THE WILDLIFE GARDEN AT THE NATURAL HISTORY MUSEUM: DEVELOPMENTS OF THE FLORA AND FAUNA UPDATE 2019-2020 – TWENTY-FIVE YEARS OF SPECIES RECORDING

DUNCAN SIVELL[1], TOM McCARTER[1], SYLVIA MYERS[1], SAM THOMAS[1] and THOMAS J. THOMAS[2]

[1]The Natural History Museum, Cromwell Road, London SW7 5BD
[2]143 Selbourne Road, Luton, Bedfordshire LU4 8LS

INTRODUCTION

The purpose of this article is to present a summary of the species recorded since the last report (Sivell *et al*. 2019) and to provide an update on changes to some of the recording and monitoring methods used. In the period covered by this report, 34 new species have been added to the Wildlife Garden list. The number of taxa known from the Garden, after undetermined records and duplicates are removed, is now 3,290.

2020 marks the 25th anniversary of the Wildlife Garden. On 10 July 1995, the Wildlife Garden opened its doors to the public "*as a place to put habitat creation and wildlife conservation into practice, where Museum visitors could learn about UK wildlife and where naturalists, students and Museum scientists could carry out research*". Over its 25-year history, the Wildlife Garden has proven to be an ideal 'living laboratory' and recording in the Garden has demonstrated the importance of small urban spaces for biodiversity. Amongst the 3,290 species known from the Garden are first records for Britain, such as the spider wasp *Agenioideus apicalis* (Notton 2018), and other scarce or unusual species, such as the Tree Snipefly *Chryopilus laetus* and the Yellow-loosestrife Bee *Macropis europaea*. Yet there is more to be discovered, both through traditional survey techniques and novel scientific methods, as demonstrated by the Barkfly surveys and Urban Nature Project (UNP) science articles in this edition. The species list is testament to the efforts of the many staff and volunteers who have contributed to the success of the Wildlife Garden, including many members and readers of the LNHS. Thank you to all who have been involved.

Unfortunately, the coronavirus pandemic has severely impacted the 2020 recording season. On 17 March 2020, the Museum closed its doors to the public for the first time since World War Two. In unprecedented circumstances Museum staff were required to work from home, all planned events and activities cancelled (including a special 25th anniversary recording day) and the volunteering programme put on hold. Despite innovative uses of technology (for example, volunteer e-teabreaks by video and online amphibian survey training run by the Angela Marmont Centre for UK Biodiversity), no recording has taken place in the Wildlife Garden since March.

RECORDING AND MONITORING METHODS

TOM McCARTER

The recording and monitoring methods outlined in Ware *et al*. (2016) remain largely the same, though there have been some changes worth noting here.

First and unusual flowerings in the Wildlife Garden have previously been recorded and submitted to the Woodland Trust's Nature's Calendar (Ware *et al*. 2016). These records have mostly been recorded *ad hoc*, making accurate identification of phenological events difficult. This year the decision was made to focus on a smaller number of the Nature's Calendar's species found in the WLG, each represented by one individual tree in the Garden. A phenology walk following a set route now takes place every volunteering morning. This allows the accurate determination of leaf burst, flowering and fruiting dates that will allow better comparison across years. Unusual flowerings outside of the set route are still recorded as casual observations.

2020 also sees developments in how casual observations are recorded in the Wildlife Garden. Historically, *ad hoc* recording by staff and volunteers has been written down on an observations sheet and later input into the Wildlife Garden database. This year, Museum staff and volunteers have been utilising iRecord for casual observations made in the Garden. iRecord is an app and website for biological recording and has a number of advantages over the paper-based system; it's quick and easy to make a record in the field, it reduces data entry and administration, with records going straight into a database – they can be then downloaded into a spreadsheet, photos and notes can be attached to the observation, records go on to be checked and verified by experts, and, if accepted, the records contribute towards a national dataset. An iRecord activity, 'NHM grounds casual observations' has been set up allowing records made by multiple users to be collated. Staff, volunteers and visitors to the Garden will now be encouraged to make records using iRecord, though a casual observations recording sheet will still be available if requested.

Another major development is the Museum's Urban Nature Project (more information below) which is widening the geographic scope of recording activities to the entire NHM grounds. Indeed, recording in 2019 by Sam Thomas, UK Biodiversity Officer, in the wider NHM grounds found two species that were previously unrecorded. *Nomada fabriciana* was caught in a Malaise trap in the East Lawn and *Sphaerocarpos michelii* was found in the Darwin Centre courtyard. Whilst outside the Wildlife Garden they are included in this report to reflect the widening scope of recording. Species of interest found outside but close to the Garden have been mentioned in previous reports. iRecord has been configured to accept records from across the NHM grounds as well as from the Wildlife Garden and will be able to distinguish between areas.

VASCULAR PLANTS AND HABITAT MANAGEMENT

TOM McCARTER

Plant communities in the Wildlife Garden have remained stable since the last update, with the distinct habitats (Figure 1) managed and enhanced in line with the Wildlife Garden's management plan. Habitat developments and Garden updates of note are reported here.

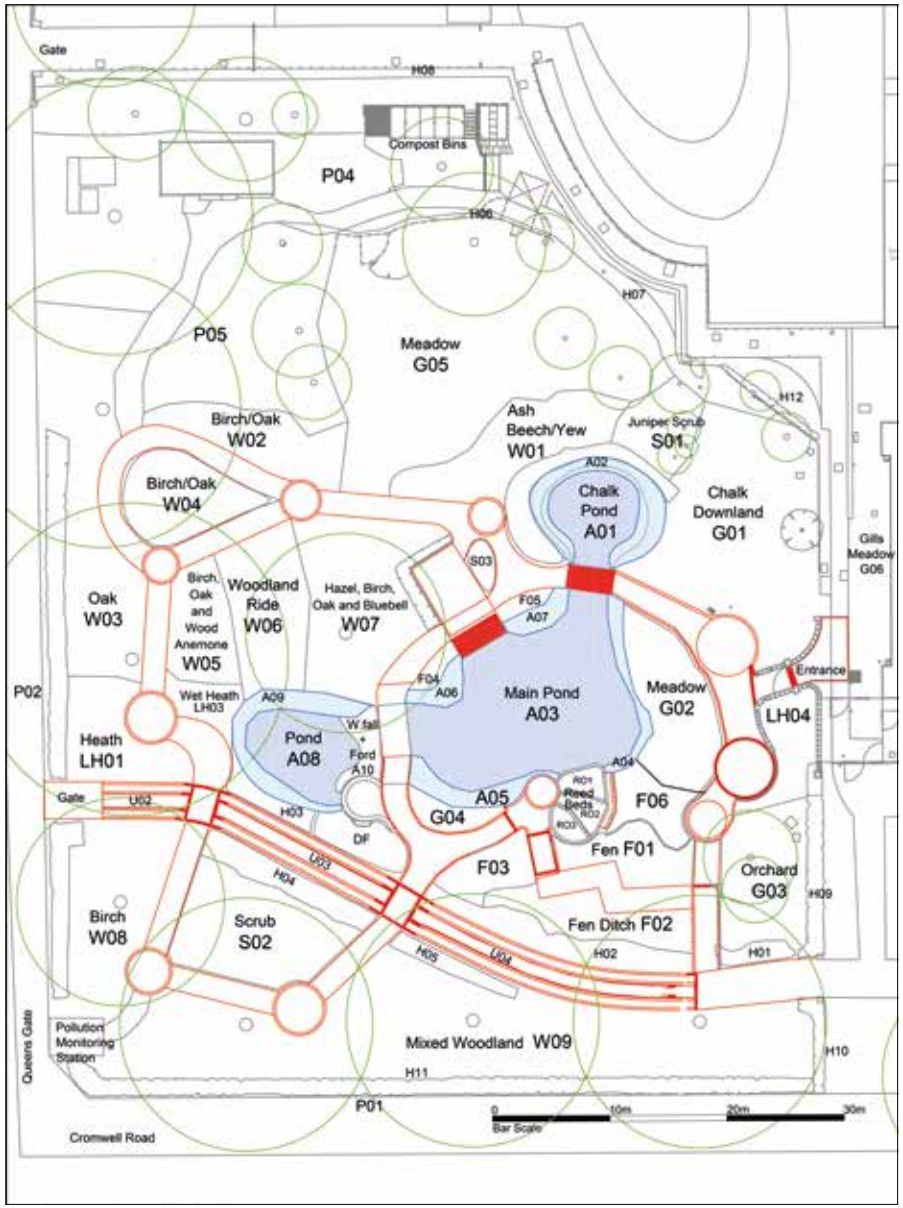


Figure 1: Wildlife Garden Habitats. © Trustees of the Natural History Museum

Woodland areas of the Garden saw the addition of several new habitat features during the autumn and winter. Two half-buried vertical log piles were constructed in W08 and W02, using Ash and Willow logs from kindly donated by WWT London Wetland Centre. In W08, a leaf pen was built and a 'hillock' made using years-old excess compost. In W06, two new dead hedges were created to stop visitors walking up the woodland ride and the Bee Tree was decommissioned, finally succumbing to the inevitable and becoming the largest deadwood habitat in the Garden. Also, in the woodland areas, several smaller trees were coppiced and some of the larger specimens thinned to allow light through to nearby habitats. Ivy was reduced in W03 and pruned down on the Planes.

The meadows were grazed again by the sheep from August to September 2019. An early spring cut was made on some areas of grassland that were becoming rank, particularly the southern edge of G01, an area that is ungrazed by the sheep. Yellow-rattle *Rhinanthus minor*, was sown in front of the Waterhouse (G07) and a section of this area was also cut early to control Barren Brome *Anisantha sterilis* mentioned in the last update (Sivell *et al*. 2019). It has not been possible to make observations about the success of this strategy, or of other meadow developments, due to the ongoing Covid-19 situation. It has also not been possible to assess the success of the Wildlife Garden orchids this year, though numerous rosettes of Bee Orchids *Ophrys apifera* and Common Spotted-orchids *Dactylorhiza fuchsii* were observed in spring 2020, including the self-sown Bee Orchid in the fen.

In the ponds and fen, the restored reedbed has developed well, now it is submerged by the higher pond levels. Nearby in F06, a self-seeded Marsh Sow-thistle *Sonchus palustris* was recorded. The pond margin A05 was cleared of vegetation and excess reeds in October 2019, and hedges bordering the chalk and upper ponds were pruned to increase light and visibility. The chalk stream running from G01 to the chalk pond was renovated and is now flowing, having previously been blocked.

In other areas, the shed green roof was repaired and the large ornamental *Berberis julianae* and *Euonymus japonica* near the shed were coppiced in autumn 2019. This has greatly increased light levels in the area, and the area was sown with Emorsgate Cornfield EC2 mix. Much of the planned planting to fill gaps and enhance communities has unfortunately not taken place this spring due to Covid-19.

SPIDERS AND HARVESTMEN

TOM THOMAS

Spiders

No further species of spider have been found despite the use of differing collecting methods. One fresh procedure was tried: a loose 'ball' of wool clippings was tied in a plastic mesh – several were hung in various trees and shrubs in the Wildlife Garden and examined after several weeks. Some spiders were found, mainly immature Philodromids and Anyphaenids. This experiment was stopped as the mesh size was thought to be too large meaning the risk that birds pecking at the 'ball' may trap their heads with sad consequences. A fine mesh material was found so that the procedure could start again.

The southern wall of the Museum was examined on one hot and sunny day: two species of jumping spider (Salticidae) were found, *Heliophanus cupreus* and *Salticus scenicus* (the Zebra Spider).

Two corrections need to be made to previous reports; the crab spider *Xysticus acerbus* is a misidentification and so must be removed from the list. The other is a misspelling of the species *Macaroeris nidicolens*.

Harvestmen

Despite all the collecting attempted, no harvestmen have been found.

BARKFLIES (PSOCOPTERA)

DUNCAN SIVELL

Barkflies are small insects that are usually found on tree trunks, on foliage or in leaf litter where they graze on algae, fungi and lichens. There are 68 species of barkfly in Britain (there are 100 species of Psocoptera but entirely synanthropic species are not considered here). Although barkflies are common and widespread they are typically under-recorded due to their small size. This first report for the Wildlife Garden has identified ten species from a mixture of Malaise trap samples, light trap catches and targeted collecting.

All ten species are new records for the Garden although some very common barkflies, such as *Ectopsocus briggsi*, *Graphopsocus cruciatus* and *Valenzuela flavidus*, may well have been present since the Garden was created. Two species of particular interest, however, are *Peripsocus milleri* and *Propsocus pulchripennis*, respectively listed as 'scarce' and 'rare' by the Barkfly Recording Scheme.

A male *Peripsocus milleri* was collected from the bark of a mature poplar tree in November 2019. For a long time this species was only known in Britain from two specimens collected in a ship's hold in Liverpool in 1953, but a couple of records in the 1990s and an increase in records since the turn of the century show that *P. milleri* has expanded its range quite considerably in the past two decades (Saville *et al*. 2005; 2007).

A female *Propsocus pulchripennis* was collected in the chalk grassland area by Tom McCarter in October 2019. This distinctive barkfly was first recorded in Britain from several coastal locations across the Scilly Isles in 2000 (Saville *et al*. 2005). It has since been found on the coast of Sussex and Kent (Saville *et al*. 2007; Denton 2009) and earlier this year it was reported from north-east England on the Durham coast (K. Alexander pers. comm.). The Wildlife Garden record seems to be the first non-coastal record for Britain that we are aware of.

To put the present tally of ten species into some context, Jennifer Owen recorded 18 barkfly species in her Leicester garden over a 19-year period; the highest number of species caught in her Malaise trap in a single year was 11 (Owen 2010). A Malaise trap placed in school grounds in Norfolk for 17 months caught 11 species, though it was noted there were other barkfly species near the trap that never entered it (Clark 1979). In contrast, only three barkfly species were recorded from Buckingham Palace Gardens because the surveys had not been designed to target Psocoptera (Plant 2001).

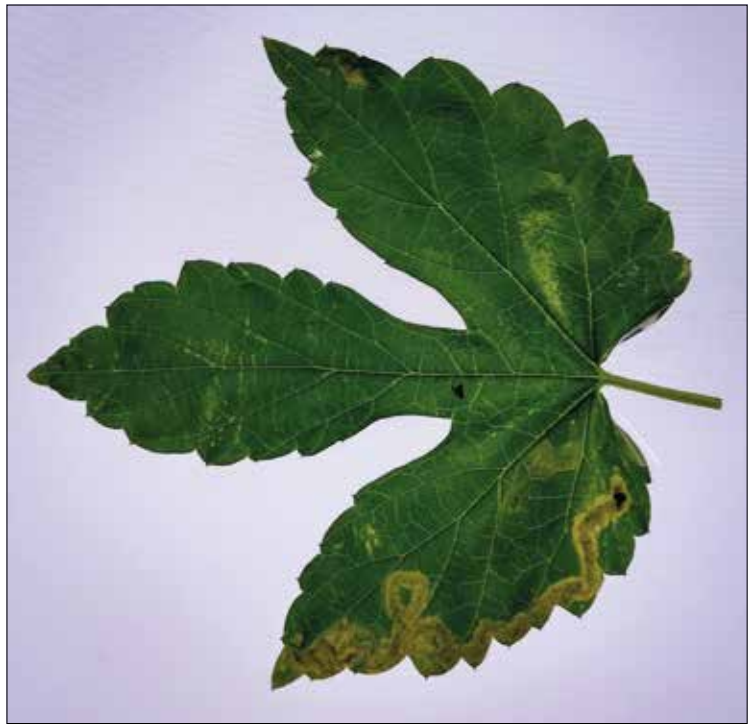
All ten barkfly species were recorded by direct searching, six of these species were also found in Malaise samples and three were caught in the light trap. At the time of writing there are two more barkfly species awaiting identification and it is anticipated that targeted surveys could easily increase the Garden list still further. No surveys for barkflies were carried out in 2020, largely due to coronavirus restrictions, although the general trapping that is being continued will produce material that can be examined in the future.

OTHER RECORDS OF INTEREST

Other new species for the Garden include the shelled slug *Testacella scutulum* which was recorded by Sylvia Myers. This species carries a very small shell on the end of its body and is a predator of earthworms and other invertebrates, potentially even other slugs (Janus 1965). Originally described from a garden in Lambeth by G.B. Sowerby in 1821, the Wildlife Garden is not far from this species' Type locality. Modern records of *T. scutulum* are valuable because historic records conflated this slug with a similar species so are difficult to interpret (Rowson *et al*. 2014).

It is notable that ten new Agromyzidae species have been added to the list in the past year by Sam Thomas. These are leaf-mining flies, many of which can be recorded by the shape of the leaf mine and identification of the host plant. A nice example of how botanical and entomological knowledge can be used in combination.

Figure 2: *Agromyza flaviceps* larval mines on *Humulus lupulus* 24/09/2019.
© Sam Thomas



While many invertebrate groups remain under-recorded, the blow flies (Calliphoridae) have been relatively well-studied due to a history of forensic research at the Museum (Leigh & Ware 2003; Ware *et al*. 2016). The discovery of the greenbottle *Lucilia richardsi* in a pitfall trap probably represents a recent colonisation by this species. The national recording scheme has also noticed an increase in *Lucilia richardsi* records more generally (O. Sivell pers. comm.).

Another Hoverfly, *Eristalinus sepulchralis* (Syrphidae), was recorded in the Garden in August 2019 by David Notton. Larvae of this species feed on decaying vegetation in ponds and are associated with polluted ditches and slurry pits (Speight 2011).

Three new Hymenoptera records were added to the Garden list. The previously mentioned nomad bee *Nomada fabriciana* was trapped in a malaise on the East Lawn by Sam Thomas during regular Urban Nature Project surveying.

Another addition is a poorly-known Ichneumonid wasp, *Isadelphus gallicola*, which was collected from a light trap set in June 2009 but only identified to species level by Gavin Broad in January 2020. The 11-year gap in species identification highlights the difficulty of positive identification for some groups. A seemingly common species, *I. gallicola* is usually found on tree trunks. It has been reared from a nest of a crabronid wasp (*Rhopalum clavipes*), but not actually reared from a definite host. It might well be attacking *Rhopalum*, or small Lepidoptera cocoons, as some other *Isadelphus* do.

Two species of parasitoid wasps in the genus *Microterys* (Encyrtidae) were recorded from the Garden in 2019 by Dawn Painter. The genus *Microterys* contains species that parasitise soft scale insects (Coccidae) (Painter 2020). *Microterys nietneri* (Figure 3)

Figure 3: Newly emerged *Microterys nietneri* male (left) and much larger female (right). Host plant *Ilex* sp. © Dawn Painter

and *Microterys seyon* were both reared from soft scale *Coccus hesperidum* collected from holly (*Ilex* sp.) in May 2019 but not covered in the last edition of *The London Naturalist*. *M. seyon* is rarely recorded and *M. nietneri* is especially interesting having first been found in Britain on an allotment site in north London in 2017 (Painter 2020). The establishment of *M. nietneri* in Britain may be explained by its previous use as a glasshouse biological control.

Sam Thomas recorded three species of leaf-mining moths new to the Wildlife Garden in 2019. *Cosmopterix pulchrimella* (Cosmopterigidae) larval mines were recorded on *Parietaria judaica* around the Wildlife Garden shed (P04, P05). This species was first recorded in the British Isles from Dorset in 2001 (Parsons 2002) and has since spread along the south coast. To the best of our knowledge this represents the first record from the London area. *Euspilapteryx auroguttella* (Gracillariidae) and *Ectoedemia septembrella* (Nepticulidae) were both recorded mining *Hypericum perforatum* in the meadow (G02). These are both common and widespread species.

THE URBAN NATURE PROJECT SCIENCE AND MONITORING

SAM THOMAS

The Urban Nature Project launched earlier this year and aims to use the Natural History Museum's five-acre outdoor space as an exemplar of urban wildlife research and conservation and engage the nation with urban biodiversity. Further information about the Urban Nature Project is available on the Natural History Museum website nhm.ac.uk/urbannature.

The Urban Nature Project (UNP) is developing scientific tools and skills urgently needed to monitor, understand and protect urban nature. As this series of papers demonstrate the NHM Wildlife Garden has a unique and valuable history of detailed biological recording (Ware *et al*. 2016; 2017; 2018). The UNP biological and environmental monitoring programme seeks to safeguard this legacy while developing new methods that allow us to better understand the biodiversity of the Garden and urban nature more widely. This will involve testing and developing additional biological and environmental monitoring approaches, extending our monitoring programme to include the entire NHM grounds and moving the biological record database to a new secure and accessible system.

Traditional survey techniques will continue to be a core element of monitoring within the Garden. Most of the current monitoring methodologies will continue and additional methods will be instigated. This will include a fixed-point quadrat vegetation survey and a butterfly transect that will both cover the entire NHM grounds rather than being restricted to the Wildlife Garden. The quadrat vegetation survey will run alongside the ongoing biennial compartment monitoring.

In addition to the traditional methodologies the UNP is piloting a range of innovative technologies for biological recording and environmental monitoring, including eDNA and digital methodologies.

Traditional biological recording faces an increasing skill shortage and tends to favour a limited number of 'popular' taxa whilst often neglecting many of the more challenging species groups, such as most invertebrates (Clark & May 2002). This means that it is

Figure 4: Urban Nature Project malaise trapping in the Wildlife Garden. © Sam Thomas

rarely, if ever, possible to comprehensively survey the full diversity of life at a site in a way that is repeatable. Promisingly, emerging DNA metabarcoding technologies have the potential to tackle this problem by allowing extraction and identification of millions of strands of DNA from environmental or mixed-species samples (Dopheide *et al*. 2019; Lui *et al*. 2020). At present, this is an experimental approach with limited existing protocols and the DNA reference libraries that are needed to match the sequenced DNA to the species' that it originates from are still at an early stage of development for most species. As part of the UNP we are testing and developing these methodologies in the NHM Garden and at partner sites. Collection of samples for DNA metabarcoding took place in 2019 and 2020 across the whole Museum grounds. This included pitfall trapping, Malaise trapping (Figure 4), soil and water sampling. As the sequencing methodologies improve and library sequences become available this will provide a more complete picture of the diversity of species present in the Garden.

Alongside the traditional and DNA-based methodologies the UNP is also experimenting with a range of digital methods for monitoring urban nature. Digital methods offer the possibility of continuous, real-time monitoring through acoustic recordings and a range of environmental sensors (Bradfer-Lawrence *et al*. 2019). While acoustic biological monitoring methodologies are well established for bats (Russo *et al*. 2016), and have been the subject of a number of studies for birds (Stowell 2019) and some Orthoptera (Bennett *et al*. 2015), the use of acoustic methods to monitor many other groups

including most invertebrates is at an early stage of development. Initially the UNP will trial Raspberry Pi based sound recording devices with a range of microphones to record bioacoustics across the Garden. This will include recording terrestrial biological activity, activity in the ponds and soil invertebrate activity. Initially this monitoring will not be used to identify species present as the sound reference libraries do not yet exist to match most species to recordings. Instead the recordings will allow us to define the diversity and volume of biological activity in the different habitats and compare this information with data on human activity and environmental variables.

Through testing and refining these new methodologies we hope to increase our knowledge of the Garden and work toward the creation of powerful new tools for biological recording and environmental monitoring that will be of value across the applied conservation sector. Once methodologies have been trialled, a series of recommendations documents will be produced and those methodologies which are deemed to be successful will form part of the ongoing monitoring programme across the Garden and at partner sites across the UK.

Conclusions

It may seem obvious to state that the success of any recording depends on the amount of effort invested but this is certainly true of the Wildlife Garden. To date an impressive 3,290 different species have been recorded, which is a great testament to the efforts of staff, volunteers and other visitors who have recorded wildlife over the past 25 years. In this update, for practical reasons, we have revised the Garden list down to only include taxa identified to species-level. There are additional taxa that have been recorded to genus-level or higher, and there are certainly many more species in the Garden awaiting discovery.

Despite the restrictions on recording imposed by coronavirus we have managed to add 34 new species to the Garden list this past year. This is an improvement on the previous two updates which recorded 14 and 23 new species respectively (Ware *et al*. 2018; Sivell *et al*. 2019) and this increase has no doubt been helped by the recording of Agromyzidae and Psocoptera. Targeting under-recorded but relatively common taxa such as these is likely to produce good returns.

In contrast some taxa have received more attention over the years and for these groups a new species record is more likely to represent a recent addition to the Garden. The fact no new spider species were reported this year suggests we already have a good understanding of the community that is present. The discovery of the new blow fly *Lucilia richardsi*, also from a well-recorded group, suggests a recent colonisation has taken place.

The future prospect of using DNA to survey biodiversity is an appealing one in terms of time and cost. This will only be viable if we can build accurate libraries of species DNA for reference. Surveys are being trialled in the Garden and efforts are also being made to sequence species' DNA. These tasks will require considerable taxonomic input in the short term but these efforts could greatly increase our ability to survey the nature around us in the longer term. It will be very interesting to see what impact these trials have on the species list of the Wildlife Garden and for the wider Museum gardens in coming years.

Acknowledgements

A huge thank you to the many recorders who have contributed over the past 25 years.

LIST OF SPECIES NEW TO THE NHM GROUNDS

FUNGI

Pucciniaceae

1. *Uromyces muscari*

BRYOPHYTES

Sphaerocarpaceae

2. *Sphaerocarpos michelii*

GASTROPODA

Testacellidae

3. *Testacella scutulum*

PSOCOPTERA

Trogiidae

4. *Cerobasis guestfalica*

Caesiliusidae

5. *Valenzuela flavidus*

Stenopsocidae

6. *Graphopsocus cruciatus*
7. *Stenopsocus immaculatus*

Ectopsocidae

8. *Ectopsocus briggsi*
9. *Ectopsocus petersi*

Peripscocidae

10. *Peripsocus milleri*

Elipsocidae

11. *Propsocus pulchripennis*

Psocidae

12. *Loensia variegata*
13. *Trichadenotecnum sexpunctatum*

HYMENOPTERA

Apidae

14. *Nomada fabriciana*

Encyrtidae

15. *Microterys nietneri*
16. *Microterys seyon*

Ichneumonidae

17. *Isadelphus gallicola*

LEPIDOPTERA

Cosmopterigidae

18. *Cosmopterix pulchrimella*

Gracillariidae

19. *Euspilapteryx auroguttella*

Nepticulidae

20. *Ectoedemia septembrella*

DIPTERA

Agromyzidae

21. *Agromyza albitarsis*
22. *Agromyza flaviceps*
23. *Aulagromyza tridentata*
24. *Cerodontha iraeos*
25. *Cerodontha iridis*
26. *Chromatomyia primulae*
27. *Liriomyza amoena*
28. *Liriomyza eupatorii*
29. *Ophiomyia melandricaulis*
30. *Phytomyza chaerophylli*
31. *Phytomyza tetrasticha*

Empididae

32. *Empis nuntia*

Syrphidae

33. *Eristalinus sepulchralis*

Calliphoridae

34. *Lucilia richardsi*

References

BENNETT, W., CHESMORE, D. and BAKER, E. 2015. Speckled Bush Cricket Data Logger - Project Report. figshare. Journal contribution. https://doi.org/10.6084/m9.figshare.1430094.v1

BRADFER-LAWRENCE, T., GARDNER, N., BUNNEFELD, L., BUNNEFELD, N., WILLIS, S.G. and DENT, D.H. 2019. Guidelines for the use of acoustic indices in environmental research. *Methods in Ecology and Evolution* **10(10)**: 1796-1807.

CLARK, J.T. 1979. Psocoptera activity as monitored by a Malaise trap. *Entomologist's Monthly Magazine* **114**: 94-95.

CLARK, J.A. and MAY, R.M. 2002. Taxonomic bias in conservation research. *Science* **297 (5579)**: 191-192.

DANILO, R. and VOIGT, C.C. 2016. The use of automated identification of bat echolocation calls in acoustic monitoring: A cautionary note for a sound analysis. *Ecological Indicators* **66**: 598-602.

DENTON, J. 2009. *Propsocus pulchripennis* (Perkins) (Psocoptera: Elipsocidae) in West Sussex. *British Journal of Entomology and Natural History* **22**: 187.

DOPHEIDE, A., TOOMAN, L.K., GROSSER, S., AGABITI, B., RHODE, B., XIE, D., STEVENS, M.I., NELSON, N., BUCKLEY, T.R., DRUMMOND, A.J. and NEWCOMB, R.D. 2019. Estimating the biodiversity of terrestrial invertebrates on a forested island using DNA barcodes and metabarcoding data. *Ecological Applications* **29(4)**: e01877.

JANUS, H. 1965. *Land and freshwater molluscs*. Burke, London.

LEIGH, C. and WARE, C. 2003. The development of the flora, fauna and environment of the Wildlife Garden at the Natural History Museum, London. *Lond. Nat*. **82**: 75-134.

LIU, M., CLARKE, L.J., BAKER, S.C., JORDAN, G.J. and BURRIDGE, C.P. 2020. A practical guide to DNA metabarcoding for entomological ecologists. *Ecological Entomology* **45(3)**: 373-385.

NOTTON, D.G. 2018. The spider wasp *Agenioideus apicalis* (Hymenoptera: Pompilidae) new to Britain, and a second British record of *Agenioideus sericeus*. *British Journal of Entomology and Natural History* **31**: 17-25.

OWEN, J. 2010. *Wildlife of a garden: a thirty-year study*. Royal Horticultural Society, London.

PAINTER, D. 2020. Two parasitoid wasp species, *Microterys tricolorcornis* and *Microterys nietneri* (Hymeoptera: Chalcidoidea, Encrytidae), new to Britain. *British Journal of Entomology and Natural History* **33**: 1-16

PARSONS, M. S. 2002. *Cosmopterix pulchrimella* Chambers, 1875 (Lepidoptera: Cosmopterigidae) new to the British Isles. *Entomologists Gazette* **53(2)**: 93-96.

PLANT, C.W. 2001. Smaller invertebrate orders in Buckingham Palace Garden. *Lond. Nat*. **80**: 303-307.

ROWSON, B., TURNER, J., ANDERSON, R. and SYMONDSON, B. 2014. *Slugs of Britain and Ireland. Identification, understanding and control*. Field Studies Council.

SAVILLE, B., ALEXANDER, K.N.A., DOLLING, W.R. and KIRBY, P. 2005. Some notable British barkfly (Psocoptera) observations. *Ent. Rec*. **117**: 35-39.

SAVILLE, R.E., ALEXANDER, K.N.A., BRATTON, J.H., CLEMONS, L, and OLDFIELD, G.M.E. 2007. Additional notable British barkfly (Psocoptera) observations. *Ent. Rec*. **119**: 113-115.

SIVELL, D., BEALE, J., REILLY, N., LOWE, M., BARCLAY, M.V.L., ELLIS, L., GEISER, M., LEES, D., NOTTON, D.G., POTTS, K. and WARE, C. 2019. The Wildlife Garden at the Natural History Museum: developments of the flora and fauna update 2018-2019 – twenty-four years of recording. *Lond. Nat*. **98**: 248-258.

SPEIGHT, M.C.D. 2011. Species accounts of European Syrphidae (Diptera) (PDF). *Syrph the Net, the database of European Syrphidae*. **65**: 285pp.

STOWELL, D., WOOD, M.D., PAMULA, H., STYLIANOU, Y. and GLOTIN, H. 2019. Automatic acoustic detection of birds through deep learning: the first Bird Audio Detection challenge. *Methods in Ecology and Evolution* **10(3)**: 368-380.

WARE, C., LOWE, M., SIVELL, D., BAKER, M., BANTOCK, T., BARCLAY, M., CARR, G., COOPER, L., ELLIS, L., HALL, M., HOLLOWDAY, E., HONEY, M., JOHN, D., MARTIN, J., NOTTON, D., OSBORNE, D., RUNDLE, A., SHERLOCK, E., TABOR, T., THOMAS, T.H., THUS, H., TOVEY, J. and WOLSELEY, P. 2016. Further developments of the flora and fauna of the Wildlife Garden at the Natural History Museum, London — twenty years of species recording. *Lond. Nat*. **95**: 45-159.

WARE, C., LOWE, M., SIVELL, D., COOPER, L., GREAVES, P., ROOT, T., SHAW, P., SHUBERT, E., SPOONER, B. and STREKOPYTOV, S. 2017. Further developments of the flora and fauna of the Wildlife Garden at the Natural History Museum, London: Part 2 – twenty-one years of species recording. *Lond. Nat*. **96**: 126-181.

WARE, C., LOWE, M., SIVELL, D., BARCLAY, M.V.L., BEALE, J., ELLIS, L., FENERU, F., HONEY, M., LEES, D., NOTTON, D., REILLY, N., STERLING, M.J. and THOMAS, T.J. 2018. The Wildlife Garden at the Natural History Museum: Developments of the flora and fauna update 2017-2018 – Twenty-three years of species recording. *Lond. Nat*. **97**: 135-152.