively engage with nature during activities they can then apply at home or in their local park.

Events are publicised on the Museum website ([www.nhm.ac.uk/wildlife-garden](http://www.nhm.ac.uk/wildlife-garden)) and Wildlife Garden blogs and posters around the Museum and in media listings.

## RECORDING AND MONITORING METHODS

Data collection and surveys are carried out by volunteers working with the garden team, specialists who come in with the sole purpose of survey work and Museum scientists. Regular lunchtime recording sessions are organized for staff. In 2011, the Museum's Big Nature Day included a Big Nature Count in the Wildlife Garden, and in 2015 staff and volunteers celebrated the Wildlife Garden's twentieth anniversary with an Anniversary Species Count. Volunteers help with sorting specimens, identification, and entering records on to the garden's database. Photography is an increasingly used record-collecting tool.

Resources are nevertheless limited and any readers wishing to contribute to the recording of any group in the garden are very welcome to apply to the authors.

The recording methods described previously (Leigh and Ware 2003) continue to be used and only changes in the methods previously reported are mentioned below.

### Cryptogams

The ponds (A01, A03 and A09), waterfall and ford area (A10) and reed beds (R01/2/3) were surveyed for freshwater algae on various dates between 2004 and 2013 using methods reported in 2003, supplemented by casual observations.

Detailed surveys of bryophytes have been carried out most years since 2004. These surveys are supplemented by casual observations throughout the year.

### Vascular plants

Vascular plants are surveyed formally in each habitat on a two-year cycle depending on volunteer availability. During the current survey all habitats were surveyed and recorded in 2014 through to July 2015. First and unusual flowerings are noted as they appear throughout the year and the information submitted to the Woodland Trust's Nature's Calendar.

### Lichens

Lichen surveys have been carried out to check the ten permanent quadrats (10 x 15 cm) established in December 2000 on rock and brick substrata and with checks in additional areas.

## Invertebrates

### Aquatic invertebrates

Standardized sweep samples for macroinvertebrates are taken at irregular intervals using methods previously described (Honey *et al.* 1998). Samples for aquatic microinvertebrates are collected as previously described Leigh and Ware (2003:78).

Other samples are occasionally taken from the ponds and their contents identified and recorded by colleagues from the Museum and by members of other organizations. All records of adult dragonflies are of field identifications and larval exuviae. Annual checks for Bryozoa and Porifera are carried out by Mary Spencer-Jones.

### Terrestrial invertebrates

Observations of unusual sightings are recorded during the course of working in the garden and by trapping methods described previously (Leigh and Ware 2003: 79).

A Malaise trap was run for one year, July 2012 to July 2013, and for 2 weeks 12 to 26 June 2015. Specimens collected from the Malaise trap include most groups of flying insects. Identification of these specimens is ongoing.

**Orthoptera** Orthoptera are recorded through direct searches and using a bat detector for species such as speckled bush-cricket.

**Hymenoptera** Specimens were collected by occasional hand netting or Malaise trapping and identified using the following works: Bees - Amiet *et al.* 2001, Amiet *et al.* 2004, Amiet *et al.* 2007, Amiet *et al.* 2010, Amiet *et al.* 2014, Benton 2006, Falk 2015; Digger wasps - Lomholdt 1975, 1976, Richards 1980, Pulawski 1984. Voucher specimens of all species collected by the author have been preserved in the Museum's collection. Flower visits were recorded where possible. For a few conspicuous species, where field identification was considered reliable, specimen records were supplemented by observations.

**Coleoptera** The list of beetles from the garden has benefitted from regular light trapping using the Robinson's light trap during the spring and summer months. Subterranean traps were used in the early years while Malaise traps and pitfall traps continue to be used. As the list shows, particular attention has been paid to the faunas of the compost heaps and water bodies. Much of the list was generated by the hard work over many years of former Coleoptera researcher, Peter Hammond, more recently augmented by other members of the Mueum's Coleoptera team and garden team including volunteers. Occasional bioblitzes, 'Big Nature Days', National Insect Week and other public events have led to increased recording of all groups of insects by adults and children, especially conspicuous groups such as ladybirds and species recorded by pond dipping.

Special mention should be made of a systematic survey of ladybirds (Coccinellidae) carried out by volunteer Emily Shaw, a second-year Zoology student at Cardiff University. She carried out searches within the vegetation of all habitats. Additional records were collected from a beating tray, the Robinson light trap and a check was made of historic photographs.

**Lepidoptera** Between 2005 and 2009, whilst the Lepidoptera section was temporarily housed in Wandsworth, the Robinson's light trap was run less frequently. The running of the trap and the initial sort of specimens was carried out by the garden team, including volunteers, and as a result of unavoidable inexperience, the number of specimens sent to Martin Honey for identification at Wandsworth (via the library shuttle) was usually

quite small. Since 2010 the light trap has been set more frequently. Gay Carr monitored butterflies and dragonflies on her weekly bird walks.

**Diptera** In addition to Malaise trapped specimens, Diptera records are collected by general searches and during forensic studies.

**Isopoda and Amphipoda, Diplopoda, Chilopoda and terrestrial Mollusca** Searches were made for these invertebrates below ground and under logs and stones.

Pitfall traps were set, as previously described, three to four times a year depending on volunteer availability. Spiders, millipedes, beetles, molluscs and other orders were identified from these samples by the relevant specialists.

**Oligochaetes - Earthworms** Earthworms were also sampled by digging pits of 25 cm x 25 cm x 10 cm and hand-sorting the soil extracted. Microhabitat surveys were carried out by looking in compost bins, in rotting logs, under plant pots and in leaf-litter. A vermicuge (mustard powder in water) was applied to the ground and the worms collected on emergence. All worms were relaxed in 30% alcohol, straightened while fixed in 80% alcohol and transferred to vials of 80% alcohol for later identification. Many were identified alive *in situ*.

**Arachnids, Araneae - Spiders** Surveys have been carried out sporadically and specimens checked by Jan Beccaloni, Stuart Hine and John McGaw. Since 2013, regular surveys have been carried out by Thomas Thomas by visual searches, sweep netting and leaf beating - usually with a large following of visitors.

**Acari - Mites** Deserted nests of several bird species were collected from various locations, including hedgerows, ivy-clad trees, bird boxes and the eaves of the garden shed, in November 2014 and February 2015. They were stored in separate plastic bags until the invertebrate inhabitants were extracted through desiccation funnels into 80% industrial methylated spirit. After removal from the spirit samples, mites were prepared for microscopical examination by mounting in 50-60% lactic acid and macerating for 15-30 minutes on a hotplate set at about 70°C.

## Vertebrates

Birds have been monitored by observation on a regular basis. Weekly to fortnightly walks were carried out by Gay Carr from 1999 until 2014. Gay's article below was completed in January 2013, the original target date for this report. Unfortunately, she did not get the chance to update her article. Daniel Osborne took over Gay's fortnightly bird walks in 2015 and has updated her article with changes since 2013. In addition, unusual observations of birds and mammals are recorded throughout the course of daily garden work. Dr. Florin Feneru (Identification and Advisory Officer) is the current garden bird recorder.

Small mammals have been monitored using Longworth as well as hair traps. Longworth traps were set less frequently during the past year as they tend to be disturbed by resident foxes. As with other groups, these records have been supplemented by casual observations. Evening bat surveys have been undertaken between one and three times a year. An Anabat (a stationary bat recorder designed for passive surveillance of bats) was installed on the lime tree in the centre of the garden for a month in August 2014 and at the end of August 2015.

Larger mammals - foxes and wild rabbits have been recorded as casual observations. Grey squirrels are present throughout the year and were recorded by Gay Carr during her regular bird walks until 2014.

## Environmental

Air quality - data from the air monitoring station in the south west corner of the garden are available on the London Air Quality Network (LAQN) website:  
[http://www.londonair.org.uk/london/asp/publicbulletin.asp?la\\_id=20&MapType=Google](http://www.londonair.org.uk/london/asp/publicbulletin.asp?la_id=20&MapType=Google).

The RBKC progress report contains a summary of the data from the NHM (Cromwell Road) site for 2013, (see Chapter 2). The air quality data are used in conjunction with lichen survey data.

## Water chemistry

Samples of water from each of the three ponds and the reservoir have been taken between three to four times a year, subject to volunteer and staff availability, and the water chemistry analysed by Stanislav Strekopytov in the Mineralogy Department.

## Soil

Soil samples were collected by Natalie Bryson during her MSc project: 'Development of next generation sequencing within an integrated strategy for utilising microbial molecular data as evidence in serious crimes'. Samples collected from woodland and grassland habitats were analysed.

Additional soil samples were collected by Mark Lane, Garden Manager, Buckingham Palace, in December 2015. These were analysed by Bartlett Tree Research Laboratories.

## Databasing records and voucher specimens

All records are entered on the garden database developed by Mike Sadka in 2002 and further developed and maintained by Nicky Reilly.

The data are a means to monitor and assess the garden's value to wildlife, to track trends since the garden opened in 1995 and to illustrate the development of successful habitat creation. The continuity of the Wildlife Garden's species recording over twenty years will increase in importance over time as an aid to our understanding of urban ecosystems and how different species respond and adapt to environmental and climate change. This will add valuable data to London's environmental records centre, Greenspace Information for Greater London (GiGL) <http://www.gigl.org.uk/>.

A few voucher specimens of invertebrates are retained for a small reference collection that is being assembled and made available as an educational resource. Specimens collected from the Wildlife Garden form a valuable part of the Collections. The first specimen of *Camilla nigrifrons* (Diptera) in the Museum collection was taken from the Wildlife Garden. The second specimen of *Rhyzobius forestieri* (Coccinellidae) to be recorded in Britain in 2014 and found in the garden is in the Museum collection.

A collection of flowering plants from the garden is in progress and kept in the British Herbarium.

## A 'living laboratory'

The garden provides a 'living laboratory' to Museum scientists and others. Records of first flowers are shared with the Woodland Trust's Nature's Calendar - a UK wide phenology project.

Species expanding their range in Britain can be detected in the garden, giving scientists

information about their rate of spread; e.g. the southern oak bush-cricket *Meconema meridionale* and the daffodil fly *Norellia spinipes*.

There is enormous potential for continuing research, for example, analysing pond water sample data pre-2009 and post-2009 and the effects of the change from mains water supply to borehole water on aquatic invertebrate and plant populations; and the continuing effects of pollution on lichens in the garden. Two possible related areas for PhD projects have also been suggested (K.Thompson pers. comm.). The first is colonisation in relation to species traits, such as dispersal ability and life history, plus possible sources of colonists. The second is the relationship between habitat conditions (e.g. chalk grassland and heathland) and the exact identity of what has turned up in each habitat.

## DISCUSSION OF RESULTS

The total number of taxa recorded by the end of 2015 was 2,765. 2,614 taxa have been identified to species level, the remaining 151 taxa have been identified to genus level. Additional taxa have been recorded in 2016, these are not included in the garden totals, but they have been added to the species lists in this article. The species lists below are additions to groups previously reported (Algae, Bryophytes, Lichens, vascular plants, aquatic macroinvertebrates including Odonata and Mollusca, Lepidoptera (moths)); complete lists of newly reported groups Hemiptera, Hymenoptera and Acari, and complete lists of those groups which were either incomplete or included errors in the previous report (Leigh and Ware 2003) including Arachnids and Rotifers. The location of a particular garden habitat can be found on the plan of the garden (Figure 1).

## FLORA AND FUNGI

### FRESHWATER ALGAE

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The three ponds (A01, A03, A08) in the Wildlife Garden have been sampled at irregular intervals since they were last surveyed in 2003. More than a decade has elapsed since John and York (2003) published the first detailed account of the freshwater algal flora in which were discussed changes since creation of the ponds in 1995 and possible sources of the introduced algae. During this decade there has been a change in water chemistry. Since 2009 the ponds have been increasingly supplied by borehole water containing a higher level of sodium sulphate.

All ponds require periodic management and these are no exception. Blanket weed had to be physically removed mainly from the main pond A03 so as to ensure weed-free areas of open water exist. Over the past decade the amount of these floating mats of filamentous green algae have declined as floating-leaved (e.g. *Nyphaea alba*) and submerged aquatics (e.g. *Myriophyllum spicatum*, *Elodea canadensis*, *Ceratophyllum demersum*) have increased. However since 2009, the abundance of submerged aquatics has also declined. The principal green filamentous alga in the ponds remains *Cladophora glomerata*, although occasionally present are the coarser unbranched filaments of *Oedogonium* and the more slimy ones of the zygnematalean algae *Spirogyra* and *Mougeotia*. Over the decade the



Freshwater algae *Chara globularis*: organs of sexual reproduction borne of a corticated branchlet. Branchlet about 400 micrometres in width. © Chris Carter

surface of the upper pond is frequently covered in the summer months by floating aquatics (principally *Lemna* spp., *Cladophora glomerata*). Often planktonic forms become trapped on the surface of aquatic plants, especially if finely divided. Few planktonic forms were discovered when such plants were collected and the surface water removed by squeezing and then examined microscopically.

The most conspicuous and abundant alga currently present is the stonewort *Chara globularis* which was first observed in 2009 growing in the more alkaline water of the chalk pond (A01). This stonewort has begun to colonize the main pond where two of the formerly abundant aquatic plants (*Ceratophyllum demersum* and *Potamogeton crispus*) appear to be declining since the pond began to be topped up with borehole water. Its olive-green erect branches, arising from a creeping stoloniferous base, reach up to 50 cm in height and characteristically bear whorls of smaller branchlets. This *Chara* is fairly frequent in southern and eastern England where it is largely restricted to similar calcareous and moderately nutrient-rich habitats (Bryant and Stewart 2011). The source of the introduction is unknown although it most probably arrived as very resistant, thick-walled spores (oospores) along with aquatic plants or on waterfowl.

The water surface in the relatively wind-sheltered chalk pond (A01) still occasionally has a golden-coloured iridescence in autumn, varying on the viewing angle and degree

of shading, caused by the chrysophyte *Chromophyton rosanoffii*. Such a phenomenon was first observed in the pond in September and October 2002 although reported from ponds in Richmond Park in London as far back as the 1940s (Lund 1942).

About 100 algae were recorded in the garden by Leigh and Ware (2003) of which the majority were planktonic or loosely associated with submerged surfaces, with just a few from soil or on soil-free surfaces. Only a further 10 taxa have been recorded since 2003 and many of those recorded earlier have not been rediscovered. John and York (2003) mention that 16 of the taxa reported in a survey carried out in May and November 1992 (Honey *et al.* 1998) were not rediscovered just five years later although 42 additional taxa were recorded in 2002. Not too much significance can be placed on these findings since microalgae are easily overlooked if present in low numbers and only for short periods.

The ford and waterfall area (A10) represents an interesting but particularly unstable environment for algae since flow is intermittent and dependent on water being pumped into the upper pond. Occasionally the area is completely dry although sometimes it is drying out or else wetted by water cascading down the limestone wall. Sometimes present in the water flow are the dark-greenish, cushion-like clumps of *Vaucheria* (Xanthophyta, yellow-green algae), occasionally accompanied by purplish-black mats of the blue-green alga *Phormidium*. It is not possible to identify *Vaucheria* to species unless reproductive organs are present or samples are grown in laboratory culture under conditions leading to their formation. Such organs formed on material collected in September 2012 and two species of *Vaucheria* were identified, namely *V. sessilis* and *V. taylori*. Often small muddy

Freshwater yellow-green alga *Vaucheria taylori*: organs of sexual reproduction. Filaments about 100 micrometres in width. © Chris Carter



pools persist at the base of the limestone wall once flow has ceased and these sometimes contain small flagellated algae (John and York 2003).

The open water in the main and chalk ponds is often relatively clear reflecting relatively low numbers of planktonic micro algae even during the summer months. Macroscopic growths of filamentous green algae still develop in early summer although rarely to nuisance proportions as was the case prior to 2003. Few new algae have been recorded in the past decade (just 10 taxa) and many of those known prior to 2003 have not been rediscovered. The only large and conspicuous alga recorded since 2003 has been the stonewort *Chara globularis*. Ecologically, the ponds represent closed communities and the occurrence and periodicity of the algae cannot be considered in isolation from other organisms and other chance events. No doubt sequestering of nutrients by some of the submerged aquatic macrophytes, shading by floating macrophytes, changes in water chemistry since 2009 and high numbers of grazing animals are just some of a complex of factors contributing to the changes in abundance and diversity of algae within the ponds.

### BRYOPHYTES

LEN ELLIS, CURATOR OF BRYOPHYTES, LIFE SCIENCES DEPARTMENT, NATURAL HISTORY MUSEUM

Leigh & Ware (2003) reported a high diversity of bryophytes in the Wildlife Garden. Some 56 species (49 mosses, 7 liverworts) flourished for a time. Subsequently, the number of species represented in the garden has reduced. The factors contributing to this decline were quite natural and their consequences might have been expected.

When the garden was created, rocks and logs from diverse habitats were imported, carrying with them mosses rarely found in London and the South East. Many of these species found themselves in circumstances unfavourable to their growth. For example, *Racomitrium aciculare*, a northern/western moss, rare in lowland England, although persisting in the garden for several years, has long since succumbed to the abnormal conditions. The disappearance of such mosses, uncomfortable in the garden, accounts for part of the apparent decline in diversity.

Of other early records, several ephemeral species (e.g. *Tortula truncata*, *Phascum cuspidatum*) had taken advantage of disturbed conditions prevailing in the earlier life of the garden. These mosses largely disappeared as the various habitats matured. However, a small range of tiny ephemerals (notably including *Barbula unguiculata*) persist on a few areas of bare soil, especially at the margins between habitats.

The successful colonization of the garden by the seed plants has reduced habitat available for the growth of bryophytes. This is particularly apparent in the chalk grassland habitat from which various bryophytes have been crowded out, not least the liverwort, *Leiocolea turbinata*. The moss, *Calliergonella cuspidata*, was also ousted by the dense grass but fortunately occurs elsewhere in the garden.

Through recent years, typical lowland/urban species (*Brachythecium rutabulum*, *Orthotrichum diaphanum*, *Grimmia pulvinata*, *Bryum capillare*, *Amblystegium serpens*, *Kindbergia praelonga*) have begun to overtake and dominate the garden's bryophyte flora. *Brachythecium rutabulum* in particular, tolerant of the differing conditions presented by the various types of habitat, was able to displace more specialized but less robust mosses and liverworts.



White-tipped bristle-moss *Orthotrichum diaphanum*. © The Trustees of the Natural History Museum, London

Especially in drier years, the diversity of bryophyte species in the garden has been very low. However, encouraged by the relatively clean London air and the recent persistently damp conditions, the number of species occurring in the garden is presently slowly increasing. Various English-lowland species have begun to colonize the area and mosses new to the garden are still being found. Sheltered on wooden fencing, *Cryphaea heteromalla* was recorded for the first time in February 2013. In the same year, *Cratoneuron filicinum* was newly discovered in the reed bed, and in the chalk grassland stream *Leptodictyum riparium* appeared. However, the most recent new reappearance in the garden, recorded in April 2015, was the common woodland moss, *Mnium hornum*.

The heathland habitat LH04, introduced into the garden in 2012, supported a community of mosses that included *Hypnum jutlandicum*, *Dicranum scoparium*, *Polytrichum juniperinum* and *Campylopus introflexus*. These species have continued to thrive and are beginning to dominate the soil-hugging flora that grows beneath the heather.

In summary, the bryophyte flora in Wildlife Garden is evolving dynamically, and after an initial decline, appears to be largely gaining in both diversity and complexity.

## VASCULAR PLANTS

CAROLINE WARE, WILDLIFE GARDEN, NATURAL HISTORY MUSEUM

There were over 417 taxa, including microspecies and subspecies, identified in the garden during the current survey period. The survey results are summarised in Table 1 showing comparable results for the 1998/1999 and 2002/3 surveys. The list of vascular plants in Appendix 1 includes all species recorded in 2014-15.

Three categories of plants previously discussed (Honey *et al.* 1998:24, Ware 1999, Leigh and Ware 2003:86-93) are present: remnant plants, deliberate introductions and accidental arrivals, though there have been changes within these categories.

### Remnant plants

There are no changes in the numbers of mature trees. The south and west boundaries of the garden are bordered by seven London planes *Platanus x hispanica* which cast an increasing shade over the garden. A small-leaved lime *Tilia cordata* cv in the centre of the garden, and two Lombardy poplars *Populus nigra* 'Italica' at the edge and north of the meadow (G05) provide maturity to the garden and support many insects including the lime hawk-moth *Mimas tiliae* and the poplar hawk-moth *Laothoe populi*. These poplars also support the Nationally Scarce soldier fly *Solva marginata* and a number of beetles including the Nationally Scarce poplar weevil *Dorytomus ictor*. All mature trees are subject to Tree Preservation Orders (TPOs).

Several large holly *Ilex aquifolium* remain in the north of the garden in P04, P05 and the edge of G01 with *Ilex x altaclarensis* on the edge of meadow (G05). A holm oak *Quercus ilex* grows near the western side of the meadow G05. Its leaves are mined by a micromoth *Ectodemia heringella* discovered in 1996 but not identified until 2001 (Leigh and Ware 2003:102). The box tree *Buxus sempervirens* in P05 on the edge of woodland (W03) remains and is now the food plant of the recently arrived box tree moth *Cydalima perspectalis*.

Ornamental shrubs that persist include seedlings of garden privet *Ligustrum ovalifolium*,

Table 1. Number of vascular plant species by habitat type (see Figure 1 for habitat areas)

Habitat	Code	Number of species			
		1998/1999	2002/2003	2014/2015	Evolution
Woodland	W01-W09	172	191	186	
Scrub	S01-S02	83		89	
Hedgerow	H01-H06	107	127	124	
Grassland	G01-G05	162	170	206	
Heathland	LH01-LH04	42	54	79	
Wetland (ponds and banks)	A01-A10	112	92	105	
Fen	F01-F04, R01-R03	92	89	106	
Urban	U01	37	56		
Other	DF, P03-P05			71	
Total number of species in all areas (not sum)		340	360	417	

the occasional Oregon grape *Mahonia aquifolium* and mock-orange *Philadelphus coronarius*. Several shrubs of garden privet in area P05 provide cover for bird feeders. Hazel *Corylus avellana*, field maple *Acer campestre* and elder *Sambucus nigra*, planted in the area in 1999, will soon provide sufficient cover to replace the garden privet. Crocus *Crocus* spp., Spanish bluebell *Hyacinthoides hispanica*, ground elder *Aegopodium podagraria*, lemon balm *Melissa officinalis* and green alkanet *Pentaglottis sempervirens* are remnant herbaceous species that reappear from time to time.

### Accidental arrivals

Our most notable arrival since 2003 was a single plant of broad-leaved helleborine *Epipactis helleborine* spotted on 26 May 2007 under beech *Fagus sylvatica* in woodland area (W01). This is a rare plant in London: the nearest known population, also self-sown and found in 1997, is in the south-east corner of the London Wetland Centre (Spencer 2012).

In 2010 soil exposed after disturbance along the north boundary, following completion of the Darwin Centre courtyard, saw a flush of new species, mainly ruderals. These included black-bindweed *Fallopia convolvulus*, shaggy soldier *Galinsoga quadriradiata*, common cudweed *Filago vulgaris* rare in London and flixweed *Descurainia sophia* (which is a rare archaeophyte in London). Less transitory species were also observed, including Canadian goldenrod *Solidago canadensis* (previously recorded and removed from the edge of fen (F03) in 1999) and hemp *Cannabis sativa*, the former still present in the hedge (H08) lining the lane from Queen's Gate to the Darwin Centre courtyard. *C. sativa* was also recorded in other parts of the garden (G04 and LH01) having arrived soon after a change in bird feed supplier.

Hemlock water-dropwort *Oenanthe crocata* is a self-sown addition to the waterfall/ford (A10), appearing initially in 2008 and now spread to the main pond margins and to one of the moorhen islands - this species is notable in Greater London (Burton 1983). Another arrival in the Apiaceae was corky-fruited water-dropwort *Oenanthe pimpinelloides* in the woodland glade W06, recorded in 2007; however, this was not recorded in the current survey. Other accidental arrivals include water bent *Polypogon viridis*, recorded near the waterfall from May 2011, and Mexican fleabane *Erigeron karvinskianus*, first recorded in May 2014. Our most recent arrival, narrow-leaved ragwort *Senecio inaequidens*, was recorded in July 2015 growing on the green roof of the sheep shed. This non-native species is becoming more frequent throughout London, having first been recorded around east London (Spencer 2012).

Populations of previously recorded self-sown arrivals have increased, such as common ragwort, *Senecio jacobaea* (see also Appendix 2), docks *Rumex* spp., fleabanes *Conyza* spp., willowherbs *Epilobium* spp. and common nettle *Urtica dioica*. The last was celebrated during the Museum's biennial Nettle Weekends and, as a result, the subject of several recently published books (Vickery 2006, Edom 2010, Tuffney 2015). As habitats have developed, leaving fewer gaps between plants, annuals such as groundsel *Senecio vulgaris*, *Chedopodium* spp., annual mercury *Mercurialis annua* and shepherd's-purse *Capsella bursa-pastoris* have declined.

### Plant introductions

The number of introductions within most habitats has decreased as species planted over the years have developed self-sustaining populations within the habitats. Plant additions

since 2003 are mentioned in the discussion of habitats below. Increasingly, seeds are collected from the garden, or sometimes sourced from elsewhere, propagated and raised in the garden's nursery and planted out from 9 cm pots.

## Habitats Summary

### Woodland

Many of the originally planted faster growing trees, such as silver birch *Betula pendula* and ash *Fraxinus excelsior*, have been coppiced or pollarded, leaving selected trees to grow to maturity and to provide gaps to fill with younger trees. All trees have grown healthily, though field maple is susceptible to damage by grey squirrel *Sciurus carolinensis*. Unfortunately a small wild service tree *Sorbus torminalis*, planted in 2003 (Leigh and Ware) did not survive. Whips of silver birch, pedunculate oak *Quercus robur*, field maple, beech *Fagus sylvatica* and ash *Fraxinus excelsior* have been planted in remaining gaps and in recently expanded areas such as W03. However, many species are now self-seeding including wild cherry *Prunus avium*, field maple, hornbeam *Carpinus betulus*, pedunculate oak, holly and yew *Taxus baccata*, removing the need to purchase further additions.

Shrubs include hazel, elder, hawthorn *Crataegus monogyna*, guelder-rose *Viburnum opulus*, wayfaring tree *Viburnum lantana*, dog rose *Rosa canina*, field rose *Rosa arvensis*, dogwood *Cornus sanguinea* and spindle *Euonymus europaeus*. Many are now self-seeding, dogwood and spindle excessively so, and require periodic thinning, as does bramble *Rubus fruticosus* agg. The shrub layer is managed by coppicing and pruning, providing structural diversity, food and habitat for invertebrates, birds and small mammals.

Hazel is coppiced in short rotation, approximately every five years, providing material for educational talks and coppicing demonstrations, as well as for practical use within the garden such as creating stock-proof woven fences and repairs to the garden coracle. Larger logs from pollarded trees are used for log piles which, together with naturally occurring deadwood, provides habitat for invertebrates such as stag beetle larvae and earthworms, including the rare *Dendrobaena pygmaea*, hibernating amphibians, bryophytes and fungi.

Ground flora is developing particularly well in mixed woodland in the north-west side of the garden with the planted sub-communities of bluebell *Hyacinthoides non-scripta* and wood anemone *Anemone nemorosa* in W06/W07 and W05 respectively retaining their identity - and both spreading towards the woodland glade/ride area W06. However, although native bluebells were carefully sourced during introductions and efforts made to remove all Spanish bluebells, many have hybridized and are now dominated by the hybrid *H. x massartiana*. We accept that this is unavoidable in central London, as in many urban areas, where Spanish bluebell is a common garden or park plant. The glade (W06), dominated by false brome *Brachypodium sylvaticum*, includes red campion *Silene dioica*, common spotted-orchids *Dactylorhiza fuchsii*, agrimony *Agrimonia eupatoria*, wood sage *Teucrium scorodonia* and the Nationally Scarce starved wood-sedge *Carex depauperata* (the latter donated by the Species Recovery Trust in 2013). Wild daffodils *Narcissus pseudonarcissus* have multiplied over the years producing an attractive display in W07 beneath the small-leaved lime.

In the winter of 2004-2005 the raised mound in woodland area W03 - alongside Queen's Gate - was planted with a mixed community of woodland species in memory of Sonia Philpotts

(1959-2004) who worked in the garden from September 2003. The area, previously a monoculture of ivy *Hedera helix*, was cleared. One thousand native bluebell bulbs were planted together with sweet woodruff *Galium odoratum*, greater stitchwort *Stellaria holostea*, great woodrush *Luzula sylvatica*, Solomon's-seal *Polygonatum multiflorum* and primrose *Primula vulgaris*. Wood anemone is spreading into this area from neighbouring W05.

Other species now firmly established include lesser celandine *Ficaria verna*, sweet violet *Viola odorata*, enchanter's-nightshade *Ciraea lutetiana*, garlic mustard *Alliaria petiolata*, bramble and common nettle. Dog's-mercury *Mercurialis perennis* is now spreading its areas within W05 and beneath hornbeam in W09. Sanicle *Sanicula europaea*, planted in 2005 in woodland W04, has now self-sown into W03 and W05. Asarabacca *Asarum europaeum*, an unexpected arrival in 1999 (Ware 1999), remains constant in W04. Woodland grasses include wood melick *Melica uniflora* (mainly in W08 and 09) and false brome. A few plants of wood millet *Milium effusum*, introduced to W04 in 1999, have spread throughout woodland and hedgerows. This grass is especially attractive during April to June. Tufted hair-grass *Deschampsia cespitosa* is tucked away in a few woodland corners. Successfully grown sedges include wood sedge *Carex sylvatica*, grey sedge *C. divulsa* ssp. *divulsa* and pendulous sedge *C. pendula*, the last requires constant thinning. There are of course several species which, without judicious weeding carried out by the garden team with volunteers, would dominate the woodland and adjoining habitats. These, mainly in the family Apiaceae, include cow parsley *Anthriscus sylvestris*, hogweed *Heracleum sphondylium*, stone parsley *Sison amomum* and ground elder *Aegopodium podagraria* as well as nettles and creeping thistle *Cirsium arvense*.

Area W02 is a monoculture of wild garlic or ramsons *Allium ursinum* and looks spectacular when in full flower, though needs to be restrained from colonizing further woodland areas. Yellow archangel *Lamiastrum galeobdolon* is present in most woodland beds and tends to thrive in partial shade in areas away from London planes such as W01 and W07. Recent plant introductions include bugle *Ajuga reptans* and nettle-leaved bellflower *Campanula trachelium*, the latter providing colour in woodland during summer months. This corner of the woodland in the north-west of the garden is developing well. A walk through the area in April and May and you can catch the scent of bluebells, followed by the scent of wild garlic around the corner in W02. A bee tree observation hive, installed on the edge of W07 in 2007, is also a popular and informative feature for visitors in this area. Woodland on the southern boundary has been slower to develop due to heavier shading by the London planes and greater disturbance caused by annual removal of their leaves. In recent years however, it has developed with species such as butcher's-broom *Ruscus aculeatus* (now reproducing over ten years since its introduction), stinking iris *Iris foetidissima* and dog's-mercury. This woodland area is managed to provide glimpses and wider views through to the rest of the garden and the Darwin Centre, with spring colour provided by primrose, red campion, cherry plum *Prunus cerasifera*, wild cherry, hawthorn, elder and dog rose *Rosa canina* - views that are an unexpected delight from alongside Cromwell Road! Woodland W08 is now confined to one wild cherry tree (planted in 1998) with a ground and shrub layer kept low to maximise sunlight entering this south-western end of the garden.

The more successful plants in W08 and W09 are species with a preference for disturbance including cow parsley, chickweed *Stellaria media*, common nettle and red campion.



Shade-tolerant species from adjacent habitats have colonized the woodland as previously noted (Leigh and Ware 2003) including wild angelica *Angelica sylvestris*, great willowherb *Epilobium hirsutum* and hemp agrimony *Eupatorium cannabinum* - a species notable in Greater London (Burton 1983).

Ferns, including male fern *Dryopteris filix-mas* and broad buckler-fern *Dryopteris dilatata* in W03 and soft shield-fern *Polystichum setiferum* in W07, thrive but can be vulnerable to annual London plane tree leaf-raking.

The ground flora of the beech/ash woodland community W01 includes dog's-mercury, sweet violet, common dog-violet *Viola riviniana*, ramsons, yellow archangel, crosswort *Cruciata laevipes* and primrose which is hybridising with cowslip *Primula veris* to produce *Primula x polyantha*. This beech woodland habitat is the area in which broad-leaved helleborine has appropriately colonised. Ash is coppiced on short rotation to prevent over-shading of the adjoining meadow G05. Beech is coppiced or pollarded, with additional beech whip replacements planted as required. Great willowherb *Epilobium hirsutum*, previously a dominant in this area (Ware 1999), has now disappeared from this habitat.

Evidence that the garden's woodland is developing into a more mature and complex habitat is shown by the presence of diverse invertebrate species, colonising fungi such as St George's mushroom *Calocybe gambosa*, bryophytes and lichens (see below).

#### Scrub

The most significant scrub area is S02 illustrating the transition stage between grassland and woodland. This scrub is dominated by bramble of which four subspecies were identified by David Allen (Leigh and Ware 2003), honeysuckle *Lonicera periclymenum*, traveller's-joy *Clematis vitalba*, ivy and hedge bindweed *Calystegia sepium* with self-sown goat willow *Salix caprea* and rowan *Sorbus aucuparia*. Rosebay willowherb *Chamerion angustifolium* was introduced to provide additional colour and nectar in late summer. The area is largely undisturbed and harbours lesser stag beetle larvae *Dorcus parallelipipedus*. The land hopper amphipod *Arcitalitrus dorrieni* was first recorded in 1999 from pitfall traps set in this scrub.

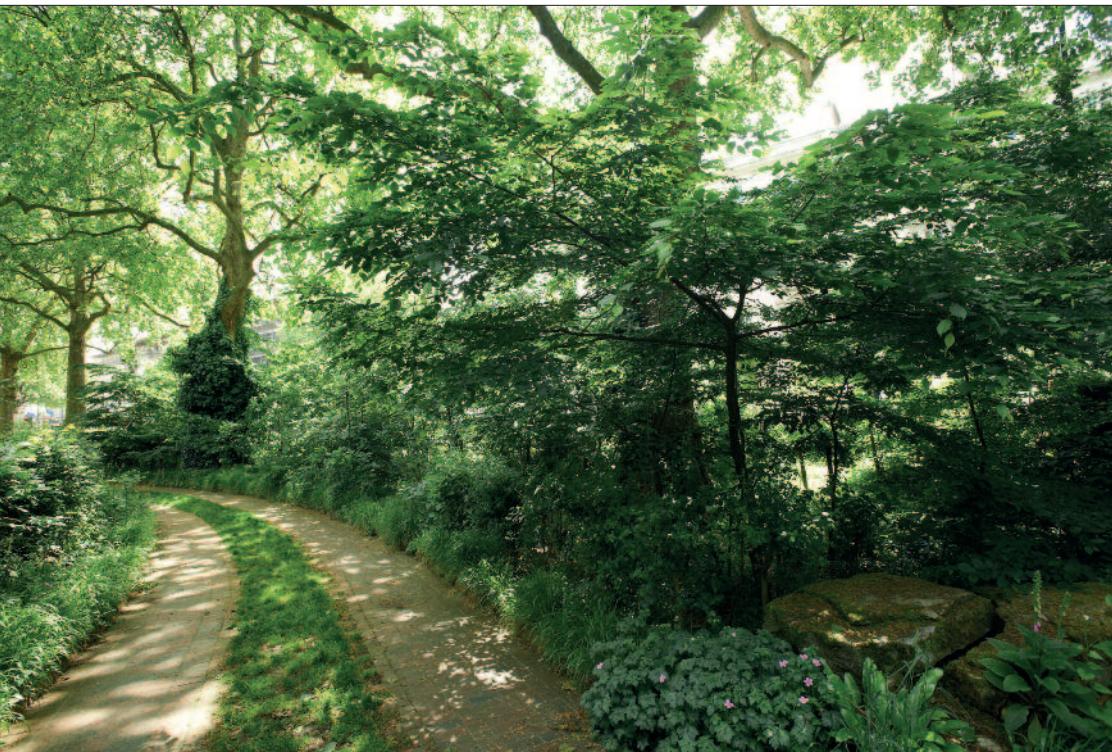
Chalk scrub S01, between the meadow G05 and chalk area, comprises juniper *Juniperus communis* ssp. *communis*, at the base of the chalk downland with hawthorn, and spindle. Juniper is also present in the small island bed (S03) adjacent to the teaching area.

#### Hedgerows

Hedges are an important contribution to the garden's mosaic of habitats providing structural interest both to our visitors and to wildlife with links between different habitats. Since 2003 we have added nearly 60 metres of mixed hedge to the garden (H08 and H09 on Figure 1).

Our hedge species include hawthorn, blackthorn *Prunus spinosa*, guelder-rose *Viburnum opulus*, dog rose *Rosa canina*, holly, crab apple *Malus sylvestris*, wayfaring tree *Viburnum lantana*, sweet chestnut, elder and sweet briar *Rosa rubiginosa* - all important sources of nectar for pollinating insects. Together with hazel, hornbeam and field maple, the

Left: Woodland - beech woodland area in November. © The Trustees of the Natural History Museum, London



Hedge-lined brick lane - west to east. © The Trustees of the Natural History Museum, London

hedgerow species provides foliage and food for a range of other invertebrates and their larvae. Azure damselflies and southern hawker dragonflies are frequently seen patrolling the length of these hedges hunting their prey of midges and other flies.

Woody climbers have increased in abundance since the previous survey (Leigh and Ware 2003) notably honeysuckle and traveller's-joy. Additional climbers include hops *Humulus lupulus*, hedge bindweed and tufted vetch *Vicia cracca*. White bryony *Bryonia dioica* was added in 2013 with the aim of attracting the Nationally Notable bryony bee *Andrena florea*.

Hedge bank flora includes originally-planted species (Ware 1999): primrose, red campion, bugle, ground-ivy, yellow archangel, hedge bedstraw *Galium album*, lords and ladies *Arum maculatum*, hedgerow crane's-bill *Geranium pyrenaicum* with self-sown nettles and bramble. Both wood speedwell *Veronica montana* and germander speedwell *Veronica chamaedrys* thrive, the former in hedges H07, the latter in H04. Interestingly, the former is uncommon in Greater London (Middlesex) and, according to Spencer (2012), the latter is declining. Both are also present along woodland edges and germander speedwell is also well established in the meadow G05.

The laying of hedges H03 and H06 in 2010 and 2012 respectively and the relaying of

hedges H02 and H04 in 2011 has resulted in thick bushy growth beneficial to nesting birds. Hedge H02 was poor and gappy in 1999 and is a good example of hedge restoration through hedge-laying. The garden's hedges are included on RBKC's list of flagship species and sites in the Local Biodiversity Action Plan (RBKC 2010).

### Grassland

#### Chalk downland

The number of species recorded on the chalk downland area in 2014 was 134, compared to 84 in 2003, the increase partly explained by the extension of the chalk habitat (see above) with an additional short length of hedge plants alongside the stone wall.

There have been changes in the dynamics of the chalk grassland community over the past eleven years (see Tables 2 to 5).

There are ten dominant species of forbs (those with over 100 plants per habitat area (G01) and ten abundant species (between 51-100 plants per habitat area (G01)). However with different flowering seasons these species do not appear to visually dominate this

*Below: Table 2. Chalk downland: dominant species - forbs*

G01 Dominant species (>100) - forbs		
1998	2002-2003	2014-2015
<i>Achillea millefolium</i>	<i>Anthyllis vulneraria</i>	<i>Achillea millefolium</i>
<i>Leontodon hispidus</i>	<i>Galium verum</i>	<i>Leontodon hispidus</i>
<i>Leucanthemum vulgare</i>	<i>Leontodon hispidus</i>	<i>Leucanthemum vulgare</i>
	<i>Lotus corniculatus</i>	<i>Plantago lanceolata</i>
	<i>Plantago lanceolata</i>	<i>Primula veris</i>
	<i>Primula veris</i>	<i>Ranunculus acris</i>
	<i>Ranunculus acris</i>	<i>Rhinanthus minor</i>
	<i>Trifolium repens</i>	<i>Poterium sanguisorba</i> ssp. <i>Sanguisorba</i>
		<i>Trifolium pratense</i>
		<i>Trifolium repens</i>

*Below: Table 3. Chalk downland: Abundant species - forbs*

G01 Abundant species (51-100) - forbs		
1998	2002/2003	2014/2015
<i>Galium album</i>	<i>Achillea millefolium</i>	<i>Daucus carota</i>
<i>Galium verum</i>	<i>Galium album</i>	<i>Galium album</i>
<i>Origanum vulgare</i>	<i>Origanum vulgare</i>	<i>Galium verum</i>
<i>Plantago lanceolata</i>	<i>Poterium sanguisorba</i> ssp. <i>sanguisorba</i>	<i>Knautia arvensis</i>
<i>Scabiosa columbaria</i>	<i>Primula veris</i>	<i>Leucanthemum vulgare</i>
	<i>Rhinanthus minor</i>	<i>Lotus corniculatus</i>
		<i>Origanum vulgare</i>
		<i>Plantago lanceolata</i>
		<i>Taraxacum officinale</i> agg.
		<i>Trifolium dubium</i>

chalk habitat. Cowslips have increased and are a welcome sight at the end of winter with their long flowering period extending from late March to May. Oxeye daisy *Leucanthemum vulgare* whose populations fluctuate from year to year has increased in abundance since 2012 - partly due to its inclusion in the Emorsgate seed mix sown in the extended area. It is again one of the dominant species but at least now it exists within a richer tapestry of species and colour than in 1998. Other dominant species (Table 2) include rough hawkbit *Leontodon hispidus*, a consistently dominant species since 1998, meadow buttercup *Ranunculus acris*, yellow-rattle *Rhinanthus minor*, red clover *Trifolium pratense*, white clover *Trifolium repens* and salad burnet *Poterium sanguisorba* ssp. *sanguisorba*.

Abundant species include Lady's bedstraw *Galium verum* and hedge bedstraw (Table 3). The hybrid of these two species, *Galium x pomeranicum*, first recorded in 2011, is unusual and it is thought that this is the only place where it occurs in the London area. Bird's-foot trefoil *Lotus corniculatus*, previously dominant (2003) is abundant whereas kidney vetch *Anthyllis vulneraria* has declined to less than 50 plants. Yarrow *Achillea millefolium* has increased in abundance and is now a dominant species on the chalk downland.

Most of the grasses fall within the abundant category - or less - although it is harder to accurately measure their abundance. Red fescue *Festuca rubra* and smaller cat's tail *Phleum bertolonii* are estimated as dominant grasses (Table 4) with glaucous sedge *Carex flacca*, which is especially abundant around the top of the chalk mound. Crested dog's-tail *Cynosurus cristatus*, quaking grass *Briza media*, cock's-foot *Dactylis glomerata* and false oat-grass *Arrhenatherum elatius* are abundant (Table 5).

Below: Table 4. Chalk downland: Dominant species - grasses and sedges

G01 Dominant species (>100) - grasses and sedges		
1998	2002-2003	2014-2015
<i>Festuca rubra</i>	<i>Anthoxanthum odoratum</i>	<i>Carex flacca</i>
		<i>Festuca rubra</i>
<i>Lolium perenne</i>	<i>Arrhenatherum elatius</i>	<i>Phleum bertolonii</i>
	<i>Festuca ovina</i>	
	<i>Festuca rubra</i>	
	<i>Phleum bertolonii</i>	

Below: Table 5. Chalk downland: Abundant species - grasses

G01 Abundant species (51-100) - grasses		
1998	2002-2003	2014/2015
<i>Agrostis capillaris</i>	<i>Agrostis stolonifera</i>	<i>Arrhenatherum elatius</i>
	<i>Cynosurus cristatus</i>	<i>Briza media</i>
	<i>Dactylis glomerata</i>	<i>Cynosurus cristatus</i>
	<i>Festuca ovina</i>	<i>Dactylis glomerata</i>
	<i>Festuca rubra</i>	<i>Festuca ovina</i>
	<i>Holcus lanatus</i>	<i>Holcus lanatus</i>

Bee orchid *Ophrys apifera* var. *belgarum* on chalk grassland. © The Trustees of the Natural History Museum, London



False oat-grass, noted in 2003 as appearing to the rear of the chalk mound, has increased greatly and is a target species for thinning to prevent shading of smaller species. Its habit has not yet been affected by the spread of yellow-rattle. Lack of grazing is considered to be a key factor in the expansion of this species (Rodwell 1992) but perhaps in our case, timing of grazing is the issue. A detailed study of this species would be helpful. The community grass, meadow oat-grass *Avenula pratensis* is present if not abundant, downy oat-grass *Avenula pubescens* is present in small amounts, mainly on the top of the mound. Sheep's fescue *Festuca ovina* and Yorkshire fog *Holcus lanatus* are both present and are abundant only in the recently sown addition along the east side of the mound. Other species that give the chalk its particular identity are wild marjoram *Origanum vulgare*, field scabious *Knautia arvensis*, wild basil *Clinopodium vulgare*, yellow-wort *Blackstonia perfoliata* and orchids. Common spotted-orchids *Dactylorhiza fuchsii*, introduced in 2003 on the south-facing bank, are slowly spreading. Bee orchids *Ophrys apifera* and *Ophrys apifera* var. *belgarum*, donated by Bill Temple of the Hardy Orchid Society, were planted in 2013. These are a great attraction in June and are already spreading to other areas of this habitat. Common poppy *Papaver rhoeas* was dominant in 2012, introduced in the seed bank with chalk soil that year. It is still present in small numbers on the east side of the chalk. Thyme *Thymus polytrichus*, out-shaded by other herbs when previously planted in the turf, has been increasing since 2012 when it was planted in cracks on the low wall near the garden entrance.

Plants such as viper's-bugloss *Echium vulgare* and harebell *Campanula rotundifolia* are now self-seeding close by. It is especially pleasing to see a sustainable colony of harebell in infertile areas around path edges in the centre of the garden. It is a scarce plant over much of Greater London (Spencer 2012) although is known to grow in neighbouring Kensington Gardens.

This chalk community includes ten of the thirteen constant species found in the NVC chalk downland community CG2 *Avenula pratensis-Festuca ovina* (Rodwell 1992:140). However a specific NVC Survey analysis has not been carried out since 2003. This would be a suitable project for a BSc or MSc student.

### Meadows

The hay meadow (G05) has remained one of the most challenging habitats to create due to the soil's fertility and its early life as a lawn dominated by perennial rye-grass *Lolium*

*perenne* (Ware 1999). Despite its unpromising beginnings the meadow had a total of 93 species in 2002. The area has since been increased by replacing a clump of garden privet in the eastern corner, in March 2009, with meadow turf sourced from Wildflower Turf. The total species count in 2014/15 was 109. These figures include woody species around the edges of the meadow.

Meadow crane's-bill *Geranium pratense* continues as a dominant species, its striking blue flowers are welcome in late summer. Bulbous buttercup *Ranunculus bulbosus* has greatly increased, now dominant it makes a great impact in May and a contrast to meadow buttercup *Ranunculus acris* and creeping buttercup *R. repens*, present in other grassland areas. Red clover and betony *Betonica officinalis* have decreased in abundance, betony markedly so. White clover has moved from abundant to dominant compared to 2002/03 and, whilst offering little meadow colour, is an important nectar plant. Yellow-rattle has been slow to establish in this meadow but is now a dominant species. Additional yellow-rattle seeds are added each year when the sheep return to graze (and trample the seeds) to help boost its population with the aim of further reducing the abundance of rye-grass.

Yarrow remains abundant (Table 7) with black medick *Medicago lupulina*, germander speedwell and common nettle. Common knapweed *Centaurea nigra* is gradually making an impact as a community species. Common spotted-orchid, introduced in 2003 and 2004, is gradually spreading around this meadow.

Grassland: sheep grazing meadow. © The Trustees of the Natural History Museum, London



#### G05 Dominant species (>100) - forbs

1998	2002-2003	2014-2015
<i>Achillea millefolium</i>	<i>Trifolium pratense</i>	<i>Trifolium repens</i>
<i>Conyza summatrensis</i>	<i>Geranium pratense</i>	<i>Geranium pratense</i>
<i>Senecio jacobaea</i>	<i>Betonica officinalis</i>	<i>Ranunculus bulbosus</i>
<i>Trifolium repens</i>		<i>Ranunculus repens</i>
<i>Geranium pratense</i>		<i>Galium album</i>
<i>Leucanthemum vulgare</i>		<i>Rhinanthus minor</i>

Above: Table 6. Meadow G05: Dominant species - forbs

#### G05 Abundant species (51-100) - forbs

1998	2002-2003	2014/2015
<i>Epilobium</i> sp.	<i>Achillea millefolium</i>	<i>Achillea millefolium</i>
	<i>Bellis perennis</i>	<i>Stellaria media</i>
	<i>Lotus corniculatus</i>	<i>Medicago lupulina</i>
	<i>Trifolium pratense</i>	<i>Trifolium pratense</i>
	<i>Trifolium repens</i>	<i>Trifolium repens</i>
	<i>Plantago lanceolata</i>	<i>Plantago lanceolata</i>
	<i>Ranunculus acris</i>	<i>Galium album</i>
	<i>Potentilla reptans</i>	<i>Veronica chamaedrys</i>
	<i>Rhinanthus minor</i>	<i>Urtica dioica</i>

Above: Table 7. Meadow G05: Abundant species - forbs

#### G05 Dominant species (>100) - grasses

1998	2002-2003	2014-2015
<i>Agrostis capillaris</i>	<i>Agrostis capillaris</i>	<i>Anthoxanthum odoratum</i>
<i>Agrostis stolonifera</i>	<i>Agrostis stolonifera</i>	<i>Cynosurus cristatus</i>
<i>Lolium perenne</i>	<i>Anisantha sterilis</i>	<i>Holcus lanatus</i>
<i>Poa trivialis</i>	<i>Holcus lanatus</i>	<i>Lolium perenne</i>
	<i>Lolium perenne</i>	<i>Poa trivialis</i>
	<i>Poa trivialis</i>	

Above: Table 8. Meadow G05: Dominant species - grasses

Five of the dominant species (Table 8) continue to be grasses: Yorkshire-fog, perennial rye-grass, rough meadow-grass *Poa trivialis*, false brome (which is hard to restrict to the adjoining woodland and hedgerow habitats) and crested dog's-tail, one of the main species of NVC MG5 *Cynosurus cristatus-Centaurea nigra* 'hay meadow' grassland community on which the meadow is very loosely based, its numbers boosted when the meadow turf was introduced to extend the meadow in March 2009.

Abundant grass species in meadow (G05) are cock's-foot *Dactylis glomerata*, soft brome *Bromus hordaceus* and Yorkshire-fog (Table 9).

The pond-side meadow (G02), loosely based on NVC MG4 *Alopecurus pratensis-Sanguisorba officinalis*, has a total of 76 species compared to 67 in 2002/3. The area is

G05 grasses only Abundant species (51-100)		
1998	2002-2003	2014/2015
	<i>Dactylis glomerata</i>	<i>Bromus hordaceus</i>
		<i>Dactylis glomerata</i>
		<i>Holcus lanatus</i>

Table 9. Meadow G05: Abundant species - grasses

dominated by cowslips in spring and later includes meadow buttercup, bird's-foot trefoil, red clover, great burnet *Sanguisorba officinalis*, wild carrot *Daucus carota*, bladder campion *Silene vulgaris* and small knapweed. Dominant grasses are false oat-grass, smaller cat's-tail *Phleum bertolonii*, common bent *Agrostis capillaris* and cock's-foot. Common reed *Phragmites australis* and greater pond-sedge *Carex riparia* are beginning to creep in from the pond margin at the base of this bank. The Nationally Scarce hog's-fennel *Puucedanum officinale*, introduced in 1995, is still thriving, though not self-seeding, near the edge of the pond.

The orchard area, created in G03, has had mixed fortunes with over-shading from the London planes along the garden's south boundary and shade from ornamental hawthorn and crab apple in the centre of the orchard, both retained for their rough bark which provides niches for invertebrates and nesting holes for blue tits. The area was reduced in size to make way for the heathland created in 2012. Nevertheless this grassland area has 48 species of plants including grasses meadow foxtail *Alopecurus pratensis*, creeping bent *Agrostis stolonifera*, cock's-foot and red fescue. Bladder campion, planted in G02 and G03 in 1995, remains in both areas. Mistletoe *Viscum album*, planted by Jonathan Briggs in April 2009, looks spectacular on the small apple tree *Malus pumila* 'Brownlees Russett'. It produced fruit for the first time in 2014. Mistletoe is a target species in the local RBKC Biodiversity Action Plan.

The small grassland area G04 on the edge of the pond had become invaded by blackthorn and was increasingly over-shaded by two rowan trees. The rowans have been coppiced, the blackthorn reduced, and in spring 2013 the area successfully reseeded with a seed mix of wet grassland species, sourced from Emorsgate Seeds.

### Heathland

The original dry heathland LH01, planted in April 1998, has suffered from the shade of the London planes but retains heather/ling *Calluna vulgaris* though this is no longer the dominant species, which are now gorse *Ulex europaeus* and bracken *Pteridium aquilinum*. Much of the gorse lining the brick lane became woody and replacement plants have been added during the past five years. Bristle bent *Agrostis curtisii* remains but false brome and herbs including red campion and wood avens have colonised despite endless weeding sessions. The area sustains a small population of self-sown foxglove *Digitalis purpurea* and hard fern *Blechnum spicant* was a recent addition in 2015. The pH of this heathland has increased from 4.2 in 2001 to between 5.2 and 7.2 in 2012. Lessons learned before creating the new heathland habitat LH04 included omitting existing garden soil to create the heathland mound.

The 'new' heathland LH04, planted in 2012 - NVC community NVC H3 - *Ulex minor*-



Lowland heath habitat in 2015. © The Trustees of the Natural History Museum, London

*Agrostis curtisii* comprises low shrubs heather/ling, bell heather *Erica cinerea* and dwarf gorse *Ulex minor* whose flowering peak coincides with the heathers. This community includes bristle bent *Agrostis curtisii*, wavy hair-grass *Deschampsia flexuosa* and sheep's-sorrel *Rumex acetosella* with bryophytes and lichens. Gorse was planted in the adjacent hedge and silver birch planted nearby. The heathland provides rich colour and interest at a time when the meadows and chalk downland flowers have faded and set seed. Nectar and pollen are especially beneficial at this time of year for honey bees *Apis mellifera* and bumblebees, such as *Bombus lapidarius* and *B. terrestris*.

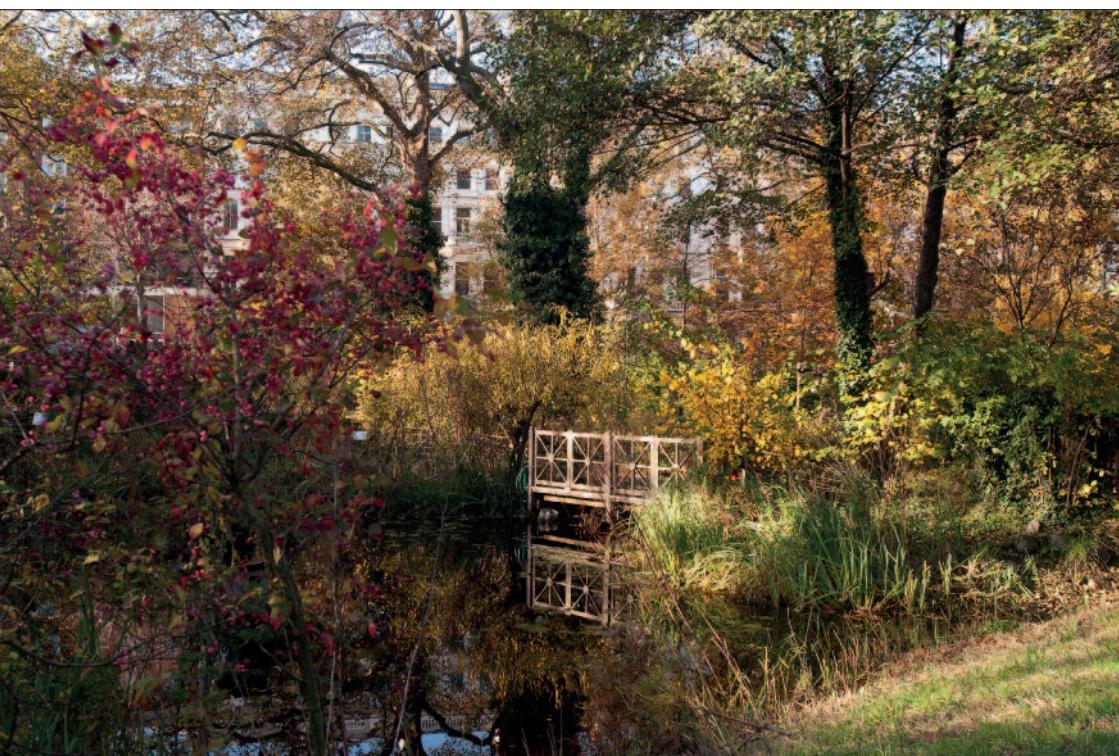
The wet heath/bog habitat (LH02) formed in 1999 suffered from the increasing shade of the London plane trees along the west boundary. Bog-myrtle *Myrica gale* remained with purple moor-grass *Molinia caerulea* but false brome soon colonised the area together with red campion, common couch *Elytrigia repens* and wood avens. This habitat was restored in 2013 using low pH compost made from bracken and sheep wool (Barker and Bland, Dalefoot Farm) and with plants including yellow flag *Iris pseudacorus*, ragged-robin *Silene flos-cuculi* and devil's-bit scabious *Succisa pratensis* (all sourced from British Wild Flower Plants in 9 cm pots), marsh ragwort *Senecio aquaticus* (propagated in the garden's nursery from seeds sourced from Slapton Ley) and bog-myrtle propagated from cuttings from plants in the garden. Sedges include false fox-sedge *Carex otrubae* and star sedge *Carex echinata*.

## Wetland Ponds

In recent years, there has been no problem with excessive algae or over-abundant submerged species as reported in Leigh and Ware (2003). In fact the abundance of all submerged aquatic macrophytes has greatly declined since the source of water to top up ponds was changed in 2009 from mains supply to borehole. Samples of water have been collected annually as noted above but no specific analyses have yet been carried out on the collected data to fully ascertain the link, if any, between the change in water source supply, the decline in submerged aquatic macrophytes and the effect on aquatic Mollusca.

Of the submerged aquatics, hornwort *Ceratophyllum demersum*, once over-abundant in the main pond, is now scarce. There is no evidence of spiked water-milfoil *Myriophyllum spicatum* which was introduced with hornwort in 2000. Similarly, curled pond weed *Potamogeton crispus*, the dominant plant in the main pond in 2003 is not evident. Water-starwort *Callitricha* sp. remains in all three ponds, the chalk pond (A01), main pond (A03) and top pond (A08). The non-native duckweed *Lemna minuta* appeared around 2010 in the top pond (A09) and is present with duckweed *Lemna minor* and *L. gibba*, while the attractive ivy-leaved duckweed *L. trisulca* is more or less confined to the chalk

Main pond - east to west. © The Trustees of the Natural History Museum, London



Bogbean *Menyanthes trifoliata*.  
© The Trustees of the Natural History  
Museum, London

pond (A01). Submerged aquatics have been replaced by the Charophyte, fragile stonewort *Chara globularis* (see above).

White water-lily *Nymphaea alba* and yellow water-lily *Nuphar lutea* thrive in the main pond and chalk pond respectively. Water soldier *Stratiotes aloides*, introduced to the chalk pond in 2007, from the London Wetland Centre, now requires thinning on an annual basis.

Pond margins are more species-rich though there is a risk that common reed *Phragmites australis* will dominate the main pond if it is not controlled by thinning on a regular basis. Emergent plants around the chalk pond include marsh-marigold *Caltha palustris*, water mint *Mentha aquatica*, yellow flag and purple loosestrife *Lythrum salicaria*, with ragged-robin, greater bird's-foot trefoil *Lotus pedunculatus* and common valerian *Valeriana officinalis* on the lower banks. Marsh woundwort *Stachys palustris*, an interesting species not known to be well established in urban Greater London apart from along the Regent's Canal, is doing well around the chalk pond margins.

The main pond has a diverse range of marginal plants with galingale *Cyperus longus*, great water dock *Rumex hydropathum* and yellow loosestrife *Lysimachia vulgaris* on the south margin (A05), flowering-rush *Butomus umbellatus*, reed sweet-grass *Glyceria maxima*, water mint and greater spearwort *Ranunculus lingua* along the south and west margins (A06) and mare's-tail *Hippuris vulgaris* in open water on the north side of A03. Hemlock water-dropwort which appeared by the waterfall (A10) has now spread to margins on the west side of the pond. Cowbane *Cicuta virosa*, one of the many unusual plants introduced twenty years ago by Clive Jermy, is frequent on the main pond.

Shade-tolerant competitors, great willowherb and hemp agrimony, are frequent around the pond and are subject to some regular thinning.

The top pond (A09) marginals include bogbean *Menyanthes trifoliata* and bottle sedge *Carex rostrata*. Water horsetail *Equisetum fluviatile* that thrived around this pond before the waterfall was restored in 2006 was reintroduced in 2015.

In addition to shrubs of willow *Salix phylicifolia* and bog-myrtle, soft-rush *Juncus effusus*, hard rush *Juncus inflexus*, brooklime *Veronica beccabunga*, lesser water-parsnip *Berula erecta* and water-plantain *Alisma plantago-aquatica* are present around the waterfall area with ferns including hart's-tongue *Asplenium scolopendrium*. Opposite-leaved golden saxifrage *Chrysosplenium oppositifolium* was added in 2015.

Summer lady's-tresses *Spiranthes aestivalis*, donated by Bill Temple (Hardy Orchid Society), was introduced in 2013. This orchid is now extinct in Britain. The last site, in the New Forest, was drained thus killing the remaining plant. In Europe it lives in wet acidic conditions and can sometimes be found growing in a mat of earth and vegetation



floating on top of lakes. The plants now growing in the garden are descendants of a plant propagated from French seed (Bill Temple pers. comm.). They are a beautiful and rare addition to the waterfall area.

The ford area includes lesser water-parsnip, water forget-me-not *Myosotis scorpioides*, yellow iris, purple-loosestrife and occasionally common reed along the edge of the stepping stones. Celery-leaved buttercup *Ranunculus sceleratus* appeared on the south edge of the ford (A10) area in 2007 but has not been recorded since.

The Wildlife Garden ponds are included on RBKC's list of flagship species and sites in the Local Biodiversity Action Plan (RBKC 2010:47).

#### Fen and reedbeds

The main fen areas are F01 and F02 with area F03 restored as fen carr in 2008. In spite of shade from overhanging plane trees, the fen habitats provide a variety of damp-loving species. These include common reed, reed canary-grass *Phalaris arundinacea*, meadowsweet *Filipendula ulmaria*, purple-loosestrife, yellow loosestrife, hemp agrimony, tufted-sedge *Carex elata*, marsh fern *Thelypteris palustris*, meadow-rue *Thalictrum flavum* and fen nettle *Urtica dioica* ssp. *galeopsifolia*. Marsh sow-thistle *Sonchus palustris*, an interesting addition, was successfully introduced to the fen (F01 and F02) and pond margin (A04) in 2012 and 2013, and originated from remaining plants collected from Crayford Marsh by Mark Spencer (2012).

The three reedbeds have been cut in rotation since 2003. The beds require regular weeding as other wetland plants self-seed into this area, including purple-loosestrife, marsh-marigold and alder. Monkeyflower *Mimulus guttatus* is an occasional unwanted arrival in this area.

#### Problems of edge influence

In 1998 the number of species occurring in 15 or more habitat plots was 10 compared to 20 in 2003. However the number of plots in which some of those species occurs has increased, for example red campion was recorded in 14 plots in 1999, 20 in 2003 and now in 43. A few species have decreased such as Yorkshire-fog, present in 23 beds in 1998, 18 in 2003 and now in just 11 plots. Bramble, originally introduced to just one habitat, scrub S02, has now spread to 32 plots.

Whilst plants such as bramble, common angelica and common nettle are relatively easy to find and thin out or remove, smaller species such as wood avens and herb-Robert are less easy to find and remove from plant communities where they might be considered inappropriate. However several of these are catholic species found in a range of habitats anyway. It is the larger and more invasive plants such as cow parsley, hogweed *Heracleum sphondylium*, bindweeds *Calystegia* spp. and nettles that need most regular monitoring and thinning to prevent over-shading of smaller light-demanding species. It is with the help from our generous volunteers that we are able to carry out this work and maintain the distinctiveness of our main plant communities in small areas of habitat.

The different plant communities are dynamic and show changes over time. Different survival strategies of individual plants in this urban setting are a continual source of interest and study. As the garden matures, there is further potential for studying associations between plants and insects in this unique garden of native species.

#### LICHENS

PAT WOLSELEY AND HOLGER THÜS, LIFE SCIENCES, NATURAL HISTORY MUSEUM

Species composition in all habitats changes, either due to arrival of late colonisers over time or by species replacements in response to changing environmental conditions. With lichens this is often a slow process as they are usually slow-growing and may hang on in a location where conditions have already changed in a direction which would not allow a fresh recolonisation.

The garden was established in 1995 to demonstrate typical plant communities of the British Isles. However the establishment of the site in an urban environment next to an arterial road also provided an opportunity to monitor changes in lichen communities over time in response to changing environmental conditions. Unlike the plant communities in the garden, lichens have not been introduced deliberately but have either colonised the area spontaneously or have been introduced on substrates, e.g. rocks, soil, or young trees that have been transferred to the garden. By 2003 (Leigh and Ware) 43 lichens were recorded in the garden and 10 permanent quadrats established on lichen communities. It also included pollution-tolerant lichens such as *Lecanora conizaeoides* characteristic of urban habitats at the time and reflecting the history of high concentrations of acidifying pollutants (mainly SO<sub>2</sub>). Over time conditions changed and some of the early colonisers disappeared but it took time for species associated with the new habitat conditions to arrive. This section charts the losses, gains and changes in lichen communities between 2003 and 2015.

Lichen quadrats were established in December 2000 to monitor changes in lichen species which were seen as suitable indicators sensitive to acidifying pollutants but rather tolerant to elevated levels of ammonia and nitrogen oxides, such as *Xanthoria parietina* in a site where atmospheric conditions were monitored as part of a national monitoring network (Leigh and Ware 2003). Permanent quadrats of 10 x 15 cm were established on a variety of saxicolous substrates across the garden from limestone boulders with a high base content to sandstones and hard acid rocks of gneiss. By 2009 some of the quadrats no longer contained the lichen species that they had been set up to monitor mainly due to changes in the habitat structure such as increasing shade from growing trees and shrubs and subsequent overgrowth by flowering plants and mosses. Other changes that affect fixed quadrats could be very local, such as water birds using a quadrat area on a stone on the edge of the upper pond as a resting place, resulting in an accumulation of highly nutrient-enriched droppings on this spot and the loss of the lichens. However, while specimens may be lost from a quadrat they may still be present in the adjacent area. This required a different procedure for monitoring changes in a complex mosaic of micro-habitats.

In addition, new habitats were being developed in the garden; a split chestnut fence was established around the meadow (G05) in 2003 and the chalk downland (G01) in 2004. The wood from coppiced chestnut was untreated and has been colonised by a comparatively rich lichen community which contributed many new records for the garden. More recently in February 2012 a new heathland area was established using turfs introduced from Merritown Heath, Dorset (see above). We continued to monitor the quadrats established in 2000 but also extended the monitoring to include species lists for specified substrata and 'habitat-areas' following the delimitation set out in the site map (Figure 1).

The air quality data are recorded in a hut on the boundary of the WLG with Cromwell Road and are available on the Defra site ([http://ukair.defra.gov.uk/data/data\\_selector](http://ukair.defra.gov.uk/data/data_selector)). Since 2010 RBKC have recorded the data including NO<sub>2</sub>, CO and particulates (PM10). The results for NO<sub>2</sub> at the roadside remain in exceedance of the objective of 40 µg/m<sup>3</sup> in all years (RBKC report). However, the increasing vegetation in the garden acts as a filter and even at an early stage between October 2001 and July 2002 the measurement of gaseous nitric oxide (NO) and nitric dioxide (NO<sub>2</sub>) across the garden using diffusion tubes showed a distinct gradient of both components from the road to 75m inside the garden (Leigh and Ware 2003). Since 2002 the woodland areas adjacent to Cromwell Road and Queen's Gate have become well established. Similar to many studies elsewhere it was confirmed that in London there is a strong correlation between bark pH and atmospheric pollutant levels (Larsen *et al.* 2007, Wolseley *et al.* 2006). In 2015 the pH of a range of substrata across the garden including oak trees, rocks, walls and chestnut fence rails was recorded using a flat-tip electrode.

## Results and discussion

The location of quadrats and sites that we monitored or surveyed is shown in Table 10 together with the pH of substrata recorded in 2015.

All species and their locations are shown in Table 11.

Of the 94 species that have been recorded in the garden since the lichen recording started, 23 of these have not been recorded recently. Many of these species were pioneers, colonisers of new substrates where both habitat and environmental conditions have

**Table 10: Lichens in the NHM Wildlife Garden. Location of quadrats and sites monitored or surveyed together with pH measurements of different substrata in 2015**

Substrate	Map code	Changes in environment	substrate pH
Limestone wall top	P05	overgrown with moss	7.6 7.1 6.7 7.2 7.3
Schist boulder	F03	shaded + undergrowth	5.8 6.9 6.9 6
Purbeck limestone boulder	DF	shaded	
Gneiss boulder	W08	shaded + undergrowth	
Brick path edge	LH01	moss	
Old red sandstone boulder	S03	dense undergrowth	
Chalk and flint boulder	G01	overgrown adjacent pond	
Chestnut paling	G05	exposed	6.7 4.8 5 6.2
Chestnut paling	G01	exposed	7.2 7.1 6.4
Brick path edge	U01/2	exposed	
Bee tree	W06	exposed	
Heathland peat	LH04	exposed	
Wall	LH04	exposed	
Woodland	W01/4/5/6/7	increased shade	
Oak tree	W04	woodland area	6.4 6.2 6.7
Oak tree	W09	adjacent monitoring station	6.8 6.6 6.8
New limestone wall to heathland	G03	exposed	7.4 7.7 7.3
NHM west facing wall	G06	exposed	7.8 7.9 7.8

Species list	Sub.	2003	2005	2009	2011/12	2014/15
<i>Amandinea punctata</i>	ep,li	WLG	G01	A02,G05		A02,G05, W04/9
<i>Anisomeridium polypori</i>	ep		P05			P05,W09
<i>Arthonia radiata</i>	ep		W01			P04,W04/9
<i>Arthopyrenia punctiformis</i>	ep	WLG				P05,W09
<i>Bacidia adasta</i>	ep			G01,G04	A02,P05	A02,P05
<i>Bacidia egenula</i>	sx		W08			
<i>Bacidia neosquamulosa</i>	sx		G04			
<i>Bacidia inundata</i>	sx				F03	F03
<i>Bacidia delicata</i>	ep	WLG				G05
<i>Bacidia</i> sp.	li					G05
<i>Buellia griseovirens</i>	li			A01		
<i>Caloplaca crenulatella</i>	sx	A10,P05				
<i>Caloplaca cerina</i>	li					G05
<i>Caloplaca decipiens</i>	li		G05			
<i>Caloplaca flavocitrina</i>	sx	P05,G01	U01/2, G05,G01	A10		G01
<i>Caloplaca flavovirescens</i>	sx		U01/2	A10		
<i>Caloplaca holocarpa</i> agg.	sx	DF,P05				DF
<i>Caloplaca lithophila</i>	sx	WLG		A10		
<i>Caloplaca saxicola</i>	sx	WLG			DF	G06
<i>Caloplaca variabilis</i>	sx					P05
<i>Candelaria concolor</i>	sx					G05
<i>Candelariella aurella</i>	li	F03,S03	G01	P05		G05,P05
<i>Candelariella medians</i>	sx	WLG				
<i>Candelariella reflexa</i>	ep		G05			P05
<i>Candelariella vitellina</i>	sx	WLG	A01/2	G01		
<i>Catillaria chalybeia</i>	sx					F03
<i>Cladonia chlorophaeaa*</i>	ter	WLG				
<i>Cladonia ciliata*</i>	ter	WLG				
<i>Cladonia coniocraea*</i>	ter	WLG				LH04
<i>Cladonia crispata*</i>	ter	WLG				
<i>Cladonia 'diversa'</i>	ter					G03
<i>Cladonia fimbriata</i>	ter	WLG				G03
<i>Cladonia floerkeana</i>	ter	WLG				LH04
<i>Cladonia furcata</i>	ter					G03
<i>Cladonia portentosa</i>	ter					LH04
<i>Cladonia pyxidata</i>	ter					G03
<i>Cladonia ramulosa*</i>	ter	WLG				
<i>Collema tenax</i>	ter	WLG				
<i>Cyrtidula quercus</i>	ep	WLG				

**Table 11. All species of lichenised fungi and their locations recorded in the NHM Wildlife Garden 2003-2015**

Species list	Sub.	2003	2005	2009	2011/12	2014/15
<i>Evernia prunastri</i>	ep				G05	
<i>Felhanera viridisorediata</i>	sx			DF,G01	DF,S03,A02	
<i>Flavoparmelia caperata</i>	li			G01		G05
<i>Hyperphyscia adglutinata</i>	ep,sx			G01	G01	G05,P04/5, W08/9
<i>Hypogymnia physodes</i>	ep	WLG				
<i>Lecania erysibe</i>	sx	F03		P05		
<i>Lecania rabenhorstii</i>	sx			A10		P05 to DF
<i>Lecanora albescens</i>	sx	A10,P05,DF		P05		P05 to DF,G06
<i>Lecanora campestris</i>	li		G01			
<i>Lecanora chlorotera</i>	ep	WLG	W01/5			W04
<i>Lecanora conizaeoides</i>	ep	WLG				
<i>Lecanora dispersa</i> agg.	li	P05,F03,DF	G05	A10,DF,P05		G06,P05
<i>Lecanora expallens</i>	ep		A01			
<i>Lecanora hagenii</i>	li		G01		G01	
<i>Lecanora muralis</i>	sx	A10, F03, W08,S03	U01/2, G01/4/5	A10		G06
<i>Lecanora persimilis</i>	ep		LH01			
<i>Lecanora saligna</i>	li			G05	G05	
<i>Lecanora symmicta</i>	ep		A01			G05
<i>Lecidea fuscoatra</i>	sx					G06
<i>Lecidella elaeochroma</i>	ep		G01			W04/5
<i>Lecidella scabra</i>	li,sx		A01,G04			
<i>Lecidella stigmataea</i>	sx	P05,W08, S03,G01	U01/2	P05,DF,G01	DF,Q9,G01	F03,P05
<i>Lepraria incana</i>	li		G05			
<i>Lepraria lobificans</i>	sx	WLG	P05			
<i>Melanelia subaurifera</i>	ep	WLG	G05			
<i>Micarea denigrata</i>	li		G05,Q7			
<i>Opegrapha vulgata</i>	li	WLG				
<i>Opegrapha vermicellifera</i>	li				W07	
<i>Parmelia sulcata</i>	li	WLG	G05			G05
<i>Parmotrema perlatum</i>	li					G05
<i>Peltigera cf. hymenina</i>	ter			U01		
<i>Phaeophyscia nigricans</i>	li,sx		G05			G05/6,F04
<i>Phaeophyscia orbicularis</i>	ep,li	A10,S03	G01/5	G01	DF,W08,G01	G05, P04/5, W04/8/9
<i>Physcia adscendens</i>	ep	S03,G01	G05			G05/6
<i>Physcia caesia</i>	sx		G05			G06
<i>Physcia dubia</i>	sx	WLG				G06
<i>Physcia tenella</i>	ep,li,sx	S03	A01,G01/5	G01	G01	G05
<i>Placynthiella icmalea</i>	li					G05

Species list	Sub.	2003	2005	2009	2011/12	2014/15
<i>Porina chlorotica</i>	li	WLG				
<i>Porpidia tuberculosa</i>	sx	WLG				
<i>Protoblastenia rupestris</i>	sx			G04	P05	P05,F03
<i>Punctelia subrudecta</i>	ep,li					G05
<i>Ramalina farinacea</i>	ep	WLG				G05
<i>Rhinodina oleae (gennarii)</i>	li	A02,DF,F03,	G05		G01	F03
		W08,G01				
<i>Sarcogyne regularis</i>	sx	WLG	G04	P05		
<i>Scoliciosporum chlorococcum</i>	li	WLG	G01			
<i>Scoliciosporum umbrinum</i>	sx	WLG				
<i>Steinia geophana</i>	sx	WLG				G01
<i>Thelidium minutulum</i>	sx	WLG				G01
<i>Thelidium zwackhii</i>	sx					G01
<i>Trapelia coarctata</i>	sx	WLG				G06
<i>Trapelia glebulosa</i>	sx					G06
<i>Trapelia obtegens</i>	sx	WLG				
<i>Trapeliopsis flexuosa</i>	li,sx					G05
<i>Verrucaria muralis</i>	sz	WLG				
<i>Verrucaria nigrescens</i>	sz				A10,DF,P05	A10
<i>Verrucaria dolosa</i>	sz					G01
<i>Xanthoria parietina</i>	ep,li,sx	A10,P05,DF, W08,S03,G01	G05,W01		A10	F03,P05,W09
<i>Xanthoria polycarpa</i>	ep	WLG	A01/5			F05,P05,G05
<i>Xanthoria ucrainica</i>	ep					G05
<i>Xanthoparmelia mougeotii</i>	li	WLG				G05

\* Introduced with heathland habitat

Substrate: ep = epiphytic (on living plants), li = lignicolous (on dead wood), sx=saxicolous (on rock), ter=terricolous (on soil)

For habitat locations - see Figure 1

WLG = exact localities within the Wildlife Garden not recorded

changed radically in the last 12 years especially in areas that are now overgrown or shaded by vegetation as in the woodland area. However, some changes suggest wider changes in London's environmental conditions, such as the loss of *Lecanora conizaeoides* (previously often called 'the pollution lichen') which formerly grew in a large patch on the lime tree in the centre of the garden. In the years of high SO<sub>2</sub> deposition as acid rain this lichen was common but the Clean Air Acts resulted in a decrease in SO<sub>2</sub>. The reduction of SO<sub>2</sub> levels revealed the effect of other pollutants and particularly atmospheric nitrogen compounds from traffic along Cromwell Road became more obvious. The result was an increase in species tolerant of atmospheric nitrogen oxides and ammonia such as *Xanthoria parietina* (Leigh and Ware 2003), *Phaeophyscia orbicularis* and more recently two more Physciaceae, *Hyperphyscia adglutinata* on both rocks and trees and *Phaeophyscia nigricans* on rocks. *Hyperphyscia adglutinata* is abundant on plane trees along the Cromwell Road

Right: Foliose *Xanthoria parietina* growing with the crustose lichen *Candelariella vitellina* in 2001, the latter disappeared after 2009. © The Trustees of the Natural History Museum, London

and Queen's Gate but still comparatively rare in the garden where the dense shrub layer acts as a pollution filter but also increases the shading which may contribute to the low frequency of the *Hyperphyscia* in most parts of the garden. The pH of all substrata in 2015 is consistently relatively high (Table 10), even on siliceous rocks which naturally have acidic surfaces. Strongly acidophytic species that were present during the high SO<sub>2</sub> regime of the last century (e.g. *Lecanora conizaeoides*) are now absent and replaced by species associated with a high pH, elevated nitrogen and dust deposition. The pH values measured on two young oaks range from 6.4 to 6.7 and contrast with the results of an earlier survey of oaks across London which reported pH ranges between 4.6 and 5.9 with an average of 4.92 in Hyde Park only five years ago (Larsen *et al.* 2007). The lowest pH in the garden

Below: *Parmotrema perlatum* on chestnut paling to meadow where the surface pH remains low. © The Trustees of the Natural History Museum, London



with 4.8 was recorded on the chestnut fence rails (G05). This fence has a small-scale mosaic of micro-habitats and pH values ranging from 4.8 to 6.7. This habitat diversity is reflected in a count of 23 species on rails and posts including rather sensitive taxa which become more common on suburban trees, and in parks and woodlands, e.g. *Flavoparmelia caperata*, *Evernia prunastri*, *Ramalina farinacea* and *Parmotrema perlatum*, together with nitrophytes. Other interesting species that have appeared in 2015 on this substrate include the beautiful *Caloplaca cerina* with its orange fruiting bodies and *Xanthoparmelia mougeottii*, a pioneer species which is widespread in the south of Britain and apparently increasing in recent years particularly on acidic tombstones in graveyards, but rather rare on dead wood. This habitat is today a hotspot of lichen species richness in the garden (and inner London). All other substrata in the garden have a higher pH which suggests that this is a limiting factor for many of the species that prefer a neutral to acidic pH. The result in the garden is that the trees in the woodland areas (W0 numbers) are still low in lichen species numbers and tend to support nitrophytic species. The surprisingly high pH values and dominance of nitrophytic lichens on all of the rock surfaces may be influenced by the accumulation of dust and of plane tree seeds which cover the horizontal surface of the boulders and which also alter the nutrient status and surface pH. This, together with the increased shade, has resulted in the loss of pioneer species such as *Lecidella stigmatica*, *Lecania erysibe* and *Rinodina oleae* from the quadrats on boulders

Below left: Lichen quadrat on a flint boulder in 2002 showing early colonisation of chalk by crustose species *Lecidella stigmatica*, *Caloplaca citrina* and a small *Physcia adscendens* (centre). © The Trustees of the Natural History Museum, London

Below right: Detail of flintstone surface colonized by *Hyperphyscia adglutinata* in 2009.  
© The Trustees of the Natural History Museum, London





Pink apothecia and pale green soredia of *Bacidia adasta*.  
© The Trustees of the Natural History Museum, London

although they are still present on exposed surfaces on the walls along the edge of the meadow in G06. In 2003 *Xanthoria parietina* was still abundant and recorded in six of the quadrats on sandstone and calcareous boulders (though not on granite boulders) (Leigh and Ware 2003). In recent years although it has been lost in quadrats that have become shaded and overgrown it has appeared in other habitats as on young ash trees in the woodland area as well as on fallen plane twigs and on the chestnut fence rails around the meadow.

Species that came in with an introduced habitat element have rarely survived for long. However the heathland that was sourced from Merritown Heath in February 2012 included five species of *Cladonia* on the turf between the *Calluna* stems. *Cladonia* species are regarded as sensitive to even low levels of eutrophication yet two species are still present in 2015 in a site situated less than 50m from Cromwell Road. The cover of these species however is decreasing constantly and more and more of the *Cladonia* is outcompeted mainly by mats of the moss *Hypnum jutlandicum*. *Peltigera cf. hymenina* which still continues to grow, for example, on graves in nearby Brompton Cemetery had colonised the heathland patch spontaneously but disappeared within two years with *Hypnum jutlandicum* now also occupying the once open space where the *Peltigera* lived. A remarkable survivor of an introduction is *Opegrapha vermicellifera* on a dead oak trunk which is used as an observation beehive. This species is typical of extensive lowland woodlands and rarely found in urban areas. It was certainly introduced with the oak trunk

two years ago but continues to thrive in this shaded environment in the absence of stronger competitors.

The chalk downland has always produced surprises. Early on *Steinia geophana*, an ephemeral species of disturbed habitats, was recorded on flint in the chalk and subsequently two species of *Thelidium* were recorded on pebbles near the stream (Leigh and Ware 2003). In 2009 Holger Thüs found *Verrucaria dolosa* on flint at the edge and in temporarily inundated parts of the small stream rising in the chalk, and in 2014 *Thelidium zwackhii* on pebbles on the opposite side of the meadow, inside the shaded gate by the path leading out of the garden. Although these species are found in urban habitats across Britain they are often under-recorded (Gilbert 1990). In December 2005 Dr Andre Aptroot from the Netherlands paid a visit to the Museum and we spent a morning in the garden. This led to several records of species associated with an increase in nitrogen compounds in the Netherlands that are now appearing in the UK; *Bacidia adastra* (Sparrius and Aptroot 2003) was found on rocks near the pond in G04 and on the fence rails by the chalk downland, *Bacidia neosquamulosa* (usually a corticolous species) described in 1999 by Aptroot and van Herk was found on the same rock as *Bacidia adastra*. A close look at the gneiss rock in heavily shaded W08 where Q7 had become dominated by bryophytes produced *Bacidia egenula* - a species characteristic of this shady habitat. In 2011 *Bacidia inundata* was found in Q5 on another gneiss rock. *Bacidia inundata* is a species which is often abundant on river banks but also occurring in other often half-shaded habitat types.

Corticulous species have also increased. In 2005 the trees in the woodland area, planted between 1993 and 2000, supported eight species. Today the highest cover and species richness is found on the bark of younger trees which are not (yet) as shaded as the first generation of trees on the site (Table 10). The pattern of colonisation during sun-exposed early periods followed by disappearance and replacement with shade-tolerant species later is evident for the epiphytic species. *Phaeophyscia nigricans* was first observed in the garden on trees from where it has disappeared due to the shading but it is now starting to colonize sun-exposed limestone blocks in large numbers on the wall which surrounds the heathland patch as well as the walls of the west end of the main Museum building alongside Gill's meadow, G06.

Overall, the composition of the lichen biota in the garden is mainly driven by three factors, two external and one internal:

- the change from a dominant acidic pollution by SO<sub>2</sub> to a pollution cocktail which continues to contain a high level of NOx from traffic. This is reflected in the dominance of *Xanthorion*-related communities in sun-exposed parts (particularly on trees and dead wood) and *Bacidia*-rich communities in the shaded areas (on rocks and trees).
- Introduction of species by transferring materials from areas outside of the urban environment (e.g. heathland soil and Ericaceae plants, 'bee-tree'). These introductions constitute an active manipulation of the species pool and although unintended can be used to assess the role of pollution tolerance versus dispersal limitation in a range of lichen species.
- Succession of the marginal areas towards a more typical woodland microclimate with an increase of (heavily) shaded areas resulting in the loss of light-demanding pioneer species on older trees and rocks and the appearance of woodland species on the chestnut fence.

## FAUNA

### INVERTEBRATES

#### AQUATIC MACROINVERTEBRATES

ADRIAN RUNDLE, LEARNING CURATOR, NATURAL HISTORY MUSEUM

The aquatic insect fauna is still very diverse in all the ponds. The true bugs (Hemiptera) are well represented and there are several new additions. A small juvenile water scorpion *Nepa cinerea* was found in the main pond. There were three species of surface-dwelling bugs: *Gerris argentatus*, *Hydrometra stagnorum* and *Mesovelia furcata*, the last being new. The water boatmen *Notonecta glauca* and *Hesperocorixa linnei* were both common. Water beetles were especially common in the main pond and included *Acilius sulcatus*, *Hygrobria tarda*, *Hyphydrus ovatus* and *Haliplus* sp. Whirligig Beetles (*Gyrinus* sp.) were common in the chalk pond but were always out of reach. Of the larger crustaceans present, only *Asellus aquaticus* was seen and *A. meridionalis* doesn't seem to occur. Only two species of water fleas were seen between June and August 2014. These were *Daphnia longispina* and *Scapholeberis mucronata*. Caddis fly *Limnophilus* spp. reported as absent from previous surveys (S.Brooks, in Ware and Leigh 2003: 100) are now commonly found, as are mayfly *Cloeon dipterum*, midge larvae *Chaoborus* species and *Chironomus* species.

Larvae of azure damselflies *Coenagrion puella* are commonly found during pond-dipping sessions but whilst dragonfly larvae have not been recorded during the current pond surveys,

*Blue-tailed damselfly* *Ischnura elegans*. © The Trustees of the Natural History Museum, London



exuviae of southern hawker *Aeshna cynea* and migrant hawker *Aeshna mixta* have recently been collected. The former collected from marginal vegetation around the top pond (A09), the latter from the main pond margins. The regular presence of these dragonflies as well as large red damselfly *Pyrrhosoma nymphula*, common blue damselfly *Enallagma cyathigerum*, emperor dragonfly *Anax imperator* and common darter dragonfly *Sympetrum striolatum*, strongly suggests that these seven species are breeding in the ponds.

## ORTHOPTERA

DUNCAN SIVELL, LIFE SCIENCES, NATURAL HISTORY MUSEUM

Eight Orthoptera species are listed for the Wildlife Garden, including a recent addition to the British fauna, the southern oak bush-cricket *Meconema meridionale* and a very unexpected species for central London, the bog bush-cricket *Metrioptera brachyptera*. Some common London species are still missing from the list, however, and three species that were recorded early in the garden's history are now presumed to be absent.

The southern oak bush-cricket was first recorded in Britain in 2001 and has been expanding its range in southern England ever since. This bush-cricket was found in the garden in 2013 and its appearance is consistent with an increase in sightings across London. More unexpected was the discovery of an adult bog bush-cricket in 2012. This was caught and photographed, then released back into the garden. There are few records of this species within the M25 and the nearest population appears to be at least 10 miles from South Kensington. As this species has not been seen or heard since its first discovery we presume the record was a stray individual, probably introduced with the heathland plants in 2012.

Two species noticeably absent from the garden are the common green grasshopper *Omocestus viridulus* and Roesel's bush-cricket *Metrioptera roeselii*, which are both relatively common within London. The common green grasshopper was present in the garden between 1995 and 1998, along with the common ground-hopper *Tetrix undulata* and slender ground-hopper *Tetrix subulata* (Honey et al. 1998), but as none of these three species have been recorded in recent years we assume their populations died out and have failed to recolonize. The ground-hoppers are relatively small and cryptic and may be missed by casual recording, although some populations can be ephemeral, lasting just a few years (Baldock 1999). Both ground-hopper species are considered to be good colonizers and may reappear if other populations exist near the Museum.

The common green grasshopper is quite large and distinctive and is easily recognized by its song, so it is unlikely this species has been overlooked. Roesel's bush-cricket is similarly distinctive in appearance and song, and although it has not been recorded in the garden one was seen resting on the wall of the Museum's Darwin Centre in 2015, literally a stone's throw away. This individual was a female of the long-winged form of the bush-cricket (*Metrioptera roeselii* f. *diluta*). This recent sighting suggests Roesel's bush-cricket could soon be added to the garden's Orthoptera list.

A total of eleven Orthoptera species has been recorded since the garden was created, but the Orthoptera community has changed and developed over time and not all of these species persist. There is potential for new colonizers to arrive and targeted survey effort is recommended for this group, particularly for the more cryptic species.

## HEMIPTERA - TERRESTRIAL HETEROPTERA AND AUCHEGORRYNCHA

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Most terrestrial Heteroptera ('true' bugs) and all Auchenorrhyncha (leafhoppers and allies) are herbivores which feed on one or more plant species. As such, they have a direct relationship with the flora of any given site and reflect the plant communities present. Since the various zones created in the Natural History Museum's Wildlife Garden may be seen as small islands of 'natural' habitat within a highly urbanised local environment, the range of species which have colonised them is of particular interest.

A total of 42 species of Heteroptera ('true' bugs) have been recorded in the garden as of 2015, 34 of which are terrestrial and eight are aquatic. The Auchenorrhyncha (leafhoppers and allies) are represented by 29 species. Of the 63 terrestrial species, 7 are grass-feeding, 19 have herbaceous host plants and 37 are associated with woody shrubs and trees. All the grass-feeders are generalists which are typical of semi-improved grasslands in southern Britain, although some require areas of longer grasses in order to persist, for example the mirid *Megaloceroea recticornis*. Those feeding on herbs include three very widespread bugs which are ubiquitous on stinging nettle: the leafhopper *Eupteryx aurata* and the mirids *Liocoris tripustulatus* and *Plagiognathus arbustorum*. However, some of these species are rather more typical of natural habitats, in particular *Eupteryx tenella*, a leafhopper found on yarrow and *Polymerus nigrita*, a mirid on bedstraws. The relatively large number of species feeding on shrubs and trees is perhaps not surprising, since most of the native British tree fauna is represented in the garden. Hornbeam, hawthorn, hazel, birch, poplar, ash, sycamore and London plane are amongst the specific hosts for this group.

The British Hemiptera fauna has seen much change in recent years and more than 50 new species of Heteroptera and Auchenorrhyncha have been added to the British list since 1990. The majority of these are new colonists, as opposed to taxonomic splits or overlooked native species and have generally arrived here following natural dispersal from the near Continent or via the horticultural trade as accidental imports in ornamental plants and landscaping materials (Stewart and Kirby 2010). The London area benefits from a significantly milder climate than other parts of southern Britain and it is pertinent that a number of these new colonists appear to be found nowhere else.

Eight such species have been recorded from the garden, of which the best known is perhaps *Arocatus longiceps*. This red and black lygaeid feeds on the seeds of London plane and was discovered in central London in 2006 (Nau and Straw 2007). It has been prolific in the garden since at least 2007 and attracted considerable media attention during 2008. The bugs were originally identified as *A. roeselii*, a species long thought to be associated with alder on the Continent. After some debate (Barclay 2007, 2009; Hoffmann 2008), consensus was reached that all plane-feeding *Arocatus* in western Europe refer to the very similar *A. longiceps*. However, morphologically indistinguishable bugs have now appeared on alder in Britain and recent molecular work has failed to discriminate populations of *Arocatus* on plane and alder in Germany (Hoffmann 2012). The species limits of these taxa now seem confused and may be in need of reassessment (Bantock 2014).

The mirid *Closterotomus trivialis* was found in numbers in the garden during the Natural History Museum's Big Nature Day in 2011. This polyphagous species is native to the Mediterranean but has been recorded widely from the London area in recent years



Plane tree bug *Arocatus longiceps*. © Tristan Bantock

(Bantock 2011). Populations have also been found in Yorkshire and Oxfordshire, suggesting a pattern of repeated introduction. Two other recently arrived Heteroptera species are known from the garden, both of which were found as singletons in malaise trap samples during 2012. The anthocorid *Buchananiella continua* is most frequently associated with dead woody vegetation and was first recorded in Britain from Buckingham Palace Gardens in 1995 (Kirby 1999). The mirid *Tropidosteptes pacificus* feeds exclusively on ash and is a very recent arrival in Britain (Bantock and Stewart 2013). This bug is native to the USA but was recorded in Holland in 2007 and 2008 as a probable horticultural introduction on ornamental ash (Aukema *et al.* 2009).

The remaining four species are leafhoppers, all of which were found in Malaise trap samples during 2012. *Fieberiella florii*, a large and attractive chestnut coloured leafhopper covered with black dots, was first recorded in 1998 at Park Royal in west London. Since then, it has turned up in several places in the London area on ornamental plantings in suburban settings (Stewart *et al.* 2015). Both European species in this genus have now been recorded in Britain (Bantock and Stewart 2011). *Zygina nivea*, which feeds on white poplar, was discovered in Britain in 2010 and is now probably widespread in the London area (Bantock *et al.* 2010). *Acericerus ribauti* was first recorded in London in 2008 and is found on maples, usually with its close relative *A. vittifrons*, while *Eupteryx decemnotata* is most frequently associated with sage and is now widespread in the south-east since its discovery in 2002 (Maczey and Wilson 2004).

## HEMIPTERA - STERNORRHYNCHA

JON H. MARTIN, SCIENTIFIC ASSOCIATE, LIFE SCIENCES, NATURAL HISTORY MUSEUM

To the vast majority of people aphids are either ‘greenfly’ or ‘blackfly’ and only come on to their radar when large colonies appear (often quite suddenly) on their vegetable or flowerbed plants. A second group of people, those with more interest in the group through being entomologists or other biologists, will certainly know that there are many more species of aphids than this but may be blissfully unaware of just how many there are! To date 44 aphid species have been recorded colonising plants in the garden - a seemingly high total to most people but actually representing but a small proportion of the aphid species that are likely to be present periodically.

There are in the region of 4,400 named aphid species worldwide and Britain is home to over 400. That Britain is home to c10% of the entire world fauna immediately indicates one thing - that aphids are predominantly a group inhabiting temperate regions. In fact it is the northern temperate regions that are particularly rich in aphid species - a belt running from North America, across Europe and Russia to northern parts of Asia. Rather few species are tropical natives.

Aphids belong to the insect order Hemiptera, whose members feed on liquid food via piercing stylets. Some hemipterans (for example, assassin bugs, toe-biters, anthocorid bugs and some capsid and pentatomid bugs) feed on other arthropods, and others feed on blood (bed bugs and triatomid assassin bugs). However, the entire suborder Sternorrhyncha, which contains the aphids, whiteflies, scale insects and jumping plant lice, contains only plant-feeding (phytophagous) species. Aphids are divided between three families (Aphididae, Adelgidae and Phylloxeridae) and species within the Aphididae are further divided between ten subfamilies.

All aphids are very small, the largest having a body length of around 8 mm but some are only a millimetre or so long. Their impact on their host plants arises from the sheer numbers that can develop in a very short space of time when conditions are right. Most aphids feed on actively-growing plant shoots which have more nutritious sap. This results in spring being the ‘peak season’ for aphids, with most plants growing fast. In fact there is also an autumn peak, too, as senescence leads to tree sap being more nutritious than in summer.

As well as being very small, almost all aphids are soft-bodied and individuals are delicate and vulnerable: the phrase ‘safety in numbers’ is particularly apt. Most species possess a pair of structures, siphunculi or cornicles, which are unique to aphids. Siphunculi are tubular and can discharge alarm pheromones and defensive lipids. The bigger the colony, the more likely it is that this defence will help to ward off would-be predators or parasitoids.

Most aphids are monoecious, undergoing their life cycle entirely on one host or on a small number of closely related hosts. Very few aphids are truly polyphagous and can develop on a wide range of hosts in many plant families: unsurprisingly polyphagous aphids tend to be pests of agriculture and horticulture. Aphids are ‘mistresses of invention’ and about 10% of species can utilise seasonally deciduous trees and shrubs through host alternation. So-called primary hosts are usually deciduous and the aphids need a way of surviving on their host in the absence of leaves or rising sap: it is here that sexual morphs

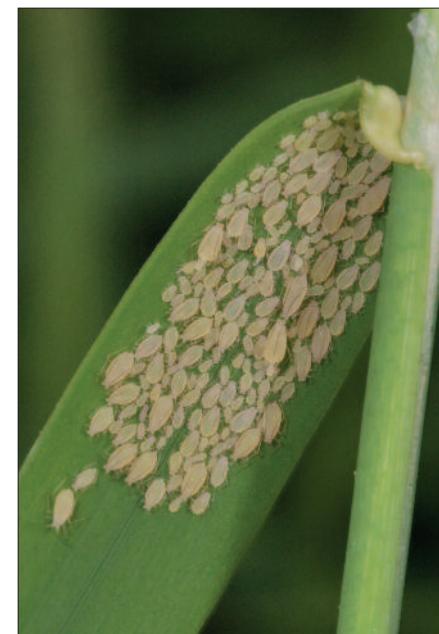
develop and adult females develop as egg-layers known as oviparae. In parallel with the production of oviparae, adult males also develop and these mate with oviparae to produce fertile, overwintering, eggs. In summer, when the sap of primary (woody) hosts is not as nutritious as in spring and autumn, host-alternating aphids employ winged females to seek out their secondary hosts - usually herbaceous plants that are only distantly related to the primary host(s).

The observation that aphids appear apparently suddenly and often in huge colonies arises from a highly specialised biology that exploits plants in optimum condition to support aphid development. Perhaps the most important aspect of aphid biology is parthenogenesis, a long word that means reproduction without recourse to sex. Parthenogenesis means that for all or most of the time (according to species) all individuals in a colony are females. As soon as an individual matures she begins to give birth to first-instar nymphs. Depending on climatic conditions and the suitability of a host plant, one individual can be mother to many offspring. Not only this but there can be ‘telescoping of generations’ where as-yet unborn embryos are already carrying their own offspring, i.e. the mother carries her own daughters, and their daughters too, within her abdomen.

Aphid populations can crash every bit as dramatically as they can burgeon. The optimum conditions of the host plant last only for a short period. In actively growing populations the adults of most species of aphids are wingless. As the condition of the host deteriorates, and as crowding leads to jostling amongst the aphids, chemical and physical signals trigger the development of winged individuals, still female, which can leave the scene and seek plants in better condition (if these winged morphs have managed to reach adulthood in time!).

The life cycles of most British aphids are now well understood but one particular aphid species has failed to reveal its secret for overwintering and this aphid has been observed in the garden on several occasions. *Tuberolachnus salignus* (Gmelin) feeds only on the trunks and woody main stems of willows (*Salix* spp.), which are deciduous. It has no alternative host and must, therefore, overwinter on willow. However, colonies sampled in late autumn and early winter contain only parthenogenetic (sex-less) females: oviparae and eggs have never been found, anywhere. Stranger still, this rather large grey aphid has only been found in autumn and winter: the Museum’s collection has no summer material of this species. Observed

Rhopalomyzus lonicerae - an aphid with a common yet highly specialised life cycle, abundant in Britain yet relatively unknown.  
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colonies have always gradually reduced and disappeared before spring. That *T. salignus* seems only to be found in autumn, but without a sexual generation, remains a puzzle and observations in the garden may yet discover how this enigmatic aphid lives during the rest of the year (when most aphid populations are burgeoning).

So, what about other aphids in the garden? The garden is a mixture of woodland trees and shrubs, interspersed with the herbs and grasses of the more open areas. Areas of such mixed flora tend to be rich in aphids. That the current aphid list for the garden is relatively small reflects the sporadic and rather short nature of most aphid searches (often in staff lunch-times!).

Early in the writer's career at the Natural History Museum, he conducted aphid searches in the garden of the family home in suburban Nottinghamshire from 1974 to 1981. These searches were more thorough and regular and yielded over 120 species of aphid in this one garden in Radcliffe-on-Trent: the key to this large species count is that the garden was actively used for vegetables, lawn, herbaceous border, troughs for other ornamental plants and several tree species. Aphids thrive on such managed habitats.

In conclusion, the garden is a valuable resource that has a high botanical diversity and is actively managed. This combination will undoubtedly have resulted in it being home to considerably more aphid species than the limited collecting hitherto might indicate.

#### HYMENOPTERA: APOIDEA - BEES AND DIGGER WASPS

DAVID G. NOTTON, LIFE SCIENCES, NATURAL HISTORY MUSEUM

Bees and digger wasps are part of the Hymenoptera, the order of insects including bees, social wasps, ants, digger wasps, cuckoo wasps, parasitoid wasps of many kinds, gall wasps, sawflies, wood wasps and their allies. Together bees and digger wasps form the superfamily Apoidea, represented by almost 400 species in Britain. They are found in most terrestrial ecosystems in the UK, the vegetarian bees foraging for pollen and nectar and the predatory digger wasps hunting prey to provision their nests. The great majority of bees and digger wasps are solitary, nesting in a burrow in the ground, or cavity in wood or plant stems, some are cleptoparasites, using the nest provisions of other bees/digger wasps for their own brood, while a few bees are social including the familiar honey bee and bumblebees.

In previous articles, formal lists although extensive in other respects, have barely touched on the Hymenoptera: Honey *et al.* (1998) did not record any bees or digger wasps; Leigh and Ware (2003) recorded two species of bumblebee (*Bombus*); some popular articles have been published on bees (Hine 2012, Notton 2009) and the garden's honey bees (Dixon 2006); a recent MSc project on the suitability of wildlife gardens, parks and surrounding areas as bee habitat in London recorded a few bees (Mosbery 2014), although this was based on field observations only so no vouchers were available for re-examination from this project and no distinction could be made between *Bombus terrestris* and *B. lucorum*.

The current paper is the first attempt to provide a reasonably comprehensive list of the species of bees (Hymenoptera: Apoidea: Andrenidae, Apidae, Colletidae, Halictidae, Megachilidae and Melittidae) and digger wasp species (Hymenoptera: Apoidea: Crabronidae) occurring in the garden, based largely on critically identified voucher specimens.

#### Garden habitats

The situation of the garden might at first appear challenging for wildlife, being surrounded by high buildings and with the pollution of a large city including an adjacent major road, however, careful habitat management by the garden team has created a wide variety of habitats (Leigh and Ware 2003) of value for bees, in particular the flower-rich chalk grassland tump, heathland, wildflower meadow and urban habitats which provide nectar and pollen forage throughout the year. The heathland was recently upgraded with plants from Dorset including ling *Calluna vulgaris*, bell heather *Erica cinerea* and dwarf gorse *Ulex minor* (Ware 2013). The marginal vegetation around the ponds is rich in flowers attractive to bees such as purple loosestrife *Lythrum salicaria*, hemp agrimony *Eupatorium cannabinum* and great willowherb *Epilobium hirsutum*. Flowering trees, shrubs and climbers make an important contribution with gorse *Ulex europaeus*, hawthorn *Crataegus monogyna*, domestic apple *Malus pumila*, holly *Ilex aquifolium*, ivy *Hedera helix*, buckthorn *Rhamnus catharticus*, cherry plum *Prunus cerasifera*, wild cherry *Prunus avium* and blackthorn *Prunus spinosa*. The goat willow *Salix caprea* around the pond is important as one of the few early season pollen sources. The ground flora and smaller flowering shrubs in the woodland areas are valuable mainly in the spring before the canopy closes over, including primrose *Primula vulgaris*, bluebell *Hyacinthoides non-scripta*, nettle-leaved bellflower *Campanula trachelium* and bramble *Rubus fruticosus* agg. Unfortunately these areas are strongly shaded by mature London plane trees around the perimeter of the garden which is bad for sun-loving bees. Although outside the garden proper, recent reduced mowing of the grassland strip immediately in front of the west wing of the Waterhouse building has resulted in a fine display of flowering herbs including clovers *Trifolium* sp., cat's ears, *Hypochaeris* sp., bird's-foot trefoil *Lotus corniculatus*, wild carrot *Daucus carota* and ragwort *Senecio jacobaea* which have attracted many bees. Bee activity is often high here because the south-facing front of the building acts as a heat sink/reflector, maintaining a high temperature. Areas of short vegetation with access to soil for digging nest burrows are of value to mining bees and diggers wasps include the meadow, grassland and urban habitats, hedge bases and outside the garden proper, the west lawns. Undisturbed grassland sward, cavities in banks/under stumps provide nesting and hibernation opportunities for bumblebees. Artificial habitats (hives, tree cavity observation hive) provide living space for the Museum's honey bees. The rich mix of plant species and vegetation structure provide niches for a variety of insect prey species upon which the digger wasps depend, while flowers with accessible nectar especially Apiaceae, such as wild carrot *Daucus carota* and angelica *Angelica sylvestris*, are suitable for the digger wasps since they have shorter tongues than many bees. Standing dead wood, log piles, brash piles and hollow plant stems, which have been deliberately left, provide opportunities for both cavity-nesting bees and digger wasps.

#### Discussion of results

A fair diversity of bees and digger wasps was recorded with 48 species of bee and 21 species of digger wasp confirmed. Most of these may be presumed to nest on site because immediately surrounding habitats (mainly tall buildings and hard surfacing) are unsuitable and, while no systematic search was made for nests, seven species certainly have nested in the garden or nearby: honey bee *Apis mellifera* (artificial hives), tawny mining bee



*Common carder bumblebee Bombus pascuorum, male at common knapweed Centaurea nigra.* © The Trustees of the Natural History Museum, London

*Andrena fulva* (burrows in west lawn), short-fringed mining bee *Andrena dorsata* (burrow in meadow), common carder bumblebee *Bombus pascuorum* (nest in grass in urban area), buff-tailed bumblebee *Bombus terrestris* (nests in hole in ditch wall and under stump), *Rhopalum coarctatum* (nest in beetle burrow in fence post) and *Stigmus solskyi* (nests in beetle

burrows in dead *Fraxinus excelsior* stem). The list of flowers visited (Appendix 2) shows the wide range of plants on which these insects are dependant. Some rare species were found: firstly, the digger wasp *Crossocerus congener*, probably a very rare and previously overlooked native species, still only known in Britain from a handful of specimens; while it does not yet have a conservation status assessment because of its recent discovery, its very limited distribution suggest that it may merit one (Archer 2007); secondly, the

*Tree bumblebee Bombus hypnorum, male at purple loosestrife Lythrum salicaria.*

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digger wasp *Crossocerus distinguendus* is Nationally Notable A, although possibly a recent colonist to England and may have extended its range recently; thirdly the large yellow-face bee *Hylaeus signatus* is Nationally Notable B, this bee visits only *Reseda* species for pollen, in the Wildlife Garden it was found on wild mignonette, *Reseda lutea*; fourthly the digger wasp *Lestiphorus bicinctus* is Nationally Notable B, a predator of froghoppers. One of the most spectacular recent range extensions among British bees was documented in the garden, that of the tree bumblebee *Bombus hypnorum*; this species was recorded as new to Britain in 2001 on the strength of a single specimen from Wiltshire (Goulson and Williams 2001), only five years later it was found by the author in the garden (Notton 2009) and has since gone on to extend its range as far as Scotland.

The value of recording and monitoring complements educational activities in the garden, which have highlighted bees and wasps, and these include:

- Personally directed study and walk showing visitors bees/wasps in near-natural habitats
- Wildlife Garden bee tree - an observation hive for honey bees
- Bumblebee walks
- Making insect hotels for mason bees and leafcutter bees
- Insect identification activities incorporating bees and wasps, e.g. Bugs Count ID Challenge incorporated into events: Open Air Laboratories (OPAL), National Insect Week, Hedgerow Harvest, etc.
- Drawing for Bee Diversity: garden artist in residence, Jessica Albarn, draws bumblebee specimens in support of the Bumblebee Conservation Trust - visitors join in too during Insect Weekend on National Insect Week
- OPAL Species Quest

Ecological and other scientific activities in the garden which have utilised bees/wasps include:

- Specimens collected in the garden have been added to the national reference collection
- Specimens from the garden have been used to provide DNA sequences for the forthcoming DEFRA national database of pollinator DNA barcode sequences; this will facilitate rapid automated mass identification of pollinators by non-taxonomists, underpinning large scale surveys of pollinators in the UK
- Surveys have been carried out to record the species of flowers visited by bees - see Appendix 2

In conclusion, the garden provides a range of suitable habitats in an inner city context for 48 species of bee and 21 species of digger wasp including the very rare digger wasp *Crossocerus congener* and three other Nationally Notable species, the digger wasps *Crossocerus distinguendus* and *Lestiphorus bicinctus* and the bee *Hylaeus signatus*. The bees in particular have provided the subject of a number of educational and scientific activities, supporting the aims of the garden.

Recent and proposed improvements to the garden which will enhance habitats for bees are recommended and have now been incorporated into the Wildlife Garden Management Plan.

## BEETLES (COLEOPTERA) RARITIES, NEWCOMERS, AND THE BIODIVERSITY VALUE OF A SMALL URBAN OASIS

MAXWELL V. L. BARCLAY, LIFE SCIENCES, NATURAL HISTORY MUSEUM

The Natural History Museum's wildlife garden is of considerable interest and not just as a rare green space with native vegetation in the midst of a built up part of the city. It has been maturing for 20 years and was designed to represent in microcosm many of the UK's most important natural habitats: lowland heath, chalk grassland, flower rich meadows. It also has a number of mature trees and well-established, fish-free ponds, but its particular importance is that it is one of the most intensely monitored wildlife sites in London, possibly in the UK. Few other sites can boast such a large number of scientists based within just a few hundred metres. This intensity of study has meant that it has provided the earliest records of a number of insect species newly colonising the British Isles and has also yielded a very comprehensive species list. The garden thus provides a useful record of species coming in from abroad, as well as a guide to which of our native species are able to colonise and survive in small areas of reconstructed natural habitat in an urban landscape, an increasingly relevant question for conservationists in the modern world, since the relative importance of urban habitats will only increase.

The total list of beetles from the wildlife garden stands at 356 species in 47 families. Some 10% of the British beetle species have been recorded, which is impressive considering the small size of the garden, and the fact that many habitats (coastal, montane etc.) are understandably absent. Nomenclature used in the list has been updated to follow Duff (2012), as does the systematic order of the families, but genera and species are listed alphabetically within families. Metadata and collection dates are not given in the present list, though this information is retained in the Wildlife Garden database.

Rarity status (Notable or Red Data Book) are based on Hyman (1992, 1994). The highest is 'RDB1' (Red Data Book category 1: Endangered), going through RDB 'K' and 'I' for poorly known species of very rare occurrence, to the two notable categories, 'Notable A' denoting a species reported from 30 or fewer 10km squares of the UK National Grid, and 'Notable A' fewer than 100. Water beetle status are updated based on Foster (2010); more recent treatments are available for several other taxa, but these remain incomplete at the time of writing, and use an incompatible evaluation system, so are disregarded in the interest of a uniform approach. The number of species with a conservation status is rather higher than might be expected and several of these rarer beetles, as well as other species of interest, are discussed in more detail below.

Specimens were identified by a number of people, often Peter Hammond and Roger Booth, but including many other entomology and enquiries staff, past and present, in some cases from photographs. Identifications have been verified wherever possible, but as the list was assembled over many years by a number of people, and voucher specimens were not always retained, some species still require confirmation by examination of additional material. As is frequently the case, the more 'obvious' species that collectors don't retain can be the most problematic. One identification included in the list is particularly questionable; the ladybird *Harmonia quadripunctata*, generally associated with conifers, is listed for the garden based on a single un-vouchered specimen from a light trap in August 2008. This was comparatively soon after the introduction of its extremely variable, and strongly light-attracted, congener *Harmonia axyridis*, which

casts doubt on what at the time was a confident identification not seeming to require a voucher specimen. The flightless burrowing water beetle *Noterus crassicornis* is another example; this has suffered nomenclatural and taxonomic confusion with the similar but commoner, flying, *Noterus clavicornis*, which appears not to have been found in the garden. I was initially tempted, in the apparent absence of a specimen, to discard *Noterus crassicornis* from the list, but have been reassured by my colleague Adrian Hine, who is a specialist of water beetles and has examined Wildlife Garden specimens, that the identification is correct, and that the rare flightless species is indeed present, maybe having originally been introduced to the ponds with water plants. These two examples do emphasise the importance of retaining voucher specimens, even of supposedly obvious or common species, for any long-term on-going survey, to allow future users of the data to confirm identifications in years, decades or centuries to come. The Natural History Museum's insect collections provide, of course, the perfect facility for long term preservation of specimens.

### Comments on Coleoptera species of note recorded from the Wildlife Garden.

#### Water beetles

'Water beetles', for the purposes of this list, refers to the Adephagan families Gyrinidae, Halpidae, Hydrobiidae, Dytiscidae and the Polyphagan family Hydrophilidae, the last of which includes several terrestrial genera including some members of *Cercyon*, *Cryptopleurum*, *Sphaeridium* and *Megasternum* recorded from the garden. Thanks to regular pond dipping, more than 40 species have been noted (although the whirligig beetle has not been identified to species, it is almost certainly the abundant *Gyrinus substriatus* Stephens). 'Notable' species include *Noterus crassicornis* (see above) and *Hydaticus seminiger*. The Screech Beetle *Hygrobia hermanni*, a taxonomically very isolated insect, and capable of producing a clearly audible squeak when handled, and the Great Diving Beetle *Dytiscus marginalis* are also worthy of mention. The abundance of water beetles may be at least in part due to the absence of fish from the garden's ponds.

#### Ground Beetles

The ground beetle family Carabidae is well represented in the garden because of the wide range of suitable habitats and because of intermittent pitfall trap surveys over the years. However, the most interesting species were collected using light, probably because they frequent habitats that are not easily accessible for hand searching or pitfall trapping. These include *Perigona nigriceps*, a species with a wide global distribution but infrequently recorded in Britain; *Elaphropus parvulus*, an extremely small and fast moving species not easily collected or even seen except by trapping; *Curtonotus convexusculus*, a scarce, primarily seed-feeding species generally associated with saline environments, and most interestingly *Polystichus connexus*, a striking and very rare species with only a handful of recent records, also generally associated with salty or brackish habitats. The presence of the two latter species may be linked to the tidal Thames, and associated riverside saline brownfield sites within flying distance. Conspicuous by their absence are the generally very common, large flightless predators, such as representatives of the genera *Carabus*, *Cyclus*, *Abax* and the bigger *Pterostichus* spp. (e.g. *niger*, *melanarius*). There

is sufficient food for these species (slugs, snails, worms etc.) so it is assumed that they have so far been unable to colonise the garden, because of their inability to fly.

#### **Staphylinoidea**

For the purposes of this work, the Staphylinoidea include Leiodidae, Ptiliidae and Staphylinidae, and comprise almost 100 species in the garden, many of which are predators in various dead organic matter. The close attention paid to the compost heaps, and NHM staff Peter Hammond and Roger Booth's special interest in and knowledge of these groups, have made this a long and impressive list, including many species of the particularly taxonomically challenging staphylinid subfamily Aleocharinae.

#### **Scarabaeoidea**

The scarabs and their relatives the stag beetles are represented in the garden by only eight species but these include the magnificent *Lucanus cervus*, the greater stag beetle, the largest of Britain's beetles. The lesser stag beetle *Dorcus parallelipipedus* is commonly seen and the presence of both of these species indicates a reasonable supply of dead wood, in which their larvae develop. The true scarabs include several species of the dung beetle genus *Aphodius*, and the emerald green rose chafer *Cetonia aurata*, another beetle often developing in dead logs and stumps, and one which declined dramatically throughout most of the 20th century and seems only recently to be making a comeback. Finally, in 2015 *Saprosites natalensis* was reported from the garden for the first time; this uncommon small wood-inhabiting scarab, thought to be, as the name suggests, of southern African origin, is only known in Britain from a few records in the London area.

#### **Elateriformia**

This infraorder includes a large slice of beetle diversity, but for the purposes of this paper unites the families Scirtidae, Byrrhidae, Heteroceridae, Throscidae, Elateridae and Cantharidae, with only 10 species reported between them from the garden. The lack of records may be because many of the adults are short-lived and hence under-recorded, and there may be scope to extend this list by targeted surveys in the right season. None of the species reported are of particular interest, perhaps the least common being the small, spiny pill beetle *Synclypta spinosa*, reported from the chalk grassland habitat.

#### **Bostrichoidea**

This superfamily comprises the Dermestidae (skin, hide and museum beetles) and Ptinidae, so-called 'spider beetles', which has been extended to include the former woodworm family Anobiidae. The 14 bostrichoids known from the garden are mostly synanthropic, associated with human dwellings, and some, such as *Anthrenus* spp., *Dermestes* spp. and *Stegobium* include species that, as larvae, can be pests in the museum's collections. *Dermestes*, which has flesh-eating larvae, is the genus used by the Museum to clean delicate vertebrate skeletons for study. *Anthrenocerus australis* and *Anthrenus sarnicus* are species of infrequent occurrence in Britain; the latter was described new to science from Guernsey in the 1960s, though no doubt introduced from further afield. *Ctesias serra* is one of the few entirely 'outdoor' species of Dermestidae in Britain; the distinctive hairy larvae feed on insect exoskeletons discarded by spiders under bark, and are common

on the garden's London plane trees. Of the Ptinidae, three species are of particular note: *Anobium nitidum*, reported at light on two occasions in the garden, is very rare in Britain, with only a handful of records; like a number of the other scarcer species, adults probably breed in dead branches and sticks on the two Lombardy poplars that are a centrepiece of the Museum's garden. *Priobium carpini* was added to the British list based on specimens from South Kensington and *Ptinus sexpunctatus* is a local species that seems, at least in part, to be associated with the nests of solitary bees.

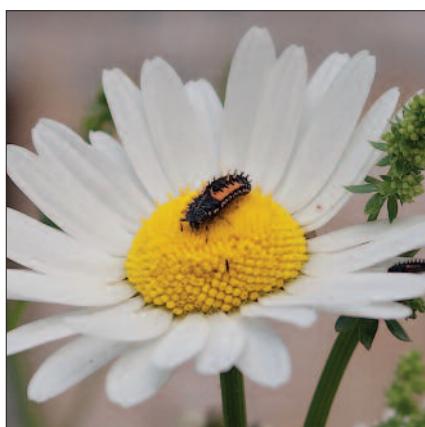
#### **Cleroidea, Cucujoidea and Tenebrionoidea**

This group of three superfamilies includes some 75 species from the garden. Of the rarer species in these three superfamilies, *Dasytes plumbeus* (Melyridae) appears to do quite well in the London area, with larvae probably in the twigs of the poplars. *Langelandia anophthalma* (Colydiidae) is an eyeless subterranean species of infrequent occurrence, though its rarity is probably partly because few entomologists use underground trapping techniques, which have been used widely in the garden. *Conopalpus testaceus* (Melandryidae) is a scarce dead-wood feeding 'false darkling' beetle, probably associated with dead twigs on the two Lombardy poplars, and collected in June 2012 by Tristan Bantock while surveying for Hemiptera. *Mordellistena acuticollis* (Mordellidae) is a phytophagous species of 'tumbling flower beetle', of generally infrequent occurrence, probably associated with thistles. The 'cardinal beetle' *Pyrochroa serraticornis* (Pyrochroidae) was reported breeding for the first time in 2015; its predatory larvae were found under the bark of logs in a log pile. Two metallic green species of the genus *Oedemera* (Oedemeridae) are common in the meadow, flying in sunshine from flower to flower.

Most familiar amongst the many cucujoid families are the ladybirds (Coccinellidae). A special project has been carried out on the garden's ladybirds by student Emily Shaw, and the list stands at 19 species, including Britain's largest, the eyed ladybird *Anatis ocellata*. The rare *Clitostethus arcuatus* can occasionally be found overwintering in ivy on the plane trees; this tiny black ladybird with a distinctive yellow horseshoe mark is known from only one or two sites in Britain. On the gorse bushes alongside Queen's Gate is a population of the cottony cushion scale insect *Icerya purchasi* Maskell (Hemiptera: Coccoidea) which supports three Australian ladybird species, *Rodolia cardinalis*, *Rhyzobius lophantheae* and *Rhyzobius forestieri* - all of which were added to the British list from London, and the last from the wildlife garden itself, after a specimen was collected at light by volunteer Anders Dennis. Similarly *Rodolia cardinalis* was first noted in the garden by a group of children testing a ladybird identification application. Other cucujoids include *Meligethes gagathinus* and *M. rotundicollis*.

*Rhyzobius forestieri* - a second sighting (July 2014) in Britain. © The Trustees of the Natural History Museum, London





Mature harlequin ladybird *Harmonia axyridis* larvae on oxeye daisy, chalk downland habitat. © The Trustees of the Natural History Museum, London

(Nitidulidae) are scarce pollen beetles associated with mint (*Mentha*) and yellow rocket (*Barbarea*). *Olibrus flavicornis* (Phalacridae) is another extremely rare species, more or less restricted to the Thames Gateway area, but with a record from the wildlife garden. It is probably associated with hawkbits (*Leontodon* spp.), and is generally a species of brownfield sites along the Thames. *Enicmus brevicornis*

(Latridiidae) is a small black beetle associated with 'sooty bark fungus' *Cryptostroma corticale*, a disease of sycamore *Acer pseudoplatanus*. *Anommatus duodecimstriatus* (Bothrideridae), like *Langelandia anophthalma* above, is a blind subterranean species reported from underground pitfall traps, and with rather few records nationwide.

#### Chrysomeloidea

The superfamily Chrysomeloidea includes the longhorn beetles (Cerambycidae) and leaf beetles (Chrysomelidae). The former family are charismatic beetles, generally associated with forest habitats, and are represented in the garden by seven species; of these, most develop as larvae in small twigs and branches, though *Rhagium bifasciatum* and *Rutpela maculata* are larger insects and generally found in fallen trunks and larger logs. *Pseudovadonia livida* is a grassland species that breeds in the soil, in the mycelia of the fairy ring mushrooms. The least common of the garden's longhorns is the tiny *Nathrius brevipennis*, a cosmopolitan species breeding in small sticks, including basket-work; it is generally very rare in Britain. The 23 species of leaf beetles mostly feed on living plants and most are widespread. The formerly rare *Longitarsus parvulus* has increased its range strikingly in recent decades, and the red and black *Luperomorpha xanthodera* is a recent import probably with flowers from China via Italy, and is found sporadically in urban areas in Britain.

#### Curculionoidea

The weevils, Curculionoidea, characterised in most cases by the distinctive elongation of the front of the head into a snout or 'rostrum', include many more uncommon species in the garden than the ecologically similar Chrysomeloidea. *Bruchela rufipes* and *Kalcapion semivittatum* are warmth-loving species of early successional vegetation, breeding on wild mignonette *Reseda lutea* and annual mercury *Mercurialis annua* respectively, and neither is at all frequently reported. *Oxystoma cerdo* is also scarce, but apparently increasing, and associated with vetches *Vicia* spp. *Magdalisa barbicornis* and *Polydrusus formosus* are both 'Notable A' listed species, and Hyman (1992) gives no post-1970 records for either from the London area, but both have recently become more abundant, almost certainly because of introduction of more vigorous stock from southern Europe with

horticulture. The *Magdalisa* bores as a larva in the twigs of living woody Rosaceae such as hawthorn and *Pyracantha*. *Polydrusus formosus* is a polyphagous species on the northern edge of its range in Britain; it has several synonyms in common use, including *P. splendidus* (Herbst) and *P. sericeus* (Schaller), and all its names ('beautiful', 'splendid', 'silky') refer to its very attractive metallic golden-green scales. *Dorytomus ictor* is a very uncommon species feeding on foliage of poplars and overwintering as an adult under the bark. *Trypophloeus binodulus* is rarer still; often referred to as *Trypophloeus asperatus*, it is now known from only four English counties, and it bores in small twigs and branches of mature poplar trees. The last two beetles are amongst the rarest of the native species reported from the garden, both of considerable interest from a conservation and distributional point of view, and both dependent on the two large poplar trees in the centre of the garden.

#### LEPIDOPTERA - MOTHS IN THE WILDLIFE GARDEN

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Despite the interruption of experienced light-trap checking mentioned above new species have continued to be recorded in the garden and some have proved to be significant records for Middlesex (the Vice County in which the garden is situated), or the London area in general. The list of new additions is as follows, with dates when they were first captured and some comments on their status:

- 0015 *Triodia sylvina* (Linnaeus 1761) orange swift 08.vi.2015
- 0075 *Stigmella floslactella* (Haworth 1828), leafmines on hornbeam 23.vi.2011 and 1.viii.2012
- 0077 *Stigmella tityrella* (Stainton 1854), leafmines on beech 7.xi.2007
- 0102 *Stigmella aceris* (Frey 1857), untenanted mines on field maple, probably of this species, 2.xi.2004 and 3.xi.2006
- 0123 *Tischeria ekebladella* (Bjerkander 1795), at light 24.v.2012
- 0125 *Coptotriche marginea* (Haworth 1828), at light 24.v.2012
- 0148 *Nemophora degeerella* (Linnaeus 1758), by day 13.v.2008
- 245 *Tinea pallescentella* Stainton 1851 large pale clothes moth, at light 24.iv.2004
- 0304 *Parornix devoniella* (Stainton 1850), leafmine on hazel *Corylus* 3.xi.2006 and 27.ix.2007
- 0309 *Deltaornix torquillella* (Zeller 1850), at light 3.viii.2006
- 0317 *Phyllonorycter heegeriella* (Zeller 1846) pale oak midget 18.viii.2015 Plant (2002:136) gives four previous localities
- 0332 *Phyllonorycter corylifoliella* (Hübner 1796), to light 24.v.2012
- 0342 *Phyllonorycter coryli* (Nicelli 1851), leafmine on hazel 3.xi.2006 (moth reared) leafmine on hazel 27.ix.2007
- 0362 *Phyllonorycter acerifoliella* (Zeller 1839) leafmines on field maple, probably of this species, 2.xi.2004 and 3.xi.2006
- 0364 *Phyllonorycter geniculella* (Ragonot 1874), leafmine, probably of this species, 14.vii.2004

0382 *Bembecia ichneumoniformis* ([Denis & Schiffermüller] 1775) six-belted clearwing moth. This species was seen by day on the chalk mound on 15.vii.2009 and 12.viii.2009. Plant (1993:12) regarded it as an extremely local resident in the London area, restricted to the chalk downs, with only two recent records during his study period. It has been recorded to my knowledge in a few West London localities since then but it remains an uncommon species

0476 *Acrolepis autumnella* (Curtis 1838), leafmines on bittersweet 24.v.2006 and 1.viii.2012

0617 *Elachista obliquella* (Stainton 1854), at light 21.v.2010 and 22.v.2010 and leafmines on *Brachypodium* on 1.viii.2012, plus at light on 24.v.2012 and 18.vi.2013; a species of microlepidoptera new to Middlesex

0816 *Scrobipalpa obsoletella* (Fischer von Röslerstamm 1841), at light on 5.viii.2003

0844 *Syncopacma larseniella* (Gozmany 1957), at light 31.vii.2012 (gen. det.)

0856 *Anarsia spartiella* (Schrank 1802), at light 29.vii.2010; Plant (2002) cites just two records of this species from Middlesex, both in the early 1970s

0889 *Mompha divisella* (Herrich-Schäffer 1854) 20.v.2004 found dead in sticky trap in DC2

0890 *Mompha jurassicella* (Frey 1881), pre-2003 record

0936 *Cochylimorpha straminea* (Haworth 1811), to light 28.viii.2012

0938 *Agapeta zoegana* (Linnaeus 1767), at light 28.viii.2010; Plant (2002) cites just two records of this species from Middlesex, both from Ruislip, the most recent in 2000

0999 *Adoxophyes orana* (Fischer von Röslerstamm 1834) summer fruit tortrix, at light 5.viii.2003

1020 *Cnephasia stephensiana* (Doubleday [1849]) grey tortrix 30.vi.2015 Plant (2002:163) gives a number of localities

1084 *Hedya ochroleucana* (Frölich 1828) buff-tipped marble 30.vi.2015 Plant (2002:165) gives just three previous localities for this species

1111 *Bactra lancealana* (Hübner 1799), at light 28.viii.2012

1120 *Ancylis mitterbacheriana* ([Denis & Schiffermüller] 1775) red roller 30.vi.2015 Plant (2002:167) cites one previous record from Ruislip (Minnion 1959)

1329 *Donacaaula forficella* (Thunberg 1794) pale water-veneer 30.vi.2015 Plant (2002:176) gives a number of localities for this species

1134 *Epinotia ramella* (Linnaeus 1758), at light 4.vi.2009

1175 *Epiblema uddmanniana* (Linnaeus 1758) bramble shoot moth, at light 30.vi.2009

1183 *Epiblema foenella* (Linnaeus 1758), at light 2.viii.2010

1408 *Palpita vitrealis* (Rossi 1794) olive-tree pearl 17.vi.2015 Plant (2002:181) gives two localities for this migrant species, Ruislip 1957 (Minnion) and Hampstead 25.ix.1997 (Softly)

1409a *Cydalima perspectalis* (Walker 1859) box-tree moth 09, 14 and 21.vii.2015. This Asian adventive and expanding species has colonised the UK since Plant (2002). There have been several records.

1853 *Eupithecia dodoniata* (Guenée 1857) oak-tree pug, at light 26.iv.2010; regarded by Plant (1993:74) as a very local and uncommon resident

1934 *Agriopsis marginaria* (Fabricius 1777) dotted border, 19.viii.2014

1947 *Ectropis bistortata* (Goeze 1781) engrailed, found in basement of Entomology Department 19.vii.2005



Poplar hawk-moth *Laothoe populi*. © Martin Honey

2007 *Pheosia tremula* (Clerck 1759) swallow prominent 29.vii.2015. A good central London record, undoubtedly dependant on the poplar trees that are currently present in the garden but which are under threat of felling at the time of writing under new plans for the garden.

2020 *Diloba caeruleocephala* (Linnaeus 1758) figure of eight 17.vi.2015

2028 *Calliteara pudibunda* (Linnaeus 1758) pale tussock, at security light 14.v.2012; a scarce central London species according to the distribution map in Plant (1993:123)

2117 *Eugnorisma glareosa* (Esper 1788) autumnal rustic, found on 1st floor of Entomology Department 1.x.2004

2138 *Anaplectoides prasina* ([Denis & Schiffermüller] 1775) green arches, to light on 2.vii.2011 which appears to be only the second record for Middlesex

2275 *Xanthia gilvago* ([Denis and Schiffermüller] 1775) dusky-lemon sallow, at light in DC2 on 10.x.2010; regarded by Plant (1993:185) as a very local and rare resident

2276 *Xanthia ocellaris* (Borkhausen 1792) pale-lemon sallow, at light 16.ix.2003; Plant (1993:185) lists this species as an extremely local and apparently rare resident, which is dependent on the catkins and leaves of black poplar and its varieties

2292 *Cryphia algae* (Fabricius 1775) tree-lichen beauty, at light on 13.viii.2007; not included by Plant (1993), this species is now resident in the London area and has been expanding since it was rediscovered in the UK in the early 1990s

- 2303 *Thalpohila matura* (Hufnagel 1766) straw underwing, to light 28.viii.2012  
 2425 *Colocasia coryli* (Linnaeus 1758) nut-tree tussock, to security light 4.viii.2004; Plant (1993:220) shows this species to be absent from all of the more urban parts of London, only occurring as a resident in woodland in the outer districts  
 2442 *Autographa pulchrina* (Haworth 1809) beautiful golden Y, to light on 22.vi.2009; apparently uncommon in the central London area  
 2463 *Euchlidia glyphica* (Linnaeus 1758) burnet companion, one specimen of this day-flying species, plus a pair mating, seen on 9.vi.2004; Plant (1993:226) regards this species as a widespread but local resident  
 2488 *Pechipogo plumigeralis* (Hübner [1825]) plumed fan-foot, first recorded at light on 29.vi.2009; this is another species that has colonized the UK since the mid-1990s and is now resident and spreading in the London area

A number of historic records were discovered during the decant of the Lepidoptera collections to Wandsworth and the installation of a new British Lepidoptera collection and although they were recorded before the garden was created, they have been included for completeness. They include:

- 1473 *Ephestia elutella* (Hübner 1796) cacao moth, one found in the Insect Room on 7 August 1894  
 1478 *Cadra calidella* (Guenée 1845) dried fruit moth, one found in the basement of the Entomology Department on 5.xi.1982  
 1790 *Triphosa dubitata* (Linnaeus 1758) tissue, historic record from 2.xi.1964 which probably relates to a hibernating individual; regarded by Plant (1993:56) as an extremely local and scarce resident  
 1936 *Menophra abruptaria* (Thunberg 1792) waved umber, historic record from 6.v.1960

There have also been several sightings of the day-flying Jersey tiger moth *Euplagia quadripunctaria* (Poda, 1761), since its successful colonization of South London.

Slightly more worrying, however, are the records of the gypsy moth *Lymantria dispar* (Linnaeus 1758) and oak processionary *Thaumetopoea processionea* (Linnaeus 1758). These are almost certainly progeny arising from an accidental introduction of these pest species in the London area and which are still surviving and spreading despite attempted eradication programmes.

Some species have been recorded as adventives to the Wildlife Garden, having been discovered as a result of new plantings, and these include *Pempelia palumbella* ([Denis and Schiffermüller] 1775) *Lycophotia porphyrea* ([Denis & Schiffermüller] 1775) true lover's knot and *Eilema complana* (Linnaeus 1758) scarce footman on 17.vii.2012 that almost certainly were brought in accidentally when fresh heathland turves were planted, in February 2012. *Neofaculta ericetella* (Geyer 1832) was recorded on 18.v.2013, probably as a result of larvae being accidentally introduced with the heathland turves.

Since 2014, when I retired from the Museum, moth trapping has still been undertaken. However, it is clear that a few misidentifications have been made and I have attempted to review them. Where I am convinced that they were in error, I have omitted the records from the main list but have included them here with comments. Time will hopefully tell if this was the correct decision.

*Agrotis trux* (Hübner, [1824]) crescent dart 21.vii.2015. In the UK this is almost exclusively a coastal species and mainly in the west of the country and, of course, it is the form/subspecies *lunigera*. The continental forms are rare or non-existent here. Unfortunately the record cannot be checked as no voucher was retained.

*Noctua janthina* ([Denis & Schiffermüller] 1775) Langmaid's yellow underwing. This species has relatively recently been split from *N. janthe* but is still often misidentified. In Britain I regard it as a mainly coastal species, probably as an immigrant, and usually on the south coast. Inland records that I have seen have, on close examination, often been specimens of *N. janthe*. The specimen from the Wildlife Garden was identified by a colleague and I have to trust his identification. However, it would have been preferable to retain the specimen as a voucher.

*Idaea dilutaria* (Hübner [1799]) silky wave 15.vii.2015. In the UK this is a very local species, occurring in only a few localities in Wales, and occasionally in England. Almost certainly a misidentification but without a voucher specimen it is not possible to say of which species.

### Day-flying moths

With more awareness of butterflies and moths in the garden, both by staff and volunteers, there have been records of day-flying moths in addition to the moth trapping records.

*Zygaena filipendulae* (Linnaeus 1758) six spot burnet moth. The garden supports a breeding colony on the chalk mound and it is now also commonly seen on chalk and meadow (G02) also Gill's meadow (G06) and the meadow area behind the railings along front of the west side of the Waterhouse building.

*Pyrausta aurata* (Scopoli 1763) purple and gold. This species is regularly seen on common marjoram *Origanum vulgare* on chalk downland habitat and has also been recorded from the light trap.

*Macroglossum stellatarum* (Linnaeus 1758) hummingbird hawkmoth. Absent for a while, this charming moth has returned and is breeding on the chalk downland habitat, where larvae and pupae were found amongst hedge bedstraw *Galium album* and lady's bedstraw *Galium verum*. The moth can be seen flying in different areas within the garden, much to the delight of members of the public, volunteers and Visitor Assistants.

*Nemophora degeerella* (Linnaeus 1758) yellow-barred long-horn. Occasionally seen in woodland areas W05 and W06, also seen flying in group around willows in fen F03.

*Anthophila fabriciana* (Linnaeus 1767)

Day-flying moth *Nemophora degeerella* in mixed woodland area W05. © The Trustees of the Natural History Museum, London



nettle tap. The larvae of this species can be seen feeding on common nettle *Urtica dioica* with the adult moths occasionally being seen around nettle plants.

*Euplagia quadripunctaria* (Poda 1761) jersey tiger. This distinctive and brightly coloured moth is usually seen during August in most years. Sightings have been recorded annually since 2008 apart from 2010.

There have also been two special projects undertaken by garden volunteers as part of their broader educational studies. One was a study of *Phyllonorycter platani* (Staudinger 1870) the plane tree leaf-miner and its guild of hymenopteran parasites (Fieldsend 2013). This species was discovered as new to Britain from the Museum grounds in 1990, one of three such new additions to our moth fauna that have been discovered during the moth trapping studied. The other was a project looking at the role of temperature and humidity on the number of moths recorded at light (Mackey 2015).

## DIPTERA

DUNCAN SIVELL, CURATOR (DIPTERA), LIFE SCIENCES, NATURAL HISTORY MUSEUM

The current Diptera list for the garden is rather atypical as although it is relatively small with 235 species its coverage is broad encompassing 51 different families. The unusual composition of this list partly reflects the varied research interests of Museum staff. Two Endangered (*Chrysopilus laetus* and *Acinia corniculata*) and five Notable species (*Beris clavipes*, *Solva marginata*, *Stratiomys potamida*, *Vanoyia tenuicornis* and *Neoleria propinqua*) have been recorded so far, and the garden supports a number of uncommon Diptera that have yet to be given a conservation status.

The Endangered tree snipefly *Chrysopilus laetus* (Rhagionidae) is known from a single male specimen caught in a Malaise trap in June 2015. For many years this snipefly was thought to be restricted to Windsor Great Park, but it has recently appeared at a small number of other sites in south-east England. The adults can be elusive and many historic records were made by rearing larvae. A dead-wood species, this fly requires mature trees with stages of rot where the larvae can develop. *Chrysopilus laetus* larvae have so far been recorded from beech and poplar.

A female *Acinia corniculata* was photographed in the garden in August 2009 and was identified from the picture by its distinctive wing pattern. This Endangered picture-winged fly (Tephritidae) is believed to breed in the flower heads of common knapweed *Centaurea nigra*, although this has still to be confirmed. Environmental factors other than the food plant obviously restrict the abundance and distribution of



*Acinia corniculata: a Red Data Book fly.  
© The Trustees of the Natural History  
Museum, London*

this species. The few British records for this species that exist are nearly all in the south-east of England.

The Notable *Solva marginata* (Xylomyidae) is another dead-wood species, associated specifically with poplars, especially black and balsam varieties. The larvae live under the bark in early stages of cambial rot. This species is recorded regularly in the garden indicating that the mature poplar trees support a healthy and viable population.

Three of the Notable species are semi-aquatic soldierflies (Stratiomyidae). *Beris clavipes*, *Stratiomys potamida* and *Vanoyia tenuicornis* are all associated with lush fens and seepages, probably favouring areas with wet moss. The garden's fenland habitat and the water margins around the three ponds would provide larval habitat for these scarce flies.

Specimens of the fifth Notable species *Neoleria propinqua* (Heleomyzidae) were collected in 2014 by Dr Martin Hall as part of his forensic research. Described as a new species in 1952, very few records of this fly exist and it has not yet been found outside Britain. The ecology of other *Neoleria* species suggests that *N. propinqua* prefers decomposing vegetable or animal matter with a liquid phase.

A number of other interesting species are associated with carrion or rotting organic matter. *Fannia atripes* (Fanniidae) is an uncommon fly most likely associated with decaying organic matter, based on the ecology of closely related species, although this still needs to be confirmed. Another uncommon species living on carrion is *Athyroglossa glabra* (Ephydriidae). This fly is normally confined to northern and western Britain and specimens from the garden were the first to be added to the Museum collection in 60 years. Shore flies (Ephydriidae) are typically associated with pond margins and it is possible that *A. glabra* is taking advantage of the wet habitats within the garden as well as decaying organic matter.

The species list for the garden highlights the following habitats as important for Diptera: mature trees with some stages of decay, wet fen, pond margins and decaying organic matter or carrion. A variety of larval habitats is the critical factor in supporting a diverse Diptera community, combined with a sustainable supply of nectar and pollen or small prey items for adult flies. The mosaic habitat structure of the garden provides these conditions in close proximity, so good species diversity is expected. The Diptera are still under-recorded, however, and we would expect the species list to grow considerably with increased survey effort.

## DIPTERA - BLOWFLIES

MARTIN HALL, RESEARCHER AND HEAD OF LS PARASITES AND VECTORS DIVISION,  
LIFE SCIENCES, NATURAL HISTORY MUSEUM

A novel forensic entomology study was undertaken in the Museum's Wildlife Garden during the summer of 2013, to assess the potential for blowflies to colonise bodies disposed inside suitcases. Chicken liver baits were presented below a stiff plastic sheet that incorporated a zip to determine which species would lay eggs on zips within the first 24-hours of bait exposure. Eggs were recorded on 95% (19/20) of replicates after 24 hours. They were laid on the zip or on and between the zip's teeth. Those laid between the teeth formed "stalactites" of eggs that extended down to the bait. The dominant species reared from cultured eggs was the bluebottle blowfly *Calliphora vicina* (Diptera:

*Calliphoridae*) (200/204), with some specimens of the greenbottle blowfly *Lucilia sericata* (Diptera: Calliphoridae) (4/204) also reared.

In addition to the studies above using zips in simulated suitcase placements, two studies were undertaken in the garden as ‘proof of principle’ in which a pig’s head (4.2 kg) was used as bait within each of two dark brown zippered suitcases of aircraft cabin approved size (c. 42 x 33 x 17 cm). The heads within each suitcase became infested with insects within 24–72 hours, depending on ambient temperatures (longer delay at lower temperatures).

A third suitcase study was conducted in November 2014 and shown in the BBC4 documentary, ‘Catching History’s Criminals: the forensic story’, on 18 June 2015, when Martin Hall was interviewed by the presenter, Gabriel Weston, in the garden. In that study there was a two-week delay in fly colonisation of the suitcase due to low temperatures but a larval infestation with *Calliphora vicina* was established on 28 November 2014 that resulted in adult flies emerging in the garden from 12 March 2015.

Larvae of a variety of fly species were recorded developing on the pigs’ heads inside the suitcases including: *Calliphora vicina* (Diptera: Calliphoridae), *Lucilia sericata* (Diptera: Calliphoridae), *Sarcophaga argyrostoma* (Diptera: Sarcophagidae), *Hydrotaea capensis* (Diptera: Muscidae) and *Fannia manicata* (Diptera: Fanniidae). Many of the pupae resulting from these larvae did not complete their development to the adult stage because they became infested as larvae with parasitic wasps (*Nasonia vitripennis*, Pteromalidae). The research was published in 2014 (Bhadra *et al.* 2014).

#### ARACHNIDA

##### ARANEAE - SPIDERS AND OPILIONES - HARVESTMEN

THOMAS J. THOMAS, FBNA, 142 SELBOURNE ROAD, LUTON, BEDS LU4 8LS

As Hillyard pointed out in Leigh and Ware (2003) the Wildlife Garden has a richer spider fauna than expected. This is borne out by regular collecting resulting in some very interesting captures. Two spiders of particular note, *Anypheena sabina* (Milner 2012) and *Cryptachaea blattea* (Marriott 2012), were first found during 2011 in the UK. The former may be spreading having been found on the garden roof of Transport for London’s building (Wilson 2015).

Originally, nineteen species were listed (Leigh and Ware 2003) though *Bathyphantes concolor* was listed in addition to *Diplostyla concolor* and they are in fact the same species – a name change having taken place. With the recent additions from various collectors and methods including the malaise trap, the number of spiders known in the garden is now ninety. Amongst

*Crab spider Misumena vatia* (female) in the meadow G05. © Naomi Lake



*Tegenaria domestica* (female) inside one of the soil profile doors. © Thomas J. Thomas

them is the very local *Theridiosoma gemmosum*, a Nationally Scarce (Notable B) species.

Though London has many green spaces, the Natural History Museum’s Wildlife Garden is unique because it is a planned mosaic of major habitats found in southern England (Vickery 2004) and so would be expected to have an interesting fauna, not only amongst the arachnids, especially as the plant communities mature.

Harvestmen tend to be autumnal creatures and, as collecting has only been during the spring and early months, more may be found later on in the year. However, as the harvestmen are poorly represented, by just two to four species in the current survey, it may be that they are not such good colonisers. Nevertheless, as the garden’s habitats continue to mature other species may come in.

#### ACARI - MITES

ANNE BAKER, LIFE SCIENCES, NATURAL HISTORY MUSEUM

This is the most detailed survey of mites that has been carried out in the garden and the first one to look at those in birds’ nests. Previously, the presence of the water mites *Piona coccinea stjordalensis* (now *P. stjordalensis*) and *Arrenurus* sp. was reported in Honey *et al.* (1998), while plant galls have been attributed to five species of Eriophyidae (gall mites) (Leigh and Ware 2003). The gall/mite associations, however, were based on the plant host and type of formation rather than on the identification of mite specimens. The species list in Leigh and Ware (2003) also includes *Pergamasus crassipes*, a terrestrial predator frequently found in soil and leaf litter. It has rarely been recorded in birds’ nests and was not found in the present survey.

The mite fauna of birds’ nests is not well known; in the UK, only six studies have been

dedicated to this ecosystem before now (Hull 1915, Woodroffe and Southgate 1951, Woodroffe 1953, 1954, Turk 1954, Fain *et al.* 1991). All but one species identified in the garden have been recorded in the UK, although a few only rarely.

The only obligate bird ectoparasite found came from a robin nest built on the eaves of the garden's shed. *Dermanyssus carpathicus* is a new record for the UK fauna, although it is possible that examples collected in the past were identified as the morphologically similar *D. hirundinis*. The original description (Zeman 1979) appears to have been overlooked during subsequent studies as further records were not published until thirty years later (Roy *et al.* 2009a, b), although unpublished ones from 2006–2008 are mentioned by Roy *et al.* (2009b). A review of samples from Slovakian birds and their nests resulted in many specimens determined as *D. hirundinis* being reassigned to *D. carpathicus* (Masan *et al.* 2014). Members of the genus parasitize a wide range of wild and domesticated birds, feeding on the host at night, but hiding in and around the nest or roost during the day. If nests are deserted, the mites eventually go in search of a new host. The occurrence of *D. carpathicus* in only one of the sites is suspected to be due to the nests being empty for some time before collection.

*Blattisocius tarsalis* was extracted from five nests or nestboxes (blackbird, robin, blue/great tit, moorhen and an unknown occupant). Both adults and immatures were present, indicating the populations were established. This species is well known in UK grain stores where it feeds on pest Lepidoptera and mites. It has also been found in birds' nests in other countries. Females use adult moths for dispersal and have been found on at least two species, *Plodia interpunctella* and *Tineola bisselliella*, recorded in the garden (Treat 1975, Honey *et al.* 1998). The latter has also been found, albeit in small numbers, in UK birds' nests (Woodroffe and Southgate 1951). Transport by moth could explain the mites' route to the nests.

*Holoparasitus lawrencei*, from two robin or blackbird nests, was represented by adults and nymphs in both sites. Immatures have not been documented for this species and morphological data from the specimens will enable future identifications to be based on nymphal stages alone. This mite is widely distributed in the UK (Hyatt 1987) but has never before been found in the London area. Habitats include leaf litter, humus, moss, tree-holes and the nest of a blackbird (Hyatt 1987). It has also been found in a dipper (*Cinclus cinclus aquaticus*) nest in Wales (Fain *et al.* 1991). Little is known about the food preferences of *Holoparasitus* species, but two have been reported feeding on spider mites, while other members of the family Parasitidae are known to feed on small insects and other mites, both of which were plentiful in the nests examined.

The mite fauna of one of the moorhen nests included numerous female *Androlaelaps casalis*. This species thrives in a wide range of habitats, e.g. house dust, broiler house litter, grassland, farm-stored cereals, and on birds and mammals and in their nests. It occurred in dipper nests in the UK (Fain *et al.* 1991) and those of a variety of other species elsewhere, although not the moorhen. *Androlaelaps casalis* takes food of both animal and plant origin, e.g. lightly sclerotized mites, immature insects and wheat germ, and will also feed opportunistically on blood and haemolymph. It has been found on adult moths, mainly noctuids, which it is suspected to use for dispersal.

*Tyrophagus longior* was the most abundant species, occurring in three blackbird or robin nests, and one of a blackbird and wren. This cosmopolitan, mainly fungivorous, mite is a

common find in stored food products but also in outdoor situations such as haystacks in open fields, bee hives and birds' nests. In the UK, it has been recorded in a dipper nest (Fain *et al.* 1991). The garden samples comprised all life stages of the mite, indicating the nests supported sufficient microfungi for the populations to thrive. *Anystis baccarum*, found in two blackbird or robin nests and one of a moorhen, is a generalist predator and a common sight running in a rapid cork-screw path over vegetation. It is likely it was attracted by the plentiful supply of mites and insects living in the study nests.

Other predatory, detritivorous and fungivorous mites occurred in small numbers in one or two nests. These are probably accidental inhabitants that could have been introduced with nest material or species that had invaded from adjacent vegetation. Two are of particular interest. *Cheletomimus berlesei* (a blackbird/robin and blackbird nest), represented by immatures, belongs to the predatory family Cheyletidae. The few previous UK findings have been on fruit trees and pasture weeds, although the species was present in a bird's nest in Hawaii. Several life stages of *Aphelacarus nr acarinus* were extracted from one of the moorhen nests. The genus has evidently only been recorded a few times here, from moorland in north Yorkshire and amongst bat dung and straw in the attic of a house in Hampshire, and also on a grassland weed in the Republic of Ireland.

## MYRIAPODA

DUNCAN SIVELL, LIFE SCIENCES, NATURAL HISTORY MUSEUM

The Chilopoda and Diplopoda (Myriapoda) are typically studied together, even though they are quite distinct in their morphology and ecology, as they occur in the same microhabitats. Both groups have been recorded in the garden for a number of years. The current list of myriapods represents a fifth of the British fauna and includes two Nationally Scarce species.

Centipedes (Chilopoda) are predatory, feeding on springtails, woodlice and other small invertebrates. Those adapted to hunting amongst leaf litter or under bark or stones can move very quickly, while those living in the soil have flexible segmentation allowing them to negotiate their way through tight angles and cramped spaces. All centipedes are adept at moving in reverse, the hindmost legs are usually elongate and act as a rear pair of antennae.

The centipedes found in the garden are indicative of a human-influenced site with a woodland component located in southern England. Nationally common and widespread species include *Cryptops hortensis*, *Lithobius forficatus*, *Lithobius microps*, *Lithobius variegatus*, *Stigmatogaster subterranea* and *Schendyla nemorensis*. More restricted species are *Cryptops anomalans*, *Stenotaenia linearis* and *Henia brevis*, the latter of which is Nationally Scarce. These last three centipedes all have a southern distribution and are associated with synanthropic habitats.

In contrast, the millipedes (Diplopoda) are detritivores and slow-moving, relying on chemical defence for protection. Many are quite catholic in their choice of habitat but, as with the centipedes, the species list reflects a site with woodland and human influence and is consistent with a London setting. *Blaniulus guttulatus*, *Cylindroiulus caeruleocinctus*, *Ophiodesmus albonanus* and *Polydesmus coriaceus* are associated with cultivated or synanthropic sites whereas *Julus scandinavicus* and *Cylindroiulus punctatus* are typical

woodland species. The Nationally Scarce *Choneiulus palmatus* is associated with both synanthropic and woodland habitats, tending to become more urbanised in the northern parts of its range.

*Cylindroiulus vulnerarius* and *Haplopodiulus spathifer* are two relative newcomers to Britain, first recorded in this country by Adrian Rundle in the mid-1970s. *Cylindroiulus vulnerarius* has since spread to more than twenty, mostly urban, locations that reach as far north as central Scotland. *Haplopodiulus spathifer* is more localised and until recently the garden was only the fourth known site for this species in Britain (Corbet and Jones 1996). Despite their restricted national distributions both *Cylindroiulus vulnerarius* and *Haplopodiulus spathifer* can be relatively abundant within the garden.

Although the garden supports some scarce myriapods, there are some common and widespread species that have not been recorded. In particular, the millipede *Proteroiulus fuscus*, a woodland species that lives under bark, is notable by its absence. The omission of this and some other common species may be due to the relative isolation of the garden and the varying abilities of different myriapod species to disperse and colonize new areas.

The garden currently supports a fifth of the British myriapod fauna. This may represent a large proportion of the species actually present, although additional centipede and millipede species will no doubt be discovered as more survey work is carried out.

#### ROTIFERA AND CRUSTACEA ROTIFERA AND ANOMPODAN CRUSTACEA

ERIC D. HOLLOWDAY, 45 MANOR ROAD, AYLESBURY, BUCKS.

#### Taxonomy and Listing

In the previously published account (*Lond. Nat.* 82, 2003), at some stage during the preparation of the 'Species lists', some typographic and taxonomic errors were introduced. (In particular the Anomopoda had erroneously been placed under Amphipoda). Owing to an administrative oversight, this final version was not seen by the recorder prior to publication but the necessary corrections have now been addressed with the present updated listing.

With the current listing it must be emphasised that the designation of *Cephalodella tenuiseta americana*, as a subspecies, is purely provisional in order to ensure the inclusion of this taxa in the list. Both the very large *sensu stricto* species, first described by W. B. Burn (1890) {page 34, Fig. 22 was at that time designated as *Furcularia tenuiseta* with a dimension of 1/40th of an inch [= 625 µm]}, and the very similar but much smaller animal occur together in the same pond at the Wildlife Garden. The designation for the listing may in fact be taxonomically incorrect as there has been considerable confusion and misunderstanding concerning *Cephalodella tenuiseta* for almost a century. The taxonomic status of *C. tenuiseta americana* is still unresolved, requiring further investigation, possibly involving SEM microscopy. Also, in the opinion of the recorder, it is probably almost certain that *Cephalodella gigantea*, Remane (1933), is a synonym of Burn's (1890) original *Cephalodella tenuiseta*.

The smaller animal was first found and described [total length 380-390 µm] in Wisconsin in 1924 by Harring & Myers (1924) who identified it as Burn's species despite the great difference in size. It has later been found in other parts of the world and in 1949 was

designated as *C. tenuiseta* var. *americana* by Donner (1949) in Austria, for which Koste (1978) gives a range of 205-314 µm. Varieties are not now recognised according to the International Code of Zoological Nomenclature and have more recently been regarded as ecotypes, but these are not normally thought to co-habit and are deemed to be separate species. However both the large and much smaller animals do occur together at the Wildlife Garden and it was observed that the larger, *sensu stricto* species was actually preying on the smaller animal in one of the ponds in which they both occurred.

#### Deterioration of the Rotifer and Anomopodan Crustacean fauna in the Wildlife Garden Ponds

During the twelve years since the last report (2003), there has been a considerable decline in both of these groups.

In February 2006, to reduce leakage, the top pond was dredged-out. This pond and the waterfall were relined before refilling. At the same time a much more powerful circulatory system was installed pumping a much larger volume of water from the main pond to the top pond for the waterfall. From that time onward, the phytoplankton (especially the nano-plankton on which many of the rotifers depend for their food supply) declined and many of the species previously listed were absent or present in only very small numbers. The Chydorid Anomopoda almost completely disappeared. Although since 2009 borehole water was used to top up the ponds there is nothing in the water analyses that might be considered harmful or indeed distinguish the borehole water from that already in the ponds.

Both the rotifer and anomopodan crustacean groups tend to prefer fairly still water. The circulation has been much reduced since 2011 and there has been recently some recovery in numbers of some species. With the most recent samples (May 2013) the Top Pond (A09) had the greatest number of individuals, *Keratella brevispina*, *Polyarthra dolichoptera* and now *Daphnia longispina* and these were seen to be carrying *Proales daphnicola* as did the Main Pond (A03) Daphnia in an earlier (February) collection. Thus, although the situation is much improved it has not yet regained its former richness either in respect to actual species or the number of their individuals.

#### MOLLUSCA

ADRIAN RUNDLE, LEARNING CURATOR, NATURAL HISTORY MUSEUM

#### Land Gastropods

Seventeen species of land molluscs were found in survey work carried out between June and August 2014. Of these ten are new records for the Wildlife Garden. The most surprising find was of a small juvenile slug, *Testacella cf. maugei*, which was too small for reliable species identification. *Testacella* is a subterranean genus which hibernates for much of the year and feeds on earthworms. Several minute snails were found in soil and leaf litter near the boundary wall in a wooded area (W09). These were living *Lauria cylindracea* and shells of *Carychium minimum* and *Cecilioides acicula*. *Cochlicopa lubricella* was common in all wooded areas and it is surprising that it wasn't recorded before. The other species of the genus, *Cochlicopa lubrica*, was found near the shed in P05. Another very common species throughout the garden which was not found in the previous survey in

2003 was *Aegopinella nitidula*. Several live specimens of *Oxyloma elegans* were found on reeds in a wet area next to the main pond.

Several previously common species were not found. They were *Arion hortensis*, *Milax budapestensis*, *Milax sowerbyi* and *Oxychilus draparnaudi*. However *Arion intermedius*, not recorded since 1996, was found in September 2015. Additional new species include *Oxychilus alliarius* from around silver birch logs on the boundary wall adjacent to heathland LH04. This species probably came with heathland plants in 2012.

### Freshwater Mollusca

The freshwater mollusc fauna in the garden seems to have depleted since the last report and only eight species were found. Two of three new additions: *Hippeutis complanatus* and *Pisidium obtusale* turn up regularly in educational pond-dipping sessions. Both occurred in the main pond and the shadier top pond (A08). Both species of *Bithynia* (*B. leachii* and *B. tentaculata*) were common in all the ponds. The bivalve *Musculium lacustre* that was fairly common in the leaf debris of the main pond (Leigh and Ware 2003) has not been seen since April 2005. The following species could not be found: *Anisus vortex*, *Bathyomphalus contortus* and *Gyraulus albus*, all normally found amongst submerged aquatics, this may possibly be due to changes in the submerged aquatic vegetation since the introduction of borehole water and the increased colonisation of Charophytes, notably *Chara globularis*. *Radix balthica* (= *Lymnea peregra*), *Lymnaea stagnalis* and *Physa acuta*, normally widespread species, were not found in the current survey. Great ramshorn nail, *Planorbarius corneus* continues to be found in the main (A03) and top pond (A08) sporadically.

A freshwater limpet *Acroloxus lacustris*, possibly overlooked in previous surveys, is the most recent new find.

### OLIGOCHAETA - EARTHWORMS

EMMA SHERLOCK, LIFE SCIENCES, NATURAL HISTORY MUSEUM

With its differing habitats of leaf litter-rich wooded areas, compost heaps, waterlogged pond edges and meadow, the garden attracts a variety of earthworm species. Over the ten year period, twelve different species have been located in the garden so far: 1) *Eisenia fetida* - a constant in the compost heaps, 2) *Lumbricus terrestris* - mainly found in the meadow, 3) *Allolobophora chlorotica* - in both woodland and meadow areas, 4) *Aporrectodea caliginosa* - found in most habitats and also thought to be quite tolerant of disturbance, 5) *Aporrectodea longa* - only found in the grassland, 6) *Aporrectodea rosea* - only found once in the meadow. This is surprising as it is usually relatively common in grassland and wooded areas but it does usually prefer neutral and alkaline soils so potentially the meadow soil can on occasion be more acidic. 7) *Aporrectodea icterica* - another grassland species found in the grassland once, 8) *Lumbricus rubellus* - a ubiquitous earthworm that can do well in acidic conditions, found in the fen and grassland, 9) *Octolasion lacteum* - generally has a preference for wet habitats, found once in the meadow, 10) *Eiseniella tetredra* - has a preference for waterlogged soils and was found once at the pond edge in 2008, 11) *Dendrobaena veneta* - like *Eisenia fetida*, this worm has a preference for high organic matter and is usually found in compost bins as it was

*Dendrobaena pygmaea*. This worm had not been collected in the UK for 32 years until its sighting in deadwood (24 June 2015).  
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here. It has only been recorded once from the compost so is not prevalent currently. 12) *Dendrobaena pygmaea* - the most significant find to date. This worm had not been collected in the UK for 32 years until its sighting in deadwood in the garden on the 24 June 2015. It likes rich organic matter but with its full size being approximately 1-1.5 cm it is extremely difficult to find and collect.

In the 2003 (Leigh and Ware) the species list comprised just five of the species listed above. With the addition of compost heaps, and as the garden's managed woodland and grassland mature, new niches have been created to enable other species to inhabit the area. Further regular monitoring needs to continue to capture fully the range of these species. Digging, hand sorting and a vermicuge (mustard solution is used here) is needed to systematically sample the area. In the previous study only a vermicuge was used (washing up liquid), this would limit the species found.



### VERTEBRATES

#### BIRDS

GAY CARR (ARTICLE SUBMITTED IN JANUARY 2013)

WITH RECENT UPDATE BY DANIEL OSBORNE, WILDLIFE GARDEN, NATURAL HISTORY MUSEUM

Since 2003 there have been a few changes to the birds in the Wildlife Garden. From the list printed in the last report we have not seen pied wagtail *Motacilla alba*, house sparrow *Passer domesticus* or pheasant *Phasianus colchicus*. We have seen starling *Sturnus vulgaris* once in the last 10 years (October 2009) and song thrush *Turdus philomelos* has not been seen since March 2004. However, apart from starling, these species were never frequent visitors. Grey wagtail *Motacilla cinerea* was seen only infrequently until 2014 and 2015 when its visits became relatively frequent. Although mistle thrush *Turdus viscivorus* had only been seen three times in October and December 2007 and in November 2008, it was a regular visitor in the winter of 2013/14 feeding off late berries on the garden's rowans.

However, we have gained some species such as long-tailed tit *Aegithalos caudatus* which bred successfully in 2004, 2006, 2007, 2009 and 2011, using the gorse bushes (in LH01 and W08). Sparrowhawk *Accipiter nisus*, first seen in September 2007, was recorded twice in 2012 (May and September), twice in 2014 and once, so far, in 2015. Green woodpecker *Picus viridis* was seen for the first time on 14 December 2009 and again on 6 August 2012. It has been sighted twice in 2015 and heard calling from the poplar tree several times.

Chiffchaff *Phylloscopus collybita* still occurs occasionally as a passage bird, having been seen six times since 2006. Willow warbler *Phylloscopus trochilus* is another rare passage bird having only been seen in April and October 2010 and reed warbler *Acrocephalus scirpaceus* only seen on 21 August 2005. Redwing *Turdus iliacus*, which first appeared in December 2002, was seen five times at the beginning of 2004 with six birds in March. Redwing has been a regular visitor feeding off rowan and holly berries in December/January in 2005, 2006, 2010, 2013, 2014 and 2015. Peregrine falcon *Falco peregrinus* has been seen four times since December 2014 when a probable breeding pair were observed for around half an hour, circling above the garden and alighting on the west side of the Waterhouse building.

The regular breeders in the garden are robin *Erithacus rubecula* (1-2 pairs), wren *Troglodytes troglodytes* (1-2 pairs), blackbird *Turdus merula* (several pairs), blue tit *Cyanistes caeruleus* (1-2 pairs), great tit *Parus major* (1-2 pairs), greenfinch *Chloris chloris* (1 pair) and moorhen *Gallinula chloropus* (1 pair) which has ousted the mallard *Anas platyrhynchos*, which is now only a occasional visitor. Other species which have bred successfully are blackcap *Sylvia atricapilla* (1 pair) which was first seen in May 2006 and bred for the first time in 2012, carrion crow *Corvus corone* (1 pair) which has bred every year since 2004 and magpie *Pica pica* (1 pair) which has bred during a couple of years. Dunnock *Prunella modularis* (1 pair) and chaffinch *Fringilla coelebs* (1 pair) have been breeding in the garden or nearby since 2004 and coal tit *Periparus ater* (1 pair), which became a regular visitor in 2006, has certainly bred in the vicinity since 2010. Woodpigeon *Columba palumbus* is a regular visitor and probably breeds nearby, as is great spotted woodpecker *Dendrocopos major*, seen frequently since 2012. Other new visitors include nuthatch *Sitta europaea*, observed in a mixed flock of tits, in July 2014 and there was one sighting of tufted duck *Aythya fuligula* on 7 May 2009.

Goldfinch *Carduelis carduelis* which became a regular winter visitor with a flock of over 10 birds being seen in March 2012 is now, since 2014, seen in the garden daily, feeding on seedheads of common knapweed, alder, and amongst the foliage of beech and silver birch. Goldcrest *Regulus regulus* is a winter visitor, seen ten times since 2004 and is probably overlooked and even more frequent. Jay *Garrulus glandarius* is also a regular visitor but more usually in the winter. Kestrel *Falco tinnunculus* is an infrequent but regular visitor. A juvenile was seen in a tree on a number of occasions in August 2012. Feral rock pigeon *Columba livia* is occasionally seen in the garden but stays mainly in other areas of the Museum grounds though more recently gathers in high numbers (up to ten) below the bird feeders.

In the London area in general, the same birds that have increased or newly appeared in the garden have also increased in London and those that have declined in general have declined in the garden. Carrion crow and magpie have both increased in London and now breed in the smallest of gardens with only 1 or 2 trees suitable for nesting. Blackcap has increased by 102% in London since 1995 and goldfinch, chaffinch, long-tailed tit and goldcrest have also increased in the London area. Blackbirds, however, which are stable in the garden, have declined by 18% since 1995 and, although raptors such as sparrowhawk have increased, kestrel is declining. The Greenfinch, which has declined significantly in recent years, has a stable population of around twenty birds in the garden.

## MAMMALS

LARISSA COOPER, WILDLIFE GARDEN, NATURAL HISTORY MUSEUM

Nine mammal species have been recorded in the garden since 2004, though the species and abundance have altered since the previous survey period.

Sightings of foxes *Vulpes vulpes* were once rare but can now be seen regularly in the garden - mornings and often during the day - to the delight of visitors and staff. Foxes have bred in the garden since 2010, with three cubs in 2013, four in 2014 and three in 2015 utilising two earths within the garden - one in the fen carr and one on the edge of woodland (W01) not far from the staff shed. Along with visual observations, scat is often found in prominent positions and evidence of their evening's activities can be seen in the mornings through foraged rubbish, tennis balls and squashed vegetation.

Grey squirrels *Sciurus carolinensis* are the most visible mammal in the garden for visitors to see, climbing trees and foraging below the bird feeders and on hazel nuts and rosehips in late summer. For a short while during autumn to winter months 2007 to 2010 a solitary rabbit *Oryctolagus cuniculus* was occasionally sighted all around the garden, possibly originating from Kensington Gardens. There have been no sightings of wild rabbits in the garden during the past five years though they are regularly sighted in neighbouring Kensington Gardens.

Regular trapping using Longworth traps and hair traps for small mammals has revealed good mixed-sex populations of house mouse *Mus domesticus*, especially in the woodlands and the log piles. However these trapping methods have failed to confirm the presence of any wood mouse *Apodemus sylvaticus*. The last record in the garden was in 2009 from a single visual sighting of a juvenile, whilst records of wood mouse in 2002 were obtained through hair traps and covered a large proportion of the garden suggesting a large population (Harbord, in Leigh and Ware 2003:108). Both species of mice are able to coexist providing there are enough resources (Derek Crawley, Mammal Society pers. comm.). However, as suggested by The Mammal Society, when resources are limited, the wood mouse tends to out-compete the house mouse due to its larger size (Crawley 2013). This has not been the case in the garden. Further investigation into records of wood mice in the wider geographical area reveals few records. However small mammals are often under recorded (e.g. Battersby 2005, Mammal Society 2014) which is likely to account for some of the absence in the London datasets. Given the few records of wood mice in the wider area, along with the high numbers in the current population of house mice in the garden, it may be possible that the previous records for wood mouse were misidentified. However wood mice are present in neighbouring Kensington Gardens (Julia Clark pers. comm.). We shall continue to monitor the small mammal populations.

Common rats *Rattus norvegicus* are rarely seen, the last sighting was in March 2014.

## MAMMALS - BATS

JOHN TOVEY, THE LONDON BAT GROUP

Bats have been routinely recorded by a number of experts over this period. The bats are visiting the garden to forage utilising the insect resources. The garden contains an invertebrate-rich pond, open compost heaps and a good variety of vegetation, shrubs and mature trees. There is also an excellent selection of bat boxes that have not been used to date.

The identified sightings have all been single pipistrelles feeding in the tree canopy and above the pond, with durations of feeding activity at any one time ranging from 5 to 55 minutes. Since the number of bat sightings was falling during surveys in 2013 and 2014, an Anabat automated recorder was installed in August 2014 for three weeks on the lime tree overlooking the pond at a height of about 3m. This showed extensive all night foraging by common pipistrelle *Pipistrellus pipistrellus* and soprano pipistrelle *P. pygmaeus* (and possibly *Nathusius' pipistrelle P. nathusii*) in mid-August which soon declined to occasional visits. This corresponds to the early dispersal of breeding roosts seen this year (J.Tovey pers. obs.).

The usual pattern of recordings showed single bat visits starting well after dusk and continuing through the night. This implies the bats are using the garden as a secondary feeding site most of the time and signifies the importance of this site of varied habitats as a foraging area in South Kensington.

As we conclude this paper, and following analysis of recordings from an Anabat installed on 24 August 2015, we can now report confirmation of foraging *Nathusius' pipistrelle* on several nights in September and a visit by Leisler's bat *Nyctalus leisleri*.

## SPECIES LISTS

The species are additions to the lists of Honey *et al.* 1999 and Leigh and Ware 2003, with full lists for previously unreported groups: Hemiptera, Hymenoptera and Acari, and for groups which included errors or omissions in 2003 (Leigh and Ware).

### FLORA AND FUNGI

#### FRESHWATER ALGAE

Additional species recorded since 2003

(Leigh and Ware)

#### Chlorophyta: Green algae

*Chara globularis* Fragile stonewort

*Closterium moniliferum*

*Coelastrum microporum*

*Pediastrum biradiatum* (=*Parapediastrum biradiatum*)

*Pediastrum boryanum* var. *corniculatus*

*Pleurotaenium truncata*

#### Cyanophyta: Blue-green Algae

*Anabaena* sp.

*Phormidium* sp.

#### Dinophyta

*Peridinium bipes*

#### Xanthophyta: Yellow-green Algae

*Characiopsis saccata*

*Vaucheria sessilis*

*Vaucheria taylori*

#### BRYOPSIDA

All records since 2003 (Leigh and Ware)

\* Previously listed in 2003

#### Amblystegiaceae

*Amblystegium serpens*\*

*Calliergonella cuspidata*

*Cratoneuron filicinum*\*

*Leptodictyum riparium*

#### Brachytheciaceae

*Brachythecium albicans*

*Brachythecium rutabulum*\*

*Kindbergia praelonga*\*

*Platyhypnidium ripariooides*

*Rhynchostegium confertum*\*

#### Bryaceae

*Bryum argenteum*

*Bryum capillare*

*Bryum dichotomum*\*

*Bryum* sp.

*Pohlia melanodon*\*

*Pohlia nutans*\*

#### Cryphaeaceae

*Cryphaea heteromalla*

#### Dicranaceae

*Campylopus introflexus*\*

*Ceratodon purpureus*\*

*Dicranum scoparium*\*

#### Fissidentaceae

*Fissidens taxifolius*\*

#### Grimmiaceae

*Grimmia pulvinata*\*

*Grimmia* sp.

*Schistidium apocarpum*\*

*Schistidium crassipilum*\*

#### Hypnaceae

*Hypnum cupressiforme*\*

*Hypnum cupressiforme* var. *resupinatum*

*Hypnum jutlandicum*

#### Mniaceae

*Mnium hornum*\*

#### Orthotrichaceae

*Orthotrichum affine*

*Orthotrichum cf. anomalum*\*

*Orthotrichum diaphanum*\*

*Orthotrichum* sp.

*Oxyrrhynchium hians*

*Oxyrrhynchium* sp.

#### Polytrichaceae

*Polytrichum juniperinum*

#### Pottiaceae

*Barbula convoluta*\*

*Barbula unguiculata*

*Didymodon insulanus*

*Didymodon luridus*\*

*Phascum cuspidatum*

*Syntrichia ruraliformis*

*Tortula muralis*

*Tortula truncata*\*

#### VASCULAR PLANTS

See Appendix 1 for full list of vascular plants recorded 2014-2015

#### LICHENISED FUNGI 2003-2015

#### Acarosporaceae

*Sarcogyne regularis*

#### Arthoniaceae

*Arthonia radiata*

#### Arthopyreniaceae

*Arthopyrenia punctiformis*

#### Candelariaceae

*Candelaria concolor*

*Candelariella aurella*

*Candelariella medians*

*Candelariella reflexa*

*Candelariella vitellina*

#### Catillariaceae

*Catillaria chalybeia*

#### Cladoniaceae

*Cladonia chlorophaea*\*

*Cladonia ciliata*\*

*Cladonia coniocraea*\*

*Cladonia crispata*\*

*Cladonia diversa*'

*Cladonia fimbriata*

*Cladonia floerkeana*

*Cladonia furcata*

*Cladonia portentosa*

*Cladonia pyxidata*

*Cladonia ramulosa*\*

**Collemataceae**  
*Collema tenax*

**Lecanoraceae**  
*Lecanora albescens*  
*Lecanora campestris*  
*Lecanora chlarotera*  
*Lecanora conizaeoides*  
*Lecanora dispersa* agg.  
*Lecanora expallens*  
*Lecanora hagenii*  
*Lecanora muralis*  
*Lecanora persimilis*  
*Lecanora saligna*  
*Lecanora symmicta*  
*Lecidella elaeochroma*  
*Lecidella scabra*  
*Lecidella stigmataea*

**Lecideaceae**  
*Lecidea fuscoatra*  
*Steinia geophana*

**Monoblastiaceae**  
*Anisomeridium polypori*

**Parmeliaceae**  
*Evernia prunastri*  
*Flavoparmelia caperata*  
*Hypogymnia physodes*  
*Melanelixia subaurifera*  
*Parmelia sulcata*  
*Parmotrema perlatum*  
*Punctelia subrudecta*  
*Xanthoparmelia mougeotii*

**Peltigeraceae**  
*Peltigera cf. hymenina*

**Physciaceae**  
*Amandinea punctata*  
*Hyperphyscia adglutinata*  
*Phaeophyscia nigricans*  
*Phaeophyscia orbicularis*  
*Physcia adscendens*

**Physciaceae**  
*Physcia caesia*  
*Physcia dubia*  
*Physcia tenella*  
*Rinodina oleae*

**Pilocarpaceae**  
*Felhanera viridisorediata*  
*Micarea denigrata*

**Porinaceae**  
*Porina chlorotica*

**Porpidiaceae**  
*Porpidia tuberculosa*

**Psoraceae**  
*Protoblastenia rupestris*

**Ramalinaceae**  
*Bacidia adasta*  
*Bacidia delicata*  
*Bacidia egenula*  
*Bacidia inundata*  
*Bacidia neosquamulosa*  
*Buellia griseovirens*  
*Lecania erysibe*  
*Lecania rabenhorstii*  
*Ramalina farinacea*

**Roccellaceae**  
*Opegrapha vermicellifera*  
*Opegrapha vulgata*

**Scoliosporaceae**  
*Scoliosporum chlorococcum*  
*Scoliosporum umbrinum*

**Stereocaulaceae**  
*Lepraria incana*  
*Lepraria lobificans*

**Teloschistaceae**  
*Caloplaca cerina*  
*Caloplaca crenulatella*  
*Caloplaca decipiens*

**Caloplaca flavocitrina**  
**Caloplaca flavovirescens**  
**Caloplaca holocarpa** agg.  
**Caloplaca lithophila**  
**Caloplaca saxicola**  
**Caloplaca variabilis**  
**Xanthoria parietina**  
**Xanthoria polycarpa**  
**Xanthoria ucrainica**

**Trapeliaceae**  
*Placynthiella icmalea*  
*Trapelia coarctata*  
*Trapelia glebulosa*  
*Trapelia obtogens*  
*Trapeliopsis flexuosa*

**Verrucariaceae**  
*Thelidium minutulum*  
*Thelidium zwackhii*  
*Verrucaria dolosa*  
*Verrucaria muralis*  
*Verrucaria nigrescens*  
genera incertae sedis  
*Cyrtidula quercus*

**FAUNAL RECORDS**  
**INSECTA**

**ODONATA - Dragonflies and damselflies**  
\*Previously listed in 2003 (Leigh and Ware)

**Calopterygidae**  
*Calopteryx splendens* Banded demoiselle

**Coenagrionidae**  
*Pyrrhosoma nymphula* Large red damselfly  
*Coenagrion puella*\* Azure damselfly  
*Enallagma cyathigerum*\* Common blue damselfly  
*Ischnura elegans*\* Blue-tailed damselfly

**Aeshnidae**  
*Aeshna mixta*\* Migrant hawker  
*Aeshna cyanea*\* Southern hawker

**Aeshna grandis**\* Brown hawker  
**Anax imperator**\* Emperor dragonfly

**Libellulidae**  
*Libellula depressa*\* Broad-bodied chaser  
*Orthetrum cancellatum* Black-tailed skimmer  
*Sympetrum striolatum*\* Common darter

**ORTHOPTERA - Crickets and grasshoppers**  
\* Previously listed in 2003 (Leigh and Ware)

**Acrididae**  
*Chorthippus albomarginatus*\* Lesser marsh grasshopper  
*Chorthippus brunneus*\* Common field grasshopper  
*Chorthippus parallelus* Meadow grasshopper

**Conocephalidae**  
*Conocephalus discolor* Long-winged cone-head

**Meconematidae**  
*Meconema meridionale* Southern oak bush-cricket  
*Meconema thalassinum* Oak bush-cricket

**Phaneropteridae**  
*Leptophyes punctatissima* Speckled bush-cricket

**Tettigoniidae**  
*Metrioptera brachyptera* Bog bush-cricket

**HEMIPTERA - True Bugs**  
\* previously listed in 2003 (Leigh and Ware)

**TERRESTRIAL HETEROPTERA AND AUCHEGORRYNCHA**

**Acanthosomatidae**  
*Acanthosoma haemorrhoidale* (Linnaeus)\*

*Cyphostethus tristriatus* (Fabricius)  
*Elasmostethus interstinctus* (Linnaeus)\*  
*Elasmucha grisea* (Linnaeus)\*

**Pentatomidae**  
*Palomena prasina* (Linnaeus)\*  
*Pentatoma rufipes* (Linnaeus)\*  
*Piezodorus lituratus* (Fabricius)

**Coreidae**  
*Coreus marginatus* (Linnaeus)

**Rhopalidae**  
*Rhopalus subrufus* (Gmelin)

**Anthocoridae**  
*Anthocoris nemoralis* (Fabricius)  
*Anthocoris nemorum* (Linnaeus)  
*Buchananiella continua* (White)

**Miridae**  
*Asciodesma obsoletum* (Fieber)  
*Campyloneura virgula* (Herrich-Schäffer)  
*Closterotomus norwegicus* (Gmelin)  
*Closterotomus trivialis* (Costa)  
*Deraeocoris flavilinea* (Costa)  
*Deraeocoris lutescens* (Schilling)  
*Deraeocoris ruber* (Linnaeus)  
*Dicyphus errans* (Wolff)  
*Liocoris tripustulatus* (Fabricius)  
*Lygocoris pabulinus* (Linnaeus)  
*Lygocoris rugicollis* (Fallén)  
*Malacocoris chlorizans* (Panzer)  
*Megaloceroea recticornis* (Geoffroy)  
*Orthops campestris* (Linnaeus)  
*Orthops kalmii* (Linnaeus)  
*Pantilius tunicatus* (Fabricius)  
*Phylus coryli* (Linnaeus)  
*Pinalitus cervinus* (Herrich-Schäffer)  
*Plagiognathus arbustorum* (Fabricius)  
*Polymerus nigrita* (Fallén)  
*Stenodema laevigata* (Linnaeus)  
*Tropidosteptes pacificus* (Van Duzee)

**Reduviidae**  
*Empicoris vagabundus* (Linnaeus)

**Lygaeidae**  
*Arocatus longiceps* (Stål)  
*Kleidocerys resedae* (Panzer)

**Corixidae**  
*Hesperocorixa linnaei* (Fieber)

**Notonectidae**  
*Notonecta glauca* (Linnaeus)  
*Notonecta maculata* (Fabricius)

**Gerridae**  
*Gerris lacustris* (Linnaeus)  
*Gerris argentatus* (Schummel)

**Hydrometridae**  
*Hydrometa stagnorum* (Linnaeus)

**Naucoridae**  
*Ilyocoris cimicoides* (Linnaeus)

**Nepidae**  
*Nepa cinerea* (Linnaeus)

**Mesovelidae**  
*Mesovelia furcata* (Mulsant & Rey)

**Pleidae**  
*Plea minutissima* (Leach)

**AUCHENORRHYNCHA**

**Aphrophoridae**  
*Philaenus spumarius* (Linnaeus)

**Cicadellidae**

- Acericerus ribauti* (Nickel & Remane)
- Arboridia ribauti* (Ossiannilsson)
- Arthaldeus pascuellus* (Fallén)
- Balclutha punctata* (Fabricius)
- Edwardsiana avallanae* (Edwards)
- Edwardsiana crataegi* (Douglas)
- Edwardsiana rosae* (Linnaeus)

**Empoasca vitis** (Göthe)  
*Eupteryx aurata* (Linnaeus)  
*Eupteryx decemnotata* (Rey)  
*Eupteryx florida* (Ribaut)  
*Eupteryx melissae* (Curtis)  
*Eupteryx tenella* (Fallén)  
*Euscelis incisus* (Kirschbaum)  
*Fieberiella florii* (Stål)  
*Hauptidia maroccana* (Melichar)  
*Iassus lanio* (Linnaeus)  
*Kybos populi* (Edwards)  
*Linnauvioriana decempunctata* (Fallén)  
*Mocydia crocea* (Herrick-Schäffer)  
*Ossiannilssonola callosa* (Then)  
*Rhytidodus decimusquartus* (Schrank)  
*Ribautiana debilis* (Douglas)  
*Ribautiana tenerima* (Herrick-Schäffer)  
*Tremulicerus vitreus* (Fabricius)  
*Zonocysba bifasciata* (Bohemian)  
*Zygina angusta* (Lethierry)  
*Zygina nivea* (Mulsant & Rey)  
*Zyginidia scutellaris* (Herrick-Schäffer)

**HEMIPTERA - STERNORRHYNCHA**

**Aleyrodidae**  
*Siphonius phillyreae*

**Aphididae**

- Acyrthosiphon pisum*
- Acrythosiphon primulae*
- Amphorophora gei*
- Amphorophora rubi\**
- Aphis fabae\**
- Aphis pomi*
- Aphis rumicis*
- Aphis sambuci*
- Aulacorthum solani\**
- Brachycaudus cardui*
- Brachycaudus klugkisti*
- Brevicoryne brassicae*
- Capitophorus similis\**
- Cinara juniper*
- Drepanosiphum platanoidis*
- Euceraphis betulae*
- Hayhurstia atriplicis*

**Hyadaphis foeniculi**  
*Hyalopterus pruni*  
*Hyperomyzus lactucae\**  
*Linosiphon galiphagum*  
*Macrosiphoniella millefoliae*  
*Macrosiphum euphorbiae*  
*Macrosiphum rosae\**  
*Megoura viciae*  
*Metopolophium dirhodum*  
*Myzocallis carpini*  
*Myzocallis coryli*  
*Myzus ligustri\**  
*Myzus ornatus*  
*Myzus persicae\**  
*Pemphigus bursarius\**  
*Pemphigus spirothecae\**  
*Periphyllus acericola*  
*Periphyllus testudinacea*  
*Phorodon humuli*  
*Phyllaphis fagi*  
*Rhopalosiphum padi\**  
*Sitobion fragariae*  
*Schizolachnus pineti*  
*Tuberolachnus salignus*  
*Uroleucon sp.\**  
*Utamphorophora humboldti*  
*Vesiculaphis theobaldi*

**Diaspididae**  
*Unaspis euonymi*

**Psyllidae**  
*Psyllopsis fraxini*  
*Psyllopsis fraxinicola*

**Monophlebidae**  
*Icerya purchasi*

**Triozidae**  
*Trioza urticae* (Linnaeus)

**HYMENOPTERA**

ANTHOPHILA - BEES

Andrenidae

*Andrena bicolor**Andrena cineraria**Andrena dorsata**Andrena flavipes**Andrena fulva**Andrena haemorrhoa**Andrena nigroaenea**Andrena nitida**Andrena scotica**Andrena (Micrandrena) sp.**Panurgus banksianus*

Apidae

*Anthophora furcata**Anthophora plumipes**Apis mellifera**Bombus hortorum**Bombus hypnorum**Bombus lapidarius**Bombus lucorum sensu lato**Bombus pascuorum**Bombus pratorum**Bombus terrestris**Bombus vestalis**Melecta albifrons**Nomada fabriciana**Nomada flava/panzeri**Nomada flavoguttata**Nomada goodeniana**Nomada ruficornis*

Colletidae

*Colletes daviesanus**Colletes similis**Hylaeus communis**Hylaeus confusus**Hylaeus hyalinatus**Hylaeus signatus* Notable B

Halictidae

*Lasioglossum calceatum**Lasioglossum lativentre**Lasioglossum morio**Lasioglossum smethmanellum**Sphecodes monilicornis*

Megachilidae

*Anthidium manicatum**Chelostoma campanularum**Coelioxys elongata**Megachile centuncularis**Megachile willughbiella**Osmia bicornis**Osmia caerulescens**Osmia leaiana*

Melittidae

*Melitta haemorrhoidalis*

SPHECIFORMES - DIGGER WASPS

Crabronidae

*Astata boops**Crossocerus annulipes**Crossocerus congener**Crossocerus distinguendus* Notable A*Crossocerus elongatulus**Crossocerus ovalis**Ectemnius cavifrons**Ectemnius cephalotes**Ectemnius continuus**Lestiphorus bicinctus* Notable B*Mimumesa dahlbomi**Passaloecus gracilis**Passaloecus singularis**Pemphredon lethifera**Pemphredon lugubris**Psenulus concolor**Psenulus pallipes**Rhopalum coarctatum**Spilomena* sp.*Stigmus solskyi**Trypoxylon figulus*

Pompilidae

*Auplopus carbonarius* Notable B

Although Pompilidae are not included in the Apoidea list, the Nationally Notable B

- *Auplopus carbonarius* is worthy of inclusion at this point.

**COLEOPTERA - Beetles**

All records since 1995 formatted to most recent checklist. 356 species, of 47 families, and including 28 species with a published conservation status, as of November 2015.

**Gyrinidae - Whirligig Beetles***Gyrinus* sp.**Haliplidae - Crawling water beetles***Haliplus immaculatus* Gerhardt*Haliplus lineatocollis* (Marsham)*Haliplus ruficollis* (De Geer)**Noteridae - Burrowing water beetles***Noterus crassicornis* (Müller) Notable**Hydrobiidae - Screech Beetle***Hygrobria hermanni* (Fabricius)**Dytiscidae - Diving beetles***Acilius sulcatus* (Linnaeus)*Agabus sturmii* (Gyllenhal)*Dytiscus marginalis* Linnaeus*Hydaticus seminiger* (De Geer) Notable*Hydroglyphus geminus* (Fabricius)*Hydroporus planus* (Fabricius)*Hygrotes confluens* (Fabricius)*Hygrotes inaequalis* (Fabricius)*Hyphydrus ovatus* (Linnaeus)*Laccophilus minutus* (Linnaeus)*Rhantus suturalis* (MacLeay)**Carabidae - Ground beetles***Acupalpus dubius* (Schilsky)*Acupalpus parvulus* (Sturm)*Amara aenea* (De Geer)*Amara apricaria* (Paykull)*Amara ovata* (Fabricius)*Anchomenus dorsalis* (Pontoppidan)*Asaphidion curtum* (Heyden)*Badister bullatus* (Schrank)*Bembidion articulatum* (Panzer)*Bembidion deletum* (Audinet-Serville)*Bembidion guttula* (Fabricius)*Bembidion lampros* (Herbst)*Bembidion lunulatum* (Geoffroy)*Bembidion obtusum* (Audinet-Serville)*Bembidion tetricolum* (Say)*Bembidion varium* (Olivier)*Bradyceillus harpalinus* (Audinet-Serville)*Bradyceillus verbasci* (Duftschmid)*Curtonotus convexiusculus* (Marsham)*Dromius meridionalis* (Dejean)*Elaphroprus parvulus* (Dejean) Notable B*Harpalus affinis* (Schrank)*Harpalus rubripes* (Duftschmid)*Harpalus rufipes* (De Geer)*Leistus rufomarginatus* (Duftschmid)*Nebria brevicollis* (Fabricius)*Notiophilus biguttatus* (Fabricius)*Notiophilus rufipes* (Curtis)*Notiophilus substriatus* (Waterhouse)*Ophonus rufibarbis* (Fabricius)*Paradromius linearis* (Olivier)*Paranchus albipes* (Fabricius)*Perigona nigriceps* (Dejean)*Platyderus depressus* (Audinet-Serville)

Notable B

*Polystichus connexus* (Geoffroy) RDB2*Pterostichus madidus* (Fabricius)*Pterostichus strenuus* (Panzer)*Pterostichus vernalis* (Panzer)*Stenolophus mixtus* (Herbst)*Trechus obtusus* (Erichson)*Trechus quadristriatus* (Schrank)**Hydrophilidae - Water scavenger beetles***Anacaena limbata* (Fabricius)*Cercyon analis* (Paykull)*Cercyon laminatus* (Sharp)*Cercyon lateralis* (Marsham)*Cercyon marinus* (Thomson)*Cercyon melanocephalus* (Linnaeus)*Cercyon terminatus* (Marsham)*Cercyon unipunctatus* (Linnaeus)

*Cryptopleurum minutum* (Fabricius)  
*Cryptopleurum subtile* (Sharp)  
*Cymbiodya marginellus* (Fabricius)  
*Enochrus bicolor* (Fabricius) Notable  
*Helochares lividus* (Forster)  
*Helophorus brevipalpis* (Bedel)  
*Hydrobius fuscipes* (Linnaeus)  
*Megasternum concinnum* (Marsham)  
*Sphaeridium marginatum* (Fabricius)

**Histeridae**

*Carcinops pumilio* (Erichson)  
*Kissister minimus* (Aubé)  
*Margarinotus brunneus* (Fabricius)

**Ptiliidae - Featherwing beetles**

*Acrotrichis fascicularis* (Herbst)  
*Acrotrichis sericans* (Heer)  
*Ptenidium nitidum* (Heer)  
*Ptenidium pusillum* (Gyllenhal)

**Leiodidae - Round fungus beetles**

*Catops fuliginosus* (Erichson)  
*Liocyrtusa vittata* (Curtis)  
*Ptomaphagus medius* (Rey)  
*Ptomaphagus subvillosus* (Goeze)

**Staphylinidae - Rove beetles**

*Acrotona aterrima* (Gravenhorst)  
*Acrotona muscorum* (Brisout)  
*Acrotona parvula* (Mannerheim)  
*Alaobia trinotata* (Kraatz)  
*Aleochara lanuginosa* (Gravenhorst)  
*Aloconota gregaria* (Erichson)  
*Amischa analis* (Gravenhorst)  
*Amischa decipiens* (Sharp)  
*Amischa nigrofusca* (Stephens)  
*Anotylus complanatus* (Erichson)  
*Anotylus rugosus* (Fabricius)  
*Anotylus sculpturatus* (Gravenhorst)  
*Anotylus tetracarinatus* (Block)  
*Astenus pulchellus* (Heer)  
*Atheta crassicornis* (Fabricius)  
*Atheta obliqua* (Erichson)  
*Atheta triangulum* (Kraatz)

*Atheta vaga* (Heer)  
*Atheta xanthopus* (Thomson)  
*Autalia rivularis* (Gravenhorst)  
*Bisnius fimetarius* (Gravenhorst)  
*Bisnius parcus* (Sharp)  
*Bisnius sordidus* (Gravenhorst)  
*Bledius spectabilis* (Kraatz)  
*Callicerus rigidicornis* (Erichson)  
*Carpelimus bilineatus* (Stephens)  
*Carpelimus corticinus* (Gravenhorst)  
*Carpelimus rivularis* (Motschulsky)  
*Carpelimus similis* (Smetana) Notable  
*Chaetida longicornis* (Gravenhorst)  
*Cypha longicornis* (Paykull)  
*Dalotia coriaria* (Kraatz)  
*Datomicra nigra* (Kraatz)  
*Datomicra sordidula* (Erichson)  
*Gabrius appendiculatus* (Sharp)  
*Gabrius nigritulus* (Gravenhorst)  
*Gabronthus thermarum* (Aubé)  
*Gnypeta carbonaria* (Mannerheim)  
*Gnypeta rubrior* (Tottenham)  
*Gyrohypnus angustatus* (Stephens)  
*Gyrohypnus fracticornis* (Müller)  
*Habrocerus capillaricornis* (Gravenhorst)  
*Leptacinus pusillus* (Stephens)  
*Lithocaris nigriceps* (Kraatz)  
*Megarthrus prosseni* (Schatzmayr)  
*Metopispa clypeata* (Müller)  
*Microdota amicula* (Stephens)  
*Micropeplus fulvus* (Erichson)  
*Mocyta amplicollis* (Mulsant & Rey)  
*Mocyta clientula* (Erichson)  
*Mocyta fungi* (Gravenhorst)  
*Mocyta orbata* (Erichson)  
*Mycetoporus clavicornis* (Stephens)  
*Mycetota laticollis* (Stephens)  
*Neobisnius lathroboides* (Baudi)  
*Ocyphus olens* (Müller)  
*Oligota inflata* (Mannerheim)  
*Oligota parva* (Kraatz)  
*Oligota pumilio* (Kiesenwetter)  
*Omalium caesum* (Gravenhorst)  
*Omalium italicum* (Bernhauer)  
*Omalium rivulare* (Paykull)

*Oxypoda haemorrhoa* (Mannerheim)  
*Oxypoda umbrata* (Gyllenhal)  
*Philhygra elongatula* (Gravenhorst)  
*Philhygra palustris* (Kiesenwetter)  
*Philonthus carbonarius* (Gravenhorst)  
*Philonthus cognatus* (Stephens)  
*Philonthus discoideus* (Gravenhorst)  
*Philonthus politus* (Linnaeus)  
*Philonthus quisquiliaris* (Gyllenhal)  
*Philonthus rectangulus* (Sharp)  
*Philonthus varians* (Paykull)  
*Proteinus ovalis* (Stephens)  
*Quedius curtipennis* (Bernhauer)  
*Quedius humeralis* (Stephens)  
*Quedius levicollis* (Brullé)  
*Quedius mesomelinus* (Marsham)  
*Quedius schatzmayri* (Gridelli)  
*Rugilus orbiculatus* (Paykull)  
*Stenus brunnipes* (Stephens)  
*Stenus ossium* (Stephens)  
*Sunius propinquus* (Brisout)  
*Tachinus rufipes* (Linnaeus)  
*Tachyporus dispar* (Paykull)  
*Tachyporus hypnorum* (Fabricius)  
*Tachyporus nitidulus* (Fabricius)  
*Tachyporus pusillus* (Gravenhorst)  
*Tachyporus tersus* (Erichson)  
*Tasgius ater* (Gravenhorst)  
*Trichiusa immigrata* (Lohse)  
*Xantholinus linearis* (Olivier)  
*Xantholinus longiventris* (Heer)

**Lucanidae - Stag beetles**  
*Dorcus parallelipedus* (Linnaeus)  
*Lucanus cervus* (Linnaeus) Notable B

**Scarabaeidae - Scarab beetles**  
*Amphimallon solstitiale* (Linnaeus)  
*Aphodius contaminatus* (Herbst)  
*Aphodius rufus* (Moll)  
*Cetonia aurata* (Linnaeus)  
*Oxyomus sylvestris* (Scopoli)  
*Saprosites natalensis* (Peringuey)

**Scirtidae - Marsh beetles**  
*Cyphon variabilis* (Thunberg)

**Byrrhidae - Pill beetles**  
*Chaetophora spinosa* (Rossi)  
*Simplocaria semistriata* (Fabricius)

**Heteroceridae**  
*Heterocerus fenestratus* (Thunberg)

**Throscidae**  
*Trixagus dermestoides* (Linnaeus)

**Elateridae - Click beetles**  
*Dalopius marginatus* (Linnaeus)

**Cantharidae - Soldier beetles**  
*Cantharis lateralis* (Linnaeus)  
*Cantharis rufa* (Linnaeus)  
*Cantharis rustica* (Fallén)  
*Rhagonycha fulva* (Scopoli)

**Dermestidae - Skin and hide beetles**  
*Anthrenocerus australis* (Hope)  
*Anthrenus museorum* (Linnaeus)  
*Anthrenus sarnicus* (Mroczkowski)  
*Anthrenus verbasci* (Linnaeus)  
*Ctesias serra* (Fabricius) Notable B  
*Dermestes haemorrhoidalis* (Küster)  
*Dermestes peruvianus* (Laporte)

**Ptinidae (including Anobiinae) - Spider and woodworm beetles**  
*Anobium nitidum* (Fabricius) RDB 'I'  
*Anobium punctatum* (De Geer)  
*Ochina ptinoides* (Marsham)  
*Priobium carpini* (Herbst)  
*Ptilinus pectinicornis* (Linnaeus)  
*Stegobium paniceum* (Linnaeus)  
*Ptinus sexpunctatus* (Panzer) Notable B

**Melyridae**  
*Axinotarsus marginalis* (Laporte)  
*Dasytes plumbeus* (Müller) Notable B

**Kateretidae**  
*Brachypterus glaber* (Stephens)  
*Brachypterolus pulicarius* (Linnaeus)  
*Kateretes rufilabris* (Latreille)

**Nitidulidae - Pollen beetles**  
*Meligethes aeneus* (Fabricius)  
*Meligethes carinulatus* (Förster)  
*Meligethes gagathinus* (Erichson) Notable  
*Meligethes rotundicollis* (Brisout) Notable  
*Meligethes ruficornis* (Marsham)

**Monotomidae**  
*Monotoma bicolor* (Villa & Villa)  
*Monotoma picipes* (Herbst)  
*Rhizophagus perforatus* (Erichson)

**Phalacridae - Smut beetles**  
*Olibrus affinis* (Sturm)  
*Olibrus flavicornis* (Sturm) RDB 'K'  
*Olibrus liquidus* (Erichson)  
*Stilbus testaceus* (Panzer)

**Cryptophagidae - Silken fungus beetles**  
*Atomaria apicalis* (Erichson)  
*Atomaria atricapilla* (Stephens)  
*Atomaria fuscata* (Schönherr)  
*Atomaria lewisi* (Reitter)  
*Atomaria linearis* (Stephens)  
*Atomaria nitidula* (Marsham)  
*Atomaria pusilla* (Paykull)  
*Atomaria rubella* (Heer)  
*Atomaria testacea* (Stephens)  
*Cryptophagus acutangulus* (Gyllenhal)  
*Cryptophagus reflexus* (Rey)  
*Cryptophagus scanicus* (Linnaeus)  
*Ephistemus globulus* (Paykull)

**Bothrideridae**  
*Anommatus duodecimstriatus* (Müller)  
 Notable A

**Coccinellidae - Ladybirds**  
*Adalia bipunctata* (Linnaeus)  
*Adalia decempunctata* (Linnaeus)

**Anatis ocellata** (Linnaeus)  
*Calvia quattuordecimpunctata* (Linnaeus)  
*Chilocorus renipustulatus* (Scriba)  
*Clitostethus arcuatus* (Rossi) RDB1  
*Coccinella septempunctata* (Linnaeus)  
*Exochomus quadripustulatus* (Linnaeus)  
*Halyzia sedecimpunctata* (Linnaeus)  
*Harmonia axyridis* (Pallas)  
*Harmonia quadripunctata* (Pontoppidan)  
*Propylea quattuordecimpunctata* (Linnaeus)  
*Psyllobora vigintiduopunctata* (Linnaeus)  
*Rhyzobius chrysomeloides* (Herbst)  
*Rhyzobius forestieri* (Mulsant)  
*Rhyzobius litura* (Fabricius)  
*Rhyzobius lophanthae* (Blaisdell)  
*Rodolia cardinalis* (Mulsant)  
*Stethorus punctillum* (Weise)

**Corylophidae**  
*Sericoderus lateralis* (Gyllenhal)

**Latridiidae**  
*Cartodere bifasciata* (Reitter)  
*Cartodere nodifer* (Westwood)  
*Corticarina fuscula* (Gyllenhal)  
*Cortinicara gibbosa* (Herbst)  
*Enicmus brevicornis* (Mannerheim)  
 Notable  
*Stephostethus lardarius* (De Geer)

**Mycetophagidae - Fungus beetles**  
*Typhaea stercorea* (Linnaeus)

**Ciidae - Minute fungus beetles**  
*Cis boleti* (Scopoli)

**Melandryidae - False darkling beetles**  
*Conopalpus testaceus* (Olivier) Notable B

**Mordellidae - Tumbling flower beetles**  
*Mordellistena acuticollis* (Schilsky) RDB 'K'  
*Mordellistena variegata* (Fabricius)

**Colydiidae**  
*Langelandia anophthalma* (Aubé) RDB3

**Tenebrionidae - Darkling beetles**  
*Lagria hirta* (Linnaeus)  
*Tenebrio molitor* (Linnaeus)  
*Tenebrio obscurus* (Fabricius)

**Oedemeridae - Thick-legged flower beetles**

*Oedemera lurida* (Marsham)  
*Oedemera nobilis* (Scopoli)

**Pyrochroidae - Cardinal beetles**  
*Pyrochroa serraticornis* (Scopoli)

**Anthicidae - Ant-like flower beetles**  
*Omonadus floralis* (Linnaeus)  
*Omonadus formicarius* (Goeze)

**Scriptiidae**

*Anaspis fasciata* (Forster)  
*Anaspis lurida* (Stephens)  
*Anaspis maculata* (Geoffroy)  
*Anaspis regimbarti* (Schilsky)

**Cerambycidae - Longhorn beetles**

*Clytus arietis* (Linnaeus)  
*Grammoptera ruficornis* (Fabricius)  
*Leiopus nebulosus* (Linnaeus)  
*Nathrius brevipennis* (Mulsant)  
*Pseudovadonia livida* (Fabricius)  
*Rhagium bifasciatum* Fabricius  
*Rutpela maculata* (Poda)

**Chrysomelidae - Leaf beetles**

*Aphthona euphorbiae* (Schrank)  
*Bruchidius varius* (Olivier)  
*Bruchus rufimanus* (Bohemian)  
*Chaetocnema concinna* (Marsham)  
*Chaetocnema hortensis* (Geoffroy)  
*Crepidodera aurata* (Marsham)  
*Galeruca tanaceti* (Linnaeus)  
*Galerucella lineola* (Fabricius)  
*Lilioceris lilii* (Scopoli)

**Longitarsus flavicornis** (Stephens)  
*Longitarsus luridus* (Scopoli)  
*Longitarsus melanocephalus* (De Geer)  
*Longitarsus parvulus* (Paykull) Notable A  
*Longitarsus pratensis* (Panzer)  
*Longitarsus succineus* (Foudras)  
*Luperomorpha xanthodera* (Fairmaire)  
*Phratora laticollis* (Suffrian)  
*Phyllotreta diademata* (Foudras)  
*Phyllotreta nigripes* (Fabricius)  
*Phyllotreta undulata* (Kutschera)  
*Psylliodes chrysocephala* (Linnaeus)  
*Psylliodes napi* (Fabricius)  
*Pyrrhalta viburni* (Paykull)

**Anthribidae - Fungus weevils**  
*Bruchela rufipes* (Olivier)

**Apionidae - Seed weevils**

*Apion frumentarium* (Linnaeus)  
*Aspidapion aeneum* (Fabricius)  
*Aspidapion radiolus* (Marsham)  
*Exapion ulicis* (Forster)  
*Kalcapion semivittatum* (Gyllenhal)  
 Notable A

*Malvapion malvae* (Fabricius)  
*Oxystoma cerdo* (Gerstaecker) Notable B  
*Perapion hydrolapathi* (Marsham)  
*Protagon apricans* (Herbst)  
*Protagon fulvipes* (Geoffroy)  
*Pseudapion rufirostre* (Fabricius)

**Nanophyidae**

*Nanophyes marmoratus* (Goeze)

**Curculionidae - True weevils**

*Barypeithes pellucidus* (Bohemian)  
*Ceutorhynchus erysimi* (Fabricius)  
*Ceutorhynchus pallidactylus* (Marsham)  
*Cionus scrophulariae* (Linnaeus)  
*Dorytomus dejani* (Faust)  
*Dorytomus ictor* (Herbst) Notable B  
*Dorytomus melanophthalmus* (Paykull)  
*Euophryum confine* (Broun)  
*Magdalis barbicornis* (Latreille) Notable A

*Mecinus pascuorum* (Gyllenhal)  
*Mecinus pyraster* (Herbst)  
*Otiorhynchus rugosostriatus* (Goeze)  
*Otiorhynchus sulcatus* (Fabricius)  
*Phyllobius pomaceus* (Gyllenhal)  
*Phyllobius pyri* (Linnaeus)  
*Pityophthorus pubescens* (Marsham)  
*Polydrusus formosus* (Mayer) Notable A  
*Rhinusa antirrhini* (Paykull)  
*Scolytus intricatus* (Ratzeburg)  
*Scolytus multistriatus* (Marsham)  
*Sitona hispidulus* (Fabricius)  
*Sitona lepidus* (Gyllenhal)  
*Sitona lineatus* (Linnaeus)  
*Trichosirocalus troglodytes* (Fabricius)  
*Trypophloeus binodulus* (Ratzeburg)  
  Notable A  
*Tychius picirostris* (Fabricius)  
*Xyleborinus saxesenii* (Ratzeburg)

**LEPIDOPTERA - Moths**

New since 2003 (Leigh and Ware)

**Adelidae**

*Nemophora degeerella* Yellow-barred long-horn

**Autostichidae**

*Oegoconia* sp

**Bedellinae**

*Bedellia somnulentella* Bindweed bent-wing

**Coleophoridae**

*Coleophora glaucicolella* Grey rush case-bearer

*Coleophora spinella* Apple & plum case-bearer

**Crambidae**

*Cydalima perspectalis* Box tree moth  
*Donacaula forficella* Pale water-veneer  
*Palpita vitrealis* Olive-tree pearl

**Elachistidae**

*Elachista obliquella* Wood dwarf

**Erebidae**

*Calliteara pudibunda* Pale tussock  
*Eilema complana* Scarce Footman  
*Euclidia glyphica* Burnet companion  
*Euplagia quadripunctaria* Jersey tiger  
*Lymantria dispar* Gypsy moth  
*Spilosoma lubricipeda* White ermine

**Eriocraniidae**

*Dyseriocrania subpurpurella* Common oak purple

**Gelechiidae**

*Anarsia spartiella* Small crest  
*Athrips mouffetella* Dotted grey groundling  
*Neofaculta ericotella* Heather groundling  
*Scrobipalpa oboletella* Summer groundling  
*Syncopacma larseniella* White-strap sober

**Geometridae**

*Agriopsis marginaria* Dotted border  
*Chesias legatella* The streak  
*Dysstroma citrata* Dark marbled carpet  
*Ectropis crepuscularia* The engrailed  
*Eupithecia tripunctaria* White-spotted pug  
*Idaea dilutaria* Silky wave  
*Idaea rusticata* Least carpet  
*Thera cupressata* Cypress carpet

**Glyptipterigidae**

*Acrolepia autumnitella* Bittersweet smudge

**Gracillariidae**

*Cameraria ohridella* Horse-chestnut leaf-miner  
*Parornix devoniella* Hazel slender  
*Parornix torquillella* Blackthorn slender

*Phyllonorycter acerifoliella* Maple midget

*Phyllonorycter coryli* Nut leaf blister moth

*Phyllonorycter corylifoliella* Hawthorn midget

*Phyllonorycter geniculella* Sycamore midget

*Phyllonorycter heegeriella* Pale oak midget

*Phyllonorycter leucographella* Firethorn leaf miner

*Phyllonorycter nicellii* Red hazel midget

*Phyllonorycter tristrigella* Elm midget

**Hepialidae**

*Triodia sylvina* Orange swift

**Incurvariidae**

*Incurvaria masculella* Feathered bright

**Momphidae**

*Mompha divisella* Neat cosmet  
*Mompha jurasicella* Scarce cosmet

**Nepticulidae**

*Ectoedemia heringella*  
*Ectoedemia* sp.  
*Stigmella aceris* Scarce maple pigmy  
*Stigmella floslactella* Coarse hazel pigmy  
*Stigmella* sp.  
*Stigmella tityrella* Small beech pigmy

**Noctuidae**

*Abrostola tripartita* The spectacle  
*Agrotis trux* Crescent dart  
*Anaplectoides prasina* Green arches  
*Autographa pulchrina* Beautiful golden Y  
*Cirrhia gilvago* Dusky-lemon sallow  
*Cirrhia ocellaris* Pale-lemon sallow  
*Colocasia coryli* Nut-tree tussock  
*Cryphia algae* Tree lichen beauty  
*Diarsia mendica* Ingrailed clay  
*Diloba caeruleocephala* Figure of eight  
*Eugnorisma glareosa* Autumnal rustic

*Hoplodrina blanda* The rustic

*Leucania comma* Shoulder-striped wainscot

*Melanchia persicariae* Dot moth

*Oligia strigilis* Marbled minor

*Pechipogo plumigeralis* Plumed fan-foot

*Thalpophila matura* Straw underwing

**Notodontidae**

*Pheosia tremula* Swallow prominent

**Psychidae**

*Psyche casta* Common sweep

**Pterophoridae**

*Amblyptilia acanthadactyla* Beautiful plume

**Pyralidae**

*Achroia grisella* Lesser wax moth  
*Acrobasis advenella* Grey knot-horn  
*Cataclysta lemnata* Small china-mark  
*Ephestia unicolorella* False cacao moth  
*Eudonia angustea* Narrow-winged grey  
*Eudonia pallida* Marsh grey  
*Eudonia truncicolella* Ground-moss grey  
*Pempelia palumbella* Heather knot-horn  
*Scoparia ambigualis* Common grey

**Sesiidae**

*Bembecia ichneumoniformis* Six-belted clearwing

**Tineidae**

*Tinea pallescentella* Large pale clothes moth

**Tischeriidae**

*Coptotriche marginea* Bordered carl

**Tortricidae**

*Adoxophyes orana* Summer fruit tortrix  
*Agapeta zoegana* Knapweed conch  
*Ancylis mitterbacheriana* Red roller  
*Bactra lancealana* Rush marble

*Celypha lacunana* Common marble  
*Cnephiasia stephensiana* Grey tortrix  
*Cochylimorpha straminea* Straw conch  
*Cydia fagiglandana* Large beech piercer  
*Endothenia oblongana* Downland marble  
*Epiblema foenella* White-foot bell  
*Epiblema uddmanniana* Bramble shoot moth  
*Epinotia ramella* Small birch bell  
*Hedya ochroleucana* Buff-tipped marble  
*Orthotaenia undulana* Woodland marble  
*Pammene aurita* Sycamore piercer  
*Phtheochroa rugosana* Rough-winged conch

**Yponomeutidae**  
*Argyresthia semitestacea* Large beech argent

**DIPTERA - Flies**  
 All species recorded since 1995  
**Tipulidae**  
*Nephrotoma appendiculata*  
*Nephrotoma flavescentia*  
*Nephrotoma flavipalpis*  
*Nephrotoma quadrifarea*  
*Tipula oleracea*  
*Tipula paludosa*  
*Tipula rufina*

**Limoniidae**  
*Cheilotrichia cinerascens*  
*Dicranomyia mitis*  
*Dicranomyia modesta*  
*Helius flavus*  
*Limonia nubeculosa*  
*Rhipidia maculata*

**Trichoceridae**  
*Trichocera annulata*  
*Trichocera hiemalis*

**Bibionidae**  
*Dilophus febrilis*

**Keroplatidae**  
*Macrocerata phalerata*

**Sciaridae**  
*Bradysia albanensis*  
*Epidapus gracilis*  
*Lycoriella ingenua*  
*Lycoriella solani*

**Cecidomyiidae**  
*Campylomyza flavipes*  
*Hartigiola annulipes*  
*Macrodiplosis dryobia*  
*Macrolabis heraclei*  
*Parepidosis longinodis*  
*Wachtliella rosarum*

**Psychodidae**  
*Clogmia albipunctata*  
*Psychoda albipennis*

**Anisopodidae**  
*Sylvicola fenestralis*

**Dixidae**  
*Dixella aestivalis*

**Chaoboridae**  
*Chaoborus crystallinus*

**Culicidae**  
*Anopheles claviger*  
*Culex pipiens*  
*Culiseta annulata*

**Ceratopogonidae**  
*Culicoides oboletus*

**Chironomidae**  
*Chironomus dorsalis*  
*Chironomus plumosus*  
*Chironomus tentans*  
*Cricotopus trifasciatus*  
*Polypedilum sordens*  
*Procladius choreus*

**Smittia aterrima**  
**Xylomyidae**  
*Solva marginata* Notable  
**Stratiomyidae**  
*Beris clavipes* Notable  
*Beris fuscipes*  
*Beris vallata*  
*Chloromyia formosa*  
*Chorisops tibialis*  
*Oxytropis rara*  
*Pachygaster atra*  
*Pachygaster leachii*  
*Sargus bipunctatus*  
*Stratiomys potamida* Notable  
*Vanoyia tenuicornis* Notable

**Rhagionidae**  
*Chrysopilus asiliformis*  
*Chrysopilus laetus* Endangered

**Bombyliidae**  
*Bombylius major*

**Therevidae**  
*Thereva nobilitata*

**Asilidae**  
*Dioctria baumhaueri*

**Dolichopodidae**  
*Campsicnemus curvipes*  
*Campsicnemus picticornis*  
*Dolichopus griseipennis*  
*Dolichopus unguulatus*  
*Gymnopternus metallicus*  
*Liancalus virens*  
*Rhaphium appendiculatum*  
*Sciapus longulus*  
*Sciapus platypterus*  
*Sympycnus desoutteri*  
*Xanthochlorus galbanus*

**Phoridae**  
*Diplonevra nitidula*  
*Megaselia aequalis*  
*Megaselia badia*  
*Megaselia brevicostalis*  
*Megaselia dimidia*  
*Megaselia infraposita*  
*Megaselia largifrontalis*  
*Megaselia latifemorata*  
*Megaselia longicostalis*  
*Megaselia spinicincta*  
*Megaselia subtumida*

**Lonchopteridae**  
*Lonchoptera lutea*

**Syrphidae**  
*Baccha elongata*  
*Cheilosia pagana*  
*Cheilosia scutellata*  
*Cheilosia soror*  
*Dasyphorus tricinctus*  
*Epistrophe eligans*  
*Episyphus balteatus*  
*Eristalis intricarius*  
*Eristalis pertinax*  
*Eristalis tenax*  
*Eupeodes corollae*  
*Helophilus pendulus*  
*Helophilus trivittatus*  
*Melanostoma mellinum*  
*Melanostoma scalare*  
*Merodon equestris*  
*Myathropa florea*  
*Neoascia podagraria*  
*Platycheirus albimanus*  
*Sphaerophoria scripta*  
*Syritta pipiens*  
*Syrphus ribesii*  
*Volucella inanis*  
*Volucella pellucens*  
*Volucella zonaria*

**Micropezidae**  
*Calobata cibaria*

**Conopidae**  
*Sicus ferrugineus*

**Pallopteridae**  
*Palloptera umbellatarum*  
*Palloptera ustulata*

**Piophilidae**  
*Liopiophila varipes*  
*Parapiophila vulgaris*  
*Protopiophila latipes*  
*Stearibia nigriceps*

**Ulidiidae**  
*Physiphora alceae*  
*Seioptera vibrans*

**Tephritidae**  
*Acinia corniculata* Endangered  
*Anomoia permunda*  
*Euleia heraclei*  
*Rhagoletis alternata*  
*Terellia tussilaginis*

**Lauxaniidae**  
*Minettia insta*  
*Tricholauxania praeusta*

**Sciomyzidae**  
*Elgiva cucularia*  
*Pherbina coryleti*

**Sepsidae**  
*Nemopoda nitidula*  
*Sepsis punctum*

**Clusiidae**  
*Clusiodes albimana*  
*Clusiodes gentilis*

**Agromyzidae**  
*Amauromyza labiatarum*  
*Phytomyza agromyzina*  
*Phytomyza horticola*  
*Phytomyza ilicis*

**Phytomyzidae**  
*Phytomyza lappae*  
*Phytomyza minuscula*  
*Phytomyza ranunculi*  
*Phytomyza spondylii*

**Opomyzidae**  
*Geomyza tripunctata*  
*Opomyza florum*  
*Opomyza germinationis*  
*Opomyza petrei*

**Chloropidae**  
*Oscinella frit*  
*Oscinella pusilla*

**Heleomyzidae**  
*Neoleria propinquua* Notable  
*Suillia affinis*  
*Suillia bicolor*  
*Suillia variegata*  
*Tephrochlamys rufiventris*

**Trixoscelididae**  
*Trixoscelis frontalis*

**Sphaeroceridae**  
*Copromyza equina*  
*Copromyza nigrina*  
*Leptocera caenosa*  
*Leptocera fontinalis*  
*Leptocera nigra*  
*Limosina vitripennis*  
*Opacifrons coxata*  
*Pullimosina moesta*  
*Pullimosina pullula*  
*Spelobia clunipes*  
*Spelobia palmata*  
*Spelobia rufilabris*  
*Sphaerocera monilis*

**Drosophilidae**  
*Scaptomyza pallida*

**Campichoetidae**  
*Campichoeta punctum*

**Camillidae**  
*Camilla nigrifrons*

**Ephydriidae**  
*Athyroglossa glabra*  
*Notiphola riparia*

**Scathophagidae**  
*Cordilura albipes*  
*Norellia spinipes*  
*Norellisoma spinimanum*  
*Scathophaga lutaria*  
*Scathophaga stercoraria*

**Anthomyiidae**  
*Anthomyia procellaris*  
*Botanophila fugax*  
*Delia criniventris*  
*Delia platura*  
*Emmesomyia socia*  
*Hydrophoria ruralis*  
*Hylemya vagans*  
*Leucophora obtusa*  
*Pegomya bicolor*  
*Pegomya flavifrons*

**Fanniidae**  
*Fannia atripes*  
*Fannia canicularis*  
*Fannia fuscula*  
*Fannia genualis*  
*Fannia hamata*  
*Fannia manicata*  
*Fannia monilis*  
*Fannia scalaris*  
*Fannia umbrosa*

**Muscidae**  
*Coenosia agromyzina*  
*Coenosia femoralis*  
*Coenosia testacea*  
*Coenosia tigrina*  
*Hebecnema nigra*  
*Hebecnema umbratica*  
*Hebecnema vespertina*

**Helina depuncta**  
**Helina erecta**  
**Helina reversio**  
**Hydrotaea armipes**  
**Hydrotaea dentipes**  
**Hydrotaea ignava**  
**Hydrotaea meteorica**  
**Limnophora olympiae**  
**Muscina levida**  
**Muscina prolapsa**  
**Muscina stabulans**  
**Phaonia errans**  
**Phaonia fuscata**  
**Phaonia halterata**  
**Phaonia palpata**  
**Phaonia serva**

**Calliphoridae**  
*Calliphora vicina*  
*Calliphora vomitoria*  
*Lucilia ampullacea*  
*Lucilia caesar*  
*Lucilia illustris*  
*Lucilia sericata*  
*Pollenia rudis*  
*Protocalliphora azurea*

**Rhinophoridae**  
*Rhinophora lepida*  
*Tricogena rubricosa*

**Sarcophagidae**  
*Sarcophaga agnata*  
*Sarcophaga albiceps*  
*Sarcophaga carnaria*  
*Sarcophaga incisilobata*  
*Sarcophaga rosellei*  
*Sarcophaga subvicina*

**Tachinidae**  
*Linnaemyia picta*  
*Phasia barbifrons*  
*Thelera nigripes*

**ROTIFERA**

All species recorded since 1995

**Brachionidae**

*Anuraeopsis fissa*

*Brachionus angularis*

*Brachionus urceolaris*

*Keratella brevispina*

*Keratella cochlearis*

*Keratella quadrata f. dispersa*

*Keratella testudo*

*Notholca acuminata*

*Platyias quadricornis*

**Collothecidae**

*Collotheca ambigua*

*Collotheca ornata* ssp. *cornuta*

**Dicranophoridae**

*Dicranophorus forcipatus*

**Euchlanidae**

*Euchlanis deflexa*

*Euchlanis dilatata*

*Euchlanis incisa*

*Euchlanis triquetra*

**Flosculariidae**

*Floscularia melicerta*

*Floscularia ringens*

**Ituridae**

*Itura aurita*

**Lecanidae**

*Lecane bulla*

*Lecane closterocerca*

*Lecane luna*

*Lecane lunaris*

*Lecane quadridenata*

**Lepadellidae**

*Colurella adriatica*

*Colurella colurus*

*Colurella obtusa*

*Colurella uncinata*

**Lepadellidae**

*Lepadella ovalis*

*Lepadella patella*

*Lepadella patella* ssp. *similis*

*Squatinella lamellaris*

**Mitilinidae**

*Mytilina bisulcata*

*Mytilina crassipes*

*Mytilina mucronata*

*Mytilina ventralis*

**Mytilinidae**

*Lophocharis oxyternum*

**Notommatidae**

*Cephalodella auriculata*

*Cephalodella gibba*

*Cephalodella tenuiseta americana\**

*Cephalodella tenuiseta tenuisets\**

*Cephalodella ventripes*

*Monommata dentata*

*Pleurotrocha petromyzon*

**Philodinidae**

*Rotaria rotatoria*

*Proales daphnicola*

*Proales decipiens*

**Synchaetidae**

*Polyarthra dolichoptera*

*Polyarthra sp.*

*Synchaeta oblonga*

*Synchaeta pectinata*

*Synchaeta tremula*

**Testudinellidae**

*Testudinella patina*

**Trichocercidae**

*Trichocerca carinata*

*Trichocerca dixon-nuttalli*

*Trichocerca porcellus*

*Trichocerca rattus*

**Trichotriidae**

*Trichotria pocillum*

*Trichotria tetractis*

**CRUSTACEA****BRACIOPODA****Bosminidae**

*Bosmina longirostris*

**Daphniidae**

*Ceriodaphnia quadrangula*

*Daphnia hyalina*

*Daphnia longispina*

*Daphnia pulex*

*Scapholeberis mucronata*

*Simocephalus vetulus*

**Eury cercidae**

*Alona quadrangularis*

*Chydorus sphaericus*

*Graptoleberis testudinaria*

**Sididae**

*Sida crystallina*

**MYRIAPODA**

All species recorded since 1995

\* previously listed in 2003 (Leigh and Ware)

**CHILOPODA - CENTIPEDES****Cryptopidae**

*Cryptops anomalans*

*Cryptops hortensis*

**Dignathodontidae**

*Henia brevis* Notable (Nationally Scarce)

**Geophilidae**

*Geophilus flavus*

*Stenotaenia linearis*

**Himantariidae**

*Stigmatogaster subterraneus*

**Lithobiidae**

*Lithobius forficatus*

*Lithobius melanops*

*Lithobius microps*

*Lithobius variegatus*

**Schendylidae**

*Schendyla dentate*

*Schendyla nemorensis*

**DIPLOPODA - MILLIPEDES****Blaniulidae**

*Blaniulus guttulatus\** Notable (Nationally Scarce)

**Julidae**

*Brachyiulus pusillus\**

*Cylindroiulus britannicus*

*Cylindroiulus caeruleocinctus\**

*Cylindroiulus punctatus*

*Cylindroiulus vulnerarius*

*Haplopodoiulus spathifer*

*Julus scandinavicus*

*Ophyiulus pilosus\**

*Tachypodoiulus niger\**

**Macrosternodesmidae**

*Ophiodesmus albonanus*

**Polydesmidae**

*Brachydesmus superus\**

*Polydesmus angustus*

*Polydesmus coriaceus*

*Polydesmus inconstans\**

**ANNELIDA****Erpobdellidae**

*Erpobdella octoculata*

*Trocheta bykowskii*

**Glossiphoniidae**

*Alboglossiphonia heteroclite*

*Helobdella stagnalis*

*Theromyzon tessulatum*

**OLIGOCHAETA - Earthworms**

Lumbricidae  
*Allolobophora chlorotica*  
*Aporrectodea caliginosa*  
*Aporrectodea icterica*  
*Aporrectodea longa*  
*Aporrectodea rosea*  
*Dendrobaena pygmaea*  
*Dendrobaena veneta*  
*Eisenia fetida*  
*Eiseniella tetraedra*  
*Lumbricus rubellus*  
*Lumbricus terrestris*  
*Octolasion lacteum*

**ARACHNIDA****ARANAEAE - SPIDERS**

\*Previously listed in 2003 (Leigh and Ware)

Pholcidae  
*Pholcus phalangioides*  
*Psilochorus simoni*

Dysderidae  
*Dysdera crocata*\*  
*Harpactea hombergi*

Mimetidae  
*Ero aphana*

Theridiidae  
*Steatoda grossa*  
*Steatoda nobilis*  
*Anelosimus vittatus*  
*Achaearanea lunata*  
*Achaearanea riparia*  
*Theridion pictum*  
*Theridion varians*\*  
*Theridion melanurum*\*  
*Theridion mystaceum*  
*Theridion tinctum*  
*Neottiura bimaculata*  
*Paidiscura pallens*  
*Enoplognatha ovata*\*  
*Cryptachaea blattea*

**Nesticidae**

*Nesticus cellulanus*

**Theridiosomatidae**

*Theridiosoma gemmosum* Notable

**Linyphiidae**

*Dicybium nigrum*

*Gnathonarium dentatum*

*Gongylidium rufipes*

*Maso sundevalli*

*Oedothorax fuscus*

*Gongylidiellum vivum*

*Micrargus herbigradus*\*

*Micrargus subaequalis*

*Panamomops sulcifrons*

*Milleriana inerrans*

*Erigone dentipalpis*\*

*Erigone atra*\*

*Ostearius melanopygus*

*Meioneta rurestris*

*Microneta viaria*

*Centromerita bicolor*

*Bathyphantes gracilis*

*Bathyphantes parvulus*

*Diplosyla concolor*

*Megalepthyphantes nebulosus*

*Leptphyphantes leprosus*

*Leptphyphantes minutus*

*Leptphyphantes tenuis*\*

*Leptphyphantes zimmermanni*

*Leptphyphantes mengei*

*Leptphyphantes flavipes*

*Leptphyphantes ericaeus*\*

*Leptphyphantes pallidus*

*Linyphia triangularis*

*Linyphia hortensis*

*Neriene clathrata*

**Tetragnathidae**

*Tetragnatha montana*

*Pachygnatha degeeri*

*Pachygnatha clercki*

*Meta mengei*

**Araneidae**

*Gibbaranea gibbosa*

*Araneus diadematus*

*Araneus sturmii*

*Zilla diodia*

*Zygiella x-notata*

*Araniella opistographa*

**Lycosidae**

*Pardosa pullata*

**Agelenidae**

*Agelena labyrinthica*

*Tegenaria gigantea*

*Tegenaria domestica*

*Tegenaria silvestris*

**Hahniidae**

*Hahnia nava*

**Dictynidae**

*Dictyna arundinacea*

*Dictyna uncinata*

*Nigma puella*

*Nigma walckenaeri*

*Lathys humilis*

**Amaurobiidae**

*Amaurobius similis*

**Anyphaenidae**

*Anyphaena accentuata*

*Anyphaena sabina*

**Clubionidae**

*Clubiona terrestris*

*Clubiona comta*\*

*Clubiona brevipes*\*

**Philodromidae**

*Philodromus dispar*

*Philodromus aureolus*\*

*Philodromus cespitum*

*Philodromus albidus*

*Tibellus* spp.

**Thomisidae**

*Misumena vatia*

*Xysticus cristatus*\*

*Ozyptila praticola*

**Salticidae**

*Heliophanus cupreus*

*Salticus scenicus*

*Euophrus frontalis*

**OPILIONES - HARVESTMEN****Phalangiidae**

*Paroligolpus agrestis*

**Gyantinae**

*Dicranopalpus ramosus*

*Odiellus spinosus*\*

*Opilio saxatilis*\*

**ACARI - MITES****Acaridae**

*Thyreophagus* sp.

*Tyrophagus longior*

**Ameroseiidae**

*Ameroseius* sp.

**Anystidae**

*Anystis baccarum*

**Aphelacaridae**

*Aphelacarus nr acarinus*

**Ascidae**

*Zerconopsis remiger*

**Bdellidae**

*Spinibdella* sp.

**Blattisociidae**

*Blattisocius tarsalis*

**Cheyletidae**

*Cheletomimus berlesei*

**Dermanyssidae**  
*Dermanyssus carpathicus*

**Eupodidae**  
*Linopodes* sp.

**Humerobatidae**  
*Humerobates rostrolamellatus*

**Laelapidae**  
*Androlaelaps casalis*

**Oribatellidae**  
*Oribatella* sp.

**Oribatulidae**  
*Oribatula tibialis*  
*Zygorbatula nr exilis*

**Parasitidae**  
*Holoparasitus lawrencei*

**Phenopelopidae**  
*Eupelops* sp.

**Phthiracaridae**  
*Phthiracarus* sp.

### Water chemistry

The water in the main pond now (August 2015) has a pH of 7.86 (readings taken 19/08/15), the upper pond water pH 7.70 and the lower chalk pond pH - 7.79. Previous pH reading of the pond water samples were taken on 31/03/2015 and pH ranged from 8.02 on the hedge side of the top pond to pH 8.53 in the chalk pond. Further analyses are planned as discussed above.

### Air quality

See: [www.defra.gov.uk](http://www.defra.gov.uk) and [www.aeat.com/netcen/airqual/data/sitelon.html](http://www.aeat.com/netcen/airqual/data/sitelon.html)

### Soil pH

Heathland LH04: 4.00  
Meadow G02: 6.8  
Scrub S02: 6.7  
Woodland W03: 6.7  
Woodland W09: 6.5  
Meadow G02: 6.8

**Thyrisomidae**  
*Banksinoma nr lunare*

**Tydeidae** spp.

### VERTEBRATES

Additions since 2003 (Leigh and Ware)

### AMPHIBIANS

*Lissotriton helveticus* Palmate newt

### BIRDS

*Accipiter nisus* Sparrowhawk  
*Anser anser* Greylag goose  
*Athene noctua* Little owl  
*Aythya fuligula* Tufted duck  
*Falco peregrinus* Peregrine falcon  
*Periparus ater* Coal tit  
*Picus viridis* Green woodpecker  
*Sitta europaea* Nuthatch

### MAMMALS

*Oryctolagus cuniculus* European rabbit  
*Pipistrellus nathusii* Nathusius' pipistrelle  
*Nyctalus leisleri* Leisler's bat

### CONCLUDING COMMENT

The Natural History Museum's first living exhibition continues to be of great value to local urban biodiversity. The number of species recorded with an increasing presence of species higher up the food chain, demonstrates how habitat creation and wildlife conservation can be successfully achieved in the inner city.

The on-going biological recording is carried out almost completely by people offering their free time - that of volunteers, Museum scientists and professional and amateur naturalists. Further expertise in any group is welcome. As the Wildlife Garden matures its value for biodiversity and as an educational tool can only increase.

A further paper is already in preparation covering soil algae, fungi, plant galls, Lepidopera - butterflies, tardigrades, amphipods, springtails and amphibians.

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## APPENDIX 1

### VASCULAR PLANTS RECORDED 2014-2015

Nomenclature follows Stace (2011)

<sup>1</sup> - Remnant plants

<sup>2</sup> - accidental arrival

<sup>3</sup> - W07 only

#### Aceraceae

*Acer campestre* Field maple

*Acer pseudoplatanus*<sup>1</sup> Sycamore

#### Alismataceae

*Alisma plantago-aquatica* Water-plantain

#### Amaryllidaceae

*Allium oleraceum*<sup>2</sup> Field garlic

*Allium schoenoprasum*<sup>2</sup> Chives

*Allium triquetrum*<sup>2</sup> Three-cornered leek

*Allium ursinum* Ramsone

*Galanthus nivalis*<sup>2</sup> Snowdrop

*Narcissus pseudonarcissus* Wild daffodil

#### Apiaceae

*Aegopodium podagraria*<sup>1</sup> Ground-elder  
*Aethusa cynapium*<sup>2</sup> Fool's parsley  
*Angelica sylvestris* Wild angelica  
*Anthriscus sylvestris* Cow parsley  
*Berula erecta* Lesser water-parsnip  
*Cicuta virosa* Cowbane  
*Daucus carota* Wild carrot  
*Heracleum sphondylium* Hogweed  
*Oenanthe aquatica*<sup>2</sup> Fine-leaved water-dropwort  
*Oenanthe crocata*<sup>2</sup> Hemlock water-dropwort  
*Petroselinum segetum*<sup>3</sup> Corn parsley  
*Peucedanum officinale* Hog's fennel  
*Sanicula europaea* Sanicle  
*Sison amomum*<sup>2</sup> Stone parsley  
*Torilis japonica* Upright hedge-parsley

#### Aquifoliaceae

*Ilex aquifolium*<sup>1</sup> Holly  
*Ilex x altaclarensis*<sup>1</sup> Highclere holly

#### Araceae

*Arum maculatum* Lords-and-ladies

#### Araliaceae

*Hedera helix* Ivy

#### Aristolochiaceae

*Asarum europaeum*<sup>2</sup> Asarabacca

#### Asparagaceae

*Hyacinthoides hispanica*<sup>2</sup> Spanish bluebell

*Hyacinthoides non-scripta* Bluebell

*Hyacinthoides x massartiana*

*Ruscus aculeatus* Butcher's-broom

#### Aspleniaceae

*Asplenium scolopendrium* Hart's-tongue

#### Asteraceae

*Achillea millefolium* Yarrow

*Arctium minus*<sup>2</sup> Lesser burdock

*Artemisia vulgaris*<sup>2</sup> Mugwort

*Bellis perennis* Daisy

*Centaurea nigra* Common knapweed

*Centaurea scabiosa* Greater knapweed

*Cirsium arvense*<sup>2</sup> Creeping thistle

*Cirsium vulgare*<sup>2</sup> Spear thistle

*Conyza canadensis*<sup>2</sup> Canadian fleabane

*Conyza sumatrensis*<sup>2</sup> Guernsey fleabane

*Crepis capillaris* Smooth hawk's-beard

*Erigeron karvinskianus*<sup>2</sup> Mexican fleabane

*Eupatorium cannabinum* Hemp-agrimony

*Helminthotheca echioides*<sup>2</sup> Bristly ox-tongue

*Hypochoeris radicata* Cat's-ear

*Lactuca serriola*<sup>2</sup> Prickly lettuce

*Lapsana communis*<sup>2</sup> Nipplewort

*Leontodon hispidus* Rough hawkbit

*Leucanthemum vulgare* Oxeye daisy

*Petasites fragrans* Winter heliotrope

*Picris hieracioides*<sup>2</sup> Hawkweed ox-tongue

*Pilosella aurantiaca* Fox-and-cubs

*Pulicaria dysenterica* Common fleabane

*Senecio inaequidens*<sup>2</sup> Narrow-leaved ragwort

*Senecio jacobaea*<sup>2</sup> Common ragwort

*Senecio squalidus*<sup>2</sup> Oxford ragwort

*Solidago canadensis*<sup>2</sup> Canadian goldenrod

*Sonchus asper*<sup>2</sup> Prickly sow-thistle

*Sonchus oleraceus*<sup>2</sup> Smooth sow-thistle

*Sonchus palustris* Marsh sow-thistle

*Tanacetum vulgare*<sup>2</sup> Tansy

*Taraxacum officinale* agg.<sup>2</sup> Dandelion

*Tripleurospermum inodorum*<sup>2</sup> Scentless mayweed

*Tussilago farfara*<sup>2</sup> Coltsfoot

#### Betulaceae

*Alnus glutinosa* Alder

*Betula pendula* Silver birch

*Betula pubescens* Downy birch

*Carpinus betulus* Hornbeam

*Corylus avellana* Hazel

#### Blechnaceae

*Blechnum spicant* Hard-fern

#### Boraginaceae

*Echium vulgare* Viper's-bugloss

*Myosotis arvensis* Field forget-me-not

*Myosotis scorpioides* Water forget-me-not

*Pentaglottis sempervirens*<sup>1</sup> Green alkanet

*Symphytum grandiflorum* Creeping comfrey

*Symphytum orientale* White comfrey

#### Brassicaceae

*Alliaria petiolata* Garlic mustard

*Arabidopsis thaliana*<sup>2</sup> Thale cress

*Barbarea vulgaris*<sup>2</sup> Winter cress

*Cardamine flexuosa*<sup>2</sup> Wavy bitter-cress

*Cardamine hirsuta*<sup>2</sup> Hairy bitter-cress

*Cardamine pratensis* Cuckooflower

*Diplotaxis muralis*<sup>2</sup> Annual wall-rocket

*Hirschfeldia incana*<sup>2</sup> Hoary mustard

*Raphanus raphanistrum*<sup>2</sup> Wild radish

*Sinapis arvensis*<sup>2</sup> Charlock

*Sisymbrium officinale*<sup>2</sup> Hedge mustard

#### Buddlejaceae

*Buddleja davidii* Butterfly-bush

#### Butomaceae

*Butomus umbellatus* Flowering-rush

#### Buxaceae

*Buxus sempervirens*<sup>1</sup> Box

#### Callitrichaceae

*Callitriche stagnalis* Common water-starwort

#### Campanulaceae

*Campanula glomerata* Clustered bellflower

*Campanula latifolia* Giant bellflower

*Campanula rotundifolia* Harebell

*Campanula trachelium* Nettle-leaved bellflower

#### Cannabaceae

*Cannabis sativa*<sup>2</sup> Hemp

*Humulus lupulus* Hop

#### Caprifoliaceae

*Lonicera periclymenum* Honeysuckle

*Sambucus nigra* Elder

*Symphoricarpos albus*<sup>1</sup> Snowberry

*Viburnum lantana* Wayfaring-tree

*Viburnum opulus* Guelder-rose

#### Caryophyllaceae

*Cerastium arvense* Field mouse-ear

*Cerastium fontanum* Common mouse-ear

*Sagina procumbens*<sup>2</sup> Procumbent pearlwort

*Silene dioica* Red campion

*Silene flos-cuculi* Ragged-robin

*Silene latifolia* ssp. *alba* White campion

*Silene uniflora* Sea campion

*Silene vulgaris* Bladder campion

*Stellaria holostea* Greater stitchwort

*Stellaria media*<sup>2</sup> Common chickweed

#### Celastraceae

*Euonymus europaeus* Spindle

#### Ceratophyllaceae

*Ceratophyllum demersum* Hornwort

#### Chenopodiaceae

*Atriplex prostrata*<sup>2</sup> Spear-leaved orache

#### Cistaceae

*Helianthemum nummularium* Common rock-rose

#### Clusiaceae

*Hypericum androsaemum* Tutsan

*Hypericum hirsutum* Hairy St John's-wort

*Hypericum perforatum* Perforate St John's-wort

*Hypericum tetrapterum* Square-stalked St John's-wort

**Convolvulaceae**

*Calystegia sepium*<sup>2</sup> Common bindweed  
*Calystegia silvatica*<sup>2</sup> Large bindweed  
*Convolvulus arvensis*<sup>2</sup> Field bindweed

**Cornaceae**

*Cornus alba 'Sibirica'* Siberian dogwood  
*Cornus sanguinea* Dogwood

**Crassulaceae**

*Sedum acre* Biting stonecrop  
*Sedum album* White stonecrop  
*Sedum anglicum* English stonecrop  
*Sedum rupestre* Reflexed stonecrop  
*Umbilicus rupestris* Navelwort

**Cucurbitaceae**

*Bryonia dioica* White bryony

**Cupressaceae**

*Juniperus communis* ssp. *communis*  
 Common juniper

**Cyperaceae**

*Carex acutiformis* Lesser pond-sedge  
*Carex depauperata* Starved wood-sedge  
*Carex divulsa* Grey sedge  
*Carex echinata* Star sedge  
*Carex flacca* Glaucous sedge  
*Carex hirta* Hairy sedge  
*Carex otrubae* False fox sedge  
*Carex panicea* Carnation sedge  
*Carex pendula* Pendulous sedge  
*Carex riparia* Greater pond-sedge  
*Carex rostrata* Bottle sedge  
*Carex sp.*  
*Carex sylvatica* Wood-sedge  
*Cyperus longus* Galingale

**Dennstaedtiaceae**

*Pteridium aquilinum* Bracken

**Dioscoreaceae**

*Tamus communis* Black bryony

**Dipsacaceae**

*Dipsacus fullonum* Wild teasel  
*Dipsacus pilosus*<sup>2</sup> Small teasel  
*Knautia arvensis* Field scabious  
*Scabiosa columbaria* Small scabious  
*Succisa pratensis* Devil's-bit scabious

**Dryopteridaceae**

*Dryopteris borreri* Borrer's male-fern  
*Dryopteris dilatata* Broad buckler-fern  
*Dryopteris filix-mas* Male-fern

**Equisetaceae**

*Equisetum arvense* Field horsetail  
*Equisetum fluviatile* Water horsetail

**Ericaceae**

*Calluna vulgaris* Heather  
*Erica cinerea* Bell heather

**Euphorbiaceae**

*Euphorbia amygdaloides* Wood spurge  
*Euphorbia peplus*<sup>2</sup> Petty spurge  
*Mercurialis perennis* Dog's mercury

**Fabaceae**

*Anthyllis vulneraria* Kidney vetch  
*Cytisus scoparius* Broom  
*Lathyrus pratensis* Meadow vetchling  
*Lotus corniculatus* Common bird's-foot-trefoil  
*Lotus pedunculatus* Greater bird's-foot-trefoil  
*Medicago Arabica* Spotted medick  
*Medicago lupulina*<sup>2</sup> Black medick  
*Medicago polymorpha*<sup>2</sup> Toothed medick  
*Melilotus officinalis* Ribbed melilot  
*Ononis repens* Common restarrow  
*Trifolium campestre* Hop trefoil  
*Trifolium dubium* Lesser trefoil  
*Trifolium pratense* Red clover  
*Trifolium repens* White clover  
*Ulex europaeus* Gorse  
*Ulex minor* Dwarf gorse  
*Vicia cracca* Tufted vetch

*Vicia hirsuta*<sup>2</sup> Hairy tare  
*Vicia lathyroides*<sup>2</sup> Spring vetch  
*Vicia sativa*<sup>2</sup> Common vetch  
*Vicia sepium*<sup>2</sup> Bush vetch

**Fagaceae**

*Castanea sativa* Sweet chestnut  
*Fagus sylvatica* Beech  
*Quercus ilex* Evergreen oak  
*Quercus petraea* Sessile oak  
*Quercus robur* Pedunculate oak

**Garryaceae**

*Aucuba japonica*<sup>1</sup> Spotted-laurel

**Gentianaceae**

*Blackstonia perfoliata* Yellow-wort

**Geraniaceae**

*Geranium lucidum* Shining crane's-bill  
*Geranium pratense* Meadow crane's-bill  
*Geranium pusillum* Small-flowered crane's-bill  
*Geranium pyrenaicum* Hedgerow crane's-bill  
*Geranium robertianum* Herb-robert  
*Geranium sanguineum* Bloody crane's-bill  
*Geranium sylvaticum* Wood crane's-bill  
*Geranium versicolor* Pencilled crane's-bill  
*Geranium x oxonianum* Druce's crane's-bill

**Hippocastanaceae**

*Aesculus hippocastanum*<sup>1</sup> Horse-chestnut

**Hippuridaceae**

*Hippuris vulgaris* Mare's-tail

**Hydrangeaceae**

*Philadelphus coronarius*<sup>1</sup> Mock-orange

**Hydrocharitaceae**

*Hydrocharis morsus-ranae* Frogbit  
*Stratiotes aloides* Water-soldier

**Iridaceae**

*Crocus* sp.<sup>1</sup> Crocus  
*Iris foetidissima* Stinking iris  
*Iris pseudacorus* Yellow iris

**Juncaceae**

*Juncus effuses* Soft-rush  
*Juncus inflexus* Hard rush  
*Luzula multiflora* Heath wood-rush  
*Luzula sylvatica* Great wood-rush

**Lamiaceae**

*Ajuga reptans* Bugle  
*Ballota nigra*<sup>2</sup> Black horehound  
*Betonica officinalis* Betony  
*Clinopodium vulgare* Wild basil  
*Galeopsis tetrahit* Common hemp-nettle  
*Glechoma hederacea* Ground-ivy  
*Lamiastrum galeobdolon* Yellow archangel  
*Lamium album* White dead-nettle  
*Lamium purpureum*<sup>2</sup> Red dead-nettle  
*Lycopus europaeus* Gipsywort  
*Melissa officinalis*<sup>2</sup> Lemon balm  
*Mentha aquatic* Water mint  
*Origanum vulgare* Wild marjoram  
*Prunella vulgaris* Selfheal  
*Salvia verbenaca* Wild clary  
*Stachys palustris* Marsh woundwort  
*Stachys sylvatica* Hedge woundwort  
*Teucrium scorodonia* Wood sage  
*Thymus polytrichus* Wild thyme

**Lemnaceae**

*Lemna minor* Common duckweed  
*Lemna minuta*<sup>2</sup> Least duckweed  
*Lemna trisulca* Ivy-leaved duckweed

**Lythraceae**

*Lythrum salicaria* Purple-loosestrife

**Malvaceae**

*Malva moschata* Musk-mallow  
*Malva neglecta*<sup>2</sup> Dwarf mallow  
*Malva sylvestris* Common mallow

**Menyanthaceae**  
*Menyanthes trifoliata* Bogbean

**Myricaceae**  
*Myrica gale* Bog-myrtle

**Nymphaeaceae**  
*Nuphar lutea* Yellow water-lily  
*Nymphaea alba* White water-lily

**Oleaceae**  
*Fraxinus excelsior* Ash  
*Ligustrum lucidum*<sup>1</sup> Shiny privet  
*Ligustrum ovalifolium*<sup>1</sup> Garden privet  
*Ligustrum vulgare* Wild privet

**Onagraceae**  
*Chamerion angustifolium* Rosebay willowherb  
*Circaeа lutetiana* Enchanter's-nightshade  
*Epilobium ciliatum*<sup>2</sup> American willowherb  
*Epilobium hirsutum* Great willowherb  
*Epilobium palustre*<sup>2</sup> Marsh willowherb  
*Epilobium* sp.

**Orchidaceae**  
*Dactylorhiza fuchsii* Common spotted-orchid  
*Epipactis helleborine*<sup>2</sup> Broad-leaved helleborine  
*Ophrys apifera* Bee orchid  
*Ophrys apifera* var. *belgarum* Bee orchid  
*Spiranthes aestivalis* Summer lady's-tresses

**Oxalidaceae**  
*Oxalis acetosella* Wood-sorrel

**Papaveraceae**  
*Chelidonium majus* Greater celandine  
*Papaver rhoeas* Common poppy

**Phrymaceae**  
*Mimulus guttatus*<sup>2</sup> Monkeyflower

**Pinaceae**  
*Pinus nigra* Austrian pine  
*Pinus sylvestris* Scots pine

**Plantaginaceae**  
*Plantago lanceolata* Ribwort plantain  
*Plantago major* Greater plantain

**Platanaceae**  
*Platanus x hispanica*<sup>1</sup> London plane

**Plumbaginaceae**  
*Armeria maritima* Thrift

**Poaceae**  
*Agrostis capillaris* Common bent  
*Agrostis curtissii* Bristle bent  
*Agrostis gigantea*<sup>2</sup> Black bent  
*Agrostis stolonifera* Creeping bent  
*Alopecurus pratensis* Meadow foxtail  
*Anisantha sterilis*<sup>2</sup> Barren brome  
*Anthoxanthum odoratum* Sweet vernal-grass

*Arrhenatherum elatius*<sup>2</sup> False oat-grass  
*Avenula pratensis* Meadow oat-grass  
*Avenula pubescens* Downy oat-grass  
*Brachypodium pinnatum* Tor-grass  
*Brachypodium sylvaticum* False brome  
*Briza media* Quaking-grass  
*Bromopsis erecta* Upright brome  
*Bromopsis ramosa* Hairy-brome  
*Bromus hordaceus* Soft-brome  
*Calamagrostis canescens* Purple small-reed

*Cynosurus cristatus* Crested dog's-tail  
*Dactylis glomerata* Cock's-foot  
*Deschampsia cespitosa* Tufted hair-grass  
*Festuca rubra* Red fescue  
*Festuca vivipara* Viviparous sheep's-fescue  
*Glyceria maxima* Reed sweet-grass  
*Holcus lanatus* Yorkshire-fog  
*Hordeum murinum*<sup>2</sup> Wall barley  
*Hordeum secalinum* Meadow barley  
*Koeleria macrantha* Crested hair-grass

**Lolium perenne** Perennial rye-grass  
*Melica uniflora* Wood melick  
*Milium effusum* Wood millet  
*Molinia caerulea* Purple moor-grass  
*Phalaris arundinacea* Reed canary-grass  
*Phleum bertolonii* Smaller cat's-tail  
*Phleum pratense* Timothy  
*Phragmites australis* Common reed  
*Poa annua*<sup>2</sup> Annual meadow-grass  
*Poa humilis*<sup>2</sup> Spreading meadow-grass  
*Poa pratensis* Smooth meadow-grass  
*Poa trivialis* Rough meadow-grass  
*Polypogon viridis*<sup>2</sup> Water bent  
*Trisetum flavescens* Yellow oat-grass

**Polygonaceae**  
*Rumex acetosa* Common sorrel  
*Rumex acetosella* Sheep's sorrel  
*Rumex crispus*<sup>2</sup> Curled dock  
*Rumex hydrolapathum* Water dock  
*Rumex obtusifolius*<sup>2</sup> Broad-leaved dock  
*Rumex sanguineus* Wood dock  
*Rumex* sp.

**Polypodiaceae**  
*Polypodium cambricum* Southern polypody  
*Polystichum setiferum* Soft shield-fern

**Primulaceae**  
*Lysimachia nummularia* Creeping-jenny  
*Lysimachia vulgaris* Yellow loosestrife  
*Primula elatior* Oxlip  
*Primula veris* Cowslip  
*Primula vulgaris* Primrose  
*Primula x digenea*

**Ranunculaceae**  
*Anemone nemorosa* Wood anemone  
*Aquilegia vulgaris* Columbine  
*Caltha palustris* Marsh-marigold  
*Clematis vitalba* Traveller's-joy  
*Ficaria verna* Lesser celandine  
*Helleborus foetidus* Stinking hellebore  
*Ranunculus acris* Meadow buttercup

**Ranunculus bulbosus** Bulbous buttercup  
**Ranunculus flammula** Lesser spearwort  
**Ranunculus lingua** Greater spearwort  
**Ranunculus repens**<sup>2</sup> Creeping buttercup  
**Thalictrum flavum** Common meadow-rue

**Resedaceae**  
*Reseda lutea* Wild mignonette

**Rhamnaceae**  
*Frangula alnus* Alder buckthorn  
*Rhamnus cathartica* Buckthorn

**Rosaceae**  
*Agrimonia eupatoria* Agrimony  
*Agrimonia procera* Fragrant agrimony  
*Cotoneaster* sp.<sup>1</sup>  
*Crataegus monogyna* Hawthorn  
*Filipendula ulmaria* Meadowsweet  
*Filipendula vulgaris* Dropwort  
*Fragaria vesca* Wild strawberry  
*Geum rivale* Water avens  
*Geum urbanum*<sup>2</sup> Wood avens  
*Malus pumila* Apple  
*Malus sylvestris* Crab apple  
*Potentilla anserine* Silverweed  
*Potentilla reptans* Creeping cinquefoil  
*Potentilla sterilis* Barren strawberry  
*Poterium sanguisorba* Salad burnet  
*Poterium sanguisorba* ssp. *sanguisorba* Salad burnet

*Prunus avium* Wild cherry  
*Prunus cerasifera* Cherry plum  
*Prunus padus* Bird cherry  
*Prunus spinosa* Blackthorn  
*Rosa arvensis* Field-rose  
*Rosa canina* Dog-rose  
*Rosa rubiginosa* Sweet-briar  
*Rosa* sp.  
*Rubus armeniacus* 'Himalayan Giant'  
Himalayan giant  
*Rubus caesius* Dewberry  
*Rubus cespignyanus* Bramble  
*Rubus euryanthemus* Bramble  
*Rubus fruticosus* agg. Bramble

*Rubus polyanthemus* Bramble  
*Sanguisorba officinalis* Great burnet  
*Sorbus aria* Common whitebeam  
*Sorbus aucuparia* Rowan

**Rubiaceae**  
*Cruciata laevipes* Crosswort  
*Galium album* Hedge bedstraw  
*Galium aparine*<sup>2</sup> Goosegrass  
*Galium odoratum* Woodruff  
*Galium verum* Lady's bedstraw  
*Galium x pomeranicum*

**Salicaceae**  
*Populus nigra 'Italica'*<sup>1</sup> Lombardy-poplar  
*Populus tremula* Aspen  
*Salix alba* White Willow  
*Salix alba x fragilis* Hybrid crack-willow  
*Salix caprea* Goat willow  
*Salix cinerea* Grey willow  
*Salix phylicifolia* Tea-leaved willow

**Santalaceae**  
*Viscum album* Mistletoe

**Scrophulariaceae**  
*Cymbalaria muralis* Ivy-leaved toadflax  
*Digitalis purpurea* Foxglove  
*Linaria vulgaris* Common toadflax  
*Rhinanthus minor* Yellow-rattle  
*Scrophularia auriculata* Water figwort  
*Verbascum nigrum* Dark mullein  
*Verbascum* sp.  
*Verbascum thapsus* Great mullein  
*Veronica beccabunga* Brooklime  
*Veronica chamaedrys* Germander speedwell

**Veronica hederifolia**<sup>2</sup> Ivy-leaved speedwell  
*Veronica montana* Wood speedwell  
*Veronica persica*<sup>2</sup> Common field-speedwell  
*Veronica polita* Grey field-speedwell  
*Veronica serpyllifolia* Thyme-leaved speedwell

**Solanaceae**  
*Solanum dulcamara*<sup>2</sup> Bittersweet  
*Solanum nigrum*<sup>2</sup> Black nightshade

**Sparganiaceae**  
*Sparganium erectum* Branched bur-reed

**Taxaceae**  
*Taxus baccata* Yew

**Thelypteridaceae**  
*Thelypteris palustris* Marsh fern

**Tiliaceae**  
*Tilia cordata*<sup>1</sup> Small-leaved lime

**Urticaceae**  
*Urtica dioica*<sup>2</sup> Common nettle  
*Urtica dioica* ssp. *Galeopsifolia*<sup>2</sup>

**Valerianaceae**  
*Valeriana officinalis* Common valerian

**Violaceae**  
*Viola odorata* Sweet violet  
*Viola palustris* Marsh violet  
*Viola reichenbachiana* Early dog-violet  
*Viola riviniana* Common dog-violet

## APPENDIX 2

### LIST OF FLOWER SPECIES VISITED BY BEES

<i>Achillea millefolium</i>	<i>Osmia leiana</i>
<i>Colletes daviesanus</i>	<i>Clinopodium vulgare</i>
<i>Sphecodes monilicornis</i>	<i>Bombus pascuorum</i>
<i>Allium ursinum</i>	<i>Convolvulus arvensis</i>
<i>Lasioglossum smethmanellum</i>	<i>Apis mellifera</i>
<i>Osmia bicornis</i>	
<i>Anemone nemorosa</i>	<i>Crataegus monogyna</i>
<i>Bombus pascuorum</i>	<i>Andrena cineraria</i>
<i>Ballota nigra</i>	<i>Apis mellifera</i>
<i>Bombus pascuorum</i>	<i>Hylaeus hyalinatus</i>
<i>Calluna vulgaris</i>	<i>Osmia bicornis</i>
<i>Bombus pascuorum</i>	
<i>Campanula glomerata</i>	<i>Crepis</i> sp.
<i>Chelostoma campanularum</i>	<i>Osmia leiana</i>
<i>Campanula rotundifolium</i>	
<i>Chelostoma campanularum</i>	<i>Daucus carota</i>
<i>Campanula trachelium</i>	<i>Apis mellifera</i>
<i>Chelostoma campanularum</i>	<i>Bombus terrestris</i>
<i>Melitta haemorrhoidalis</i>	<i>Hylaeus communis</i>
<i>Centaurea nigra</i>	<i>Hylaeus hyalinatus</i>
<i>Bombus lapidarius</i>	<i>Lasioglossum smethmanellum</i>
<i>Bombus pascuorum</i>	<i>Nomada flavoguttata</i>
<i>Bombus vestalis</i>	<i>Sphecodes monilicornis</i>
<i>Osmia leiana</i>	
<i>Centranthus ruber</i>	<i>Dipsacus fullonum</i>
<i>Bombus pratorum</i>	<i>Bombus hypnorum</i>
	<i>Bombus pascuorum</i>
<i>Cirsium arvense</i>	
<i>Bombus pascuorum</i>	<i>Echium vulgare</i>
<i>Hylaeus</i> sp.	<i>Lasioglossum</i> sp.
<i>Cirsium vulgare</i>	
<i>Andrena flavipes</i>	<i>Epilobium hirsutum</i>
	<i>Bombus hypnorum</i>
<i>Erica cinerea</i>	
<i>Bombus lapidarius</i>	<i>Bombus</i> sp.
<i>Bombus pascuorum</i>	
<i>Bombus terrestris</i>	

*Eupatorium cannabinum*  
*Apis mellifera*

*Filipendula ulmaria*  
*Apis mellifera*  
*Bombus terrestris*

*Galium* sp.  
*Hylaeus hyalinatus*

*Geranium* sp.  
*Lasioglossum morio*  
*Osmia bicornis*  
*Osmia caerulescens*

*Geranium pratense*  
*Lasioglossum* sp.  
*Melitta haemorrhoidalis*

*Hyacinthoides non-scripta*  
*Bombus pascuorum*

*Hypericum* sp.  
*Bombus pascuorum*

*Hypochaeris* sp.  
*Lasioglossum* sp.

*Ilex aquifolium*  
*Andrena nitida*

*Knautia arvensis*  
*Bombus pascuorum*  
*Bombus terrestris*  
*Bombus vestalis*

*Lamium galeobdolon*  
*Bombus pascuorum*

*Leucanthemum vulgare*  
*Colletes daviesanus*

*Lotus corniculatus*  
*Bombus lapidarius*  
*Bombus pascuorum*

*Osmia caerulescens*

*Lythrum salicaria*  
*Bombus hypnorum*  
*Bombus pascuorum*

*Melilotus officinalis*  
*Andrena dorsata*  
*Bombus pascuorum*

*Origanum vulgare*  
*Apis mellifera*  
*Bombus hypnorum*  
*Bombus pascuorum*  
*Lasioglossum* sp.

*Pentaglottis sempervirens*  
*Bombus hypnorum*

*Potentilla reptans*  
*Bombus lapidarius*

*Primula veris*  
*Anthophora plumipes*  
*Bombus pascuorum*

*Primula vulgaris*  
*Anthophora plumipes*

*Prunus avium*  
*Andrena fulva*  
*Anthophora plumipes*  
*Apis mellifera*  
*Bombus pascuorum*  
*Bombus terrestris*  
*Melecta albifrons*  
*Osmia bicornis*

*Prunus cerasifera*  
*Apis mellifera*

*Prunus padus*  
*Andrena haemorrhoa*

*Prunus spinosa*  
*Andrena fulva*

*Ranunculus* sp.  
*Andrena (Micrandrena) sp.*  
*Coelioxys elongata*  
*Lasioglossum smethmanellum*  
*Osmia bicornis*  
*Osmia caerulescens*

*Reseda lutea*  
*Hylaeus signatus*

*Rubus fruticosus* agg.  
*Hylaeus* sp.

*Salix* sp.  
*Andrena fulva*  
*Anthophora plumipes*  
*Apis mellifera*  
*Bombus pascuorum*  
*Osmia bicornis*

*Scrophularia nodosa*  
*Bombus pascuorum*

*Senecio jacobaea*  
*Andrena dorsata*  
*Andrena flavipes*  
*Apis mellifera*  
*Coelioxys elongata*  
*Hylaeus communis*

*Lasioglossum calceatum*  
*Lasioglossum smethmanellum*  
*Megachile centuncularis*  
*Panurgus banksianus*

*Solidago canadensis*  
*Hylaeus communis*  
*Sorbus aucuparia*  
*Bombus pascuorum*

*Stachys officinalis*  
*Bombus pascuorum*

*Symphytum orientale*  
*Andrena nitida*  
*Anthophora plumipes*

*Trifolium pratense*  
*Bombus pascuorum*

*Ulex minor*  
*Bombus pascuorum*

*Veronica chamaedrys*  
*Andrena (Micrandrena) sp.*

*Vicia cracca*  
*Bombus pascuorum*

*Vicia sativa*  
*Osmia caerulescens*