

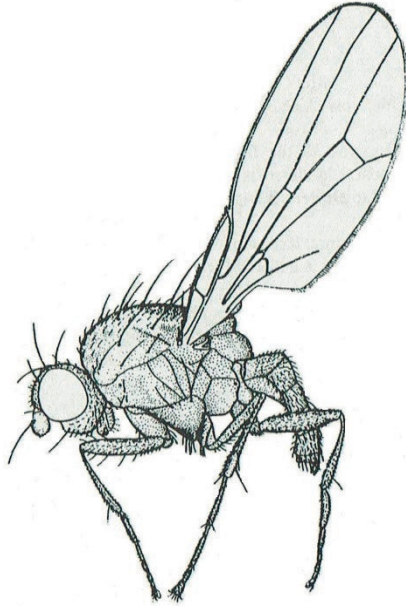
Dipterists Digest



2019 Vol. 26 No. 2

Cover illustration: A female of the Nationally Scarce kleptoparasitic satellite fly *Miltogramma germari* Meigen, 1824 (Sarcophagidae) at an aggregation of its host the pantaloon bee *Dasypoda hirtipes*. Leziate, West Norfolk, 24.vii.2019. Photo: Nick Owens (see article by Mark Welch and Nick Owens on pp 209-218).

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Dipterists Digest is the journal of the **Dipterists Forum**. It is intended for amateur, semi-professional and professional field dipterists with interests in British and European flies. All notes and papers submitted to **Dipterists Digest** are refereed. Articles and notes for publication should be sent to the Editor at the above address, and should be submitted with a current postal and/or e-mail address, which the author agrees will be published with their paper. Articles must not have been accepted for publication elsewhere and should be written in clear and concise English. **Contributions should be supplied either as E-mail attachments or on CD in Word or compatible formats.**

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- the conservation of flies;
- reports from the Diptera Recording Schemes, including maps;
- records and assessments of rare or scarce species and those new to regions, countries etc.;
- local faunal accounts and field meeting results, especially if accompanied by ecological or natural history interpretation;
- descriptions of species new to science;
- notes on identification and deletions or amendments to standard key works and checklists.

Articles should be in A5 format with text in 9-point and Times New Roman font, title 12 point and author's name 10.5 point, with 1.27cm (narrow) side margins. Figures should be drawn in clear black ink, about 1.5 times their printed size and lettered clearly. Colour photographs will also be welcomed. Figures and photographs should be supplied separately as hard copy or as jpegs at 300dpi.

Style and format should follow articles published in recent issues. A short Summary (in the form of an Abstract) should be included at the beginning of each article. References to journals should give the title of the journal in full. **Scientific names should be italicised.** Authors of scientific names should be given in full and nomenclature should follow the most recent checklist, unless reflecting subsequent changes. Descriptions of new species should include a statement of the museum or institution in which type material is being deposited.

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First records of *Helina pulchella* (Ringdahl) (Diptera, Muscidae) from Finland and notes on the biology of the species

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Summary

Helina pulchella (Ringdahl, 1918) is reported from Finland for the first time. One male specimen was reared by JP from a pheasant wing in north Karelia and a second male was collected by active netting in the Inari Lapland. As these locations are almost 1000 km apart, the species is likely to be widespread, but scarce in Finland.

Introduction

Helina pulchella (Ringdahl, 1918) (Fig. 1) is a medium-sized (~6 mm) species with partly yellow legs, bare eyes, 2+4 dorsocentral setae, 4 rows of short presutural acrostichal setulae, 0+1 acrostichal setae, 1+2 katapisternal setae, radio-cubital node dorsally and ventrally bare, narrow frons in males (0.25x width of an eye), arista short pubescent, bases of the postpedicel and pedicel yellow, and yellow palpi darkened only in the apical part (Hennig 1958: 211-212).

Helina species are difficult to identify and the available keys do not capture all of the variation seen in the specimens. This became apparent when the authors tried to identify an unknown specimen, reared by JP. Using the key in Gregor *et al.* (2002) the result was either *Helina balsaci* (Séguy, 1946) or *H. pulchella*. Both species would have been new to the Finnish fauna. When the specimen was compared against the descriptions in Hennig (1958: 211-212), it proved to be almost a perfect match for *H. pulchella* apart from the dark fore femora. However, both Ringdahl (1918: 149) and d'Assis-Fonseca (1968: 52) stated that the fore femora are almost entirely black.

The species was described by Ringdahl (1918: 149) based on a male specimen from Abisko, Swedish Lapland. In the original description, Ringdahl placed *H. pulchella* in *Mydaea*, but later transferred it to the recently defined *Helina* (Ringdahl 1924: 61). The female was described by Ackland (1961) based on British specimens. Prior to the Finnish records, *Helina pulchella* had been reported from Britain and there are apparently unpublished records from Norway, Austria, Czech Republic, Spanish mainland and European Russia (Pont 2004). In Britain *H. pulchella* is listed as provisionally Near Threatened (Falk and Pont 2017).

Considering the known localities in northern Sweden (Ringdahl 1918, Engelmark and Engelmark 1989), finding the species from neighbouring Finland is no surprise. It is perhaps more interesting that the species is known from several locations in England (Smith 1961, Ackland 1965, Pont 1990, Jones and Perry 2019), which as habitats are quite contrasting to those in Nordic countries.

Finnish records

The records here are given in the standard format for Finnish zoological specimens. Additional explanations and notes are provided in brackets. The abbreviations for locations refer to the geographical provinces (see <https://laji.fi/theme/emk>) and coordinates on the labels are given in the old national Finnish coordinate system (YKJ; see Ollikainen and Ollikainen 2004); both are still in use for biological sampling.

1♂: Kb [Karelia borealis or North Karelia], Liperi, Hovattavaara, 6947455:3626464 [N62.620565°, E29.473213°], ex larva 2017, J. Pohjoismäki leg. Specimen is deposited in the research collection of AH.

1♂: Li [Lapponia Inarensis or Inari Lapland], Utsjoki, Ravdaskaidi, 77109:35056 [N69.4777°, E27.1402°], July 1–4 2017, E. Rundgren leg. Specimen is deposited in the research collection of Iiro Kakko.

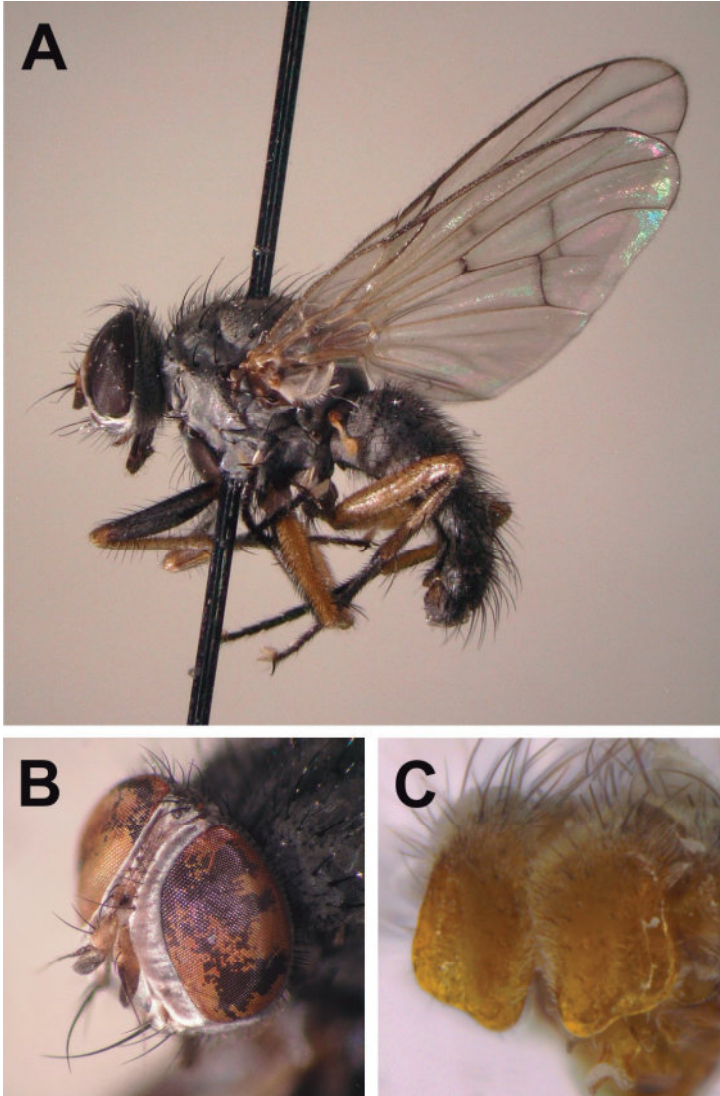


Fig. 1. *Helina pulchella* male, Kb: Liperi, Hovattavaara, 6947455:3626464, ex larva 2017, J. Pohjoismäki leg: A, habitus; B, oblique dorsal view of the head; C, cerci.

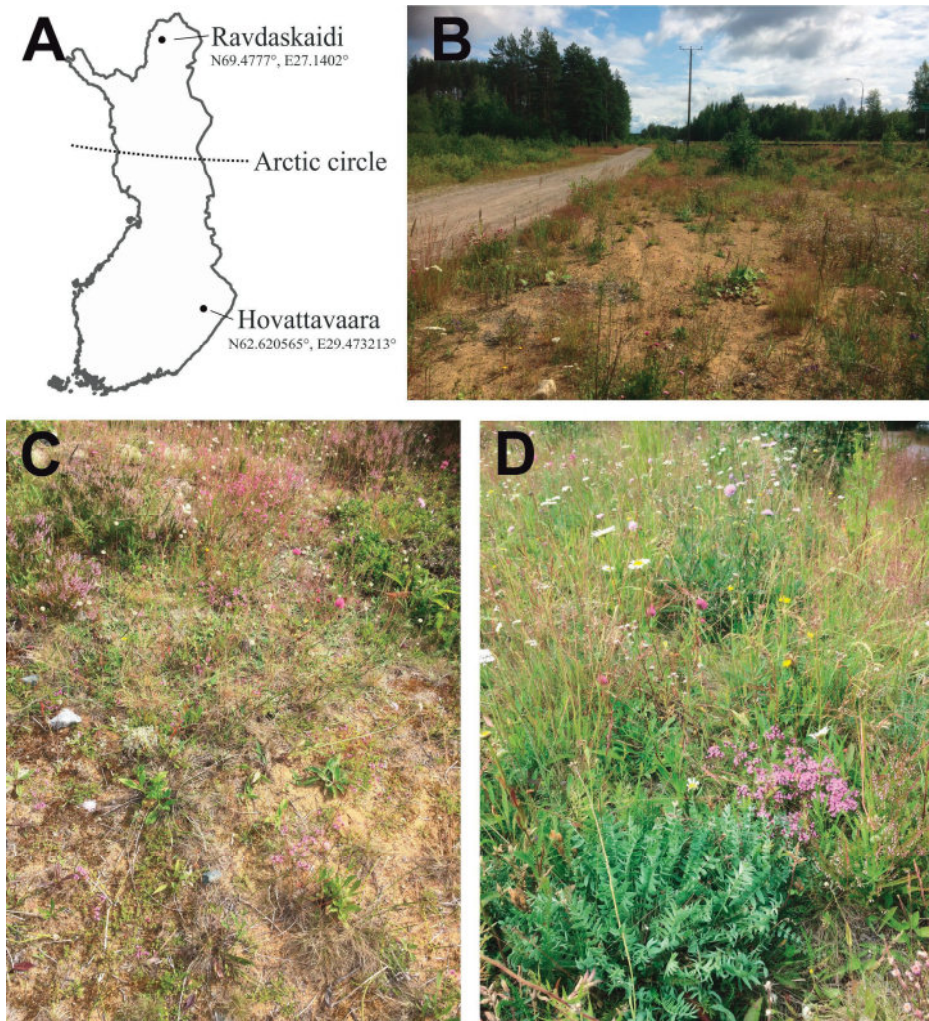


Fig. 2. *Helina pulchella* distribution in Finland: A, the collection locations of the Finnish specimens mentioned in the text; B, an overview of the Hovattavaara habitat. The location is dominated by low-growth heather, bordered by mixed woods of Scots pine (*Pinus sylvestris*), birch (*Betula* spp.) and aspen (*Populus tremula*); C, open sand where the bird wing was placed. Flowers include maiden pink (*Dianthus deltoides*) and Breckland thyme (*Thymus serpyllum*); D, rich flora at the scene, including yellow *Oxytropis* (*Oxytropis campestris*), field scabious (*Knautia arvensis*) and ox-eye daisy (*Leucanthemum vulgare*).

Description of the biotopes and some notes on the species' biology

Up until now *H. pulchella* has only been recorded from two locations in Finland. The Hovattavaara location is a xerothermic roadside (Fig. 2), characterised by heather (*Calluna vulgaris*) and a rich assemblage of herbage growing on sandy soil. The flowering plants include

specialised species such as mountain everlasting *Antennaria dioica*, field scabious *Knautia arvensis*, Breckland thyme *Thymus serpyllum* and yellow Oxytropis *campestris*.

Consequently, Hovattavaara is a refuge for a number of lepidopteran species associated with these plants, including *Nemophora metallica* (Poda) (Adelidae), *Scrobipalpa artemisiella* (Treitschke) (Gelechiidae), *Hemaris tityus* (Linnaeus) (Sphingidae) and *Cupido minimus* (Fuessly) (Lycaenidae). The fly fauna is characterised by species such as *Systoechus ctenopterus* (Mikan) (Bombyliidae), *Paragus constrictus* Šimic (Syrphidae), *Prosenia siberita* (Fabricius) (Tachinidae) and *Demoticus plebejus* (Fallén) (Tachinidae). In addition, the rare woodland species *Temnostoma sericomylaeforme* (Portschinsky) and *Brachyopa panzeri* Goffe (both Syrphidae) have been recorded from the location.

In contrast, the Ravdaskaidi location is a typical fell landscape with alternating heathland, mires and downy birch (*Betula pubescens* ssp. *czerepanovii* (N. I. Orlova)) woods, very similar to the habitat described for *H. pulchella* in Engelmark and Engelmark (1989). The male specimen was collected by a hand net between 1 and 4 July 2017 and determined by AH based on the Hovattavaara specimen. The exact date is unknown as the specimen was collected during a longer field trip to the area.

The discovery of *H. pulchella* from Hovattavaara was somewhat accidental. JP has some interest in the cadaveric entomofauna (Pohjoismäki *et al.* 2010) and had in mind to try to find rare saprophagous Tineidae (Lepidoptera) by placing the wing of a pheasant (*Phasianus colchicus* Linnaeus) on open sand on June 20, 2016. The wing was secured with a wire net to prevent interference from scavengers and was collected in at first snow on November 3, 2016. The wing was left to overwinter in an unheated garage and was exposed to frost, down to -10°C for several days. The wing was taken in on January 22, 2017 and the male *H. pulchella* emerged two weeks later. The only other insects emerging from the wing were 12 exx. *Allopiophila vulgaris* (Fallén) and 2 exx. *Stearibia nigriceps* (Meigen) (both Diptera, Piophilidae).

In Britain, *H. pulchella* has been reared from the nest box of a tawny owl (*Strix aluco* Linnaeus) (Smith 1961). Owl nests are typically littered by prey remains and probably offer a similar substrate as a feathered wing, from which the first Finnish specimen was reared. *Helina pulchella* does not obviously have a strict habitat requirement, ranging from oak-ash-sycamore woods, parkland and a suburban garden in England, to montane heathland in Finnish and Swedish Lapland. Also, the recorded microhabitats, an owl box 15 feet (4.6 m) above ground on an old oak tree and an exposed feathered wing on open sand in sunlit xerothermic environment, are highly different. It is possible that the species is specialised on dry animal remains but can be otherwise opportunistic with its habitat preference. As other *Helina* species larvae are known to be predatory (Gregor *et al.* 2002), it is likely that *H. pulchella* is also a predator of other invertebrates, such as Piophilidae larvae living in the same substrate.

Given that *H. pulchella* has rarely been reported across a wide geographical range, we hope that our report will encourage fellow dipterists to conduct further studies on the species' biology and distribution.

Acknowledgements

We would like to thank Elisabeth A. Harris for her kind help with providing literature and reviewing this article. Peter Chandler is thanked for helpful suggestions to improve our manuscript. We are grateful to Adrian Pont and James McGill for reviewing our manuscript, as well as pointing out key papers on *Helina pulchella* records that we had missed. Iiro Kakko and Eerikki Rundgren are acknowledged for their outstanding enthusiasm for Diptera and for providing the second *Helina pulchella* specimen.

References

- Ackland, D.M. 1961. *Helina pulchella* (Ringdahl) (Dipt., Muscidae): discovery of the female. *Entomologist's Monthly Magazine* **97**, 24.
- Ackland, D.M. 1965. Records of some uncommon Muscidae (Dipt.). *Entomologist's Monthly Magazine* **100**, 287.
- d'Assis-Fonseca, E.C.M. 1968. Diptera Cyclorrhapha Calypratra. Section (b) Muscidae. *Handbooks for the identification of British insects* **10**, 4(b), 118 pp. Royal Entomological Society, London, UK.
- Engelmark, R. and Engelmark, T.-B. 1989. Den calypratra flugfaunan (Diptera, Calyprtratae) på tre myrar vid Jokkmokk i Lule lappmark. *Entomologisk Tidskrift* **110**, 81-95.
- Falk, S.J. and Pont, A.C. 2017. A provisional assessment of the status of Calypterate flies in the UK. 265 pp. Natural England. Commissioned Reports, 234.
- Gregor, F., Rozkošný, R., Barták, M. and Vaňhara, J. 2002. The Muscidae (Diptera) of Central Europe. *Folia Facultatis Scientiarum Naturalium Universitatis Masarykianae Brunensis, Biologia* **107**, 280 pp.
- Gregor, F., Rozkošný, R., Barták, M. and Vaňhara, J. 2016. Manual of Central European Muscidae (Diptera). Morphology, taxonomy, identification and distribution. *Zoologica* **162**, 219 pp.
- Hennig, W. 1958. Muscidae. [Part, Lieferung 199.] In Lindner, E. (Ed.), *Die Fliegen der palaearktischen Region* **63b**, 193-232. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart, Germany.
- Jones, N.P. and Perry, I. 2019. Recent records for *Helina pulchella* (Ringdahl) (Diptera, Muscidae). *Dipterists Digest (Second Series)* **26**, 23-24.
- Ollikainen, M. and Ollikainen, M. 2004. The Finnish coordinate reference systems. Published by the Finnish Geodetic Institute and National Land Survey. Available at http://www.maanmittauslaitos.fi/sites/default/files/Finnish_Coordinate_Systems.pdf [accessed July 12, 2019.]
- Pohjoismäki, J.L., Karhunen, P.J., Goebeler, S., Saukko, P. and Sääksjärvi, I.E. 2010. Indoors forensic entomology: colonization of human remains in closed environments by specific species of sarcosaprophagous flies. *Forensic Science International* **199**, 38-42. doi: 10.1016/j.forsciint.2010.02.033.
- Pont, A.C. 1990. A list of Fanniidae and Muscidae (Insecta: Diptera) from the Wychwood Forest and Cothill Reserve, Oxfordshire. *Oxfordshire Invertebrate Group* **3**, 19-25.
- Pont, A.C. 2004. Muscidae. In Pape, T. and Beuk, P. (Eds), *Fauna Europaea: Diptera, Brachycera*. Fauna Europaea. Version 2019.08, <https://fauna-eu.org>
- Ringdahl, O. 1918. Neue nordische Anthomyiden. *Entomologisk Tidskrift* **39**, 148-194.
- Ringdahl, O. 1924. Översikt av de hittills i vårt land funna arterna tillhörande släktena *Mydaea* R.D. och *Helina* R.D. (Muscidae). [Concl.] *Entomologisk Tidskrift* **45**, 49-66.
- Smith, K.G.V. 1961. *Helina pulchella* (Ringdahl) (Dipt., Muscidae) new to Britain. *Entomologist's Monthly Magazine* **96**, 96.

Corrections and changes to the Diptera Checklist (42) – Editor

It is intended to publish here any corrections to the text of the latest Diptera checklist (publication date was 13 November 1998; the final ‘cut-off’ date for included information was 17 June 1998) and to draw attention to any subsequent changes. All readers are asked to inform me of errors or changes and I thank all those who have already brought these to my attention.

Changes are listed under families; names new to the British Isles list are in bold type. The notes below refer to addition of 6 species, resulting in a new total of **7193** species (of which 41 are recorded only from Ireland).

An updated version of the checklist, incorporating all corrections and changes that have been reported in *Dipterists Digest*, is available for download from the Dipterists Forum website. It is intended to update this regularly following the appearance of each issue of *Dipterists Digest*.

Limoniidae. The following introduced species is added in the present issue:

Achryolimonia ***neonebulosa*** (Alexander, 1924 – *Limonia*)

Sciaridae. The following changes result from P. VILKAMAA and F. MENZEL (2019. Re-classification of *Lycoriella* Frey *sensu lato* (Diptera, Sciaridae), with description of *Trichocoelina* gen. n. and twenty new species. *Zootaxa* **4665**(1), 1-67):

HEMINEURINA Frey, 1942 (generic rank from subgenus of *Lycoriella*)

LYCORIELLA Frey, 1942 (= *Lycoriella* *sensu stricto* of checklist)

STENACANTHELLA Vilkamaa & Menzel, 2019 = **COELOSTYLINA** Tuomikoski, 1960, *preocc.* (generic rank from subgenus of *Lycoriella*), including only:

Stenacanthella freyi (Tuomikoski, 1960 – *Lycoriella*)

The specific nomenclature in *Hemineurina* and *Lycoriella* is unchanged from the checklist except that *vanderwielii* (Schmitz, 1920) is listed as a synonym of *Lycoriella subterranea* (Märkel, 1844) so was not a misidentification by Freeman as was hitherto suggested in the checklist.

Dolichopodidae. The following species are added in the present issue:

Nematoproctus ***praesectus*** Loew, 1857

Sciapus ***pallens*** (Wiedemann, 1830 – *Psilopus*)

Agromyzidae. The following species are added in the present issue, the first of which is a reinstatement of a species formerly recorded from Britain but hitherto omitted from checklists:

Cerodontha (*Poemyza*) ***pygmella*** (Hendel, 1931 – *Dizygomyza*)

Cerodontha (*Poemyza*) ***zuskai*** Nowakowski, 1973

Melanagromyza ***moatesi*** Warrington, 2019

Polleniidae. The subfamily Polleniinae of family Calliphoridae was raised to family rank, and suggested as sister group to Tachinidae, by P. CERRETTI, J.O. STIREMAN, D. BADANO, S. GISONDI, K. ROGNES, G. LO GIUDICE and T. PAPE (2019. Reclustering the cluster flies (Diptera: Oestroidea, Polleniidae). *Systematic Entomology* **44**, 957-972). This includes only the genus *Pollenia* in the British fauna and involves no other nomenclatural changes.

Mechanisms and patterns of feeding in some leaf-mining larvae (Diptera, Agromyzidae, Drosophilidae and Anthomyiidae)

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Summary

Morphological analyses, observations and videos were used to resolve leaf-mining feeding mechanisms and patterns of three *Amauromyza* Hendel (Agromyzidae), one *Scaptomyza* Hardy (Drosophilidae) and three *Pegomya* Robineau-Desvoidy (Anthomyiidae) species. The results help explain linear and blotch mining and suggest a data standard for comparing leaf-mining Diptera larvae.

Introduction

Despite their importance, the feeding mechanisms of cyclorrhaphan larvae are not well known, i.e. the ways in which morphology and behaviour combine during feeding to transfer food from an external source into the alimentary tract. This is because investigations tend to focus on the results and impacts of feeding and less on the underlying mechanisms (Dowding 1967, Roberts 1971, Rotheray 2019). Complicating their resolution, however, is the small size, rapid motion and concealment of trophic structures (Tinkeu and Hance 1998). To a considerable degree, these problems can be overcome by videoing feeding using a camera attached to a binocular microscope and determining movements and roles by matching replay to morphological features (Rotheray and Lyszkowski 2015, Rotheray and Wilkinson 2015, Wilkinson and Rotheray 2017).

Understanding feeding mechanisms is fundamental, but another characteristic requiring explanation are feeding patterns, i.e. if feeding follows an order or sequence with predictable outcomes, then explaining how this occurs. For cyclorrhaphan leaf-miners a common feeding pattern is, for instance, the switch from an initial serpentine or linear mine to a patch or blotch shape (Hering 1951), but how linear and blotch mines are maintained and switches made between them is unclear.

In this two-year investigation, morphological analyses were combined with observing and videoing to investigate the feeding mechanisms and patterns of leaf-mining exemplars from three independent cyclorrhaphan families, Agromyzidae, Drosophilidae and Anthomyiidae, their independence based on Wiegmann *et al.* (2010). These exemplars were selected on the basis that one completes development by linear mining and one by blotch mining, and the remaining five produce a linear followed by a blotch mine. Disparate feeding patterns enable investigation of the differences but, for the underlying feeding mechanisms, the null hypothesis is that no differences exist. Such a hypothesis is based on the assumption that cyclorrhaphan larvae sharing a feeding mode and style, for example, phytophagy and leaf-mining, will be similar due to convergent and parallel evolution (Ferrari 1987). Moreover, given the strictures of extreme spatial confinement, convergent similarity might be especially high among leaf-mining larvae.

Material and methods

Although rates of foodplant occupation were low, the leaf miners investigated were common at the field sites and times visited (Table 1). Up to 20 mined leaves per visit were detached from plants and placed in plastic bags. Within 2-3 hours the numbers of primary and secondary mines per leaf were recorded and some leaves photographed from the adaxial or upper surface. Primary mines are due to a larva emerging from an egg and secondary mines from a larva starting a new

mine. To maintain turgor, each occupied leaf was placed in a separate plastic bag and wet tissue wrapped round the petiole. Bags were stored outdoors in shaded conditions.

Taxon	Foodplant	Sites	Times
Agromyzidae			
<i>Amauromyza flavifrons</i> (Meigen)	<i>Silene dioica</i> (Caryophyllaceae)	Parkgate to Torrs Point (NX 67 45/46), Cally Motte (NX 607557), Castramon (NX 588601)	15-30 July 2018, 2019
<i>Amauromyza labiatarum</i> (Hendel)	<i>Stachys</i> sp. (Lamiaceae)	Parkgate, Cally Motte, Castramon	15-30 July 2018, 2019
<i>Amauromyza verbasci</i> (Bouché)	<i>Scrophularia nodosa</i> (Scrophulariaceae)	Boreland Hills (NX 5856), Castramon	15-30 July 2018, 2019
Drosophilidae			
<i>Scaptomyza graminum</i> (Fallén)	<i>S. dioica</i>	Parkgate, Cally Motte	1-18 June 2019
Anthomyiidae			
<i>Pegomya flavifrons</i> (Walker)	<i>S. dioica</i>	Parkgate, Cally Motte	1-18 June 2019
<i>Pegomya laticornis</i> (Fallén)	<i>Arctium</i> sp. (Asteraceae)	Almorness (NX 8253)	1-20 June 2018, 2019
<i>Pegomya solennis</i> (Meigen)	<i>Rumex obtusifolius</i> (Polygonaceae)	Boreland Hills	15-30 July 2018, 2019

Table 1. The seven leafminers in this investigation, their foodplants and Dumfriesshire collecting sites and dates.

Each day for up to 8 days, leaves were checked for changes in larvae and mines. Larvae were observed mining using a Wild M5 stereo microscope with visibility improved by placing leaves on a digital light board. Individual larvae were often examined several times a day and for periods of an hour or more. Images and videos of feeding were obtained by placing an Olympus TG-5 camera over an objective lens of the stereo microscope. They were uploaded to a MacBook Pro computer and examined using Apple Photos v 4, Adobe Photoshop Elements 2019 and iMovie 10.1.12.

Several large larvae per species that had quit their mines were assumed to have completed development and were fixed in hot water and preserved in 70% alcohol, and were used for morphological assessment. Otherwise wandering larvae were left undisturbed although fresh leaves were often added, and they either made a new mine or pupated on or under leaves. Each puparium was reared in a foam-capped, glass bottle containing a 1-2cm layer of compressed,

moistened moss and bottles stored outdoors in dark conditions. Mines were recognised initially from the descriptions and images of mines and early stages at the websites, British leafminers (www.leafminers.co.uk) and Plant Parasites of Europe (<https://bladmineerders.nl/>). Identifications were confirmed by comparing reared adults with named material in the collections of the National Museums of Scotland and for Agromyzidae, keys in Spencer (1976), for Drosophilidae keys in Bächli *et al.* (2004) and P. Beuk *et al.* (*in litt.*) and for Anthomyiidae, the keys of M. Ackland (*in litt.*).

Head skeletons were examined by extracting them from puparia. Whole puparia minus sections loosened by the emerging adult were placed in a solution of potassium hydroxide for about 45 minutes and pins used to free head skeletons. They were washed in acetic acid to prevent further clearing and stored in 70% alcohol. Head skeletons *in situ* were also examined. The front end of a preserved larva was cut across the metathorax and the cut section cleared in potassium hydroxide for up to an hour and obscuring tissue removed with pins and forceps. Sections were washed in acetic acid and preserved in 70% alcohol. The morphology of head skeletons and preserved larvae was examined using a Wild M5 stereo microscope and an Olympus BX51 compound microscope.

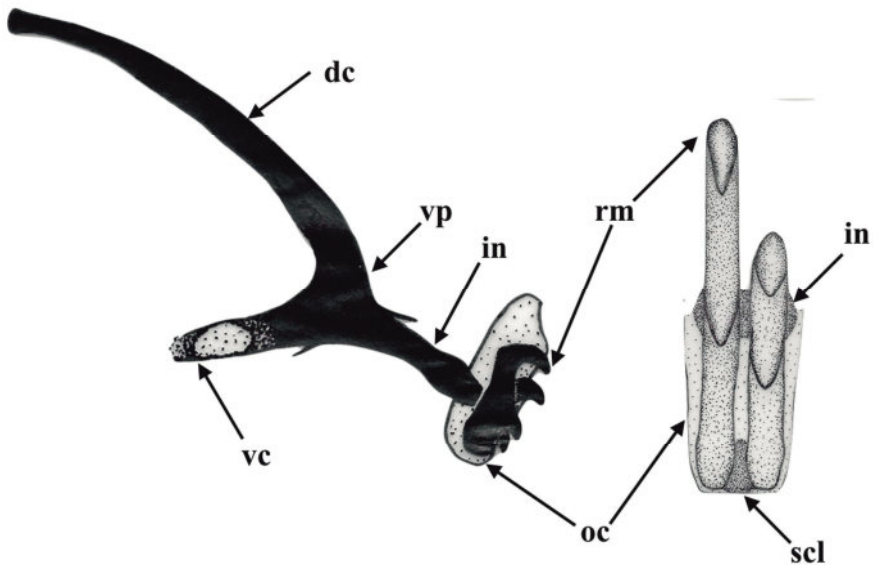


Fig. 1. *Amauromyza flavifrons*, third stage larva ex leaf mine on *Silene dioica*: left hand figure whole head skeleton, lateral view, length 0.3mm; right hand figure mandibles, anterior view; dc dorsal cornu, in intermediate sclerite, oc oral cavity, rm right mandible, scl sclerotisation fusing together the mandible bases, vc ventral cornu, vp vertical plate.

Results

Amauromyza flavifrons, *A. labiatarum* and *A. verbasci* (Agromyzidae)

Morphology

Third stage larva, size and shape: n (number larvae assessed/species) = 8 *A. flavifrons*, 7 *A. labiatarum*, 5 *A. verbasci*; abdominal segments of all three species with a similar shape being about twice as high (0.8-1mm) as long (0.3-0.5mm) and ellipse-shaped in cross-section; body

length 3.5-5mm and tapering from the anal segment to about 0.3mm high at the prothoracic apex; *A. verbasci* slightly larger than the other two species; **head skeleton** (Fig. 1): reduced and highly modified compared to the anthomyiid and drosophilid miners considered here; basal sclerite U-shaped with a narrow, backwards-sloped vertical plate; dorsal bridge absent; dorsal cornu longer than ventral cornu and both cornua narrow, about as tall as wide; ventral cornu not as sclerotised, without a projecting dorsal apodeme or a microbe filter; intermediate sclerite sclerotised and aligned and fused to the basal sclerite; slightly tapered base to apex and abuts the mandibles; parastomal bars weakly indicated and fused probably to the intermediate sclerite; mandibles orientated vertically, i.e. hooks point forwards not downwards; mandibles fused ventrally; each mandible with one main and one secondary hook and with one mandible longer than the other, the hooks arranged alternately, i.e. not opposed; **pseudocephalon** (Fig. 2): complex in form; wedge-shaped in lateral view and orientated so that the antennomaxillary organs and oral cavity face forwards, hence, taller than long; between the antennomaxillary organs a sclerotised groove or furrow; below and lateral to the groove a shallow depression with a slightly raised rim each side of the anterior end of the oral cavity; oral cavity with thin, lightly sclerotised walls formed around the mandibles including the fused base of the mandibles and supported by a lightly sclerotised oral plate; **prothorax** (Fig. 2): in front of the anterior spiracles depressed dorsally so that it is level with the pseudocephalon except for a mid-dorsal, round-tipped, fleshy protuberance; dorso-ventral margin with a similar protuberance; **anterior spiracles**: close to and inclined towards the midline on the postero-dorsal prothoracic margin; fan-shaped with 8-10 openings on short basal projections (as short or shorter than the length of the openings); **rest of the thorax and abdominal segments 1-7**: anterior and posterior margins with rings of conspicuous black spicules; spicules forming species-specific patterns: *A. flavifrons*, lateral margins of rings parallel-sided and with one line of smaller spicules along the posterior margin of each ring; *A. labiatarum*, parallel rings comprising small, densely arranged spicules except for larger, less densely arranged spicules on the lower half of the ring bordering the 7th abdominal and the anal segment; *A. verbasci*, rings with even-sized spicules not parallel-sided, but spread over the lateral margins of segments anteriorly and posteriorly, especially the ring bordering the 7th abdominal and the anal segment; **anal segment**: truncate apically with posterior spiracles close to the midline on the postero-dorsal margin; anus parallel to the longitudinal axis of the body and bordered by a pair of fleshy protuberances; **posterior spiracles**: 3 openings on short, fleshy projections and openings raised above an irregularly shaped spiracular plate.

Mines

A. flavifrons: foodplant *S. dioica*; 47 mines in 45 leaves assessed, i.e. nearly all leaves with single mines (Fig. 3a); mines confined mostly to the upper, palisade layer and consisting of a short, convoluted (with frequent, sharp-angled turns) linear section followed by a blotch also confined chiefly, but not entirely to the upper palisade layer; frass particles in the linear mine infrequent and often displaced towards the side margins and infrequent in the middle regions of blotch mines; most eggs (93.6%) oviposited in the middle rather than the edge of the leaf blade and in the basal half of leaves (78.7%); most mines (76.5%) not confined to leaf compartments, i.e. an area of leaf blade bounded by projecting veins; small leaves (<30mm long) often mined out.

A. labiatarum: foodplant *Stachys* sp.; 48 mines in 43 leaves assessed, nearly all leaves with single mines; mines confined mostly to the upper layer and consisting of a long, meandering linear section followed by a blotch (Fig 3b); frass particles in the linear mine infrequent and often displaced to one or other side and in the middle regions of blotch mines; most eggs (77%) oviposited at the edge of the leaf blade and in the distal half of leaves (66.6%) and often at the apex (Fig. 3b); most mines (76.4%) not confined to leaf compartments and leaves not mined out.

A. verbasci: foodplant *S. nodosa*; 78 mines in 47 leaves assessed (26 leaves with 1 mine, 12 with 2, 8 with 3 and 1 with 4); mines confined mostly to the upper layer (Fig. 4d), and consisting of a short, convoluted linear section followed by a blotch; frass particles in the linear mine displaced usually to the sides and irregularly distributed in the middle regions of blotch mines; most eggs (91%) oviposited in the middle of the leaf blade and in the basal half of leaves (79.4%); most mines (60%) constrained to some extent by leaf veins, i.e. mines following and not crossing projecting veins, and leaves not mined out.

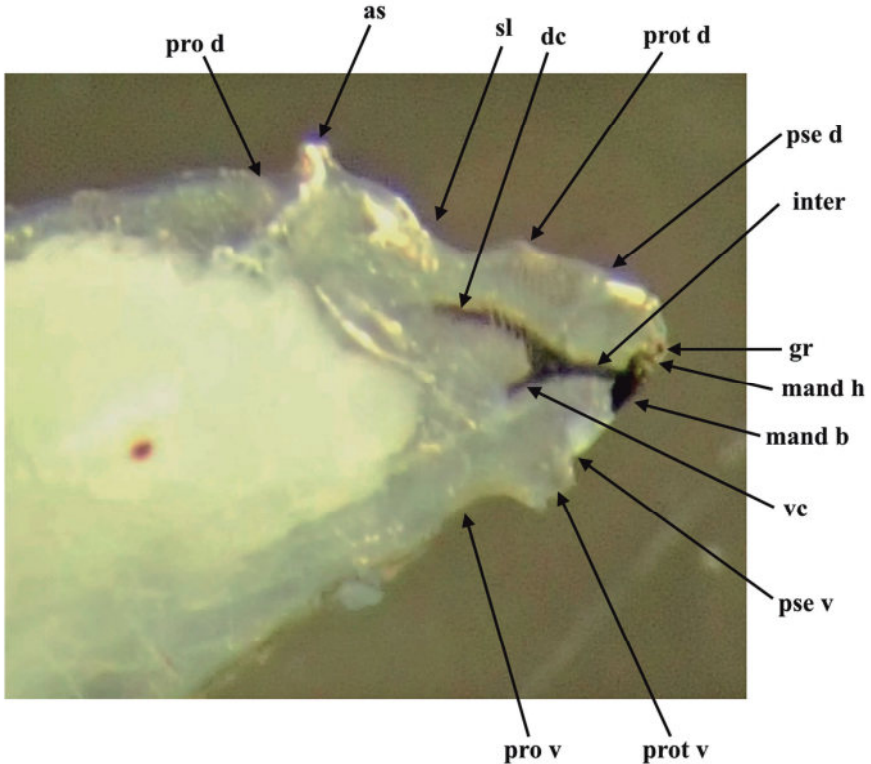


Fig. 2. *Amauromyza labiatarum*, preserved third stage larva ex leaf mine on *Stachys* sp., head end, lateral view: as anterior spiracle, dc dorsal cornu of head skeleton, gr groove between the antennomaxillary organs, inter intermediate sclerite, mand h mandible hook, mand b mandible base, pro d and v dorsal and ventral boundary between the prothorax and mesothorax, prot d and v dorsal and ventral protuberances, pse d and v dorsal and ventral boundary between the prothorax and pseudocephalon, sl sloped dorsum of the prothorax, vc ventral cornu of head skeleton.

Feeding mechanism

All larvae fed with the body in a sideways position ($n = 10/\text{species}$). To feed, a series of lunges were made and to start a series, the prothorax, pseudocephalon and head skeleton extend forward until the vertically orientated mandibles and pseudocephalon make contact with the mine face and contact may be enhanced by pressing against the mine face the prothoracic apex as far as the dorsal and ventral protuberances. The head skeleton pivots up slightly which pushes the mandible

hooks against tissue followed by pivoting down which draws them through it. Fragmented tissue and fluids gather in the oral cavity and are sucked up by the head skeleton pump. During feeding the mandibles are immobile relative to the rest of the head skeleton, i.e. the mandibles appear to be fixed in position. In third stage larvae lunge rates were similar in all 3 species, at 2-3 lunges per second.

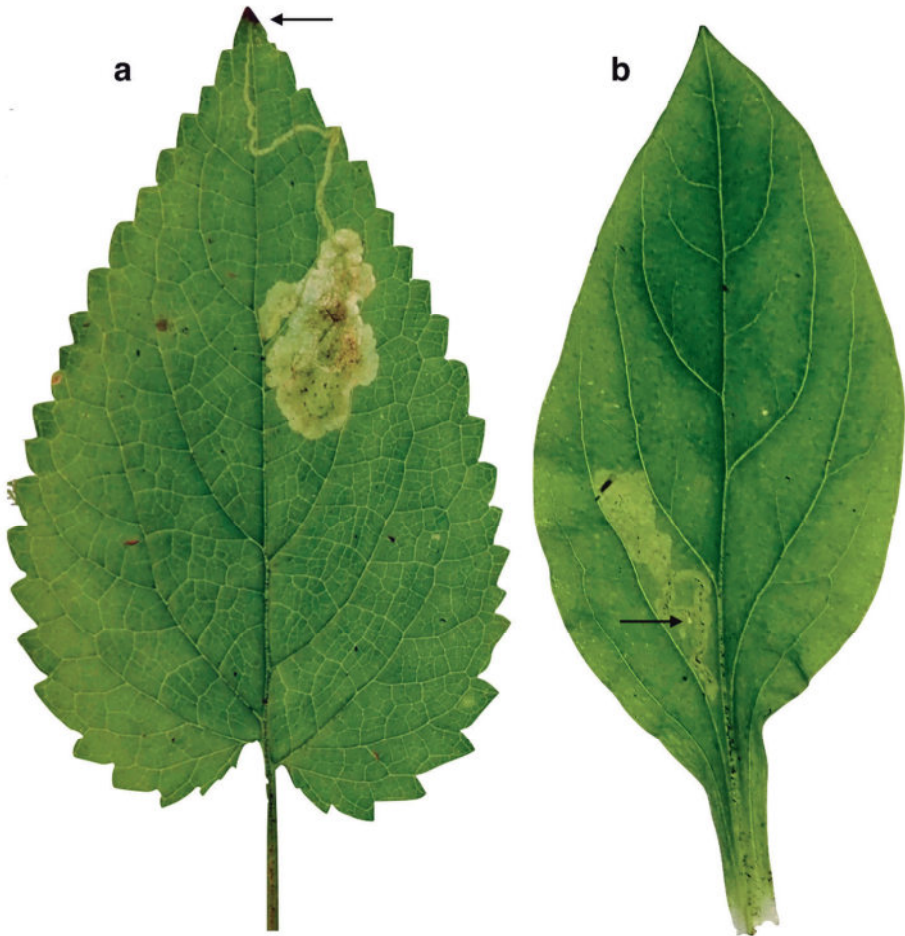


Fig. 3. *Amauromyza*, linear to blotch mines, arrows indicate position of egg: a, *A. flavifrons* on *Silene dioica*; b, *A. labiatarum* on *Stachys*.

Feeding pattern

Frass along the sides of linear mines is due to a sideways feeding position and the paired protuberances each side of the anus which guide it to the leaf surface. Distribution of frass along both sides in the same mine suggests that larvae turn over. In a mine monitored on a *Stachys* leaf the frass pattern reveals a high rate of turning over (Fig. 4a). This mine is due probably to *Amauromyza morionella* (Zetterstedt) (B. Warrington *pers. comm.*). Observations of mining in

this larva confirmed that it turned over frequently and did so by reaching forward and placing the mandibles against the mine face, following which the body twisted from the anus to the head. In two sections of the linear mine that were about 0.33mm and 0.78mm wide, the distribution of frass showed that turning had occurred at a rate of one turn per 0.4mm and 0.5mm mine length respectively, i.e. turning rates fall with larval size. Observations showed that turning was infrequent in blotch mines.

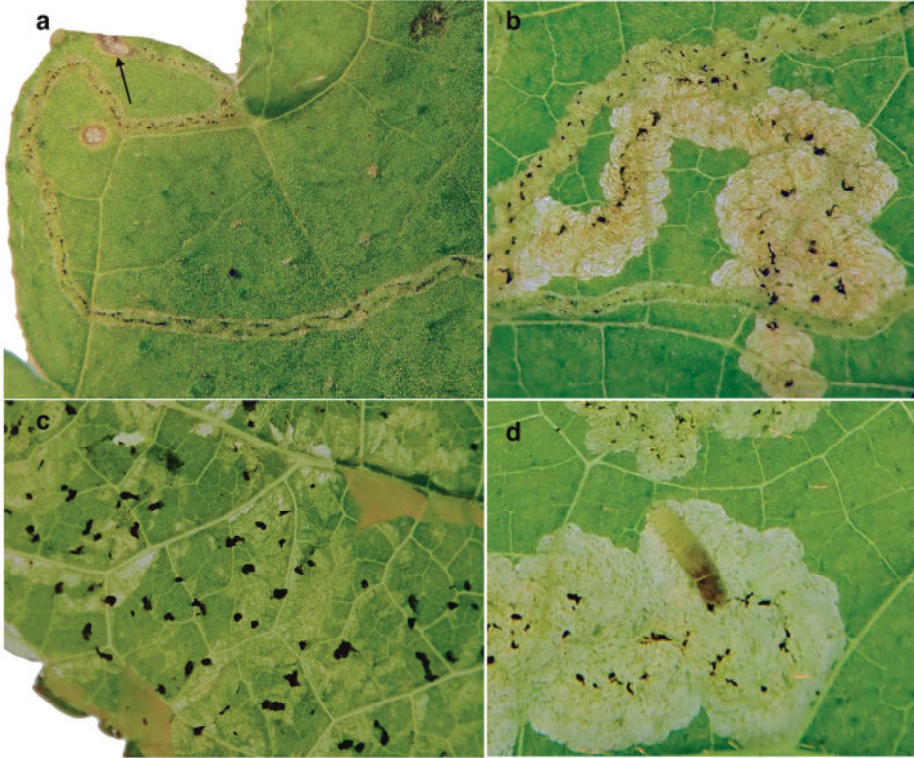


Fig. 4. *Amauromyza* leaf mines, black marks are frass: a-c, probable *A. morionella* on *Stachys*: a, initial section of a linear mine, arrow shows position of egg; b, later sections of the same linear mine and changing to a blotch; c, larva gouging in the blotch mine; d, *A. verbasci* ex mine on *Scrophularia nodosa*, adaxial epidermis removed to show complete removal of upper palisade layer and light green feeding damage to the lower spongy mesophyll.

Videos revealed that the widening of this linear mine was not only explained by increases in larval size. Initially, the sides of linear mines were more or less parallel, but later the sides of the mine bulged out on each side (Figs 4a versus b). Side bulges were due to the larva turning over and the bulges themselves were due to it bending the front of the body into the gouge during feeding, a feature that became more pronounced towards the end of the linear mine and was typical of blotch mining. Lateral frass deposition and bulges in the linear mines of the other three

Amauromyza species indicate a similar if less pronounced feeding pattern. In all these *Amauromyza* species gouging, and more frequently, strips of tissue were removed during blotch mining. In strip feeding, the larva orientates itself more or less at right angles to the mine face and extends forward to begin lunging and a gouge is made (Fig. 4c). The sides of the gouge are extended successively by the abdomen bending at the front to reach into the gouge while the rest of the abdomen remains stationary.

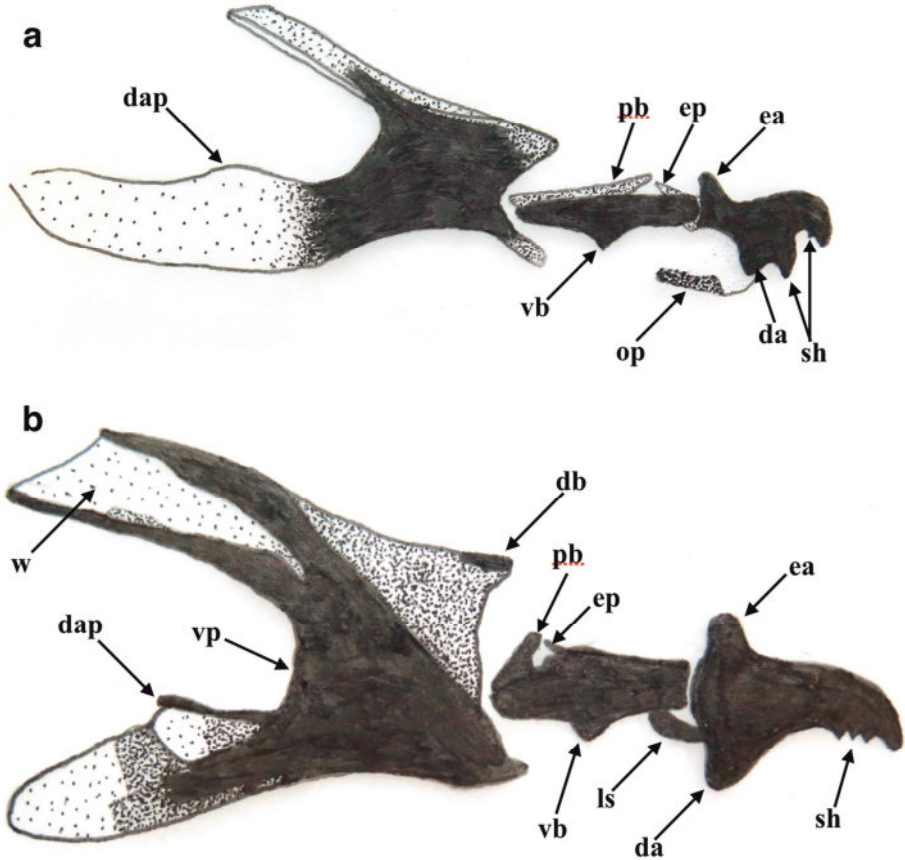


Fig. 5. Third stage larva, head skeleton, lateral view, mandible to the right, basal sclerite to the left and intermediate sclerite between them: a, *Scaptomyza graminum*, length 0.6mm; b, *Pegomya flavifrons*, length 0.7mm: da depressor muscle insertion apodeme, dap dorsal apodeme on the ventral cornu, db dorsal bridge, ea elevator muscle insertion apodeme, ep epistomal plate, ls labial sclerite, op oral plate, pb parastomal bar, sh secondary hooks, vb ventral bridge, vp vertical plate, w lightly sclerotised 'window' in the dorsal cornu.

Scaptomyza graminum (Drosophilidae)
Morphology

Third stage larva, size and shape: n = 6; body tapering from abdominal segments 3 and 4 towards the head and caudal ends; length, height and width of segments 3 and 4 similar, between 0.6-0.8mm; body length 3-3.5mm; dorsa of the first abdominal segment, metathorax, mesothorax and prothorax to just in front of the anterior spiracles with a continuous swollen lateral rim or beading; **head skeleton** (Fig. 5a): basal sclerite with vertical plate, dorsal bridge and basal regions of the dorsal and ventral cornua heavily sclerotised; dorsal cornu shorter than the ventral cornu and with a longitudinal middle region or window lacking sclerotisation; ventral cornu with prominent dorsal apodeme outlined by a ring of sclerotisation, cibarial ridges and caudal valve vestigial, i.e. faint and inconspicuous; in lateral view intermediate sclerite widening from the basal sclerite to the apical articulation points with the mandibles; not fused or aligned with the basal sclerite, i.e. dorsal and ventral margins narrower than the front of the basal sclerite; basal section of the parastomal bars fused with the intermediate sclerite but apically, they are free, incline upwards and support a conspicuous, inclined and lightly sclerotised epistomal plate; mandible with apical hook short, wide and scalloped ventrally with a small, inconspicuous secondary hook on the outside margin and a larger hook below; mandibles not fused together, orientated downwards and base rectangular-shaped with the postero-dorsal corner drawn out into a conspicuous apodeme; dental sclerites absent; labial sclerites conspicuous and heavily sclerotised; **pseudocephalon:** wedge-shaped; orientated downwards and antennomaxillary organs almost flat to the body wall; margins of the oral cavity narrow and projecting barely; posterior margin of the oral cavity with a shield-shaped, lightly sclerotised oral plate that relative to the mandibles appears underneath them (Fig. 5a); **prothorax:** anterior margin truncate and coated in transverse rows of black spicules, delimited from the pseudocephalon by a transverse infold of the body wall; **anterior spiracles:** 6 openings at the apex of variably long flexible filaments; in the larva filaments approximated, not projecting from the body wall and apparently, retracted into a depression either side of the postero-dorsal prothoracic margin; filaments supported at their base by a ring of brown-black sclerotisation; in the puparium filaments everted and openings projected and fixed in various directions and lengths at the apex of an everted section of beading; **rest of the thorax and abdominal segments 1-7:** anterior and posterior margins with rings of transverse rows of black spicules, spicules less sclerotised and not as densely arranged on the anterior margin of the mesothorax and abdominal segments 5-7; ventrally these rings incorporate barely projecting creeping welts or attachment pads; **anal segment:** comprising three tapering sections; in the larva sections retractile, in the puparium sections everted and fixed in position; anterior section with a ring of conspicuous, ventral and lateral, conical protuberances; middle section supporting a pair of fleshy, cylindrical projections each bearing a sclerotised posterior spiracle, projections approximated in the larva diverging in the puparium; **posterior spiracle:** sclerotised projection tapered almost to a point with 3 or 4 oval-shaped openings arranged around the apex.

Mine

Foodplant: *S. dioica*; 237 mines examined in 20 leaves; eggs usually oviposited singly and within a leaf compartment; a mean of 11.8 mines present per mined leaf, range 2-20, SD 4.72 (Fig. 6a); secondary mines nearly twice as frequent as primary mines (153 versus 84); primary mines varying in depth so that they are less conspicuous on one side of the leaf than the other (Figs 6b versus c and 7a); primary mines linear and broadening gradually, varying in length from 3-16mm and gently curving and sometimes with side branches (Fig. 7a), although if contact was made with a leaf vein crossing over was unusual and mines tending subsequently to zig-zag (Figs 6b, c); most primary mines (66%) progressing towards the leaf apex, the rest to the base; secondary mines linear but broader and sometimes blotch-shaped (Fig. 7a); exit slits and size variability in both types of mine suggest high rates of abandoning mines and starting new ones (Figs 7b,c).

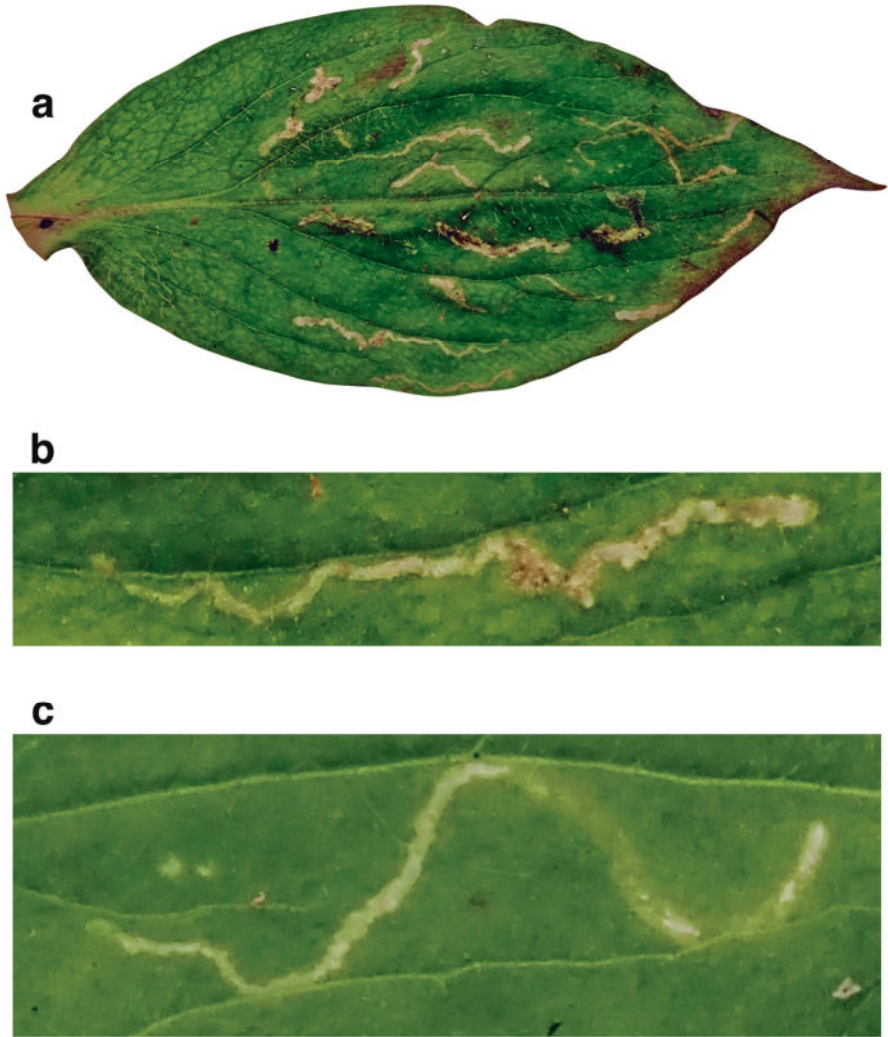


Fig. 6. *Scaptomyza graminum*, leaf mines on *Silene dioica*: a, whole leaf, adaxial view; b, single linear mine, length about 15mm; c, linear mine zig-zagging from leaf vein to leaf vein, length about 15mm.

Feeding mechanism

Third stage larvae ($n = 15$) fed either with the entire body in a sideways position or with the body in a twisted position, i.e. the abdomen is in a different plane so that the head end has to twist to access the mine face. To make a feeding lunge, the mandibles elevate, the head end extends forward and in an inclined position, the head skeleton protracts. These movements expose the mandibles, the hooks of which engage with the mine face. The mandibles depress through tissue

to complete a short feeding lunge (Figs 8a, b). Longer feeding lunges are made by either maintaining the mandibles in a depressed state and pivoting the head skeleton or extending length by contracting the thorax so that lunges finish under the larva by about a quarter body length, but with little bending of the thorax or abdomen (Fig. 8c).

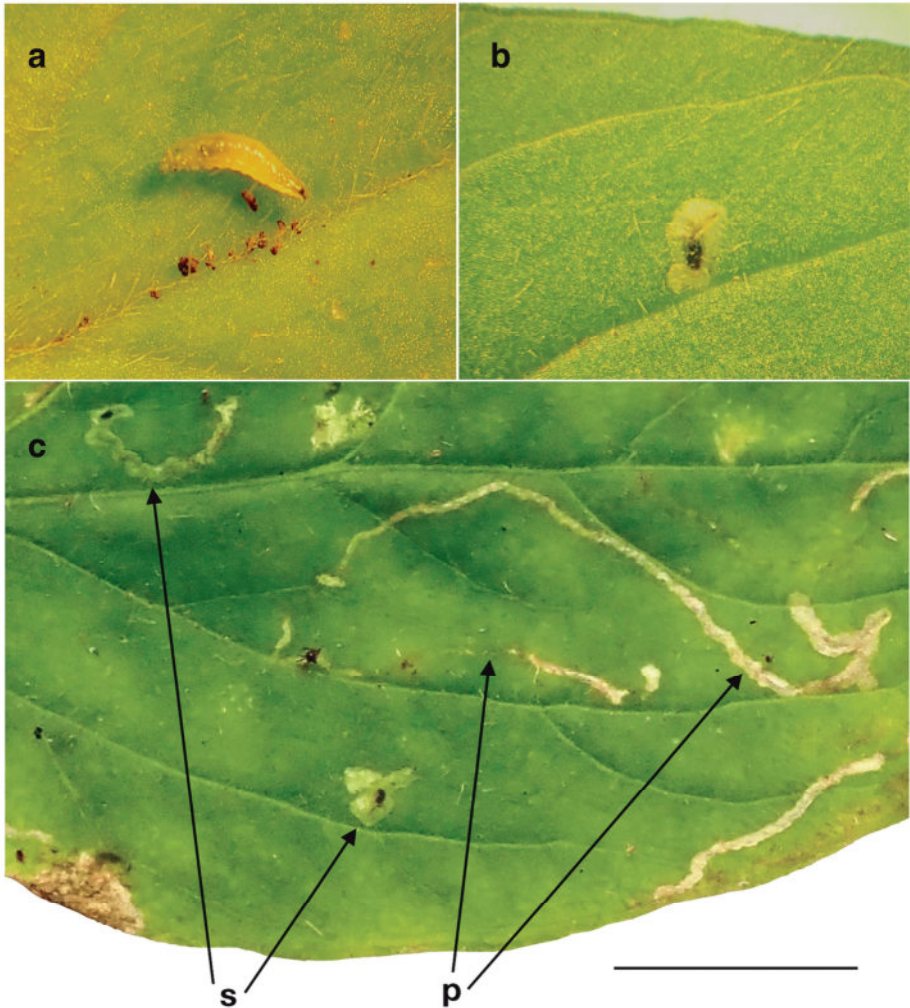


Fig. 7. *Scaptomyza graminum*: a, primary (p) and secondary (s) mines in a section of a *Silene dioica* leaf, scale line is 1cm long; b, third stage larva, on *Silene dioica* leaf having abandoned a mine; c, same larva 12 hours later in a new mine.

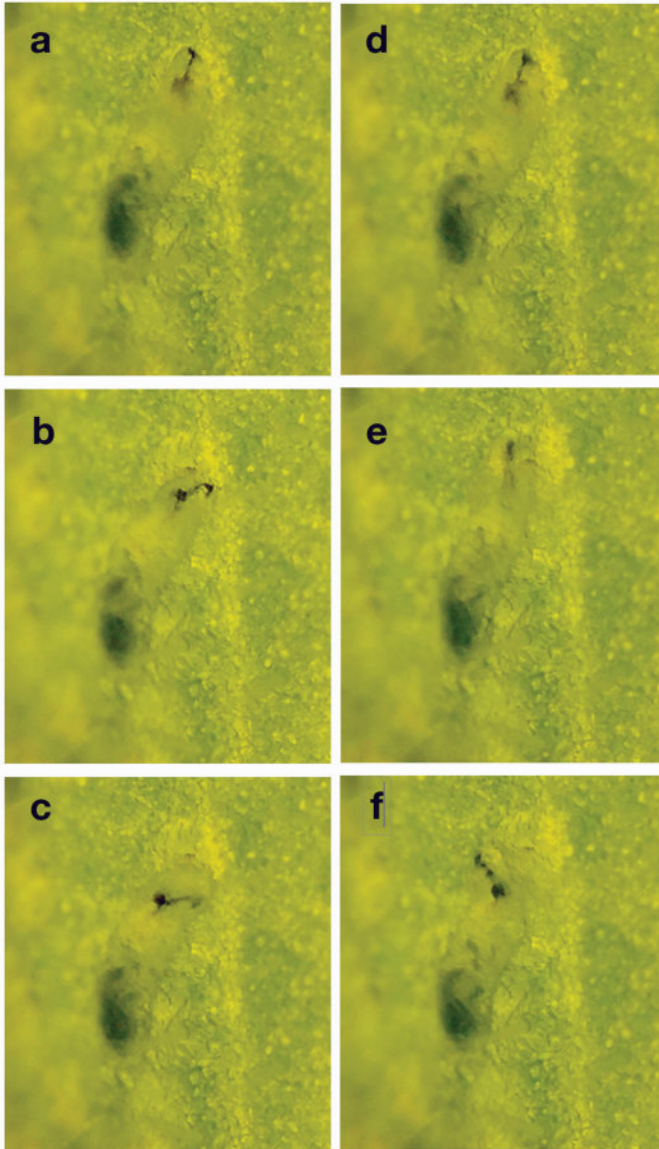


Fig. 8. *Scaptomyza graminum*, stills from a video: a-c, feeding lunges on one side of the linear mine, d-f twisting the front of the body to access the other side of the mine; a and b, short feeding lunge: a, head extended to grip the front of the mine; b, mandible depressed and head skeleton pivoted which pulls the hooks through and fragments tissue; c, a longer feeding lunge, from the position in (b), the thorax contracts which pulls the hooks through additional tissue; d, head extends to the front of the mine; e, front of the body starts twisting; f, twist completed and the hooks face the opposite side of the mine.

During lunging the rear margin of the oral cavity is probably retracted by contraction of muscles attached to the oral plate. As a lunge ends the rear margin of the oral cavity is restored by relaxation of the oral plate and fragmented food fills it, ready to be sucked up by the head skeleton pump. Lunges were interrupted frequently by positional adjustments, mainly in response to the mandible hooks catching on tissue. Variation in lunge lengths and positional adjustments result in interrupted lunging at rates of about 1.3 lunges per second.

Feeding pattern

The lateral edges of linear mines are rarely straight and, especially in wider sections, consist of scallop-shaped gouges similar to those found in the *Amauromyza* species (Figs 4 and 6b, c). Videos and observations show that larvae make alternate and successive gouges each side at the head of the mine by twisting the thorax and head skeleton. Larvae twist the thorax by extending the head skeleton forward and the mandibles grip the head of the mine (Figs 8d, e). The body then twists from the head end and either the whole body turns or just the head end as far as abdominal segment 1 or 2. The mandibles elevate to release their grip and due to connections between the head skeleton and the thorax, the head skeleton turns in the direction of the twist which directs the mandibles against the opposite side of the mine (Fig. 8f). Blotch mines were rare and only occurred in some secondary mines, which are otherwise linear. They were the result of gouging at different places along the mine face.

Pegomya flavifrons, *P. laticornis* and *P. solennis* (Anthomyiidae)

Morphology

Third stage larva, size and shape: $n = 4$ *P. flavifrons*, 7 *P. laticornis*, 12 *P. solennis*; abdominal segments of all three species with a similar shape being about twice as wide (2mm) as high (0.8-1mm) or long (0.5-0.8mm); body length 7.5-10mm and tapering from abdominal segments 5-6 towards both the caudal and head ends; prothoracic apex about 0.3mm high; *P. laticornis* slightly larger than the other two species and *P. solennis* slightly narrower; **head skeleton** (Fig 5b): basal sclerite rectangular-shaped; ventral cornu with a dorsal apodeme and sclerotisation ending sharply just beyond it; microbe filter absent except for a vestigial state in *P. flavifrons* indicated by faint, poorly sclerotised cibarial ridges and terminal valve; dorsal cornu sclerotised except for a longitudinal window, window less developed in *P. solennis*; vertical plate with dorsal bridge and projecting ventral margin, parastomal bars short, but probably fused with the intermediate sclerite; intermediate sclerite about as long as the mandibles, approximating towards the inflated, mandibular articulation points and, in lateral view, relatively broad and sclerotised and not aligned with the basal sclerite; labial sclerites sclerotised and conspicuous beneath the articulation point of the intermediate and mandibular sclerites; mandibles downwardly directed, not fused together and with elevator and depressor muscle apodemes more or less aligned vertically, but species-specific in shape: *P. flavifrons*, symmetrical, L-shaped with 3 secondary hooks that are small, i.e. not as long as the apical hook is wide; *P. laticornis*, symmetrical, triangular in shape with 3 large secondary hooks, about as wide as apical hook; *P. solennis*, asymmetrical, with, in ventral view and head facing away, the right hand mandible elongate and longer than the left hand, triangular-shaped mandible; right hand mandible with a terminal hook and two smaller hooks, left hand mandible with three even-sized hooks; **pseudocephalon:** wedge-shaped, oral cavity shallow with dorsal margin bearing, on each side of the mandibles, 4-6 cylindrical-shaped, flat-tipped studs, rear margin with a lightly sclerotised oral plate; asymmetrical in *P. solennis*, i.e. longer and with 6 studs on the right hand side and shorter and 4 on the left (figured in Rotheray and Lyszkowski 2015); **prothorax:** truncate apex with transverse rows of spicules extending on to the lateral margins; *P. solennis* with a conspicuous rounded, bar-shaped projection in the middle of the antero-ventral margin, i.e. immediately behind the oral cavity; **anterior spiracles:** orientated

anteriorly and fan-shaped in *P. flavifrons*, double fan-shaped in *P. laticornis* and *P. solennis*; **rest of the thorax and abdominal segments 1-7**: anterior and posterior margins with rings of transverse rows of black spicules, rings spreading across the lateral margins of the metathorax and abdominal segments 1 and 2, especially in *P. laticornis*; spicules less sclerotised and not as densely arranged on abdominal segments 5-7; ventrally rings incorporate barely projecting attachment pads; **anal segment**: apex inclined and ringed by a series of at least 5 pairs of fleshy protuberances; a transverse indentation may be present across the middle of the apex, making it ledge-shaped in profile view and with the posterior spiracles on the vertical aspect, this shape most developed in *P. laticornis*; anal plate well developed as a slight, bar-shaped, transverse projection outlined by grooves in the body wall and in the centre of which is the anus; anus parallel to the longitudinal axis of the body and bordered by a pair of fleshy protuberances; **posterior spiracles**: on slight, fleshy projections; 3 pairs of raised openings on an irregularly-shaped spiracular plate.

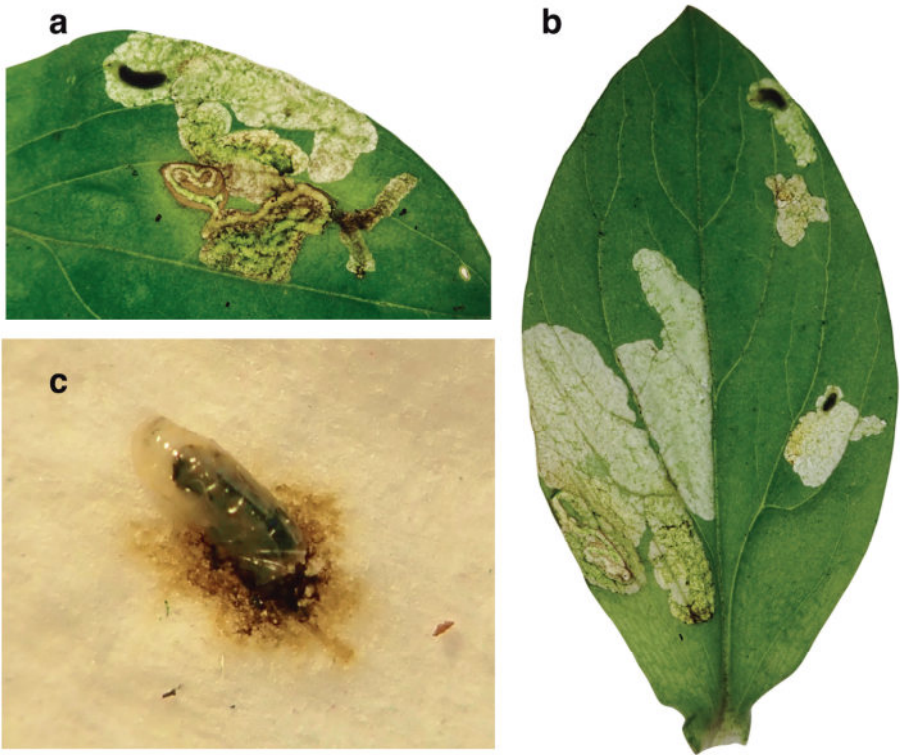


Fig. 9. *Pegomya flavifrons*: a, linear followed by blotch mining in a *Silene dioica* leaf, third stage larva in upper left hand side, gouging at the mine face; b, from a *Silene dioica* leaf in culture, abandoned primary mine on the left side and smaller, secondary mines, two occupied; c, third stage larva in transit between mines placed on a paper towel and, prodded with a pin, it released black, liquid faeces.

Mines

P. flavifrons: foodplant *S. dioica*; 86 mines in 45 leaves assessed (21 leaves with 1 mine, 14 with 2, 3 with 3 and 7 with 4); eggs oviposited singly and within a leaf compartment; larvae initiate a mine by tunnelling out from inside the egg into the leaf and a linear mine is followed by a mainly upper layer blotch; linear mine confined to a leaf compartment and highly convoluted with many turns and blotch mine may or may not cross veins (Fig. 9a); 32 mines were small with exit slits suggesting abandonment of mines before completion of development and making new mines was frequent in culture (Fig. 9b); larval gut full of black material and the blotch mine mostly free of frass (Figs 9a, b); inside and outside mines, if touched, larvae emit faeces and clear fluids and during pupariation, puparia are coated in faeces (Fig. 9c).



Fig. 10. *Pegomya laticornis*: a, eggs oviposited adjacent to the midrib on the abaxial side of an *Arctium* sp. leaf, arrow points to an egg, black patches under eggs are faecal masses; b, blotch mines confined by leaf veins with faecal material concentrated along their midlines; c, blotch mine feeding pattern consisting of successive feeding strips, indicated by lines of remnant tissue.

P. laticornis: foodplant: *Arctium* sp.; 15 leaves assessed with 2-13 mines per leaf and a mean of 13 larvae per leaf, SD 7.1, range 6-29; eggs oviposited singly adjacent to the midrib or a large lateral vein (Fig. 10a); larvae initiate a mine by tunnelling out from inside the egg into the leaf and making a mainly upper layer blotch mine that is usually confined to leaf compartments (Fig. 10b); separate mines often coalesce and larvae often feed side by side or close together; larval gut not so full of material as *P. flavifrons* and frass deposited regularly and initially, confined to a black patch at the mine origin and later to middle regions of the mine (Fig 10a,b); larvae able to start new mines and puparia not coated in faeces.

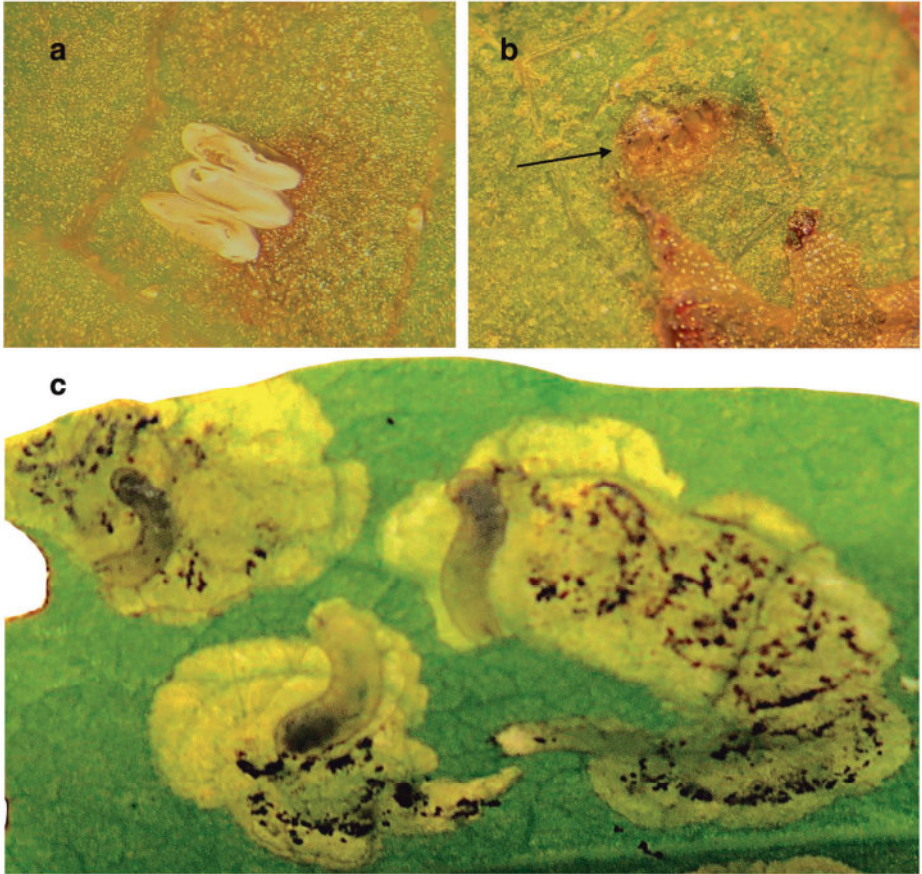


Fig. 11. *Pegomya solennis*: a, egg clutch on the abaxial surface of a *Rumex obtusifolius* leaf, eggs about 1mm long; b, a line of 3 holes made by larvae from eggs in (a) into the leaf, arrow points to the holes; c, third stage larvae gouging and stripping in secondary mines on a *Rumex acetosa* leaf.

P. solennis: foodplant: *R. obtusifolius*; 30 leaves assessed with 1-3 mines per leaf and a mean of 4.8 larvae per leaf, range 2-9; eggs oviposited side by side in clutches of up to 4 eggs (Fig. 11a); larvae initiate a mine by tunnelling out from inside the egg into the leaf (Fig. 11b); larvae in a

clutch emerge together and mine side by side in an upright orientation and the initial linear mine is followed by a mainly upper layer blotch; initial mine relatively short and straight or gently curved, but may turn from or follow a leaf vein; in blotch mines larvae often feed close together; frass deposited towards the centre of the blotch; larva able to start new mines and puparium not coated in faeces.

Feeding mechanism

Third stage larvae ($n = 10/\text{species}$) fed in a sideways position, either with the entire body turned sideways or less frequently, with just the front of the body turned sideways. To make a feeding lunge the thorax, pseudocephalon and head skeleton extend forward until the mandibles and the prothoracic apex made contact with the mine face. The mandibles depress slightly and the head skeleton pivots down, which draws the mandible hooks through tissue. The rear margin of the oral cavity is retracted during pivoting in the same way as *S. graminum*. Lunge rates were relatively rapid, at between 4 to 6 lunges per second and they varied in distance, depending on how far the head skeleton pivoted. Feeding lunges always included head skeleton pivoting, feeding with the mandibles alone was not recorded.

Feeding pattern

Blotch mines were made using gouging and stripping. Gouging consists of a larva facing a mine face at an approximate right angle and removing a scallop-shaped excavation by a series of feeding lunges against the mine face (Fig. 9a). Stripping may follow gouging in cases where the larva removes one side of the gouge and the body moves into the excavated area (Fig. 11c), with the result that a strip of tissue is removed and a line of remnant tissue is sometimes left behind (Fig. 10c). The larva usually repeats the pattern and hence, successive strips are removed and the mine enlarges.

Discussion

Morphological traits common to the seven miners assessed in this paper include: a basal sclerite with the vertical plate and inner ends of the cornua heavily sclerotised; intermediate sclerite sclerotised; mandible with secondary hooks; pseudocephalon wedge-shaped; oral cavity shallow with an oral plate; antennomaxillary organs almost flat to the body wall; prothorax truncate and, body segments with spicule rings. Many of these traits are part of a set that are widespread among cyclorrhaphan larvae and correlate to feeding on dense or compacted food, such as, hard fungal tissue in mycophages, dried decay in saprophages, tough prey tissue in zoophages and plant tissue in phytophages (Rotheray and Lyszkowski 2015). Specifically, they contribute to a fragmentation feeding mechanism (Rotheray 2019). Feeding lunges made by larvae with these traits consist of the mandibles being held in a slow-moving or partially depressed state and the rear margin of the bowl-shaped, oral cavity retracted as the head skeleton pivots and pulls the mandibular hooks through the food. Towards the end of the pivot the mandibles complete depression and the muscles of the oral plate relax which by natural elasticity restores the oral cavity, and fragmented food contained within it is sucked up.

Fragmentation is facilitated by short, wide mandibles which is a robust shape for withstanding the forces involved, secondary hooks that provide additional cutting points and parallel-moving mandibles that focus fragmentation power. A pivoting head skeleton increases the range and power of feeding lunges and a truncate prothorax provides space for pivoting. Holding the mandibles in a slow-moving or partially depressed state is achieved by simultaneous contraction of elevator and depressor muscles, a process facilitated by dorso-ventral alignment between their insertion apodemes on the mandible or, less frequently, by an extended elevator apodeme which provides space for extra muscle attachment and helps to equalise the power of

the elevator muscles with that of the generally stronger depressor muscles (Rotheray 2019). To withstand the forces involved, head skeletons are buttressed by high levels of sclerotisation and fusion and/or alignment between the intermediate sclerite, the parastomal bars and the basal sclerite. These states are opposite to those of liquid feeders that usually have a tapered prothorax and a less sclerotised and aligned head skeleton that moves forwards and backwards. The depressor muscles insert in a forward position, so emphasising lowering of the mandible that combined with a deep oral cavity supported in an open position by the dental sclerites and mandibles that move apart, are effective means of gathering viscous food (Rotheray 2019).

Fragmentation traits characterise the miners assessed here, but they vary between them, with the most striking match to feeding mechanism being that of the *Amauromyza* species. *Amauromyza* mandibles are asymmetrical (one longer than the other), are fused basally, fixed in an upright orientation and appear to have no independent mobility, and with a modified prothorax and pseudocephalon these structures function as an integrated module. This putative adaptive complex (Cheverud 1996), appears to be exclusive and efficient. Anchored to form in the caudal abdominal segments, the larva extends a blotch mine by bending the body up or down at any point from the front of the abdomen to the mesothorax, while manoeuvring independently the integrated unit at the front of the body to draw the mandibles through tissue and feed. In blotch mines tissue strips are removed by successive or overlapping gouges with minimal movement in the rest of the body. Two other features of this unit contribute to feeding: bar-shaped protuberances on the mid-dorsal and mid-ventral prothoracic margins that help probably to contain fragmented food and a sclerotised medial groove between the antennomaxillary organs that allows passage of air or fluids to reduce the tendency for a vacuum to form in the oral cavity that would interfere with sucking. A mid-ventral protuberance also occurs in *P. solennis* and all three *Pegomya* miners have a line of studs across the front of the oral cavity for passage of air and fluids during sucking. Containment and pressure relieving mechanisms are not obvious in *S. graminum*.

Scaptomyza graminum and *Pegomya* larvae do not have such high levels of integration between the prothorax, pseudocephalon and mandibles. In particular, their mandibles are not fused, are independently mobile and orientated downwards and to feed, they must be lifted, pressed and held against the mine face. Furthermore, *S. graminum* and *Pegomya* larvae appear to lack comparable levels of gripping power at the caudal end and strength and flexibility in the middle of the body for bending in the same way as *Amauromyza*, and feeding in the former taxa is more active and presumably, less energy-efficient. A consequence of these *Amauromyza* attributes is, however, poor locomotion outside the mine. In contrast to *S. graminum* and *Pegomya*, on foodplant leaves and on smooth surfaces, third stage *Amauromyza* larvae often lie on their sides as a result probably of their elliptical, cross-sectional body shape and progress is slow and haphazard. In soil where they pupate, however, larvae are able to use their lateral margins to hold on and burrow. Poor locomotion on leaves may underpin the absence of mine switching noted in *Amauromyza* larvae: even when taken out of their mines and placed on a fresh leaf, no new mines were initiated ($n = 8/\text{species}$). In contrast, *S. graminum* and the three *Pegomya* larvae readily made new mines. In the former larva and *P. flavifrons*, mines are abandoned regularly, perhaps a means of avoiding natural enemies that search mines. Abandonment might act as a deterrent by increasing rates of unsuccessful searching (Salvo and Valladares 2004). Extrinsic factors are also important, such as running out of tissue due to feeding by other folivores and physical damage to leaves (Rotheray and Rotheray 2019).

In *Amauromyza*, the mandibles are fixed in position by abutting against or possibly fusion with the intermediate sclerite and by the lightly sclerotised oral cavity which is formed around the mandibles. If mandibular muscles are present, they are probably vestigial and vestigial muscles or their loss altogether, may explain the unusual state of the ventral cornu. The

mandibular muscles originate on this cornu and in most cyclorrhaphan larvae there is a projecting dorsal apodeme which supports attachment; in *Amauromyza*, however, the ventral cornu is characteristically short, narrow and lacks an apodeme. Other *Amauromyza* features are a backwards-sloped vertical plate and narrow dorsal cornu. A backwards-sloped vertical plate optimises pivoting space in a forwards-sloped prothorax (Fig. 2).

The mandible of *S. graminum* moves in a different way to those of *Amauromyza* and *Pegomya* larvae in that it can depress during feeding lunges, independent of head skeleton pivoting and thoracic contraction; the latter movement is unique to *S. graminum* and the result is a wide range of lunging distances. *Scaptomyza graminum* has, however, a relatively slow lunging rate, due in part to the hooks which videos show catch on tissue during lunging. At almost 4x as fast the most rapid lunging is that of the *Pegomya* species. The secondary mandibular hooks of *Pegomya* larvae are species-specific in number, size or arrangement with the most distinctive being the asymmetrical mandibles of *P. solennis*. The latter feature is shared with *Amauromyza*, but developed in *P. solennis* by matching asymmetry of the pseudocephalon which is longer on the side with the longer mandible (Rotheray and Lyszkowski 2015).

An apparent irreversible switch from linear to blotch mining occurs in all *Amauromyza* species, *P. flavifrons* and *P. solennis*. In *S. graminum* larval development may complete with linear mining although secondary mines are often blotches. *Pegomya laticornis* is unusual in blotch mining throughout development (Plant Parasites of Europe, <https://bladmineerders.nl/>). As with feeding mechanisms, observations and videos suggest that these patterns are probably explained by inherent and imposed constraints on larval manoeuvrability. For instance, *P. solennis* first stage larvae feed in an upright position until they become too large to complete feeding lunges and are forced to turn on their lateral margins. In an upright-feeding larva little scope exists probably than to mine in a linear way since the mandibles are orientated and move in that direction. In a sideways-feeding larva a wider mine is possible via lunging across the mine face and, in *P. solennis*, this occurs at the changeover from upright to sideways feeding (Rotheray and Rotheray 2019). This is not maintained, however, and as space is created it is superseded by gouge and strip-feeding which extends substantially the mine face and by feeding at different places along it, creates a blotch.

Observations and videos show that linear mining in *S. graminum* is due to twisting and turning, enabling alternate removal of shallow gouges each side at the head of the mine which give it a scalloped appearance and extends it forwards more than sideways (Fig. 6). The reason for maintenance of shallow gouges is the larva not bending the body during feeding. In *Amauromyza* linear mining is also maintained by turning and gouging but, as larvae grow, bending the body facilitates deeper, larger gouges. These provide space for larvae to orientate at right angles to a mine face and to remove tissue by gouging and stripping and so, the linear mine changes to a blotch (Figs 4c, 11c). At mine faces large larvae are probably restricted spatially and if this is a factor accounting for reduced turning it was not investigated. Twisting and turning the body and sideways feeding risk damaging the anterior spiracles. Their position close to the midline in the *Amauromyza* species, high numbers of openings in two of the three *Pegomya* species that increase the chances of at least some escaping damage, and location in a depression in *S. graminum*, appear to be protective devices.

The absence of linear mining in *P. laticornis* is probably due to sideways feeding in the first stage larva, but this was not investigated. Sideways feeding at the outset may be part of a defence mechanism since, when not feeding or if disturbed, early stage larvae retreat apparently to a black faecal patch in the mine under the egg (Plant Parasites of Europe, <https://bladmineerders.nl/>) (Fig. 10a). A wider use of faeces in defence is suggested by the larvae of *Amauromyza*, *S. graminum* and *P. flavifrons* that emit faeces if disturbed and during pupariation, the puparium of the latter species is coated in faeces.

Comparing cyclorrhaphan larvae one with another is an important means of understanding morphology and ways of life. The comparisons made here show that despite shared morphological characters they differ in detail, for example, all the miners possess spicule rings, secondary hooks, a fragmentation feeding mechanism etc., but their precise forms are taxon-specific. This pattern between shared characters and individual forms is due to taxonomic origins being retained rather than eroded by convergence. Hence the null hypothesis of no differences mentioned in the introduction is not supported. The larva of each of the seven species possesses one or more distinguishing characters relative to the group and the three species each of *Amauromyza* and *Pegomya* also share features that might constitute group level distinguishing characters. Hence, larval diagnostics at both species and genus levels seems a likely prospect, but requires testing by improved taxon sampling. At the very least, assumptions that congeneric larvae are indistinguishable are premature.

One aim of comparing larvae is to determine whether exclusive traits exist for contrasts such as leaf mining. As noted above the trophic traits assessed here are not exclusive. Nor is sideways feeding, which occurs in certain saproxylic larvae within the Drosophilidae and Lonchaeidae, and turning and twisting and holding on with lateral spicules are features of tunnelling larvae (Rotheray 2019). Pressure reducing mechanisms in the oral cavity are not exclusive either, for instance, they are present in spot-sucking, saproxylic Clusiidae (Rotheray and Horsfield 2013). Determining what leaf miner traits to compare, i.e. specifying a data standard, develops as knowledge builds. Hence taxon sampling is critical to progress and as argued here, so is inclusion of living material. Videoining facilitates the latter by enabling the roles of morphological components to be worked out by matching them to feeding mechanisms and patterns. Derived from assessment of a large number of preserved agromyzid larvae Dempewolf (2001) discussed two functional contrasts or sources of variation: spicule traits relative to gripping the mine and mandible traits relative to feeding. Videos confirm the importance of these traits and the related ones of body shape for holding on and head skeleton and front of body shape and mobility for feeding. From these and other results presented here a provisional data standard for comparing leaf-mining larvae can be specified that includes: matching body shapes and spicule patterns to holding on; traits of the head skeleton, oral cavity, pseudocephalon and prothorax to feeding mechanisms; rates of lunging, turning, twisting and bending to feeding patterns; frass patterns as indicators of mine development; faeces use in defence and, spiracle traits relative to protection.

Acknowledgements

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References

- Ackland, M. Anthomyiidae, *Pegomya* UK male key (*in litt*).
- Bächli, G. Vilela, C.R. Andersson Escher, S. and Saura, A. 2004. The Drosophilidae (Diptera) of Fennoscandia and Denmark. *Fauna Entomologica Scandinavica* **39**, 1-362.
- Beuk, P., Pitkin, B. and Chandler, P.J. The British Isles species of Drosophilidae (*in litt*).
- Cheverud, J.M. 1996. Developmental integration and the evolution of pleiotropy. *American Zoologist* **36**, 44-50.
- Dempewolf, M. 2001. *Larvalmorphologie und Phylogenie der Agromyzidae (Diptera)*. Unpublished Ph.D thesis, Universität Bielefeld, Germany.
- Dowding, V.M. 1967. The function and ecological significance of the pharyngeal ridges occurring in the larvae of some cyclorrhaphous Diptera. *Parasitology* **57**, 371-388.

- Ferrar, P. 1987. A guide to the breeding habits and immature stages of Diptera Cyclorrhapha. *Entomograph* **8**, 1-907.
- Hering, E.M. 1951. *The Biology of the Leaf Miners*. Junk, Gravenhage.
- Roberts, M.J. 1971. The structure of the mouthparts of some calypterate dipteran larvae in relation to their feeding habits. *Acta Zoologica* **52**, 171-188
- Rotheray, G.E. 2019. Ecomorphology of Cyclorrhaphan Larvae (Diptera). *Zoological Monographs* 4. Springer, Heidelberg, Germany.
- Rotheray, G.E. and Horsfield, D. 2013. Development sites and early stages of eleven species of Clusiidae (Diptera) occurring in Europe. *Zootaxa* **3619**(4), 401-427.
- Rotheray, G.E. and Lyszkowski, R.L. 2015. Diverse mechanisms of feeding and movement in Cyclorrhaphan larvae (Diptera). *Journal of Natural History* **49**, 2139-2211.
- Rotheray G.E. and Rotheray E.L. 2019. The incidence of *Pegomya solennis* (Meigen) (Diptera, Anthomyiidae) leaf mines on *Rumex acetosa* (Polygonaceae). *Dipterists Digest (Second Series)* **26**, 35-47.
- Rotheray, G.E. and Wilkinson, G. 2015. Trophic Structure and function in the larva of predatory muscid flies (Diptera, Muscidae). *Zoomorphology* **134**, 553-563.
- Salvo, A. and Valladares, G.R. 2004. Looks are important: parasitic assemblages of agromyzid leafminers (Diptera) in relation to mine shape and contrast. *Journal of Animal Ecology* **73**, 494-505.
- Spencer, K.A. 1976. The Agromyzidae (Diptera) of Fennoscandia and Denmark. *Fauna Entomologica Scandinavica* **5**, 1-304.
- Tinkeu, L.N. and Hance, T. 1998. Functional morphology of the mandibles of the larvae of *Episyrphus balteatus* (De Geer, 1776) (Diptera: Syrphidae). *International Journal of Insect Morphology and Embryology* **27**, 135-142.
- Wiegmann, B.M., Trautwein, M.D., Winkler, I.S., Barr, N.B., Kim, J-W., Lambkin, C., Bertone, M.A., Cassel, B.K., Bayless, K.M., Heimberg, A.M. *et al.* 2011. Episodic radiations in the fly tree of life. *Proceedings National Academy Science U S A*. **108**, 5690-5695.
- Wilkinson, G. and Rotheray, G.E. 2017. *Melanostoma scalare* (Meigen) larvae (Diptera, Syrphidae) feed on Diptera larvae in leaf litter. *Dipterists Digest (Second Series)* **24**, 53-60.

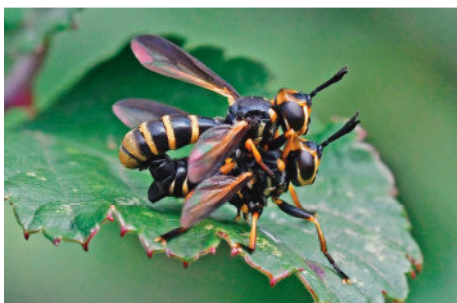
Further records of *Leopoldius calceatus* (Rondani) (Diptera, Conopidae) in Britain – This species was added to the British fauna from the Ipswich area of Suffolk by D.K. Clements and D. Basham (2018. *Leopoldius calceatus* (Rondani) (Diptera, Conopidae) new to Britain. *Dipterists Digest (Second Series)* **25**, 193-197). The Ipswich specimen, which was caught at light, was considered likely to have been a casual introduction, although recent colonisation of Britain by natural means was not ruled out.

Further records in 2019 strongly suggest that the latter is in fact the case. A male of this species was photographed in daytime on ivy (*Hedera helix*) flowers by CB at Rye Harbour Nature Reserve, East Sussex (TQ 942188), on 23 September 2019. The specimen was found on a hedge-line adjacent to an access road near areas of vegetated coastal shingle, saltmarsh, brackish ditches, amenity grassland and rough grassland, the latter managed by cutting for bumblebees (*Bombus* spp).

On 5 October 2019, PK photographed a pair of this species *in copula* in warm weather on sheltered, sunlit bramble (*Rubus fruticosus* agg.) leaves in a section of hedge alongside a farm track at Shottisham, Suffolk (TM 316435). The site is shown at Fig. 1 and comprises a track running E-W through agricultural land for about 400m, dropping down into cutting as it approaches Shottisham Creek, a tributary of the River Deben. Much of the track lies adjacent to arable fields, but nearer to the creek there are adjacent areas of broadleaved woodland with conifers, and alder (*Alnus glutinosa*) carr. The hedgerow along the trackside embankment is neglected and overgrown, with common hawthorn (*Crataegus monogyna*) and bramble dominating, together with occasional gorse (*Ulex europaeus*) and ruderal species such as common nettle (*Urtica dioica*) and docks (*Rumex* spp), etc. The flies were in view for at least 20 minutes, during which time they barely moved – see Fig. 2.



1



2

Figs 1-2: 1, site of *Leopoldius calceatus* on farm track at Shottisham, Suffolk; 2, mating pair of *L. calceatus* (photo P. Kitchener).

On 22 October 2019, a further female was captured by PB on ivy flowers at the same location. This track has produced at least six other conopid species during 2019, including *Leopoldius signatus* (Wiedemann).

These records suggest that the Ipswich specimen was not a one-off occurrence, and the significance of the mating pair at Shottisham is clear: breeding is at least being attempted in Britain. The dates and habitats of these latest sightings are consistent with recent records elsewhere in Europe, as is the occurrence at ivy flowers. There have been new records of this rare species in Belgium and The Netherlands (*inter alia*) in the last few years, possibly indicating a recent expansion in its European range (see Clements and Basham 2018, *loc. cit.*). The host of this species is unknown but is likely to be a vespine wasp. It can be readily identified using standard works such as Chvála, M. (1961. Czechoslovak species of the subfamily Conopininae (Diptera: Conopidae). *Acta Universitatis Carolinae – Biologica* **1961**, 103-145) – **DAVID K. CLEMENTS**, Conopid Recording Scheme for Britain & Ireland, 7 Vista Rise, Llandaff, Cardiff, CF5 2SD – dave.clements 1@ntlworld.com; **CHRIS BENTLEY**, Sussex Wildlife Trust, Woods Mill, Henfield, West Sussex, BN5 9SD; and **PAUL KITCHENER**, Shottisham Cottage, Alderton Road, Shottisham, Woodbridge, Suffolk, IP12 3EP

Effects of the 2018 heatwave on British hoverflies (Diptera, Syrphidae)

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Summary

In June and July 2018, a heatwave enveloped almost all the British Isles; it was followed by a period of drought that affected central and eastern England in particular. Incoming data from the UK Hoverflies Facebook group indicated that it triggered a crash in hoverfly numbers. This sequence of events particularly affected two genera (*Melanostoma* and *Platycheirus*) whose larvae are predominantly predaceous upon ground-layer aphids. Not all assemblages were affected to the same degree, however, and it is suspected that the 'summer flush' of Eristalini and partially migratory Syrphini were only affected to a limited extent. Such conclusions can only be preliminary because the long-term expression of impacts in subsequent years may be difficult to separate from responses to prevailing weather.

Introduction

There has been a steady flow of papers reporting declines in a wide variety of invertebrates across a broad geographical range. One of the most striking, and worrying, was that of Hallmann *et al.* (2017) that reported on the results of a 27-year programme of Malaise trapping on German protected areas. This study, and others (e.g. Powney *et al.* 2019; Biesmeijer *et al.* 2006) based on the extensive opportunistic datasets of various biological recording schemes, should make decision-makers and the general public sit up and ask 'why'?

A recent article by Reynolds (2019) provided a useful analysis of recent research and boldly placed the blame firmly on intensive agriculture and pesticides. There is doubtless some truth in this argument. For example, Woodcock *et al.* (2017) reported that reproduction in *Bombus terrestris* (Linnaeus) and *Osmia bicornis* (Linnaeus) was negatively correlated with neonicotinoid residues. There has been enough concern about the use of neonicotinoids for several classes of these pesticides to have been banned because of their effects on bees. The effects of pesticides and agricultural intensification can only be part of the story, however. Major declines in many insect taxa have been happening in areas far-removed from agriculture, and although it is possible to recognise likely pathways for neonicotinoids (e.g. see Goulson 2013), it is unlikely that this single factor is responsible for the extreme declines seen in insects over the past 30+ years.

Another likely factor is that climate change is exacerbating these declines. For example, there are numerous studies that describe range expansion in a wide range of taxa (e.g. Parmesan *et al.* 1999; Franco *et al.* 2006; Gillingham *et al.* 2015; Hickling *et al.* 2005 and Thomas *et al.* 2006). In the UK, we have seen dramatic changes in species such as the sphecid wasp *Philanthus triangulum* (Fabricius) (the 'beewolf') (Morris and Edwards in press) and in several Diptera, most notably in the two distinctive hoverflies *Volucella inanis* Linnaeus and *Volucella zonaria* (Poda) (Morris and Ball 2003, 2004). We can be reasonably sure from the modelling for *Volucella zonaria* that changing thermal envelopes in both the summer and winter are driving at least some of these changes. If some insects are responding positively to climate change and the combination of warmer, drier summers and warmer winters, it is equally likely that others will respond negatively. The problem is, how to detect such changes in the absence of a structured and randomised sampling system?

The one major data asset that exists in the UK is opportunistic records compiled by the many biological recording schemes (see Roy *et al.* 2014). These schemes have the potential to provide evidence but, even so, making firm causal links is extremely difficult. At this stage, we may have to be content with looking for cases where species have responded rapidly to the effects of an extreme weather event. This paper presents some analysis, based on data extracted from the UK Hoverflies Facebook page (Facebook 2019), that suggests that there was a clear response to the heatwave and drought that affected most of the British Isles in 2018.

2018 heatwave and drought

The Met Office reports (2019) that the top ten hottest years in the UK have occurred since 2000 and that 2018 was on a par with 1976, 2003 and 2006; it ranks 7th overall warmest on record. The period from May to July was exceptionally sunny (May was the sunniest on record) and the summer was the warmest since 2006, the driest since 2003 and the sunniest since 1995. Overall rainfall for the year was 8% below the 1981-2010 average, making it dry, but not exceptionally so. There were, however, regional differences, with southern England having had the driest June since 1925 and East Anglia having had the sunniest year on record. Some rain gauges reported 50 consecutive days without rainfall.

Daytime temperatures in June and July were well above average in all areas. Western areas were especially warm in June, with central/southern areas especially so in July. Monthly mean temperatures across the UK were 1.8 °C above average in June, 2.2 °C higher than average in July, but only 0.3 °C above in August. Rainfall was lower than average across most of England, with less than 10% of average in parts of the south-east, whereas rainfall totals in parts of Scotland were nearer to normal. The rainfall average across the UK in June was 48% of normal. Rainfall for most of July was also much lower (71%) than average and was especially dry towards the south-east. In August, rainfall totals recovered and were marginally down on the long-term average at 95% for the UK overall.

The Environment Agency (2018) reported that June was the third driest on record (since 1910) and the driest across England since 1925. At 15mm, the June rainfall total for England was 24% of the 1981-2010 long-term average. The combination of hot and dry weather meant that, by the end of the month, soil moisture deficits were larger than average across the whole country. Although monthly mean river flows were classed as normal or above at over half the indicator sites, Dipterists Forum members found that the Manifold Valley in Derbyshire was completely dry in late June! Soil moisture continued to diminish in July and August, although it was partially replenished by rainfall; soil moisture levels were reported as drier than average across the whole of England. Evidence of this parching was graphically illustrated by aerial surveillance of archaeological sites as the heatwave led to faster evolution of crop marks as soils dried (Historic England 2019).

By the autumn, northern and western Britain experienced some wet and stormy interludes, but still received below average rainfall, whereas southern and eastern areas were particularly dry. The UK Hydrological Status Update for December 2018 (CEH, 2018) reported that “notably severe deficits [in rainfall relative to average conditions] were registered throughout central England and in parts of East Anglia” for the period June to November.

Sunshine levels were largely above average for most areas of the British Isles throughout the autumn and especially so in the south and east.

Methods

The Hoverfly Recording Scheme compiles records of hoverflies from a wide range of sources, including traditional ‘net and pooter’ dipterists as well as an increasingly large group of photographic recorders, who use social media to report their finds and for validation of records.

The most popular interaction is through the UK Hoverflies Facebook group (Facebook 2019), which is now one of the biggest sources of data received each year. These data mainly comprise readily recognised species and large volumes of records of potential indicators of environmental change because they are common enough to create big datasets. Some of these benefits have already been discussed by Morris and Ball (2019). This analysis was confined to records extracted directly from the Facebook group in order to use a dataset whose characteristics are consistent, even if of restricted coverage. In so doing, this approach also takes account of substantial numbers of anecdotal observations that hoverflies substantially ‘disappeared’ during the 2018 heatwave.

It should be borne in mind, however, that conditions across the British Isles in 2018 were not uniform and that latitude can potentially have a significant bearing on regional data. As the Met Office report, autumnal conditions in the north and west were far wetter than those in the south and east. Consequently, it might be expected that populations of sensitive species might respond in different ways according both to Longitude and Latitude. To explore regional variation, the data were split into five units according to OS grid squares:

South-East England: 100k squares SU, SZ, TQ, TR, TV

South-West England: 100k squares SR, SS, ST, SV, SX, SY

Wales and The Midlands: 100k squares SH, SJ, SK, SM, SN, SO, SP, TF, TL, TG, TM

Northern England: 100k squares SC, SD, SE, NY, NZ

Scotland: 100k squares all squares from HO & HP (Shetland) to NW & NX (Dumfries & Galloway)

This split does not lead to uniformity in volumes of data, as there is a strong southerly bias in the distribution and abundance of recorders and hence the volume of records (Table 1).

Records received		SE England	SW England	Wales- Midlands	N. England	Scotland
2015-	Total	14,822	13,013	23,326	18,199	4,961
2017	<i>Average / year</i>	<i>4,940</i>	<i>4,337</i>	<i>7,775</i>	<i>6,066</i>	<i>1,650</i>
2018		3,872	2,253	4,516	4,041	2,046

Table 1. Breakdown of all records according to regions. It should be noted that the numbers of records in 2018 may have been somewhat lower because Facebook group members were being encouraged to move to maintaining their own spreadsheets at this point.

Even with large volumes of data, the numbers of records at a regional scale are often small, and therefore it is not always possible to be sure about individual species’ responses. A more reliable test of responses appears to be at the level of an ‘assemblage’ or ‘guild’ of species that occupy similar niches. Therefore, analyses were made for several guilds, including: *Cheilosia* (mainly stem, root and leaf miners), *Platycheirus* (ground-layer aphids), *Melanostoma* (ground-layer aphids and other soft-bodied invertebrates such as fly larvae), summer ‘migrant’ Syrphini (*Episyrphus balteatus* (De Geer), *Eupeodes corollae* (Fabricius), *Eupeodes latifasciatus* (Macquart), *Eupeodes luniger* (Meigen), *Scaeva pyrastris* (Linnaeus) and *Sphaerophoria scripta* (Linnaeus)); and generalist aquatic Eristalini (*Eristalis*, *Helophilus* and *Myathropa florea* (Linnaeus)). Data for 2018 were compared against the previous three years, constructed as an averaged weekly proportion of a given species or assemblage. When numbers of records were assessed against individual weeks it was found that at certain times of year there were insufficient data for error-bars to be calculated accurately for some assemblages and, therefore, a second analysis was performed using a monthly scale.

Results

The overall response of hoverflies to the heatwave of 2018 was seen in fewer records per week being submitted via the Facebook group (Fig. 1) and in fewer species being represented (Fig. 2). This effect started around the middle of June 2018 and is a clear deviation from the previous 3-year average in most weeks apart from in August. In addition to a decline in the numbers of hoverflies recorded, the numbers of participating contributors also declined (Fig. 3), but the numbers of records per recorder did not follow suit until the beginning of September (Fig. 4). Some recorders appear to have been affected sufficiently to change their recording behaviour and, as such, this loss would have had an undefinable impact upon the absolute numbers and therefore the shape of the graphs. We must therefore conclude that the shape of the graphs for 2018 were at least partially affected because recorder activity dropped in response to the heatwave.

Investigation of individual species responses suggests that in most cases the data were insufficient to detect a credible response that could not be explained by inter-seasonal variation. Furthermore, as the heatwave became established towards the end of the main emergence of univoltine ‘spring’ species, a drop in the numbers of these species at the end of their season is very difficult to detect. Nevertheless, it was clear from the numbers of species recorded on a weekly basis that there was a detectable response at the scale of the overall assemblage (Fig. 2). Beyond the middle of June, there are very few emergences of new species, but there are a few in which the bulk of the generation occurs between July and October. Important examples include *Volucella inanis*, *V. pellucens* and *V. zonaria*, and *Sericomyia superbiens* (Müller), most of which occur in enough numbers to allow initial analysis. Numbers of all three *Volucella* species were lower than the average for the preceding three years (see Fig. 5 for composite response).

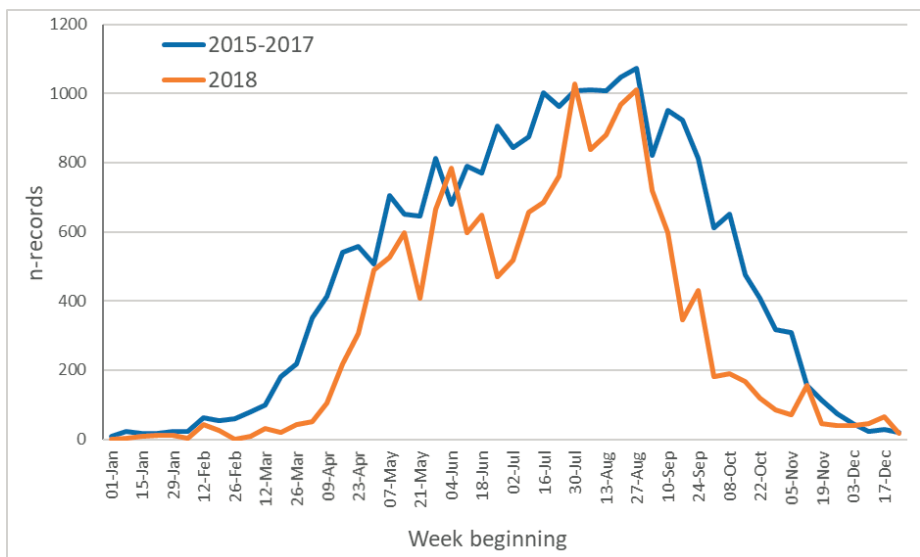


Fig. 1. Number of records each week in 2018 extracted from social media and compared against the average for the preceding 3 years (2015 to 2017).

Once univoltine species are discounted, there remains the question of possible impact on species that are bi- or multi-voltine. Several species provide possible models: *Rhingia campestris* Meigen, which was discussed by Morris (2019) and expanded upon by Morris and Edwards (in

press), and several species of Bacchini also seem to have been affected. There was no evidence of any impact upon *Baccha elongata* (Fabricius), but a composite of *Melanostoma* and *Platycheirus*, showed particularly strong signs of a negative effect (Fig. 6). These are mainly predators of ground-layer aphids (Rotheray 1993), with soft-bodied larvae that do not have the specialist adaptations of genera such as *Nausigaster* and *Brachyopa* (see Rotheray and Gilbert 2011), making them potentially vulnerable as vegetation parched (see reports by English Heritage 2019). In this case, the second generation that normally emerges in the autumn was substantially smaller than normal. Moreover, anecdotal reports from recorders of larvae drew attention to the paucity of *Melanostoma* larvae in leaf litter samples (Nicola Garnham *pers. comm.*).

	SE England	SW England	Wales- Midlands	N. England	Scotland
Total records 2015-2017	1,520	1,374	2,512	2,745	715
Proportion of all records 2015-2017	10.26	10.56	10.77	15.08	14.41
Total records 2018	210	139	229	349	187
Proportion of all records 2018	5.42	6.17	5.07	8.64	9.14

Table 2. Breakdown of records of *Melanostoma* and *Platycheirus* according to regions.

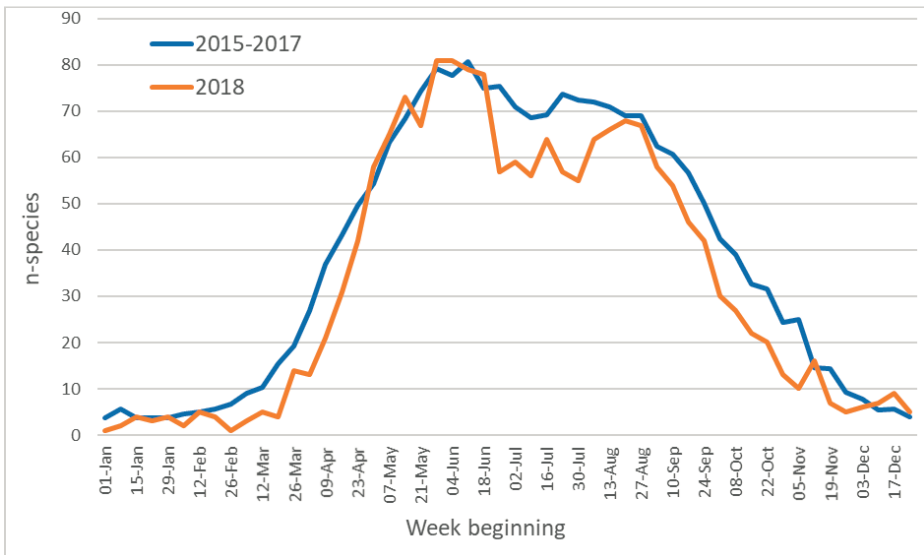


Fig. 2. Number of species each week in 2018 resulting from records extracted from social media and compared against the average for the preceding 3 years (2015 to 2017).

Records from photographic recorders suggest that *Melanostoma* and *Platycheirus* form a larger part of the assemblage in northern England and Scotland (Table 2), a characteristic that is borne out by fieldwork by RKAM over the past two years. It follows that there might be regional differences in the response of these genera to the 2018 heatwave. This seems to be borne out by comparison with the preceding 3-year average. Unlike the 3 more southerly regions, results for

Scotland and northern England do not show any significant deviation in the numbers of individuals recorded (Fig. 7).

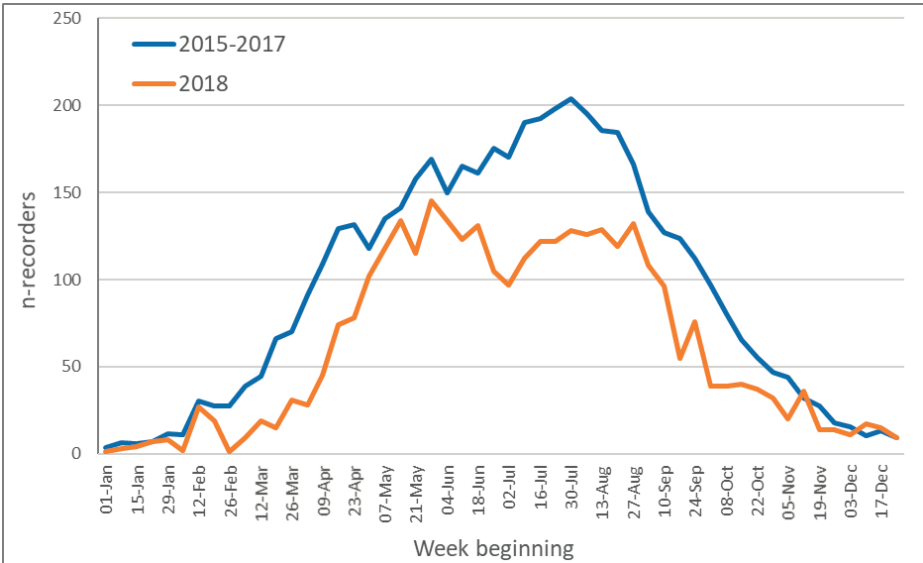


Fig. 3. Number of contributors (recorders) each week in 2018 and compared against the average for the preceding 3 years (2015 to 2017).

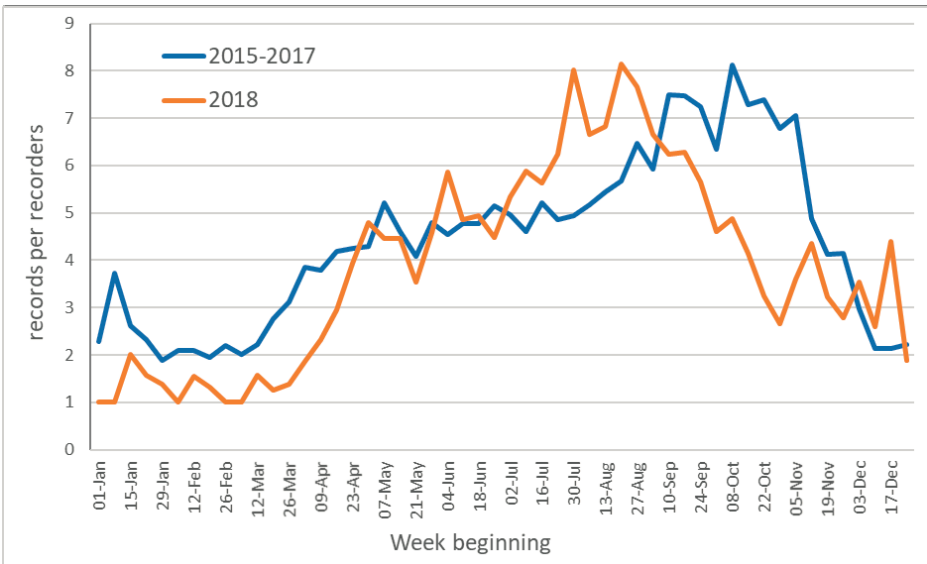


Fig. 4. Number of records per recorder each week in 2018 and compared against the average for the preceding 3 years (2015 to 2017).

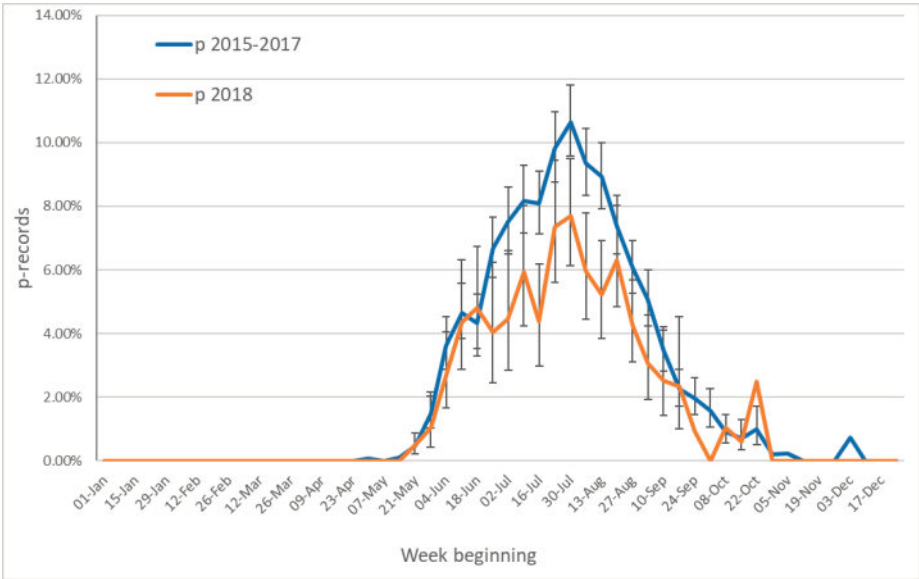


Fig. 5. Phenology of the assemblage of *Volucella inanis*, *V. pellucens* and *V. zonaria* as a proportion of all records in 2015-2017 and 2018.

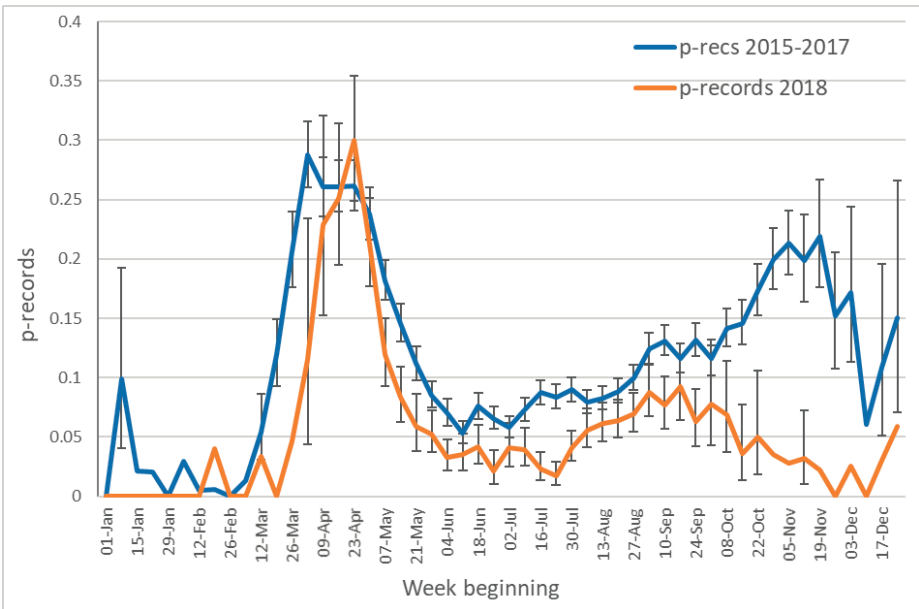
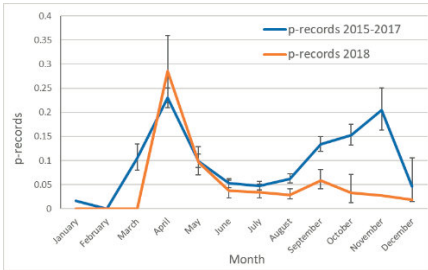
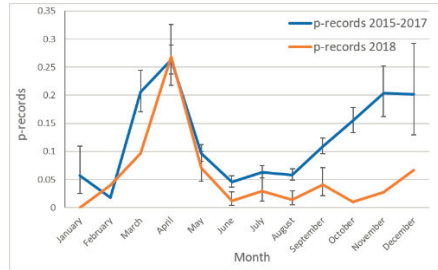


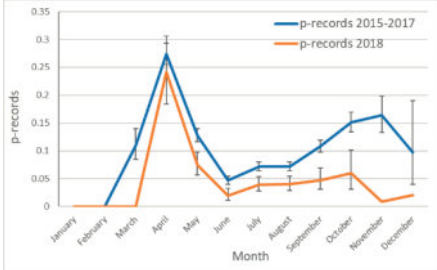
Fig. 6. The proportion of records of *Melanostoma* and *Platycheirus* in 2018 compared with the proportion of the same genera over the period 2015 to 2017.



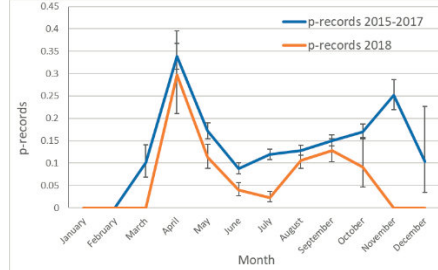
7a. South-East England



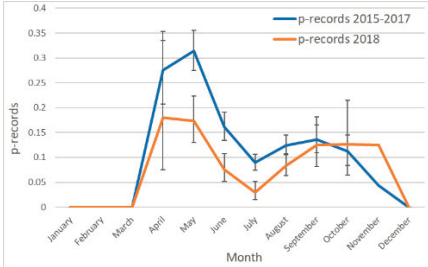
7b. South-West England



7c. Wales and The Midlands



7d. Northern England



7e. Scotland

Fig. 7. Regional phenology of the assemblage of *Melanostoma* and *Platycheirus* presented at monthly scale in comparison with the preceding 3 years 2015-2017.

Discussion

Making a credible link between changes in recorded invertebrate numbers resulting from a period of extreme (high) temperatures and low rainfall is extremely difficult. The lack of a robust network of permanent sampling stations means that we must rely on opportunistic data. In the case of hoverflies, the data appear to be sufficiently robust to provide a strong indication of a negative impact. Quantification of the effects is, however, far more problematic. Nevertheless, a network of active photographic recorders, supported by specialist identification, can provide detail where the event is substantial enough to generate a significant dip in insect numbers. Further examination of preceding years' data might therefore yield more examples of responses to major perturbations in the weather.

The critical feature of the graphs of overall numbers (Figs 1-4) is the shape of the graph and not the absolute numbers, which are determined by recorder effort. The shape of the subsequent recovery and the factors involved can also be explained from the data. Figs 1-4 look remarkably similar: a clear decline in June is followed by a relatively steep recovery from the

start of July (week 27). What happened and why did it do so when the heatwave was still well-established? The likely answer is that there is a group of species that peak in July and August that seems to be better suited to warmer weather. These might be described as the ‘summer flush’. They comprise two very different larval strategies:

The first group is the Eristalini (*Eristalis*, *Helophilus* and *Myathropa florea*) whose larvae are aquatic and are often referred to as ‘rat-tailed’ or ‘long-tailed’ maggots. Most live in shallow water bodies that will warm up (and sometimes dry up) in hot weather. They can be very abundant and usually form a major component of the summer fauna. Heal (1989) demonstrated a relationship between the duration of the pupal stage of *Eristalis tenax* (Linnaeus) and temperature at which the puparia were kept. It is therefore possible that warmer temperatures accelerated larval and/or pupal development of this species and others in the genus, and therefore increased the spike in late July and August with the knock-on effect that the population started to decline earlier in the autumn than normal. If this situation did occur, it is also possible that the heatwave eliminated part of the larval population, which could have affected the numbers of individuals recorded later in the autumn. This possible impact is, however, conjectural in the absence of reliable observations.

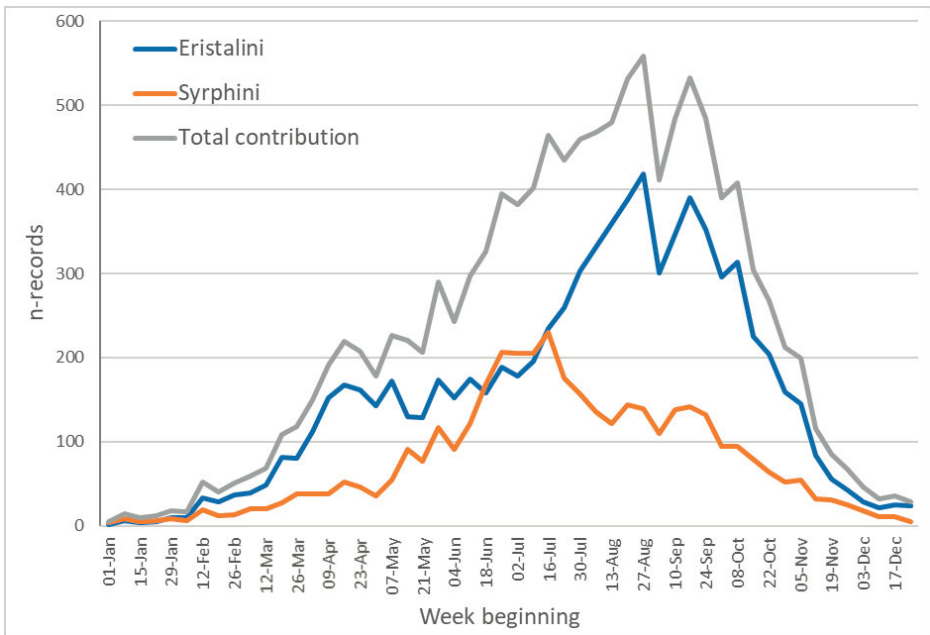


Fig. 8. Contributions to overall totals for 2018 of hoverflies by the ‘summer flush’ species

The other group comprises an assemblage of aphid predators within the Syrphini. These species are at least partially migratory (see Wotton *et al.* 2019 for evidence of detected migration) and occasionally arrive in vast numbers from the European mainland. There was no major event in 2018, but numbers started to build in early July as they normally do (Fig. 8). One species, *Episyrphus balteatus* often completely dominates the landscape for a period of several weeks and can occur as localised outbreaks when numbers are low elsewhere. This species often forms a major part of the dataset in July (Table 3) because it is noticed by everybody, from the specialist

to the mildly interested gardener. Other members of this assemblage include *Eupeodes corollae*, *E. latifasciatus*, *E. luniger*, *Scaeva pyrastris* and *Sphaerophoria scripta*.

	Week/Month								
	25	26	27	28	29	30	31	32	33
	June		July				August		
n-recs <i>E. balteatus</i>	31	32	78	100	81	117	143	105	31
Total records	647	470	517	658	686	761	1027	839	647
% all records	4.8	6.8	15.1	15.2	11.8	15.4	13.9	12.5	12.7

Table 3. The contribution made to overall numbers of records by *Episyrphus balteatus* from late June to the middle of August 2018.

Although there was a decline in abundance both of Eristalini and Syrphini during the early stages of the heatwave, some of this drop may have been consistent with their normal phenology. For example, there is usually a small peak in *Episyrphus balteatus* in late May/early June, and the spring generation of *Eristalis pertinax* (Scopoli) can extend well into May. Thus, the major part of the dip in numbers of species and numbers of records stems mainly from species that usually peak in May and June. Importantly, the peak in July and August clearly derives from the peaks in the summer flush species rather than any rebound from species with a single spring generation as can be seen from Fig. 8.

The key question is whether it is possible to detect a further response in insect numbers in years following a heatwave and drought? Making a direct correlation between any heatwave/drought and insect numbers in subsequent years is likely to be extremely difficult. Visible insect abundance is largely dependent upon prevailing weather conditions (which will also affect static traps) and therefore impacts will have to be substantial before a possible signal can be detected.

It remains to be seen how events in 2018 will translate into insect populations in 2019 and beyond, but a conceptual model of the effects can be constructed. Heat and soil moisture deficits have the potential to reduce breeding success as appears to have been seen in the *Melanostomal/Platycheirus* assemblage. If this happens, it may take several generations before a recovery is fully achieved. If, in the meantime, further extreme events occur before a full recovery has been achieved, then the population can be expected to be reduced still further. Such a scenario is most likely to occur in South-East England where the effects of the 2018 event were most severe. Thus, the rates of decline across the British Isles can be expected to vary. Nevertheless, it might be expected that such effects would be present at least into Wales and the Midlands. This very limited analysis also points to there being potentially less pressure on populations in northern England and Scotland, where rainfall is usually more reliable for the autumn and winter.

Acknowledgements

This analysis has only been possible because of the contributions of the UK Hoverflies Facebook group. There are just over 4,300 current members, of whom about 1,000 are extremely active. We are indebted to everybody who has contributed records.

References

- Biesmeijer, J.C., Roberts, S.P.M., Reemer, M., Ohlemüller, R., Edwards, M., Peeters, T., Schaffers, A.P., Potts, S.G., Kleukers, R., Thomas, C.D., Settele, J. and Kunin, W.E. 2006. Parallel declines in pollinators and insect-pollinated plants in Britain and the Netherlands. *Science* **313**, 351-354.

- Centre for Ecology and Hydrology, 2018. UK Hydrological Status Update – December 2018. <https://www.ceh.ac.uk/news-and-media/blogs/uk-hydrological-status-update-december-2018> (accessed on 30 July 2019).
- Environment Agency 2018. Water situation: national monthly reports for England 2018. <https://www.gov.uk/government/publications/water-situation-national-monthly-reports-for-england-2018> (accessed on 22 July 2019).
- Facebook 2019. <https://www.facebook.com/groups/609272232450940/>
- Franco, A.M.A., Hill, J.K., Kitschke, C., Collingham, Y.C., Roy, D.B., Fox, R., Huntley, B. and Thomas, C.D. 2006. Impacts of climate warming and habitat loss on extinctions at species' low-latitude range boundaries. *Global Change Biology* **12**, 1545-1553.
- Gillingham, P.K., Bradbury, R.B., Roy, D.B. *et al.* 2015. The effectiveness of protected areas in the conservation of species with changing geographical ranges. *Biological Journal of the Linnean Society* **115**, 707-717.
- Goulson, D. 2013. An overview of the environmental risks posed by neonicotinoid insecticides. *Journal of Applied Ecology* **50**, 977-987.
- Hallmann, C.A., Sorg, M., Jongejans, E., Siepel, H., Hofland, N., Schwan, H. *et al.* 2017. More than 75 percent decline over 27 years in total flying insect biomass in protected areas. *PLoS ONE* **12**(10): e0185809. <https://doi.org/10.1371/journal.pone.0185809>
- Heal, J.R., 1989. Variation and seasonal changes in hoverfly species: interactions between temperature, age and genotype. *Biological Journal of the Linnean Society* **36**, 251-269.
- Hickling, R., Roy, D.B. Hill, J.K. and Thomas, C.D. 2005. A northward shift of range margins in British Odonata. *Global Change Biology* **11**, 502-506.
- Historic England 2019. Hot Dry Summer Reveals Hidden Archaeological Sites in England <https://historicengland.org.uk/whats-new/news/hot-dry-summer-reveals-hidden-archaeological-sites/> (accessed on 22 July 2019).
- Met Office 2019. Climate Summaries. <https://www.metoffice.gov.uk/research/climate/maps-and-data/summaries/index> (accessed on 22 July 2019).
- Morris, R. 2019. Impact of extreme weather – species responses. *Hoverfly Newsletter* **65**, 8-10.
- Morris, R.K.A and Ball, S.G. 2004. The changing distribution of *Volucella inanis* (L.) (Diptera: Syrphidae). *British Journal of Entomology & Natural History* **16**, 221-227.
- Morris, R.K.A and Ball, S.G. 2004. Sixty Years of *Volucella zonaria* (Poda) (Diptera: Syrphidae) in Britain. *British Journal of Entomology & Natural History* **17**, 217-227.
- Morris, R.K.A. and Ball, S.G. 2019. Digital photography improves assessment of winter-active hoverflies (Diptera, Syrphidae). *Dipterists Digest (Second Series)* **26**, 25-33.
- Morris, R. and Edwards, M. (in press). What has happened to our pollinators? *Antenna*.
- Parmesan, C., Ryrholm, N., Stefanescu, C., Hill, J.K., Thomas, C.D., Descimon, H., Huntley, B., Kaila, L., Kullberg, J., Tammaru, T., Tennent, W.J., Thomas, J.A. and Warren, M. 1999. Poleward shifts in geographical ranges of butterfly species associated with regional warming. *Nature* **399**, 579-583.
- Powney, G.D., Carvell, C., Edwards, M., Morris, R.K.A., Roy, H.E., Woodcock, B.A. and Isaac, N.J.B. 2019. Widespread losses of pollinating insects in Britain. *Nature Communications* **10**, 1018.
- Reynolds, S. 2019. Pollinator Ups and Downs. *Antenna* **43**(2), 57-62.
- Rotheray, G.E. 1993. Colour Guide to Hoverfly Larvae (Diptera, Syrphidae) in Britain and Europe. *Dipterists Digest (First Series)* **9**, 1-156.
- Rotheray, G.E. and Gilbert, F. 2011. *The Natural History of Hoverflies*. 333 pp. Forrest Text, Cardigan

- Rouault, G., Candau, J-N., Lieutier, F., Nageleisen, L-M., Martin, J-C. and Warzée, N. 2006. Effects of drought and heat on forest insect populations in relation to the 2003 drought in Western Europe. *Annals of Forest Science* **63**, 613-624
- Roy, D.B., Harding, P.T. Preston, C.D. and Roy, H.E. 2014. 50 years of the Biological Records Centre. Available at: <https://www.brc.ac.uk/sites/www.brc.ac.uk/files/articles/brc-50th-anniversary.pdf>
- Thomas, C.D., Franco, A.M.A. and Hill, J.K. 2006. Range retractions and extinction in the face of climate warming. *Trends in Ecology & Evolution* **21**, 415-416.
- Woodcock, B.A., Bullock, J.M., Shore, R.F., Heard, M.S., Pereira, M.G., Redhead, J.W., Ridding, L., Dean, H., Sleep, D., Henrys, P.A., Peyton, J., Hulmes, S., Hulmes, L., Sároszpataki, M., Saure, C., Edwards, M., Genersch, E., Knaebe, S., Knaebe, F. and Pywell, R.F. 2017. Country-specific effects of neonicotinoid pesticides on honey bees and wild bees. *Science* **356**, 6345, DOI: 10.1126/science.aaa1190.
- Wotton, K.R., Gao, B., Menz, M.H.M., Morris, R.K.A., Ball, S.G., Lim, K.S., Reynolds, D.R., Hu, G. and Chapman, J.W. 2019. Mass Seasonal Migrations of Hoverflies Provide Extensive Pollination and Crop Protection Services. *Current Biology* **29**, 2167-2173 DOI: 10.1016/j.cub.2019.05.036

Further records of *Chymomyza caudatula* Oldenberg (Diptera, Drosophilidae) from England –

When I recorded *Chymomyza caudatula* Oldenberg, 1914 (Diptera, Drosophilidae) as new to Britain from Flitwick Moor, Bedfordshire in 2018 (Perry, I. 2019. *Chymomyza caudatula* Oldenberg (Diptera, Drosophilidae) new to Britain. *Dipterists Digest (Second Series)* **26**, 19-20), I didn't expect to find it again so soon and in two widely separated localities. A male was swept from a fallen birch that had been sawn into sections at Denny Wood (SU337060), New Forest, Hampshire on 14 June 2019. Unfortunately it was the last day of my visit and the chance to investigate further was lost. When I visited Chippenham Fen NNR (TL651691), Cambridgeshire on 7 September 2019, I noticed a stack of ash logs near the entrance. Several *Chymomyza* were seen running around on the cut ends and amongst several *C. fuscimana* (Zetterstedt) was a male of *C. caudatula*. Further visits failed to find any more, although *C. fuscimana* was often still present.

These further two records show that *Chymomyza caudatula* is now well established in the south of the country and may have gone unnoticed for some time. It also indicates that it is attracted to a variety of deciduous trees and may be able to utilise these for development, although to date it has only been reared from beech – **IVAN PERRY**, 27 Mill Road, Lode, Cambridge, CB25 9EN

***Nematoproctus praesectus* Loew (Diptera, Dolichopodidae) new to Britain, found together with *N. distendens* (Meigen), and notes on their habitat preferences**

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Summary

Nematoproctus praesectus Loew, 1857 and *N. distendens* (Meigen, 1824) were recorded together at a restored wetland site in West Sussex, the former being the first record for Britain. A key and figures are provided for separating both sexes. They were part of a species-rich assemblage of wetland dolichopodids that included several nationally scarce species. The ecology of *N. distendens* is summarised from British and published continental records, and it is tentatively suggested that it requires seasonally fluctuating water levels.

Introduction

Nematoproctus is a small genus of medium-sized flies with three west Palaearctic species (Pollet 2011). The genus falls within the subfamily Rhabphiinae and the species resemble *Rhaphium* but are distinguished by the arista being placed mid-dorsally rather than at or very close to the apex of the postpedicel. In Britain, *N. distendens* (Meigen, 1824) has been known since 1962 (Falk and Crossley 2005) and, although found from Hampshire to Yorkshire, it is sparsely distributed and rarely recorded (Fig. 1). This paper reports the addition of *N. praesectus* Loew, 1857, to the British fauna, and the presence of a population of *N. distendens* at the same site.

The 2019 spring field meeting of the Dipterists Forum was held at in West Sussex. The main attraction was visiting England's first and largest re-wilding site, Knepp Castle Estate. For many decades this farm was intensive arable and dairy but, owing to falling profitability on the difficult heavy Wealden clay, and inspired by examples of the Oostvaardersplassen in the Netherlands and the ideas of Frans Vera (2000), the decision was made in 2002 to ring-fence the estate, remove all internal stock barriers and allow the site to develop to wood pasture, grazed by a variety of large herbivores. The result is about 1,400ha of extensively grazed and structurally diverse habitat (Tree 2018). While most of the site is moderately dry grassland, wood and scrub, there are many waterbodies scattered through the area, consisting of the River Adur and its many small sluggish tributary streams, ponds and a lake, many of these with swamp-like margins.

Spring of 2019 was particularly dry so sampling at Knepp concentrated on the water bodies. A second visit was made by the author in mid July, during a hot dry summer. In May, 34 species of dolichopodids were recorded, and in July at least 43 species, together giving a total of 59 species. Other recorders added another three species in May 2019, and a list of earlier records included another two (and two suspect) species. Thus the site supported at least 64 species, representing about 20% of the British dolichopodid fauna. From three water bodies, *Nematoproctus praesectus* was recorded, and from several more in both May and July, *N. distendens* was also found.

Identification

Specimens were identified using Parent (1938). Males of *praesectus* differ clearly from those of *distendens* in having almost entirely yellow legs, rather than largely black hind legs, and in having small genital cerci. When using the key to genera by d'Assis-Fonseca (1978), the small size of the genitalia of *praesectus* caused the key to fail as he described the genital appendages as 'conspicuous', since the only then-known British species, *distendens*, has long cerci. Whereas

the discrepancy between the fly's appearance and the text in d' Assis-Fonseca's key to males made it clear that the male *praesectus* was an additional species, his key to genera for females, and the brief account, would not alert the user (including myself!) to *praesectus*. The following key distinguishes both sexes of the two species we now have in Britain.

Key to males

- 1 Hind leg mainly black, yellow only on basal half of femur (Fig. 2); genital cerci long ribbon-shaped, conspicuous and projecting far beyond surstylus (Fig. 3f); mid femur with ventral hairs as long as shaft's depth (Fig. 3b); front tarsus with ventral fringe as wide as shaft only at base of basitarsus, become shorter distally (Fig. 3d) *distendens*
- Hind leg mainly yellow, becoming black only at tip of tibia and on tarsi (Fig. 2); genital cerci triangular, inconspicuous and scarcely projecting beyond surstylus (Fig. 3e); mid femur with ventral hairs short, less than half shaft's depth (Fig. 3a); front tarsus with ventral fringe as deep as shaft's width on segments 1-3, becoming shorter distally (Fig. 3c) *praesectus*

Key to females

- 1 Front coxa black at base; hind tibia dark to black in at least apical half (Fig. 2); wing darker anteriorly; marginal setae of tergites 2 and 3 long, lateral setae half tergites' length *distendens*
- Front coxa entirely yellow; hind tibia dark in apical quarter (Fig. 2); wing uniformly grey; marginal setae of tergites 2 and 3 short and inconspicuous, lateral setae one third tergites' length *praesectus*

To separate females, Parent (1938) used the colour of the palps and the number of ventral setae on the mid tibia; neither work convincingly with the limited British material to hand, and these characters are not used in my key. In detail, the palps of *distendens* females may be pale at the extreme tip rather than being entirely dark, and *praesectus* has only a pale rim to the palp rather than being mainly yellow. The mid tibia of *distendens* may have only one long ventral seta and 2-3 rather short ones, rather than '3 setae', and that of *praesectus* may have one long and an additional short one, rather than just '1 seta'. His colour characters, used in my key, appear to work satisfactorily. The unreliable character of the number and size of setae is also found in the key to Holarctic species by Stackelberg and Negrobov (1976). If this character is ignored, both sexes of both species can still be correctly identified using this key, where *distendens* is mistakenly referred to as *discedens*, and also using the updated version by Negrobov *et al.* (2018) that accommodates a new species from Japan. The genitalia are illustrated by Stackelberg and Negrobov (1976) and those of *distendens* by Buchman (1961).

The third west Palaearctic species, *N. longifilus* Loew, 1857, could occur in Britain. It is distinguished by its cerci being far longer than those of *distendens*, reaching forward to the third abdominal segment, and by its almost entirely yellow legs like those of *praesectus*. In females, both the antennal scape and palps are partly yellow; neither of the other two species have both these parts partly yellow together.

Data

All specimens were from Knepp Castle Estate, West Sussex (V.C. 13); the location names are mostly compartments used by the estate and most do not appear on Ordnance Survey maps.

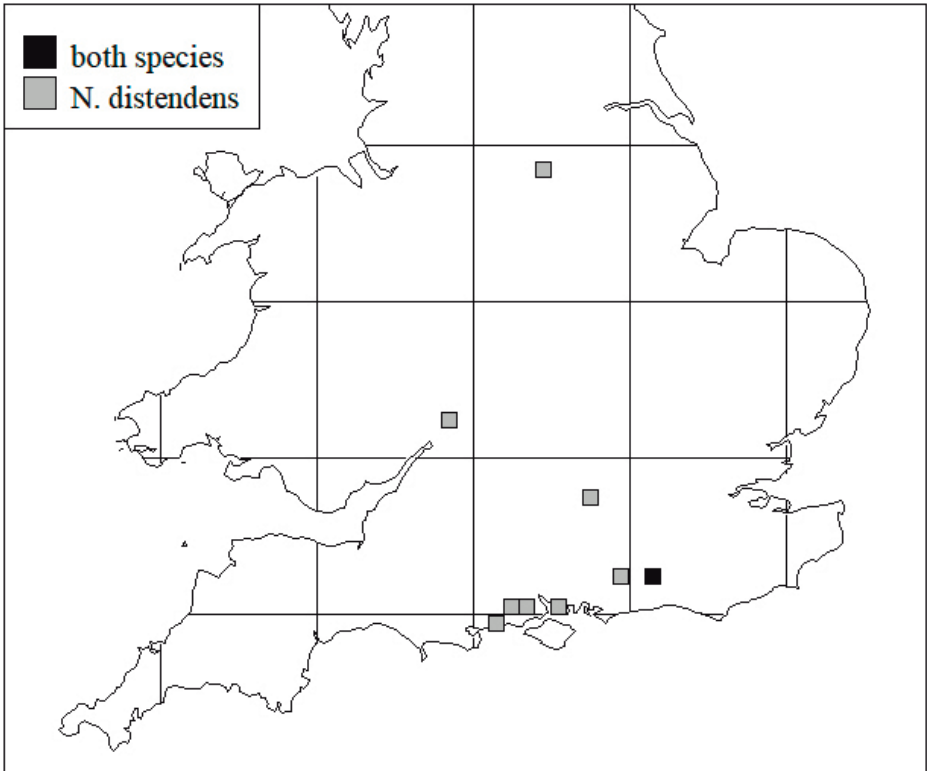


Fig. 1. Distribution of *Nematoproctus distendens* and *N. praeseclus* in Britain. All records are from 1962 onwards.

Nematoproctus praeseclus

Hammer Pond, TQ145207, 19.v.2019, 1♂ 1♀, leg. C.M. Drake. A large narrow pond with a wide drawdown zone lushly vegetated with mixed short vegetation and taller dominants including *Sparganium erectum*, *Phalaris arundinacea*, *Equisetum* sp, and *Schoenoplectus lacustris*, heavily grazed and trampled, leaving plenty of bare mud, and surrounded by recent growth of willow (*Salix cinerea*) scrub and large oaks (*Quercus robur*) from previous hedgerows.

Brookhouse 6, TQ136202, 20.v.2019, 1♀, leg. C.M. Drake. An old field pond about 20m in diameter, with a wide shelving vegetated shore dominated by *Juncus* species and with *Glyceria fluitans* in the shallow water, grazed and trampled. Flies were collected from this small unshaded section, the rest of the pond's shore being under secondary willow scrub.

Brookhouse Lagg, TQ136204, 20.v.2019, 1♀, leg. C.M. Drake. A narrow (c. 20m wide) swamp fringe to a slow-flowing stream, with structurally varied and floristically diverse vegetation dominated by *Typha latifolia*, *Phalaris arundinacea*, and *Sparganium erectum*, over grasses, *Persicaria hydropiper* and *Mentha aquatica* (among many other plants), well grazed and trampled.

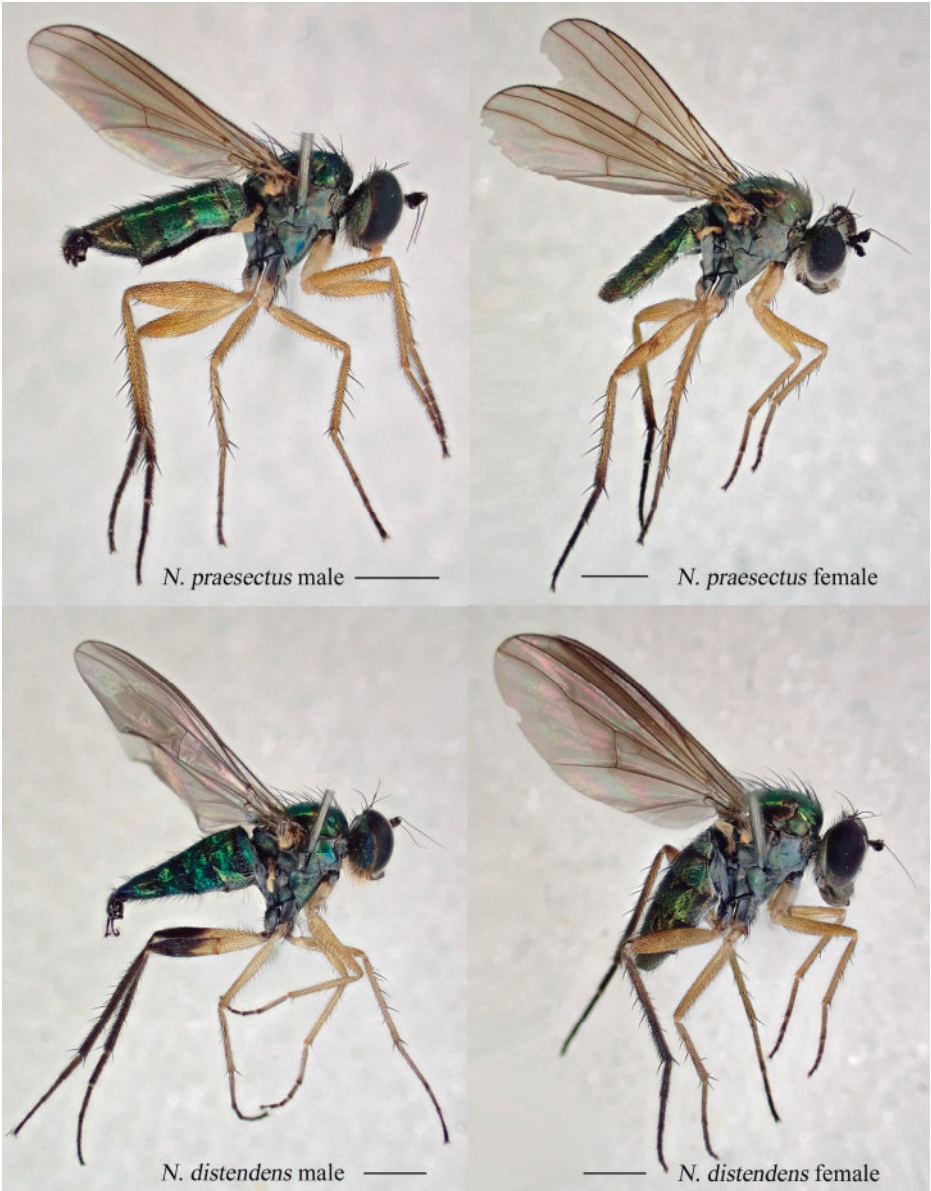


Fig. 2. *Nematoproctus praesectus* (above) and *N. distendens* (below) of each sex (males on left, females on right), from Knepp Castle Estate, May 2019. Scale line = 1mm. Photographs by Andrew J. Cunningham.

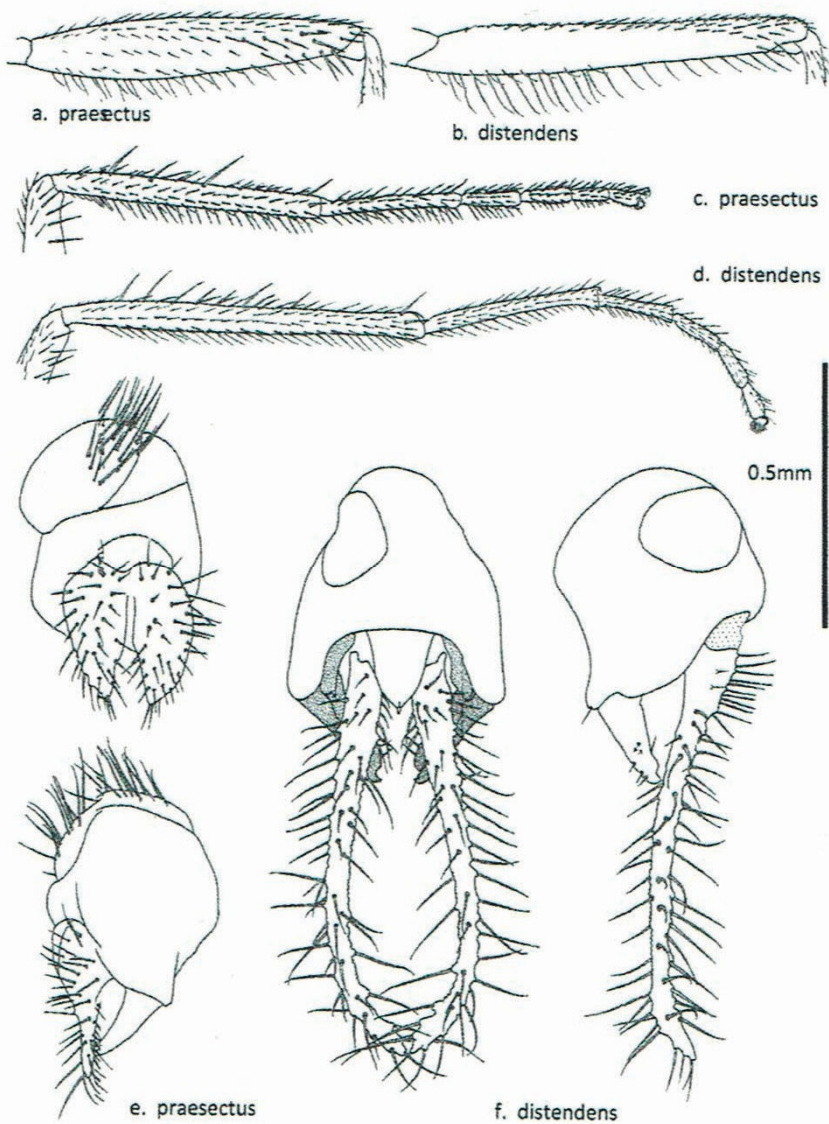


Fig. 3. *Nematoproctus distendens* and *N. praesectus* male legs and genitalia: a and b: mid femur, posterior face; c and d: front tibia and tarsus, posterior face; e and f: genitalia, dorsal (anatomically) and lateral. The lateral view for *praesectus* shows the right-hand side (as the left-hand side was slightly distorted) and tergite 7 with setae, whereas that for *distendens* shows the more conventional left-hand aspect without tergite 7. From dry-pinned specimens except *distendens* genitalia which were macerated.

Nematoproctus distendens

Hammer Pond, TQ143207, 19.v.2019, 2♀; 17.vii.2019, 2♀, leg. C.M. Drake. Similar to the Hammer Pond sample with *N. praeseectus* but with abundant *Phalaris arundinacea*, *Equisetum* sp., *Schoenoplectus lacustris* and *Mentha aquatica*.

Hammer Pond inflow stream, TQ140207, 17.vii.2019, 2♀, leg. C.M. Drake, small clay stream dominated by *Helosciadium* [formerly *Apium*] *nodiflorum* and *Sparganium erectum* in grassland, sampled at two points separated by about 200m.

Brookhouse Lagg, 18.v.2019, 1♂, leg. a f det. R.J. Wolto □ 20.v.2019, 3♂ 2♀; 17.vii.2019, 6♀, leg. C.M. Drake, site as described for *N. praeseectus*, and, where *distendens* was recorded, extending nearly 400m along the stream.

The Mill Pond, TQ159220, 18.v.2019, 1♂, leg. and det. R.J. Wolton, lake margin.

The Mill Pond, TQ161225, 18.v.2019, ♂♀, leg. and det. P.J. Chandler, woodland strip north of drained lake.

The Mill Pond, TQ158220, 18.v.2019, ♂♀, leg. and det. R.K.A. Morris, woodland next to drained lake.

The following 24 species were found in the same samples as either species of *Nematoproctus* in May: *Achalcus cinereus* (Haliday in Walker), *Argyra diaphana* (Fabricius), *Argyra leucocephala* (Meigen), *Campsicnemus curvipes* (Fallén), *C. scambus* (Fallén), *Dolichopus latilimbatus* Macquart, *D. plumipes* Scopoli, *D. simplex* Meigen, *Gymnopternus metallicus* (Stannius), *G. silvestris* Pollet, *Hercostomus nanus* (Macquart), *H. parvilamellatus* (Macquart), *Rhaphium appendiculatum* Zetterstedt, *R. caliginosum* Meigen, *R. commune* (Meigen), *R. crassipes* (Meigen), *R. fasciatum* Meigen, *Sympycnus pulicarius* (Fallén), *Syntormon denticulatus* (Zetterstedt), *S. macula* Parent, *S. pallipes* (Fabricius), *S. pumilus* (Meigen), *S. silvianus* Pârvu, *Thrypticus tarsalis* Parent.

Additional species recorded at these sites in July were *Campsicnemus pusillus* (Meigen), *Chrysotus blepharosceles* Kowarz, *C. cilipes* Meigen, *C. gramineus* (Fallén), *C. palustris* Verrall, *Dolichopus campestris* Meigen, *D. festivus* Haliday, *D. trivialis* Haliday, *D. unguilatus* (Linnaeus), *D. virgultorum* Haliday in Walker, *D. wahlbergi* Zetterstedt, *Gymnopternus aereus* (Fallén), *G. cupreus* (Fallén), *Lamprochromus bifasciatus* (Macquart), *Microphor anomalus* (Meigen), *Poecilobothrus chrysozygos* (Wiedemann), *P. nobilitatus* (Linnaeus), *Rhaphium auctum* Loew, *Sciapus platypterus* (Fabricius), *Sybistroma obscurellum* (Fallén), *Syntormon aulicus* (Meigen), *S. bicolorellus* (Zetterstedt), *Teuchophorus nigricosta* (von Roser), *T. simplex* Mik, *T. spinigerellus* (Zetterstedt) and *Thrypticus nigricauda* Wood. Collected from tree-trunks, and not part of the wetland fauna, were *Medetera borealis* Thunberg (determination unsure), *M. muralis* Meigen and *M. truncorum* Meigen. More species of dolichopodids were collected elsewhere at Knepp Castle Estate.

Of these, *Campsicnemus pusillus*, *Dolichopus virgultorum*, *Rhaphium fasciatum*, *Syntormon macula*, *Thrypticus nigricauda* and *T. tarsalis* are Nationally Scarce, and all except *D. virgultorum* almost certainly develop in the same water-margin fringe where it is thought that *Nematoproctus* larvae live, although the two *Thrypticus* species are likely to have been mining in *Eleocharis palustris* which was present where they were collected.

Discussion

Finding both species of *Nematoproctus* in the same samples or in close proximity suggests that they share a similar ecology. This co-occurrence is not unique as Pollet *et al.* (1987, 1988, 1989) also recorded both together in Belgium on the occasion that *praeseectus* was first found in that country. *Nematoproctus distendens* is Nationally Rare (Drake 2018) and there is only limited habitat data for it in the national Empididae, Hybotidae and Dolichopodidae Recording Scheme

(Dipterists Forum 2019), some of which is enlarged upon in published accounts from other countries. The habitats include several woodland streams in the New Forest (Hampshire), a shaded muddy creek adjacent to the River Loddon in Berkshire for which a published photograph shows a shelving margin and tall alder woodland around it (Chandler 1994), winter-flooded swampy grassland surrounded by willows (Gloucestershire) (Drake unpublished) and unimproved neutral grassland and riverside marsh subject to periodic flooding (Yorkshire) (Falk and Crossley 2005). Although no habitat information was supplied with other records, some sites are floodplain washlands and wet woodlands next to rivers. For 12 sites with a grid reference accurate enough to locate the site, all are at a low altitude of between near-sea-level to less than 40m OD; Knepp Castle Estate lies on land at about 10m OD. Nearly all the sites lie on Quaternary deposits of sands, gravels, alluvium, terrace deposits or lacustrine clays on floodplains (British Geological Survey 1977), with the exception of Knepp Castle Estate on Cretaceous Weald Clay. The sites therefore appear to be characterised by being on geologically recent deposits associated with floodplains or at least low-lying flat ground. It is likely that water levels fluctuate more markedly in such places than in many other types of wetlands, either from winter-flooding by rivers or summer drawdown of ponds and marshes. This perhaps is a key requirement of *distendens*. On the very limited data for *praeseectus*, living in the same sites as *distendens* at Knepp, it is tentatively suggested that it has the same requirement.

This suggestion for the habitat of *distendens* and *praeseectus* in Britain is partially supported by limited information on mainland European sites, with those further north showing greatest similarity but those to the south being distinctly different. The species appears to be uncommon to rare in most studies. In southern Belgium, all three species of *Nematoproctus* were recorded by the River Ourthe, a moderately large meandering piedmont river with a floodplain at about 150m OD in low hilly country (Pollet *et al.* 1987). In this study *distendens* occurred in several Malaise trap and sweep-net samples at sites described as humid woodland, river bank, eutrophic ponds near the river, and the bed of a rivulet; *praeseectus* was found only on the riverbank itself where the vegetation was sparse or absent; *longifilus* was present at some of the *distendens* sites and also at a reed marsh. From this study the authors concluded that *praeseectus* was 'rather stenotopic', being confined to the river bank, and this appeared to be confirmed by a later study where it was water-trapped across most of the shoreline (Pollet *et al.* 1988), although more sweep-sampling at these sites on a different occasion revealed *praeseectus* at a reed marsh and in pasture (Pollet *et al.* 1989). Both species were found in the St Petersburg Region of Russia, where Stackelberg (1962) described *praeseectus* as very rare and recorded it on a lake shore, and *distendens* as rare and recorded it on sunlit leaves of bird cherry *Prunus padus* at the edge of a small grove at a water meadow by a river. *Nematoproctus praeseectus* was recently recorded for the first time in Finland where it was collected on four occasions using a Malaise trap at the swamp margin of a lake on a bird reserve (Haarto *et al.* 2019). In north-west France *distendens* was found at several points in alder carr (*Alnus*) and oak-birch (*Quercus-Salix*) woodland by a lake, which appears to represent a rather different habitat to those in Britain (Tayoub *et al.* 1990). In the Czech Republic, a single specimen was recorded from a wetland with pools on a former clay pit at about 400m (Gelbič and Olejníček 2011). Further south in Romania, a locality for *distendens* is given as the large city of Oradea on the floodplain of the river Crisul Repede at 130m OD, and another was at a town by a fast upland river at about 290m OD, but a third record was from a village in hilly or montane country at about 600m OD (Pârvu 1982, 2000). Thus it appears that in parts of mainland Europe *distendens* may have a different ecology to that found in Britain. *Nematoproctus praeseectus* may be restricted to more sparsely vegetated habitats, or at least in vegetation kept opened by grazing and trampling, although not necessarily next to rivers.

Nematoproctus distendens appears to have a typical midsummer flight period, although the records in May at Knepp Estate provided the earliest dates available in the national recording

scheme's data (Fig. 4). So far, *praesepectus* is known only from May, and its non-appearance at Knepp Estate in July may just have been a consequence of the hot dry weather resulting in most species being present in low numbers. Records from continental Europe for *distendens* run from the beginning of June to the beginning of August, and those for *praesepectus* are from mid May to early July (all references as in paragraph above excluding Pârnu 1982). There are fewer records for *praesepectus* than *distendens* and too few to confirm whether *praesepectus* really does have a slightly earlier flight period than that of *distendens*.

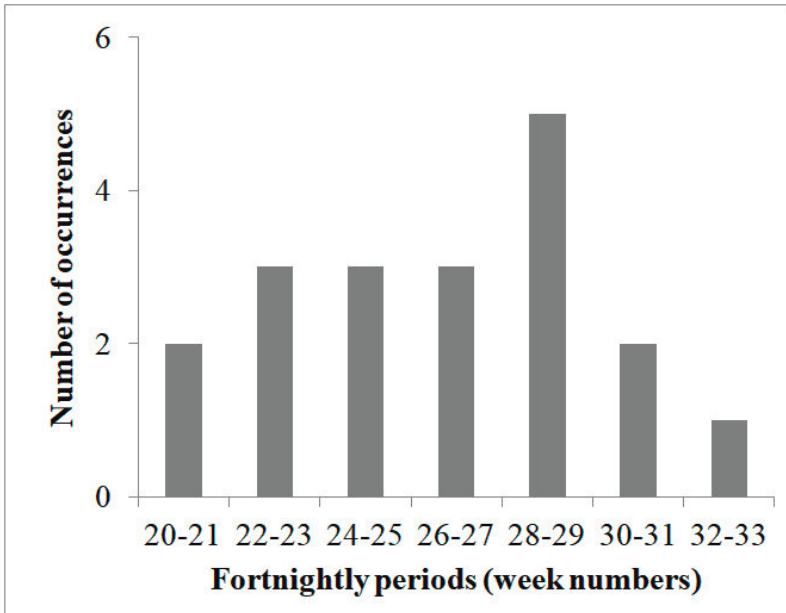


Fig. 4. Flight period of *Nematoproctus distendens* in fortnightly periods from mid May to early August, using data from the Empididae, Hybotidae and Dolichopodidae Recording Scheme.

Finding *Nematoproctus praesepectus* in Britain is not entirely unexpected as it occurs from north-west France to Ukraine, including Belgium, although it is clearly very rare in Flanders (Parent 1938, Pollet 2000, Pollet *et al.* 1987, 1988, 1989). The usual question will be asked whether this fly is a recent immigrant or a long-standing but undetected British resident. Being a recent immigrant seems unlikely in view of its scarcity in northern Europe. In favour of it being of a long-term but undetected resident is the nature of the site. I have often wondered how 19th century dipterists in mainland Europe found and described a huge number of species without the modern convenience of transport to reach seminatural habitats where uncommon species tend to be most easily found today. Perhaps the relaxed land management at Knepp more closely resembles that of pre-industrial farming where these dipterists collected, with no pesticides, limited drainage, structurally diverse vegetation, and no tidying-up after rampaging herbivores. This last item on the list may be important at wetland margins in helping to maintain open unshaded conditions with a complex micro-scale structure of tiny pools. Trampling of water margins by cattle has been shown to be beneficial to the associated insects (Dolman 1993, Drake 1995) and it is likely to be a valuable aspect of the relaxed management at Knepp encouraging

the recovery of species suppressed in productive lowland England by contemporary farming practices. A refuge may well have existed at Knepp in the 'laggs' (wet slightly swampy ground by the streams) that were difficult to cultivate (Tree 2018). The population of *praeseclusus* at Knepp is therefore thought to be ancient rather than the result of recent migration. Support for this opinion comes from its association with the species-rich assemblage of wetland dolichopodids that included several Nationally Scarce or uncommon species. These species have also probably benefited by release from constraints imposed by conventional intensive land-use, and it is unlikely that such a rich assemblage would be found nearby except perhaps at long-established wetland reserves.

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References

- d'Assis-Fonseca, E.C.M. 1978. Diptera Orthorrhapha Brachycera Dolichopodidae. *Handbooks for the Identification of British Insects* **9** (5). Royal Entomological Society, London.
- British Geological Survey 1977. *Quaternary map of the United Kingdom. South. First edition.*
- Buchmann, W. 1961. Die Genitalanhänge mitteleuropäischer Dolichopodiden. *Zoologica Original-Abhandlungen aus dem Gesamtgebiete der Zoologie* **110**, 51 pp, 13 figures.
- Chandler, P. 1994. Fieldwork at Dinton Pastures to the end of 1993. *British Journal of Entomology and Natural History* **7**, 118-126.
- Dolman, P. 1993. Trampling of pond margins. *British Wildlife* **4**, 243-244.
- Drake, C.M. 1995. The effects of cattle poaching on insects living at the margins of the River Itchen, Hampshire. *British Journal of Entomology and Natural History* **8**, 165-169.
- Drake, C.M. 2018. A review of the status of the Dolichopodidae flies of Great Britain - Species Status No. 30. *Natural England Commissioned Reports* **195**.
- Dipterists Forum 2019. Empididae, Hybotidae & Dolichopodidae Recording Scheme. <https://www.dipterists.org.uk/empid-allies-scheme/>
- Falk, S. and Crossley, R. 2005. A review of the scarce and threatened flies of Great Britain. Part 3. Empidoidea. *Species Status* No 3. Joint Nature Conservation Committee, Peterborough.
- Gelbič, I. and Olejníček, J. 2011. Ecology of Dolichopodidae (Diptera) in a wetland habitat and their potential role as bioindicators. *Central European Journal of Biology* **6**, 118-129.
- Haarto, A., Kakko, I. and Winqvist, K. 2019. Lisäyksiä Suomen Diptera-faunaan vuoden 2014 jälkeen. *w-album* **22**, 3-31.
- Negrobov, O.P., Tago, T. and Maslova, O.O. 2018. A new species of the genus *Nematoproctus* (Diptera: Dolichopodidae) from Japan. *Zoosystematica Rossica* **27**, 192-195.
- Parent, O. 1938. Diptères Dolichopodidae. *Faune de France* **35**. Lechevalier, Paris.
- Pârvu, C. 1982. Data about family Dolichopodidae (Diptera) in Romania (I). *Travaux du Muséum National d'Histoire Naturelle "Grigore Antipa"* **24**, 153-160.
- Pârvu, C. 2000. Dolichopodidae (Diptera) from Bucovina, Romania (XVII). *Travaux du Muséum National d'Histoire Naturelle "Grigore Antipa"* **42**, 143-155.

- Pollet, M. 2000. A documented Red List of the dolichopodid flies (Diptera: Dolichopodidae) of Flanders. *Communications of the Institute of Nature Conservation* **8**, 1-190. [in Dutch with English summary]
- Pollet, M. 2011. Fauna Europaea: Dolichopodidae. In Pape, T. and Beuk, P. (Eds) Fauna Europaea: Diptera, Brachycera. *Fauna Europaea version 2.4*, <http://www.faunaeur.org>
- Pollet, M., Grootaert, P. and Meuffels, H. 1987. Dolichopodid species new to the Belgian fauna with notes on their habitat (Diptera: Dolichopodidae). *Entomologische Berichten, Amsterdam* **48**, 44-46.
- Pollet, M., Mercken, L. and Desender, K. 1988. A note on the detailed distribution and diel activity of riparian dolichopodid flies (Dolichopodidae, Diptera). *Bulletin et Annales de la Société Royale Belge d'Entomologie* **124**, 248-253.
- Pollet, M., Meuffels, H., Mercken, L. and Desender, K. 1989. Faunistic data on the dolichopodid fauna (Dolichopodidae, Diptera) of some habitats in the Famenne (Prov. Namur, Belgium). *Biologisch Jaarboek Dodonaea* **56**, 50-61.
- Stackelberg, A.A. 1962. A list of Diptera of the Leningrad Region. V. Dolichopodidae. *Proceedings of the Zoological Institute of the Academy of Sciences of the USSR* **31**, 280-317. [in Russian]
- Stackelberg, A.A. and Negrobov, O.P. 1976. Dolichopodids of the genus *Nematoproctus* Loew (Diptera, Dolichopodidae) of the USSR fauna. *Entomologicheskoe Obozrenie* **55**, 205-209. [in Russian]
- Tayoub, M., Leprêtre, A. and Brunel, E. 1990. Les Diptères Dolichopodidae de la Forêt de Saint-Amand (Nord). *Bulletin de la Société entomologique de France* **94**, 259-264.
- Tree, I. 2018. *Wilding*. 362 pp. Picador.
- Vera, F.W.M. 2000. *Grazing ecology and forest history*. 527 pp. CABI Pu.

Changes to the Irish Diptera List (29) – Editor

This section appears as necessary to keep up to date the initial update of the Irish list in Vol. **10**, 135-146 and the latest checklist of Irish Diptera (Chandler *et al.* 2008). Species are listed under families. The gain of 3 species cited here brings the total Irish list to 3449.

Cecidomyiidae

Dasineura gleditchiae (Osten Sacken, 1866) (added by Tuffen and Wisdom 2019)

Syrphidae

Neocnemodon brevidens (Egger, 1865) (added by Russo *et al.* 2019)

Scathophagidae

Norellia spinipes (Meigen, 1826) (added by Mitchell 2019)

References

- Mitchell, R. 2019. *Norellia spinipes* (Meigen) (Diptera, Scathophagidae) new to Ireland. *Irish Naturalists Journal* **36**, 150-151.
- Russo, L., Stout, J. and Speight, M.C.D. 2019. On the presence of *Neocnemodon brevidens* (Egger, 1865) in Ireland (Diptera: Syrphidae). *Irish Naturalists Journal* **36**, 151-153.
- Tuffen, M. and Wisdom, R. 2019. Honey Locust Podgall Midge (*Dasineura gleditchiae*) (Diptera: Cecidomyiidae) new to Ireland. *Irish Naturalists Journal* **36**, 149-150.

Hoverflies (Diptera, Syrphidae) visiting ivy *Hedera* species

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Summary

The hoverflies that visit ivy are discussed. 82 species have been recorded on one or more occasion, but just 28 species are represented by 50 or more records. This overall list extends considerably the list provided in the Biological Flora for ivy. The majority of records (81.12%) come from the period 2013 to 2018, which coincides with the establishment of the UK Hoverflies Facebook group, thus reinforcing findings of other analyses that this event marks a turning point in the availability of data that can be used to investigate hoverfly ecology.

Introduction

There are two species of ivy (*Hedera helix* and *Hedera hibernica*) native to Britain, a widespread and common climber that frequently form large flowering masses on trees and old walls. It is often regarded as a pest by foresters and park-keepers who, frustratingly, often cut its trunk to prevent excess weight toppling trees and walls. The literature concerning its conservation value and use by flower-visiting insects appears to be very limited. Its dispersal by wild birds has been investigated (e.g. Guitián 1987) and Metcalf (2005) listed those species thought to be responsible for its dispersal.

Metcalf (2005) also listed a total of 23 hoverfly visitors as part of a longer list of Diptera reported to visit ivy. This list is, however, extremely incomplete and the experienced dipterist would rapidly recognise the scope to extend it considerably. Moreover, it contains putative UK records of species such as *Scaeva albomaculata* (Macquart, 1842), that has only occurred in Britain twice (Palmer 1996), and *Parasyrphus punctulatus* (Verrall, 1873), a species that doesn't normally fly in the autumn (see Ball *et al.* 2011), that suggest it is at least partially erroneous.

Jacobs *et al.* (2009a, b) investigated other aspects of pollination of ivy and concluded that it was at least partially dependent upon insects for pollinator services, and that social wasps played an important part in that process. Further work by Garbuzov and Ratnieks (2014) quantified the proportions of different insects attending ivy in Sussex in 2011 and 2012. In that analysis, hoverflies were reported to contribute 27% of the recorded foraging but they also highlighted temporal and spatial variation in visits by insect pollinators. Observations by contributors to the UK Hoverflies Facebook page suggest, however, that the proportions of insect visitors will vary markedly from place to place and that at least occasionally some *Eristalis* species can occur in vast numbers. For example, video footage of an ivy patch in Silverdale, Lancashire from 25 September 2019 shows exceptional numbers of, predominantly, *Eristalis pertinax* (Scopoli, 1763) (Foley 2019).

The lack of a comprehensive overview of insect visitors to ivy needs to be addressed, as part of a wider message about the importance of ivy as an autumnal nectar and pollen source for a range of pollinating insects above and beyond honey bees that receive the greatest attention. This brief account is intended to fill a gap in the literature for hoverflies. There remains considerable scope for the assiduous observer to compile a more comprehensive list of flies!

Method

Data collected by the British Hoverfly Recording Scheme (HRS) include a free-text 'comments' section in which any interesting details about an observation can be noted. Recorders are

encouraged to log flower visits in their comments, and the flower visited is routinely noted when data are extracted from photographs. The database was queried to generate those records where a reference to ‘ivy’ was present in the comment. This list inevitably included numerous records where the animal was not actually visiting ivy flowers, but was visiting such plants as ‘ground ivy’ or sunning on ivy leaves, etc. The initial list was therefore cleaned to include only those records where there was no ambiguity about a visit to ivy flowers. This yielded a total of 11,598 records (up to 2018) that were believed to be reliable.

Data validation

Until late 2018, a significant proportion of the flower visits noted were from observations recorded by RKAM transcribing posts from the UK Hoverflies Facebook page (Facebook 2019); thus, a substantial proportion of the records have been identified directly by the Recording Scheme. All other data submitted to the scheme as spreadsheets are assessed by both RKAM and SGB before being incorporated into the database. Normal protocols apply to initial visual appraisal:

- Does the record fit with the known flight time?
- Does it fall within the known range?
- Is the recorder known and does the record fall within the recorder’s abilities (if known)?
- Are there species with which the record might be confused?
- Are there species in the dataset that give grounds for concern (e.g. coastal species at inland locations or montane species in southern lowlands)?

In addition, all datasets are passed through ‘NBN Record Cleaner’ (NBN 2019), which is used to identify problem grid references and dates.

Thus, as far as is possible, all recent data have been validated as far as practicable. There are, however, some older records that are difficult to validate and, as with all datasets, there is a small proportion that may be erroneous. One of the complicating factors is that several species have been split in the past 20 years, and records that precede the date of the split are unlikely to be taken to the new segregate. In these cases the data have been adjusted to list such records as *sensu lato*. A similar process has been used for species that cannot be separated in females after a split (e.g. *Platycheirus scutatus* group and *Eumerus strigatus/sogdianus*).

Results

A total of 82 species of hoverfly is reported to have visited ivy flowers on at least one occasion (Table 1), of which just 28 are represented by 50 or more records. Together, the 28 species represent 95.6% of the records.

Ivy flowering can start as early as the end of the first week in August, although the numbers of records prior to the start of September are comparatively small (3.4%). From thereon, it becomes an important source of records until the middle of November (Fig. 1). Despite its obvious value as a nectar and pollen source, the numbers of yearly records directly related to ivy flowers were small until the establishment of the UK Hoverflies Facebook group (Facebook, 2019). Thereafter, there is a very considerable dataset (Fig. 2).

Table 1. Hoverfly species recorded at ivy between 1950 and 2018. Each record represents a single observation and takes no account of the numbers of individuals noted.

Species	nrecs	Species	nrecs
<i>Baccha elongata</i> (Fabricius, 1775)	75	<i>Leucozona glauca</i> (Linnaeus, 1758)	26
<i>Callicera aurata</i> (Rossi, 1790)	8	<i>Melangyna cincta</i> (Fallén, 1817)	4
<i>Callicera spinolae</i> Rondani, 1844	17	<i>Melangyna compositarum/labiatarum</i>	4

<i>Cheiliosia illustrata</i> (Harris, 1780)	1	<i>Melangyna umbellatarum</i> (Fabricius, 1794)	2
<i>Cheiliosia impressa</i> Loew, 1840	8	<i>Melanostoma mellinum</i> (Linnaeus, 1758)	116
<i>Cheiliosia pagana</i> (Meigen, 1822)	11	<i>Melanostoma scalare</i> (Fabricius, 1794)	537
<i>Cheiliosia proxima</i> (Zetterstedt, 1843)	7	<i>Meligramma trianguliferum</i> (Zetterstedt, 1843)	1
<i>Cheiliosia scutellata</i> (Fallén, 1817)	5	<i>Meliscaeva auricollis</i> (Meigen, 1822)	185
<i>Cheiliosia soror</i> (Zetterstedt, 1843)	5	<i>Meliscaeva cinctella</i> (Zetterstedt, 1843)	68
<i>Cheiliosia vernalis</i> (Fallén, 1817)	4	<i>Merodon equestris</i> (Fabricius, 1794)	1
<i>Cheiliosia vulpina</i> (Meigen, 1822)	1	<i>Myathropa florea</i> (Linnaeus, 1758)	919
<i>Chrysotoxum arcuatum</i> (Linnaeus, 1758)	2	<i>Neoascia podagrica</i> (Fabricius, 1775)	32
<i>Chrysotoxum bicinctum</i> (Linnaeus, 1758)	4	<i>Neoascia tenur</i> (Harris, 1780)	2
<i>Chrysotoxum elegans</i> Loew, 1841	1	<i>Platycheirus albimanus</i> (Fabricius, 1781)	450
<i>Chrysotoxum festivum</i> (Linnaeus, 1758)	2	<i>Platycheirus clypeatus</i> (Meigen, 1822)	2
<i>Dasysyrphus albostrigatus</i> (Fallén, 1817)	77	<i>Platycheirus granditarsus</i> (Forster, 1771)	6
<i>Dasysyrphus tricinctus</i> (Fallén, 1817)	7	<i>Platycheirus peltatus</i> (Meigen, 1822)	7
<i>Didea fasciata</i> Macquart, 1834	71	<i>Platycheirus peltatus</i> s. l.	1
<i>Epistrophe grossulariae</i> (Meigen, 1822)	104	<i>Platycheirus rosarum</i> (Fabricius, 1787)	1
<i>Episyrphus balteatus</i> (De Geer, 1776)	1,055	<i>Platycheirus scutatus</i> (Meigen, 1822)	14
<i>Eriozona syrphoides</i> (Fallén, 1817)	2	<i>Platycheirus scutatus</i> s. l.	61
<i>Eristalinus aeneus</i> (Scopoli, 1763)	3	<i>Rhingia campestris</i> Meigen, 1822	39
<i>Eristalinus sepulchralis</i> (Linnaeus, 1758)	1	<i>Rhingia rostrata</i> (Linnaeus, 1758)	7
<i>Eristalis abusiva</i> Collin, 1931	1	<i>Ripommensia splendens</i> (Meigen, 1822)	49
<i>Eristalis arbustorum</i> (Linnaeus, 1758)	212	<i>Scaeva pyrastris</i> (Linnaeus, 1758)	36
<i>Eristalis horticola</i> (De Geer, 1776)	21	<i>Scaeva selenitica</i> (Meigen, 1822)	5
<i>Eristalis intricaria</i> (Linnaeus, 1758)	18	<i>Sericomyia silentis</i> (Harris, 1776)	233
<i>Eristalis nemorum</i> (Linnaeus, 1758)	71	<i>Sericomyia superbiens</i> (Müller, 1776)	9
<i>Eristalis pertinax</i> (Scopoli, 1763)	1,856	<i>Sphaerophoria rupeppellii</i> (Wiedemann, 1830)	1
<i>Eristalis rupium</i> Fabricius, 1805	1	<i>Sphaerophoria scripta</i> (Linnaeus, 1758)	23
<i>Eristalis similis</i> (Fallén, 1817)	1	<i>Sphegina clunipes</i> (Fallén, 1816)	1
<i>Eristalis tenax</i> (Linnaeus, 1758)	1,997	<i>Syrpitta pipiens</i> (Linnaeus, 1758)	334
<i>Eumerus funeralis</i> Meigen, 1822	1	<i>Syrphus ribesii</i> (Linnaeus, 1758)	812
<i>Eumerus strigatus</i> s. l.	1	<i>Syrphus torvus</i> Osten-Sacken, 1875	140
<i>Eupeodes corollae</i> (Fabricius, 1794)	34	<i>Syrphus vitripennis</i> Meigen, 1822	109
<i>Eupeodes bucculatus</i> s. l.	1	<i>Volucella inanis</i> (Linnaeus, 1758)	52
<i>Eupeodes latifasciatus</i> (Macquart, 1829)	61	<i>Volucella pellucens</i> (Linnaeus, 1758)	63
<i>Eupeodes luniger</i> (Meigen, 1822)	211	<i>Volucella zonaria</i> (Poda, 1761)	250
<i>Ferdinandea cuprea</i> (Scopoli, 1763)	17	<i>Xanthandrus comtus</i> (Harris, 1780)	19
<i>Helophilus hybridus</i> Loew, 1846	13	<i>Xanthogramma pedissequum</i> s. l.	4
<i>Helophilus pendulus</i> (Linnaeus, 1758)	872	<i>Xylota segnis</i> (Linnaeus, 1758)	93
<i>Helophilus trivittatus</i> (Fabricius, 1805)	18	<i>Xylota sylvorum</i> (Linnaeus, 1758)	2

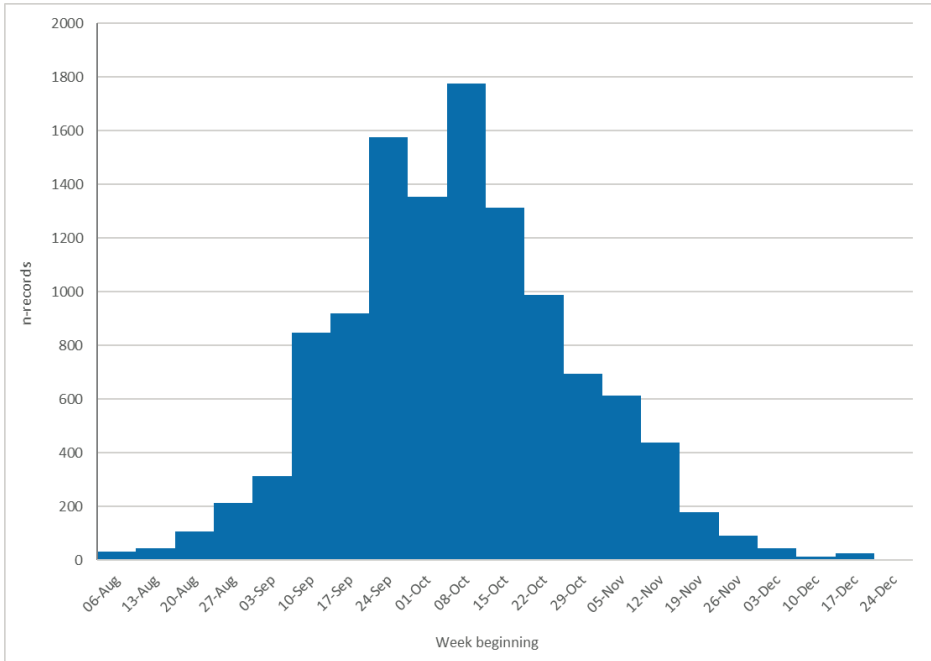


Fig. 1. Numbers of records per week of hoverflies visiting ivy (records from 1950 to 2018).

Discussion

This list extends considerably the one quoted by Metcalf (2005) and is representative of the major hoverfly visitors to ivy. There is of course the possibility that further species will be added in due course, but the hoverfly species that are the most likely to be significant pollinators are now clear. The list breaks down into a mixture of regular and occasional visitors and is arguably governed more by the time at which the ivy flowers than it is by the species that have an affinity to ivy. It may also depend upon the way a recorder works, with those who take specimens more likely to record ‘difficult’ species. Consequently, the relative frequencies of different species will vary depending upon the method of recording. Personal observations by RKAM suggest that the main flower visitors are Eristalini and Syrphini, with far less activity by ‘difficult’ tribes such as the Cheilosini.

The majority of species recorded at ivy are relatively widely distributed and ‘common’. It is these species, together with the social wasps, honey and bumblebees, and other flies (largely Calliphoridae and Muscidae) that made up the main ‘pollinator’ assemblage before the arrival of the ivy bee *Colletes hederæ* (first detected in 2001 – see Roberts and Vereeken 2009), which in southern England can now vastly outnumber other pollinator species.

This change in the relative abundance of pollinators begs the question ‘has the arrival of ivy bees affected other pollinator species and, will inter-specific competition have a bearing upon the breeding success of those species?’ Thomson (1988) demonstrated how activity by social wasps (*Vespa* species) has a measurable effect on bumblebee foraging, such that they ceased to show a response to variation in nectar content but focussed on pollen content. Moreover, Ropars *et al.* (2019) reported negative correlation between honeybee foraging and that of large solitary bees and of bumblebees. Importantly, however, no correlation was found between honeybee

foraging and smaller solitary bees and non-hymenopterous insects. At the moment there are no data to suggest that ivy bees do affect the foraging behaviour of other insects attending ivy, but males do patrol ceaselessly and can be seen to disturb feeding flies. When numerous (as is normal in southern England) female *C. hederae* must collect huge volumes of ivy pollen that is a finite resource!

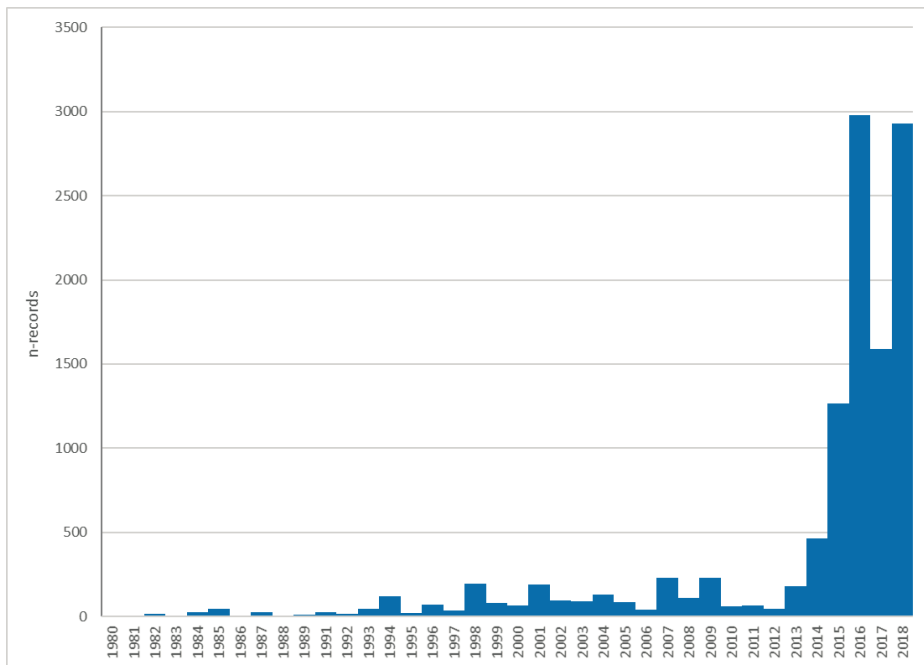


Fig. 2. Numbers of records per year for hoverflies visiting ivy between 1950 and 2018.

Unfortunately, the data held by the HRS is too weak in the years preceding, and immediately following, the arrival of the ivy bee; making any empirical analysis of the bee's impact impossible. It has recently been noted on the UK hoverflies Facebook group, that in north-west England (where ivy bees are currently at the edge of their range) *Eristalis* species can be extremely abundant at ivy, but this may be a function of the wetter climate rather than the absence of ivy bees. Indeed, it is also noticeable that there is a switch in the abundance of the dominant *Eristalis*, which in northern England and Scotland is *E. pertinax* whereas *E. tenax* (Linnaeus, 1758) is the more abundant to the south (Fig. 3).

It should also be noted that whilst some species are well-represented in the data, their real contribution to the 'pollinator' assemblage is likely to be low. The most striking examples are the *Volucella* species which, because they are large and photogenic, are more regularly recorded by casual recorders and are therefore better-represented in the data than they might otherwise be. The same may also obtain for *Sericomyia silentis* because it is a big, obvious species.

Opportunistic data such as those assembled by the HRS cannot be used to assess the absolute numbers of insects visiting ivy. Only the numbers of records can be quantified, because relatively few recorders attempt to make any sort of assessment of the numbers of individuals. At the moment, therefore, it is only possible to make informed statements about the frequency

with which species are recorded and not about the absolute numbers involved. It would be necessary to encourage more detailed recording, including quantifying abundance of each species of hoverfly at ivy flowers, if any connection between the advance of ivy bees and the abundance of hoverflies visiting ivy were to be investigated.

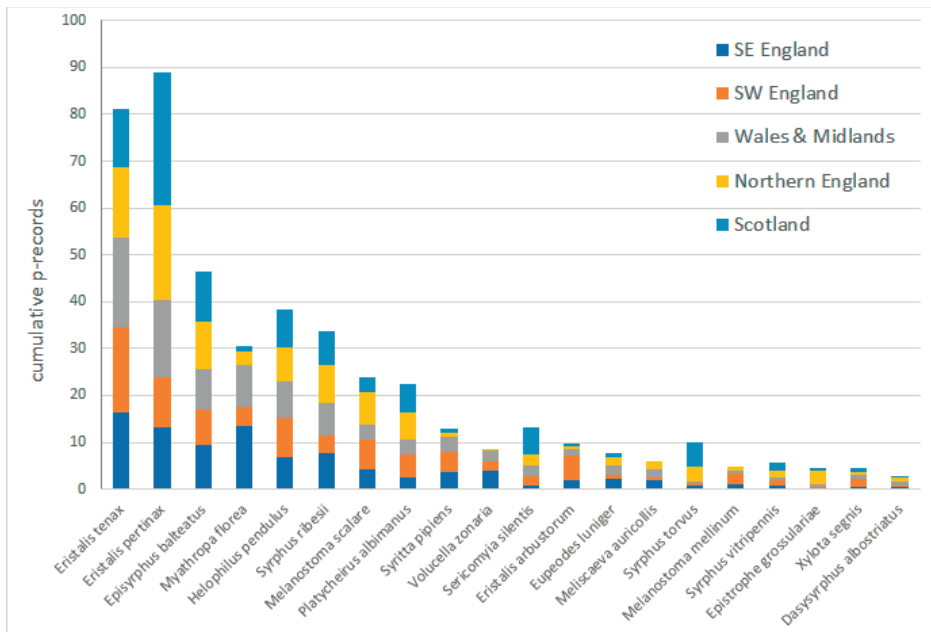


Fig. 3. The 20 most frequently recorded hoverfly visitors to ivy flowers in Great Britain, represented as the proportion of records in each of five regions and arranged in overall rank order of abundance.

Despite the limitations of photographic recording discussed by Morris and Ball (2019a and b), it is clear that it has greatly improved the available data on flower visiting by hoverflies. The extensive growth in this photographic component of the dataset started around 2015, as shown in Fig. 2, too short a period for robust analysis of trends. Once the data covers a period of at least ten years or so, it may be possible to use records of ivy visitors as one element of a wider package of measures to evaluate the state of pollinators outside the commercially important spring and early summer seasons.

Acknowledgements

This account is based on records supplied by a very large numbers of recorders. We are indebted to them all for the important contribution they make to improving the information available for analysis.

References

Ball, S.G., Morris, R.K.A., Rotheray, G.E. and Watt, K. 2011. *Atlas of the Hoverflies of Great Britain*. 187 pp. Biological Record Centre, Wallingford.

- Facebook 2019. <https://www.facebook.com/groups/609272232450940/> Accessed on 4 October 2019.
- Foley, M. 2019. Facebook post. <https://www.facebook.com/groups/609272232450940/permalink/2654039841307492/> Accessed on 4 October 2019.
- Garbuzov, M. and Ratnieks, F.L.W. 2014. Ivy: an under-appreciated key resource to flower-visiting insects in autumn. *Insect Conservation and Diversity* **7**(1), 91-102. doi: 10.1111/icad.12033
- Gutián, J. 1987. *Hedera helix* y los pajaros dispersantes de sus semillas: tiempo de estancia en la planta y eficiencia de movilización. *Ardeola* **34**, 25-35.
- Jacobs, J.H., Clark, S.J., Denholm, I., Goulson, D., Stoate, C. and Osborne, J.L. 2009a. Pollinator effectiveness and fruit set in common ivy, *Hedera helix* (Araliaceae). *Arthropod-Plant Interactions* **4**(1), 19-28. DOI: 10.1007/s11829-009-9080-9
- Jacobs, J.H., Clark, S.J., Denholm, I., Goulson, D., Stoate, C. and Osborne, J.L. 2009b. Pollination biology of fruit-bearing hedgerow plants and the role of flower-visiting insects in fruit-set. *Annals of Botany* **104**(7), 1397-1404. <https://doi.org/10.1093/aob/mcp236>
- Metcalf, D.J. 2005. Biological Flora of the British Isles No. 240 List Br. Vasc. Pl. (1958) no. 268 *Hedera helix* L. *Journal of Ecology* **93**, 632-648.
- Morris, R.K.A. and Ball, S.G. 2019a. Digital photography improves assessment of winter-active hoverflies (Diptera, Syrphidae). *Dipterists Digest (Second Series)* **26**, 25-33.
- Morris, R.K.A. and Ball, S.G. 2019b. Effects of the 2018 heatwave on British hoverflies (Diptera, Syrphidae). *Dipterists Digest (Second Series)* **26**, 139-150.
- NBN 2019. <https://nbn.org.uk/tools-and-resources/nbn-toolbox/nbn-record-cleaner/> Accessed on 17 October 2019.
- Palmer, C. 1996. A further record of *Scaeva albomaculata* in Britain and a note on the K.G. Blair collection of British Diptera. *Dipterists Digest (Second Series)* **2**, 97-99.
- Roberts, S. and Vereeken, N. 2009. Information Sheet: Ivy bee (*Colletes hederæ*). Hymettus & BWARS. <https://www.naturespot.org.uk/sites/default/files/downloads/IvyBee.pdf> Accessed on 30 September 2019.
- Ropars, L., Dajoz, I., Fontaine, C., Muratet, A. and Geslin, B. 2019. Wild pollinator activity negatively related to honey bee colony densities in urban context. *PLoS ONE*, **14**(9): e0222316. <https://doi.org/10.1371/journal.pone.0222316>
- Thomson, J.D. 1988. Reversal of apparent feeding preferences of bumble bees by aggression from *Vespa* wasps. *Canadian Journal of Zoology* **67**, 2588-2591.

***Zaphne caudata* (Zetterstedt) (Diptera, Anthomyiidae) new to the East of England (V.Cs 25-32)** – A male was swept from acid valley mire adjacent to wet woodland at Sugar Fen SSSI (TF69172070), Pott Row, West Norfolk (V.C. 28) on 12.v.2019.

It was identified using the key of D.M. Ackland, H. Bentley and P. Brighton (2017. [The British Anthomyiidae. *Dipterists Forum*]). The male genitalia are very distinctive and clearly match the illustrations in the key. Identification as *Zaphne caudata* (Zetterstedt, 1855) was confirmed by Tony Irwin, who also confirmed it as being the first record of the species for Norfolk. Phil Brighton, organiser of the Anthomyiidae Recording Scheme, informed me that it is the first record for the East of England (V.Cs 25-32). The specimen is deposited in the collection of Norwich Castle Museum.

Sugar Fen SSSI (TF693207), lying 7 km east of Kings Lynn, is a small reserve (22.6 ha) that is managed and conserved by the Grimston Fen and Allotment Trust in collaboration with local volunteer groups and is part of the Gaywood Valley Living Landscape Project. Its notification as an SSSI was primarily for its flora and the diverse habitats present, which range from calcareous fen to acid mire and wet heath. This diversity reflects the close proximity of underlying Sandringham Sands Formation, Carstone (a pebbly coarse ferruginous sandstone) and the Late Cretaceous Chalk.

The British distribution of *Z. caudata* is concentrated in Wales, central Scotland (Aviemore, Inverness) and Devon (Dartmoor). As of 27.ix.2019, the Anthomyiidae Recording Scheme has 60 verified records of *Z. caudata*, the Welsh Invertebrate Database has over 200 records, and there are 326 records on the NBN database, with Welsh and English records lying west of a line joining the Solway Firth and Dover.

Consequently, the occurrence of *Z. caudata* at Sugar Fen is something of a surprise. It is conceivable that this species was well-established in the once extensive mire system of the Gaywood valley, of which Sugar Fen and neighbouring Derby Fen and Leziate Fen SSSIs are remnants (totalling 86.3 ha). This valley mire system has become much reduced, dried out and fragmented over the last hundred years, due primarily to water abstraction, canalisation of the Gaywood River and to a marked decline in fen cutting and grazing, leading to extensive scrubbing over – **MARK WELCH**, 32 Tennyson Place, Ely, Cambridgeshire CB6 3WE. mdw@nhm.ac.uk

The Dark-edged Bee-fly *Bombylius major* Linnaeus (Diptera, Bombyliidae) in north Scotland

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Summary

228 records of the bee-fly *Bombylius major* from the north of Scotland were analysed. The fly is widely but unevenly distributed over the area, at its northern limit in Britain. It flies from late March to early June, foraging at a range of plants and is most often recorded at *Primula*. Possible associations with five species of solitary bee were noted. Oviposition was observed between late April and late May. The species is not under threat in the area.

Introduction

The Dark-edged Bee-fly *Bombylius major* Linnaeus, 1758 is widespread in Great Britain and Ireland¹ but until recently has not been much recorded in the north of Scotland. The Highland Biological Recording Group (HBRG) has targeted the species since 1999, and has accumulated over 200 records, providing an adequate base for analysis and description of its ecology. Most of our records lie in the Highland Council local authority area, which covers vice-counties 96, 97, 104-109 and parts of 95 and 98 (see Fig. 2). All those used in this paper are from 100km grid squares NM to NO and northwards, approximately north of a line from Jura to Fife Ness.

The only other member of the family known to occur in Highland is the Flea Bee-fly *Phthiria pulicaria* (Mikan, 1796) for which there are records between Tentsmuir (NO52, vice-county 85) and Coul Links (NH89, vice-county 107), though this tiny fly is likely to be severely under-recorded. There are old records of *Bombylius canescens* Mikan, 1796 from Midlothian north to Perthshire between 1901 and 1918, and three records of *Villa modesta* (Meigen, 1820) in Fife between 1979 and 2018 (NBN Atlas accessed 24 June 2019).

Methods

Records provided to HBRG are mostly casual and opportunistic with no systematic survey or monitoring. This has implications for interpretation of the data.

Comparative data were obtained from the National Biodiversity Network (NBN) Atlas using two data resources from the Soldierflies and Allies Recording Scheme (SARS): ‘Brachycera (Diptera) Records from Britain and Ireland To 1990’ and ‘Soldierflies and Allies Recording Scheme - data verified via iRecord’, both downloaded on 22 June 2019.

The collection at the National Museums of Scotland (NMS), and their Scottish Insect Records Index (SIRI) were used to identify old records.

History in north Scotland

Stubbs and Drake (2014) described the range of *B. major* in Scotland as ‘southern Scotland and further north along the west coast’. It has been suggested that *B. major* has recently expanded its

¹ <https://www.gbif.org/species/1500120>. Accessed 3 October 2019.

range into north Scotland^{2,3}. This idea was questioned in a report on the SARS scheme⁴ thus: ‘How widespread is it really in Scotland - are the recent records signs of a spread or just more people sending in records?’ NMS and SIRI have several records from Argyllshire V.C. 98 and Kintyre V.C. 101 from before 1920 and on Skye V.C. 104 NG61 in 1976. SARS has a record from Drumnadrochit NH53 V.C. 96 in 1981. Annual Scottish records in the SARS data were at best in single figures up to 2015, when the numbers of records increased suddenly, reaching a maximum of 67 records in 2018. 82.4% of the 205 SARS records were from the 4 years from 2016 when their national Bee-fly Watch⁵ was introduced. Only 29 records were from the area of interest here, all but one from 2015 onwards. HBRG records were not included in the SARS dataset and show a marked increase from 2000 (Fig. 1).

It seems clear from the temporal pattern of records in the two datasets that the increase in reports in Scotland in recent years is a consequence of increased recording effort. The date of increase in records matches exactly the start of the HBRG and SARS schemes respectively. *Bomblyus major* has been present in Scotland as far north as V.C. 96 for at least four decades. While that gives no support to the idea that there has been a recent increase northwards in range, we can say nothing about population size within that range.

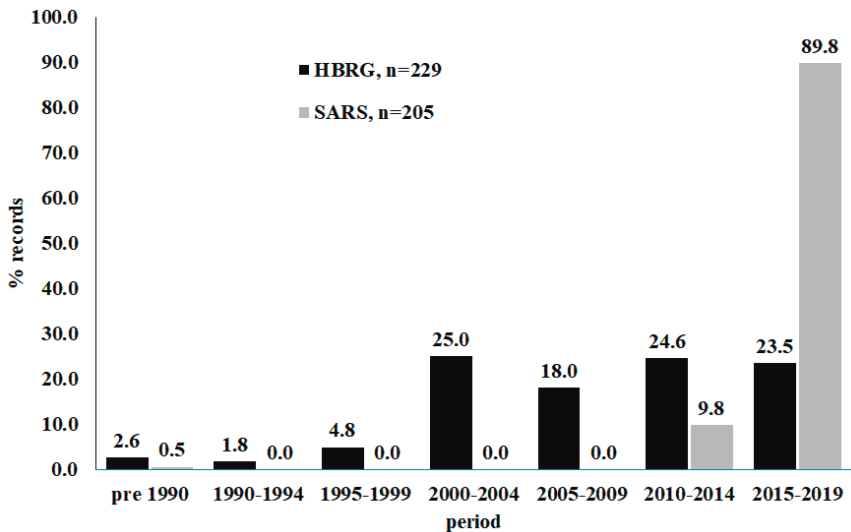


Fig. 1. Temporal distribution of records of *Bomblyus major* in north Scotland. Black bars are Highland Biological Recording Group data; grey bars are from the Soldierflies and Allies Recording Scheme, and Biological Records Centre.

Current distribution in north Scotland

The current distribution of *B. major* in Highland is shown in Fig. 2. It ranges across the area from Skye and Lochaber to Inverness, and north to East Ross. While some gaps may be a result of

² <https://www.buglife.org.uk/bugs-and-habitats/dark-edged-bee-fly>. Accessed 3 October 2019.

³ <https://www.flickr.com/photos/63075200@N07/sets/72157629234516084/>. Accessed 3 October 2019.

⁴ <http://www.brc.ac.uk/soldierflies-and-allies/bee-fly-results>. Accessed 3 October 2019.

⁵ <https://mailchi.mp/a3dc04e363c9/biological-records-centre-newsletter-2849897>.

poor recording effort, one striking gap in the current map is the area south and east of the Great Glen, including Strathspey, traditionally a well-covered area and one in which HBRG has several active members. That gap is also present in the SARS data. The ecological reason for this is obscure, but climate and altitude may play a part. Its absence from the north of Highland is likely to be real, the northern limit lying approximately from Skye to the Dornoch Firth. It was not found in SE Sutherland (V.C. 107) by the late Philip Entwistle, who was active in that area for many years. While most records were below 120m elevation, oviposition was observed as high as 230m.

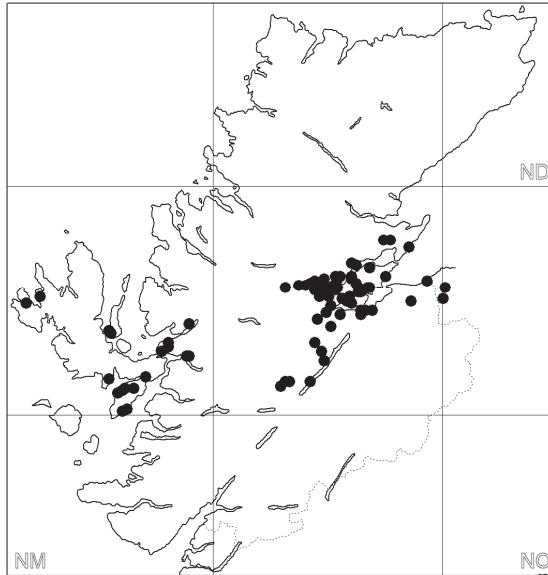


Fig. 2. Distribution of records of *Bombylius major* in the Highland Biological Recording Group database. The dotted line marks the boundary of the Highland Council local authority area.

Phenology

Table 1 and Fig. 3. show details of the flight season of *B. major* in the north of Scotland (HBRG data) and Great Britain south of a line from north Wales to the Humber estuary (SARS data).

As would be expected, activity in the north peaks later, by 15 days. Less expected, perhaps, is the very much longer season in the south, where records show a long tail at both the start and end of the flight period. However, the large number of February and March records from the south are mainly from 2019, when the season started exceptionally early, and at least some of the reports from July might correctly refer to *B. canescens* (M. Harvey *pers. comm.*).

Area	Dates			Full date range	95% date range		No. records
	First	Mean	Last				
North Scotland	25 Mar	30 Apr	9 Jun	76 days	1 Apr – 3 Jun	64 days	236
South GB	24 Feb	15 Apr	23 Jul	149 days	19 Mar – 27 May	70 days	8211

Table 1. Phenology of *Bombylius major* in the north of Scotland and in southern Great Britain. The 95% date range excludes the earliest and latest 2.5% in each dataset.

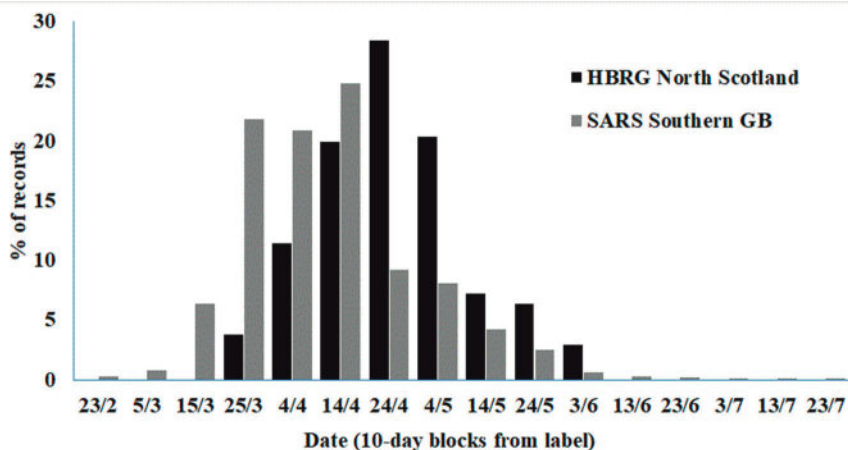


Fig. 3. Phenology of *Bombylius major* in north Scotland (black bars) and the southern part of Great Britain (grey bars).

Forage

87 records referred to an insect feeding at a named plant, usually at genus level and sometimes citing more than one species (Table 2). As there is no information on availability of forage plants, the numbers do not indicate preference but just frequency in the records.

Genus	number	Species cited	Genus	number	Species cited
<i>Primula</i>	29	<i>vulgaris</i> , <i>denticulata</i>	<i>Ribes</i>	2	<i>sanguineum</i>
<i>Lithodora</i>	10		<i>Scilla</i>	2	<i>non-scripta</i>
<i>Taraxacum</i>	10		<i>Arabis</i>	1	
<i>Pulmonaria</i>	9	<i>officinalis</i> , <i>rubra</i>	<i>Armeria</i>	1	
<i>Aubretia</i>	8		<i>Cotoneaster</i>	1	<i>horizontalis</i>
<i>Bellis</i>	3	<i>perennis</i>	<i>Petasites</i>	1	
<i>Daphne</i>	3		<i>Potentilla</i>	1	<i>erecta</i>
<i>Ficaria</i>	3	<i>verna</i>	<i>Rhododendron</i>	1	<i>ponticum</i>
<i>Lobelia</i>	3		<i>Salix</i>	1	
<i>Muscari</i>	3		<i>Silene</i>	1	<i>dioica</i>
<i>Myosotis</i>	3	<i>arvensis</i>	<i>Tussilago</i>	1	<i>farfara</i>
<i>Viola</i>	3	<i>riviniciana</i>	<i>Vaccinium</i>	1	<i>myrtillus</i>

Table 2. Plants visited by *Bombylius major* in the north of Scotland. Data are from the Highland Biological Recording Group database.

The number of exotic species used reflects the common occurrence of the fly in gardens, though use of native plants is probably under-recorded. The list shows a striking diversity of floral types with little evident consistency in colour, size or depth even among the five most frequently recorded species. *Primula*, both native and exotic, is clearly an important forage plant. No distinction was made between visits for nectaring and those for gathering pollen.

63 records included the time of observation. As *B. major* is a thermophile it is not surprising that 90% of the observations fall between 1100h and 1800h, though given the non-systematic nature of the observations that is likely to be heavily influenced by the activity of observers.

Hosts and oviposition

Eight records included identification of solitary bees active at places where the fly was seen ovipositing. Five referred to *Halictus rubicundus* (Christ, 1791), four to *Andrena* species (*scotica* Perkins, R.C.L., 1916 specified in one; *ruficrus* Nylander, 1848 and *lapponica* Zetterstedt, 1838 in two each), and two to *Lasioglossum* species (*calceatum* (Scopoli, 1763) specified in one). Ten records referred to oviposition, ranging from 20 April to 29 May.

Discussion

Data on *B. major* in north Scotland suggest that the species has been present in that area for several decades at least, though the early flight season and dearth of resident dipterists has led to it being overlooked until targeted recording was introduced since 1999. It is currently present and frequent across the Highland area from Skye to the Moray Firth, though possibly absent from the central part where habitat may be mostly unsuitable. There is no obvious conservation concern. As the current northern limit of its range seems well established, *B. major* could be a useful indicator of effects of environmental change, as there is an abundance of apparently suitable habitat in the coastal strip to the north of the Dornoch Firth where the fly is absent.

Bombylius major has no obligate relationship with any forage species, though Knight (1967) did suggest an interdependence with *Primula vulgaris*. It will, however, be restricted in its choice in its early flight season, especially in the north. The frequent use of exotic species is probably as much a reflection of the lack of native flora as ease of observation in gardens. This is obvious in the case of bumblebees also (Macdonald and Nisbet 2006). Our data show little in common among the flowers visited, but the frequent use of *Primula* is striking, that genus featuring in a third of all forage reports. A notable disagreement between our data and that of Knight relates to dandelion *Taraxacum*. Knight never recorded *B. major* on *Taraxacum* ‘no matter how abundant’. It was one of the three most frequently recorded flowers visited in the north. We might expect that *B. major* adopts, as do bumblebees *Bombus* spp. (Dunlap *et al.* 2017), the technique of sampling the available forage to identify the flowers that provide acceptably rewarding foraging. Thus, the difference we see in relation to *Taraxacum* in the two studies may simply reflect the relative rewards of the flowers available in the two areas.

Acknowledgements

We are grateful to Ashleigh Whiffin and Vlad Blagoderov at the National Museums of Scotland for access to their collection and to SIRI. Martin Harvey and Peter Chandler kindly provided unpublished information on *Phthiria pulicaria*. Martin Harvey and Stephen Moran provided helpful comments on an early draft of the paper. We are indebted to all the naturalists who provided the records to HBRG. The map was prepared with DMAP.

References

- Dunlap, A.S., Papaj, D.R. and Dornhaus, A. 2017. Sampling and tracking a changing environment: persistence and reward in the foraging decisions of bumblebees. *Interface Focus* **7**(3), [20160149]. <http://dx.doi.org/10.1098/rsfs.2016.0149>.
- Knight, G.H. 1967. Observations on the behaviour of *Bombylius major* L. and *B. discolor* Mik. (Diptera, Bombyliidae) in the Midlands. *Entomologist's Monthly Magazine* **103**, 177-182.
- Macdonald, M. and Nisbet, G. 2006. *Highland Bumblebees: Distribution, Ecology and Conservation*. Highland Biological Recording Group, Inverness.

Stubbs, A.E., and Drake, M. 2014 (second edition). *British soldierflies and their allies: an illustrated guide to their identification and ecology*. British Entomological and Natural History Society.

***Alliopsis pilitarsis* (Stein) (Diptera, Anthomyiidae) in County**

Durham – On 17 June 2019, I was leading a small group of people to record insects at Slit Wood (V.C. 66, County Durham, grid reference NY905388). The visit was organised as part of the “Cold-blooded and Spineless” project, which is run by North Pennines AONB Partnership, funded by the National Lottery Heritage Fund, and is aimed at encouraging people to record and appreciate invertebrates in the AONB area.

Slit Wood (also known as Slitt Wood) runs along the valley of Middlehope Burn, near Westgate in Weardale. It is designated as a SSSI for its mix of woodland, calcareous grasslands, fen, and open water, and takes in the former lead mine workings of Slit and Middlehope Mines (Natural England SSSI citation, 1987). At the southern (lower) end the valley is well-wooded (with ash *Fraxinus excelsior* and wych elm *Ulmus glabra* predominant among a mix of broad-leaved trees) and fairly steep-sided, with areas of flower-rich calcareous grassland on the valley sides. In the lower part of the valley, Middlehope Burn is fast-flowing and rocky. Further upstream near the mine workings there are wetland areas and more open grasslands leading up to the adjacent moors. The site has also been recognised as a “Special Invertebrate Site” by the North Pennines AONB Partnership.

Among a wide range of insect groups recorded during the visit was a male of the anthomyiid fly *Alliopsis pilitarsis* (Stein, 1900). This has a typical black, bristly appearance, but with very distinctive genitalia. The specific name *pilitarsis* refers to the tarsi of the hind legs, which have segments 2–4 rather small and each bearing a very long bristly hair on both the anterior and posterior distal corners. The full record details and photographs of the specimen can be seen on iRecord at www.brc.ac.uk/irecord/record-details?occurrence_id=10527712.

Alliopsis pilitarsis was assessed as provisionally Near Threatened by Falk and Pont (2017). A Provisional Assessment of the Status of Calypterate flies in the UK. *Natural England Commissioned Reports*, no. 234, who listed a total of nine records since 1960. The Slit Wood record appears to be the first in England or Wales since 1997, and the first for County Durham, with the only previous records for northern England being in Yorkshire (1989) and Lancashire (1963). There are more recent Scottish records from 1998 and 2005.

The status review gives the broad habitat for *Alliopsis pilitarsis* as “alongside streams in broad-leaved woodland”, and notes that the larval biology is unknown. My specimen was swept from the wooded part of the valley so it fits in with that general habitat category. The other anthomyiids recorded from the site were both common species: *Hylemya vagans* (Panzer, 1798) and *Hylemyza partita* (Meigen, 1826). Also recorded was *Limnophora exuta* (Kowarz, 1893) (Muscidae), a species associated with rocky streams.

I am grateful to Genevieve Tompkins of the North Pennines AONB Partnership for organising access to Slit Wood, and to both her and Carol Inskipp for contributing to the survey; and to Phil Brighton for verifying the record via iRecord, and for alerting me to the lack of recent records for this species – **MARTIN C. HARVEY**, Evermor, Bridge Street, Great Kimble, Aylesbury, HP17 9TN, kitenetter@googlemail.com

***Cerodontha (Poemyza) pygmella* (Hendel) (Diptera, Agromyzidae) new to Wales, and reinstatement as a British species**

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36 Marlborough Avenue, Hessle, East Yorkshire, HU13 0PN; agromyzidaeRS@gmail.com

Summary

Cerodontha (Poemyza) pygmella (Hendel, 1931) (Diptera, Agromyzidae) is reported as a species new to Wales, representing the first known record in Britain for over 60 years. A description of the larval habits, adult and comparison with similar species is provided. The species is also restored to the British list on the basis of previously overlooked published records.

Introduction

In May 2019, an Agromyzidae study of the River Dee was undertaken. Within the samples collected, several *Cerodontha (Poemyza)* were swept from riverside vegetation in Shotton (SJ305695), Flintshire, Wales. Upon examination, using the key in Papp and Černý (2016), they run to couplet 24. As the lunule of the specimens is only weakly narrowed by the orbits, *Cerodontha (Poemyza) pygmella* (Hendel, 1931) was the determination. Dissection and examination of the male genitalia agreed with *C. (P.) pygmella*, with the phallus being identical to the illustrations of Nowakowski (1973) and Papp and Černý.

An image of the genitalia was sent to Michael von Tschirnhaus who confirmed that the specimen is *Cerodontha (Poemyza) pygmella*, a species which has not previously been recorded in Wales.

Identification

Cerodontha (Poemyza) pygmella [syn. *lapplandica* (Rydén, 1956), *tatrica* Nowakowski, 1967] possesses a broad frons, marginally less than twice the width of the eye, with the orbits projecting above the eye in profile. There are 2 equal *ors*, 2 *ori*. Lunule higher than a semicircle, upper margin reaching lower *ors*. Mesonotum, black, slightly shining but appearing matt, greyish when viewed from the front, with 1+3 *dc*, with *acr* in 5 irregular rows, *prsc* much longer than *acr*.

Mesopleuron black, only upper margin narrowly yellow. Frons, orbits, jowls, lunule, face and antennae black, although infrequently orbits narrowly yellow adjoining eye at level of *ors*. Legs all black, with only fore knees yellow. Wing length 2.8-3.2mm, with ultimate section of vein M_{3+4} 1.75-2.75 times that of penultimate, wing base yellow. Squamae bright yellow with dark fringe.

In comparison to the very similar *Cerodontha (Poemyza) pygmaea* (Meigen, 1830), externally there is very little difference between the two except that in *C. (P.) pygmella*, the lunule is only weakly narrowed by the orbits whilst in *C. (P.) pygmaea*, the orbits strongly narrow the lunule; *C. (P.) pygmella* possesses a black abdomen [tergites may be faintly yellowish along hind margin], while in *C. (P.) pygmaea* all tergites are conspicuously yellow along the hind margin.

Male genitalia with cercus narrow, hypandrium V-shaped with medium-broad arms, slightly sigmoid in lateral view. Phallus (Fig. 1): mesophallus long, with large posteriorly directed hypophallus; paraphallus arrow-like; basal part of distiphallus short, connection to the tubules with a pair of longish broad swellings; tubular part thin [weakly sclerotised], with distal cones broad, slightly longer than broad. Ejaculatory apodeme small, Y-shaped, with a narrow blade.

In *C. (P.) pygmaea*, the hypophallus is much less curved, weaker [shorter], the paraphallus being less acute and the distal end of the distiphallus being conspicuously curved, often forming a complete loop.

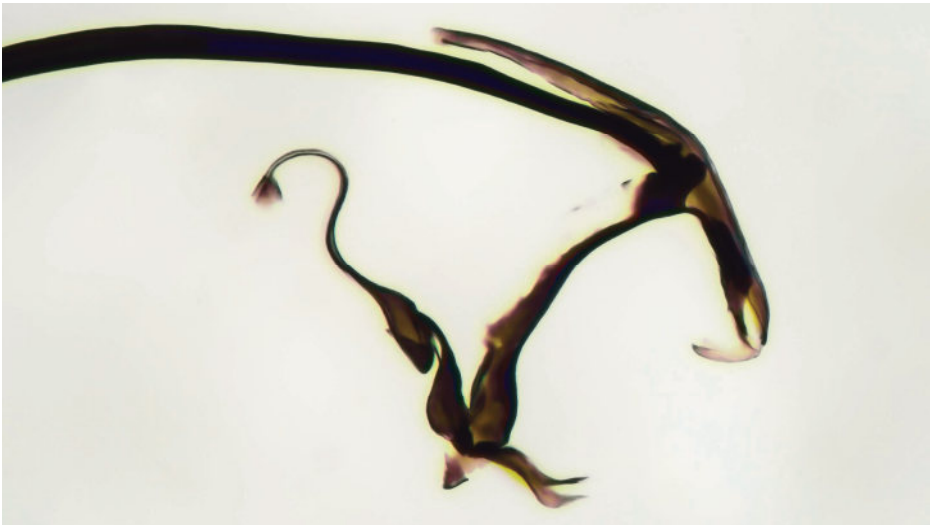


Fig. 1. *Cerodontha (Poemyza) pygmella* (Hendel, 1931): phallus in left lateral view.

Biology

This species forms a broad, elongated blotch with greenish frass on Poaceae [*Calamagrostis*, *Drymochloa*, *Festuca* and *Leucopoa*]. The larvae usually feed communally, with pupariation occurring within the mine, with the puparia anchored in the mine by a silk thread attached to the posterior end. Larva with 5-6 claw-shaped papillae on the rear spiraculum, which possess on their outside, half-ventrally, a relatively large black ‘wart’ with a deep, well-visible ‘root’. Puparium metallic black, with a violet or blue shine, rear spiracula on a common base. (Nowakowski 1973).

In 2018, I reared a female *Cerodontha (Poemyza)* from *Calamagrostis* in East Yorkshire which, upon external features, agrees with *C. (P.) pygmella*; however, the posterior spiracles are, albeit minutely, sufficiently different not to allow a definitive determination.

Distribution

Although this species has not been recognised as a British species in recent checklists, previously overlooked published records were discovered during the writing of this manuscript, confirming its British status. These records are: material identified by Professor E.M. Hering which included ‘*Phytobia pygmella* Hend., Bookham Common, Surrey, June 10th, 1951’ (Parmenter, 1954) and ‘*Phytobia pygmella* (Hd.), Dumbartonshire, late 1890’s, based on undetermined material, collected by J. R. Malloch, held in the collection at the National Museums of Scotland, Edinburgh, examined by Spencer (1956). This species may be more widespread than it appears as it is well represented in Europe, being known from the Czech Republic, Estonia, Denmark (Peterson and von Tschirnhaus 2001), Finland (Kahanpää 2014), Germany, Hungary (Papp and Černý 2016),

Lithuania, Norway, Poland (Griffiths 1968), Russia (Kamchatka, Kuril Islands) (Iwasaki 2000), Slovakia, Spain (Gil-Ortiz *et al.* 2010) and Sweden (Zlobin 2005).

Acknowledgements

I would like to thank Michael von Tschirnhaus (University of Bielefeld, Germany) for confirming the determination and supplying additional references.

References

- Gil-Ortiz, R., Martínez, M. and Jiménez-Peydró, R. 2010. New species records of Agromyzidae (Diptera) from Spain. *Journal of entomological Science* **45**(2), 91-105.
- Iwasaki, A. 2000. Agromyzidae (Insecta: Diptera) of Kuril Islands. *Natural History Research. Special Issue* **7**, 141-162.
- Kahanpää, J. 2014. Checklist of the leaf-mining flies (Diptera, Agromyzidae) of Finland. (In Kahanpää, J. and Salmela, J. Checklist of the Diptera of Finland. V + 408 pp.). *ZooKeys* **441**, 291-303.
- Nowakowski, J.T. 1973. Monographie der europäischen Arten der Gattung *Cerodontha* Rond. (Diptera, Agromyzidae). *Annales zoologici*, Warszawa **31**, 1-327.
- Papp, L. and Černý, M. 2016. *Agromyzidae (Diptera) of Hungary*. Volume 2. Phytomyzinae I. 385 pp. Pars Ltd, Nagykovácsi.
- Parmenter, L. 1954. London Natural History Society – Entomological Section : March 30th, 1954. Exhibits: Agromyzidae (Diptera) not previously recorded for Britain, determined by Prof. E. M. Hering. *Entomologist's Monthly Magazine* **90**, 119-120.
- Peterson, F.T. and von Tschirnhaus, M. 2001. Agromyzidae. pp 179-182. In Peterson, F.T. and Meier, R. (Eds). A preliminary list of the Diptera of Denmark. *Steenstrupia* **26**(2), 119-276 + Errata).
- Spencer, K.A. 1956. Observations on the British Agromyzidae (Dipt.) – II. Records of Agromyzidae (Dipt.) in Scotland. *Entomologist's Gazette* **7**, 51-54.
- Zlobin, V.V. 2005. A revised checklist of the Swedish Agromyzidae. *International Journal of dipterological Research* **16**(3), 175-189.

***Cerodontha (Poemyza) zuskai* Nowakowski (Diptera, Agromyzidae) new to Britain, with additional European records**

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Summary

Cerodontha (Poemyza) zuskai Nowakowski, 1973 (Diptera, Agromyzidae), a leaf-miner of *Elymus repens*, is reported as a species new to Britain based upon a single male collected in Hessle, East Yorkshire.

Introduction

A male *Cerodontha (Poemyza)* was swept from mixed vegetation in Hessle (TA047260), East Yorkshire, on 29 April 2019. Upon examination of its morphological features, the specimen runs readily to couplet 22 using Papp and Černý (2016), with the options being *Cerodontha (Poemyza) incisa* (Meigen, 1830) and *Cerodontha (Poemyza) zuskai* Nowakowski, 1973.

Here, as the specimen possesses four postsutural *dc*, *C. (P.) zuskai* was the determination and not *C. incisa* [only three postsutural *dc*]. The specimen was dissected and examined in detail, with the genitalia agreeing with the illustrations by Papp and Černý (*op. cit.*) and Nowakowski (1973). However, in Papp and Černý, the hypophallus lamellae are depicted in a slightly different arrangement than those by Nowakowski and those of the dissected male but still possessing the very broad, distinctive, posterior lamella.

An image of the male and its genitalia was sent to Miloš Černý who confirmed that the specimen is *Cerodontha (Poemyza) zuskai*, a species which has previously not been recorded in Great Britain.

Identification

This species possesses 2 *ors* and 2 *ori*, with the orbits not projecting above the eye in profile and orbital setulae being in a single row. Lunule higher than wide, with gena deepest in posterior part, 1/5th height of eye. Third antennal segment with short pubescence. Mesonotum with 1 + 4 *dc*, with the 2nd, 3rd and 4th being noticeably weaker and shorter, *acr* in 5-6 irregular rows. Mesonotum and scutellum entirely black, only weakly shining, upper and hind margin of mesopleuron narrowly yellow. Squamal margin and fringe whitish-yellow.

Wing length 2.1-2.7mm, with ultimate section of vein M₃₊₄ 1.5-1.7 times that of the penultimate; base of wings yellow with veins ochre brown. Legs black with only fore knees narrowly yellowish. Abdomen blackish.

If the most up to date or specialised literature is not used and without examination of the male genitalia, this species could easily be determined as *C. (P.) incisa* or *C. (P.) hamni* Spencer, 1971, as the keys most frequently utilised by British workers, those by Spencer (1972, 1976), have no consideration for the number of *dc* and/or do not discuss *C. (P.) zuskai*. Apart from the number of postsutural *dc*, the differences between these species are subtle.

The epandrium possesses a caudal projection, with narrow cerci, almost 0.35 height of epandrium. Hypandrium U-shaped with narrow arms but lamella between arms broad. Mesophallus almost as long as the distiphallus, with posterior lamella of hypophallus very large and broad. Tubular part of distiphallus sigmoid, with distal funnels broad. Ejaculatory apodeme small, with an asymmetrically based Y-shaped blade.

The phallus (Fig. 1) is shown in a slightly suboptimal position, with one distal funnel of the distiphallus being out of its natural rest position and the hypophallus lamellae being shifted to the left due to the dissection process.

Although superficially resembling the phallus of the similar *C. (P.) hammi* and *C. (P.) incisa*, the broad posterior lamellae of the hypophallus in left lateral view of *C. (P.) zuskai* are much different from the curved, rather acute, lamellae of *C. (P.) hammi* and *C. (P.) incisa*.

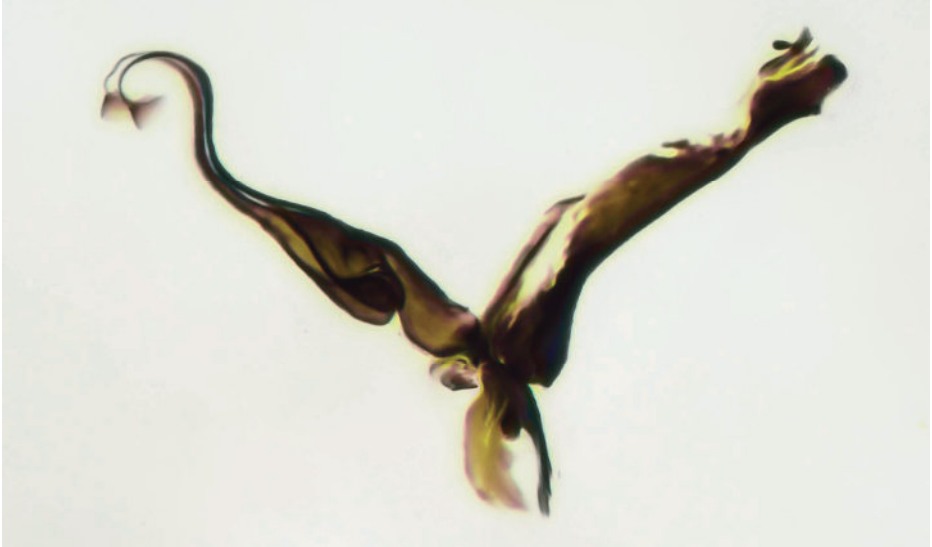


Fig. 1. *Cerodontha (Poemyza) zuskai* Nowakowski, 1973: phallus in a suboptimal left lateral view.

Biology

The larvae of *Cerodontha (Poemyza) zuskai* form a lower-surface blotch mine on common couch grass *Elymus repens* (= *Elytrigia repens*), which occupies most of the top section of the leaf, with several larvae within the mine. Frass is irregular, flaky and frequently washed out, greenish. Pupariation occurs inside the mine, with the puparium anchored within the mine by a silk thread which is produced by the rear spiraculum, a typical feature of the subgenus *Poemyza*.

The larva possesses a front spiraculum with 7-12 papillae over two short arms, with the posterior spiraculum having three elongated and strongly curved papillae. The rear spiraculum also has a small, black, finely spinulose wart on its outer side. The puparium is black, matt, rather flat and compressed, 2.5-2.7mm in length (Nowakowski 1973).

Distribution

This is a seemingly rare species, known only from Czech Republic (Černý 2013), Slovakia (Vála and Černý 1997), Germany and Poland (Nowakowski 1973). Previously unpublished records from Germany are hereby included; ♂ leg. Dr Martin Boness, ii/iii.1970, river Rhine nr Leverkusen, North-Rhine Westphalia, Germany, reared from puparium collected in plant debris along the winter flood edge, det. Dr M. von Tschirnhaus; ♂ with data label "Roderbrunn, Oberlausitz, Mitteleuropa-DDR, 9.7.1966. Leg. Dr Habil. HERBERT BUHR, ex Agropyron

repens, ex larva, Zucht 3001 Dr. HERBERT BUHR. Imago geschl. 12.4.1967, *Cerodontha (Poemyza) zuskai* Nowak., det. J. T. Nowakowski 1972", in coll. von Tschirnhaus.

Acknowledgements

I would like to thank Miloš Černý (Halenkovice, Czech Republic) for taking the time to confirm the determination and Michael von Tschirnhaus (University of Bielefeld, Germany) for providing previously unpublished data.

References

- Černý, M. 2013. Additional records of Agromyzidae (Diptera) from the West Palaearctic Region. *Časopis slezského zemského Muzea v Opavě* **62**, 281-288.
- Nowakowski, J.T. 1973. Monographie der europäischen Arten der Gattung *Cerodontha* Rond. (Diptera, Agromyzidae). *Annales zoologici*, Warszawa **31**, 1-327.
- Papp, L. and Černý, M. 2016. *Agromyzidae (Diptera) of Hungary*. Volume 2. Phytomyzinae I. 385 pp. Pars Ltd, Nagykovácsi.
- Spencer, K.A. 1972 *Handbooks for the Identification of British Insects (Diptera, Agromyzidae)*. Vol X, Part 5 (g), 1-136.
- Spencer, K.A. 1976. *The Agromyzidae (Diptera) of Fennoscandia and Denmark. Fauna entomologica scandinavica* **5**(in two parts), 1-304, 305-606, 1 map.
- Vála, M. and Černý, M. 1997. Agromyzidae. pp 75-78. In Chvála, M. (Ed) Check List of Diptera (Insecta) of the Czech and Slovak Republics. 132 pp. Karolinum, Charles University Press, Prague.

A new species of the genus *Melanagromyza* (Diptera, Agromyzidae) from eastern England

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Summary

A new species, *Melanagromyza moatesi* sp. n. (Diptera, Agromyzidae) is described. Several adults were reared from puparia obtained from the stems of *Eupatorium cannabinum* from various sites in eastern England, Great Britain. A description of the larval stages and adult is given, along with comparisons with similar species.

Introduction

During the winter of 2019, photographs of puparia obtained from the stems of hemp-agrimony (*Eupatorium cannabinum*) were sent to me by Graham Moates. The puparia evidently belonged to the genus *Melanagromyza*, owing to being found in the pith of the stem and possessing a strong central horn on each of the adjoining posterior spiracles. In Britain, only *Melanagromyza eupatorii* Spencer, 1957 is known from this host plant genus but this species possesses posterior spiracles which are separated, with a very short central horn, much different to that in the images provided.

As the host plant belongs in the Asteraceae, the known British species *Melanagromyza aeneoventris* (Fallén, 1923), *M. dettmeri* Hering, 1933, *M. eriolepidis* Spencer, 1961, *M. lappae* (Loew, 1850), *M. oligophaga* Spencer, 1990 and *M. tripolii* Spencer, 1957 were considered. Amongst these species, only *M. dettmeri*, *M. eriolepidis*, *M. lappae* and *M. oligophaga* possess puparium features which agree with the material from *E. cannabinum*. The puparia were kindly sent to me for rearing to ascertain the species involved. Upon examination, the posterior spiracles possessed >23 bulbs around the strong central horn, which is more than in *M. dettmeri* [c15], *M. eriolepidis* [20-25], *M. lappae* [16-22] and *M. oligophaga* [c15]. Although the number of bulbs is often variable within individual *Melanagromyza* specimens (Warrington 2018), it was considered unlikely that any of the four species with similar posterior spiracles were the species involved here. In light of this, I advised Graham to collect more puparia to enhance the likelihood of successfully rearing adult male material. Over the coming weeks, Graham collected many puparia ex *E. cannabinum* stems from several sites across eastern England, most of which were sent to me for rearing.

A small number of the collected puparia were retained indoors in the hope adult material may be forced into emerging, whilst the majority were retained in rearing jars and left in an unheated outbuilding until the end of February/early March.

On 13 March 2019, an adult male emerged from the puparia retained indoors. Initially, the key by Spencer (1976) was utilised, with the specimen running to couplet 14, with *Melanagromyza aenea* (Meigen, 1830) the determination based upon the specimen possessing proclinate orbital setulae. However, as this species has a puparium with posterior spiracles separated by their own diameter, along with a very different host plant family, this was considered highly unlikely. Allowing for variation of the squamal fringe colouration [this feature is often unreliable or misinterpreted], the specimen runs to couplet 4; *Melanagromyza angeliciphaga* Spencer, 1969 or *M. tripolii*. Again, owing to the puparium details [and in the case of *M. angeliciphaga*, a different host plant family], these two species were not considered to be the specimen reared from *E. cannabinum*.

The key in Papp and Černý (2015) was then used, with the specimen running to couplet 20, where *M. eupatorii* or *M. tschirnhausi* Pakalniškis, 1996 were the options. The former species was not considered owing to the greatly different posterior spiracles, whilst the latter was also considered unlikely owing to the host plant family [Lamiaceae]. Again, allowing for variation of the squamal fringe, the specimen runs to couplet 3, where *M. artemisiae* Spencer, 1957 or *M. tripolii* are the options; *M. artemisiae* was not considered owing to it possessing only 12 bulbs around a short horn.

Spencer's generic revision key (1966) was next, with the options being [allowing for either pale or dark squamal fringe] *M. aenea*, *M. angelicae* (Frost, 1934), *M. artemisiae*, *M. eupatorii* or *M. ferulae* Spencer, 1966. The host plant family and posterior spiracle details ruled out *M. angelicae* whilst *M. ferulae* was considered unlikely owing to frons and arista detail.

The male genitalia were examined in detail, with the phallus not agreeing with any of the eleven species listed above. Discussions with Michael von Tschirnhaus (MvT) resulted in *M. limata* Spencer, 1971, a species known from Britain, being considered, owing to the proclinate orbital setulae and similar genitalia, albeit with a different host plant family. Spencer's holotype and paratype, collected from North Wales, were loaned from the Natural History Museum, London for comparison. Detailed morphological and genitalia examination of the male holotype [and female paratype] confirmed that the species reared from *E. cannabinum* is not *M. limata* and the differences are discussed within this paper.

The genitalia of *M. limata* are depicted by Spencer (1971, 1990) in a suboptimal position, being too sharp. A more accurate representation is that by Koçak and Sasakawa (2011); however, their illustration of the left surstylus from its inner side has a small 'spine' at the right edge; this does not exist and is actually the attachment to the hypandrium. In lateral view, the phallus of the specimen reared from *E. cannabinum* does resemble their *M. limata*; however, from below, the differences are obvious. The Koçak and Sasakawa *M. limata*, reared from *Heracleum platytaenium* in Turkey, has the puparium with posterior spiracles separated, with an ellipse of 9 or 10 bulbs around the short central horn, disagreeing with the adult reared from *E. cannabinum*. Based on the account of Koçak and Sasakawa, the species from *E. cannabinum*, again, was considered not to be *M. limata*.

Due to other features discussed by Koçak and Sasakawa [number of *ori*, postero-dorsal bristles on mid tibia, wing length, ejaculatory apodeme], there is a distinct possibility their *M. limata* is actually an undescribed species, mistakenly identified as *M. limata* on the basis of the host plant and similar genitalia. Attempts were made to obtain these specimens but unfortunately, the authors have not been able to locate them.

Melanagromyza limata is stated to utilise *Heracleum sphondylium* as a host based on adults reared by S. Derji, a Ph.D student at Cardiff University (Spencer 1990). It may be that these specimens are not conspecific with *M. limata* type material and are actually the same as the Koçak and Sasakawa specimens [and specimens in the collection of MvT determined as *M. limata*]. Unfortunately, the specimens reared by Derji have not been located [understood to be stored at Oxford Museum of Natural History, England]. Therefore, clarification on these *Melanagromyza* from *Heracleum*, regrettably, is not possible at this time.

The keys and publications discussing a further 18 valid Palaearctic *Melanagromyza* species were utilised (Černý 2007, Guglya 2016, Pakalniškis 1996, Sasakawa 1988, Sasakawa 1993, Sasakawa 2015, Spencer 1974, Warrington 2018, Wenn 1985 and Zlobin 2005), with all descriptions and illustrations checked; none was considered to be the species described here. *Melanagromyza* species with similar genitalia from other regions were also checked (Spencer 1977, Spencer and Steyskal 1986, Shi and Gaimari 2015), with no species found to possess identical genitalia and proclinate orbital setulae.

Detailed images and notes, along with reared adults, were sent to MvT and Miloš Černý, who confirmed that the specimen must be an undescribed species.

In total, 32 [19♂, 13♀] adults were successfully reared [three others also reared but these failed to mature] from eleven locations in the east of England, with just two parasitoids emerging and treated below.

Melanagromyza moatesi Warrington sp. n.

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Description

Head: Frons, 1.5x width of eye, projecting above eye in profile, with 2 strong reclinate *ors*, the lower being slightly shorter, often slightly incurved [4 specimens possessed 3 *ors* on one or both sides], with 3 or 4 strong, incurved *ori* [in 32 specimens, 15 possessed 3 *ori*, 16 possessed 4 *ori*, 1 possessed 5 *ori*]. Orbital setulae long, numerous [not as dense as *M. limata* type material] and entirely proclinate [with some infrequently erect at level of lunule but never reclinate], in a single row at level of upper *ors*, increasing to two rows between lower *ors* and upper *ori* and often three rows at lower *ori*.

Eye in male with patch of white pubescence at level of *ors*; in female, less so but still present. Gena broad, slightly deeper in centre below eye, 1/3 height of eye (measured in all 32 specimens). Cheeks forming a distinct ring below eye. Orbits wide with lunule broad, semi-circular, with a slight central furrow (Fig. 1) [present in 25 specimens]. Ocellar triangle reaching to level of lower *ors*, sometimes to upper *ori*. Third antennal segment small, rounded, with short pubescence, not longer than the basal section of the arista. Palpi and proboscis without peculiarities.

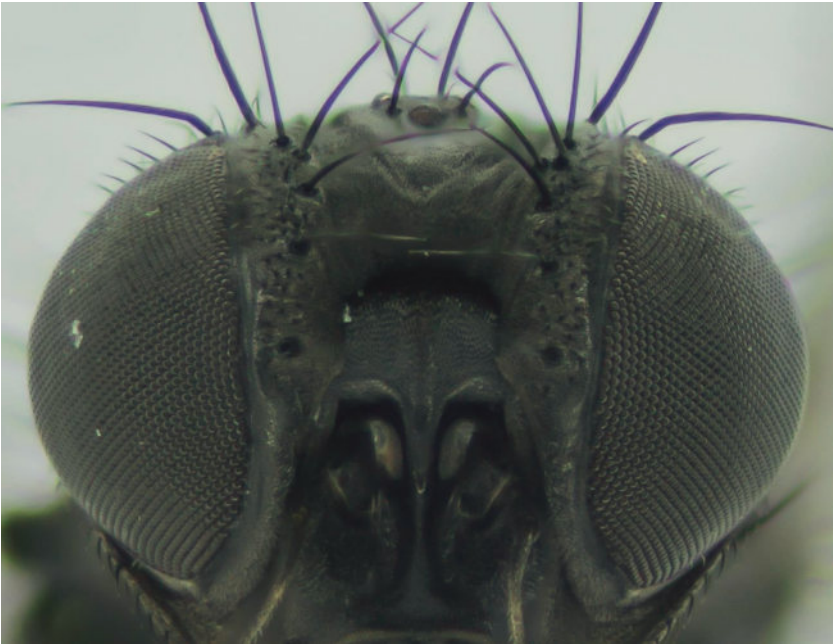


Fig. 1. Frontal view of male *Melanagromyza moatesi* sp. n.

Mesonotum: 2 strong dorsocentral [*dc*] bristles, with acrostichals in 10 rows at front, reducing to 5-6 rows at level of first *dc*. No setulae detected on or at the side of the scutellum.

Wing: (Fig. 2) hyaline, length 2.7mm-2.9mm in male, 2.8mm-3.2mm in female, with costa extending to vein M_{1+2} . All veins ochre-brown. Distal section of vein R_{4+5} possesses three [27 specimens possessed three, five specimens possessed two] small dots [Fig. 2], each carry one sensillum. Ultimate section of vein M_{3+4} 0.75 that of the penultimate; this feature was measured in all reared specimens, with the results summarised in the table below:

Length of ultimate section of vein M_{3+4} to penultimate	No. of males	No. of females	Total
0.50 – 0.69	2	0	2
0.70 – 0.79	14	8	22
0.80 – 0.89	3	4	7
0.90 – 0.99	0	0	0
Both sections equal	0	1	1
TOTAL	<u>19</u>	<u>13</u>	<u>32</u>

Costal sections (2-4) of all specimens were measured, with an average ratio of 100:24:22.



Fig. 2. Wing of *Melanagromyza moatesi* sp. n., with vein R_{4+5} sensilla indicated.

Colour: Frons matt black, with a slight grey tinge. Orbits and ocellar triangle only moderately shining, paler than frons. Lunule lighter than frons, grey-black. Gena blackish-brown, palpi black. Third antennal segment and arista black. Mesonotum matt, greyish-black but with a distinct metallic, coppery-green shine. Abdomen weakly to moderately shining, greenish, more so in female. Squama (Fig. 3) whitish-grey, with margin orangey-brown, fringe dark, brownish, the hairs dark basally but becoming paler [in *M. limata* type material, margin is pale orange, yellowish, with fringe much paler, almost white in female]. Legs all black, with 2 postero-dorsal setae on mid tibia [4 specimens possessed an additional, smaller seta on one side]. Halteres black, sometimes slightly brownish.

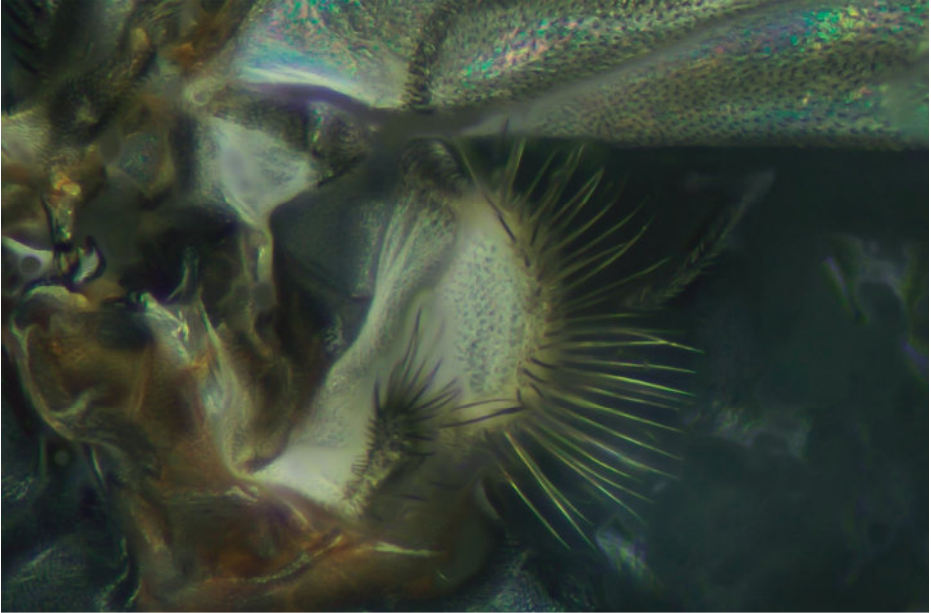


Fig. 3. Squama detail showing brown margin and dark fringe.

Male genitalia: Phallus distinctive (Figs 4 and 5) with conspicuous gap between basiphallus [U-shaped] and distiphallus complex. Distiphallus spinulose internally in dorsal lobes, extremely noticeable when viewed from above (Fig. 5 upper). Distal tubule membranous but extremely weak, appearing absent compared to other *Melanagromyza* species.

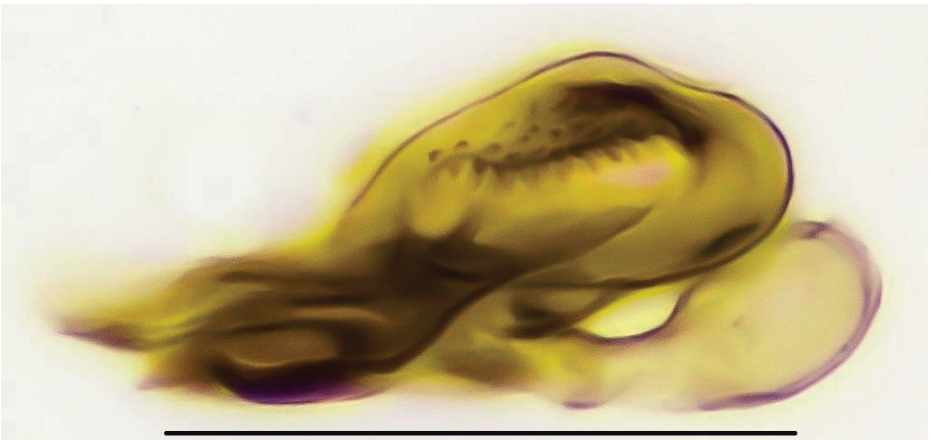


Fig. 4. Distiphallus of male *Melanagromyza moatesi* sp. n. in left lateral view (with tip left). Scale bar: 0.1mm.

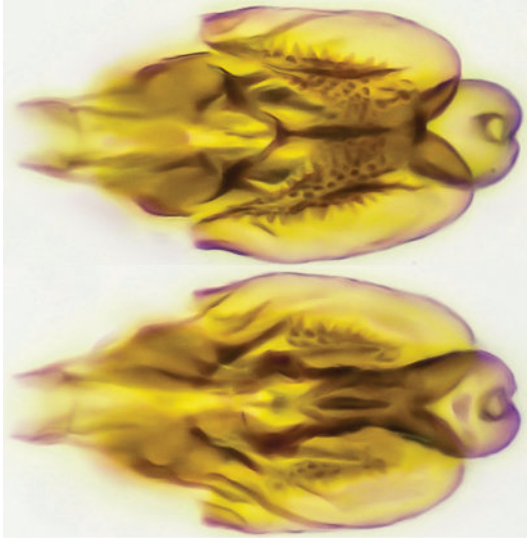


Fig. 5. Distiphallus of male *Melanagromyza moatesi* sp. n.; upper, viewed from above; lower, viewed from below.

The distiphallus of *M. limata* holotype (Fig. 6), despite being mounted in a less than optimal position, is substantially different to that of *M. moatesi* sp. n.

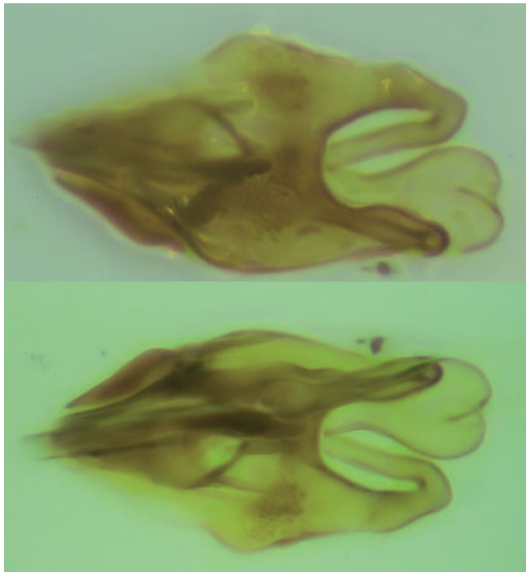


Fig. 6. Distiphallus of *M. limata* holotype; upper, viewed from above; lower, viewed from below.

Epandrium (Fig. 7, left) hemispherical, covered with sparse setae, surstylus with a small group of long setae on the ventral margin, with numerous spines [25-31] on the inner surface. Cerci club-shaped, with a few long thin setae ventrally and a group of strong setae on the inner margin. Hypandrium (Fig. 7, centre and right) with broad arms.



Fig. 7. *Melanagromyza moatesi* sp. n. outer genitalia (not to scale): left, epandrium in caudal view; centre, epandrium/hypandrium complex viewed from above; right, epandrium/hypandrium complex from below.

Ejaculatory apodeme (Fig. 8, left) rod-like, slightly broadened, much different to the ejaculatory apodeme of *M. limata* holotype (Fig. 8, right).

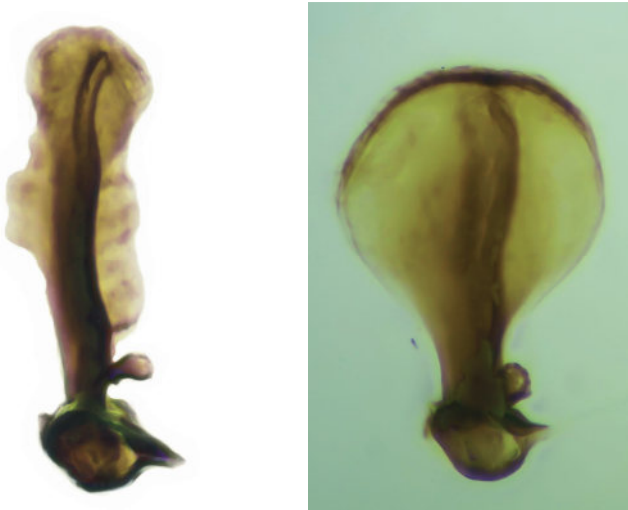


Fig. 8. Ejaculatory apodeme left lateral view; left *Melanagromyza moatesi* sp. n.; right, *M. limata* holotype.

The ejaculatory apodeme of *M. limata* reared by Koçak and Sasakawa is extremely similar to that of *Melanagromyza moatesi* sp. n., not agreeing with the *M. limata* holotype. Although the ejaculatory apodeme can show considerable variation amongst individual specimens, the difference supports the suggestion that theirs may indeed belong to a separate species.

Female genitalia: Egg guides (Fig. 9), relatively narrow, 6.1-6.3x as long as maximum width (measured in three females), acute apically, with the central and ventral part of medial membrane sparsely covered with small, orange-brown, spinules, these never reaching dorsal edge. Spermathecae (Fig. 10) unequal in size, dark brown, almost black, both possessing a collar of curved projections.



9



10

Figs 9-10. *Melanagromyza moatesi* sp. n. female genitalia (not to scale): 9, left egg guide viewed from outside, serrated dorsal edge top of image; 10, spermathecae.

Early stages: Puparium (Fig. 11) orange-yellow, 2.9-3.5mm in length; posterior spiracles [Fig. 12] virtually adjoining, each with an ellipse of 23-29 elongate pores on bulbs around a strong central horn. The number of pores on the posterior spiracles is variable; the following table shows the number of pores present on the left and right spiracle of twenty specimens.



Fig. 11. *Melanagromyza moatesi* sp. n. puparium.

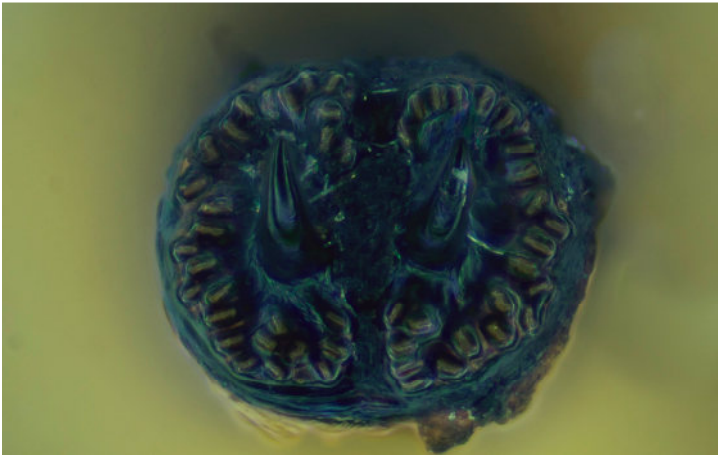


Fig. 12. *Melanagromyza moatesi* sp. n. posterior spiracles.

	Spiracle		Adult	Spiracle	
	Left	Right		Left	Right
Adult	No. of pores		No. of pores		
1 ♂	23	25	11 ♀	24	23
2 ♂	24	25	12 ♀	23	23
3 ♂	24	26	13 ♀	24	26
4 ♂	25	23	14 ♀	26	23
5 ♂	24	27	15 ♀	24	25
6 ♂	27	26	16 ♀	26	24
7 ♂	25	29	17 ♀	23	25
8 ♂	26	29	18 ♀	28	24
9 ♂	25	23	19 ♀	27	24
10 ♂	24	23	20 ♀	26	25

Host plant: *Eupatorium cannabinum*.

To estimate how frequent puparia are, twenty stems were gathered, at random, from one collecting site, with 6 stems containing *M. moatesi* sp. n. puparia [2 stems containing puparia of *M. eupatorii*]. The results are shown in the table below;

Stem	Height of stem (mm)	No. of puparia present	Height of puparia from base (mm)	Species
1	1770	2	90 / 120	<i>M. moatesi</i> sp. n.
2	1680	-	-	
3	1570	1	130	<i>M. moatesi</i> sp. n.
4	1640	-	-	
5	1840	1	40	<i>M. moatesi</i> sp. n.
6	1770	-	-	
7	1780	-	-	
8	1770	2	170 / 210	<i>M. moatesi</i> sp. n.
9	1640	-	-	
10	1910	2	110 / 140	<i>M. moatesi</i> sp. n.
11	1670	-	-	
12	1710	-	-	
13	1560	-	-	
14	1710	1	10	<i>M. eupatorii</i>
15	1620	1	60	<i>M. eupatorii</i>
16	1800	-	-	
17	1640	-	-	
18	1670	-	-	
19	1580	1	120	<i>M. moatesi</i> sp. n.
20	1720	1	160	Lost

Biology: Unknown in detail. Larva feeding in the pith of the stem, pupariating therein. One or two larvae per stem, with pupariation occurring low down the stem. Puparia January to May [puparia were collected 12 May 2019 which were still to eclose, with two adults subsequently emerged 17/22 May 2019], although the true phenology of this species cannot be ascertained until additional studies are undertaken.

Collection sites: Adults were successfully reared from stems collected at eleven sites across eastern England, all with a similar biotope. The collecting sites [see table below] span from South Walsham, East Norfolk, to Wicken Fen, Cambridgeshire, a range of 90km. indicating that this species is rather widespread and may well be present elsewhere in the country if searches were conducted.

Puparia, agreeing with *M. moatesi* sp. n., were found in *E. cannabinum* stems at an additional location, Sculthorpe, Norfolk, TF901302; unfortunately, no adults were successfully reared to confirm the species involved but it is highly probable they were the species described here.

Location	Grid reference	Habitat
Betty's Fen, Blo' Norton, Norfolk	TM016791	Wet lowland fen, fringed by alder (<i>Alnus</i>)/willow (<i>Salix</i>) woodland.

Buckenham Carrs, Norfolk	TG361055	Private site with wet woodland in the Broads National Park.
Fairhaven Woodland & Water Gardens, South Walsham, Norfolk	TG366135	Wet woodland with drainage dykes.
Foulden	TF763000	Birch (<i>Betula</i>) woodland and lowland fen.
SWT Lackford Lakes, Suffolk	TL799706 TL801708	Naturalised former gravel workings, now a nature reserve with lakes, streams, drainage ditches and wet woodland.
Thelnetham New Fen, Suffolk	TM013787	Lowland fen under restoration.
Bleyswyck's Bank, Thelnetham, Suffolk	TM015789	Riverside surrounded by wet lowland fen and meadows.
Thetford, Norfolk	TL874824	Riverbank with wet woodland.
Thorpe Woodlands, Norfolk	TL944841	Riverbank with wet woodland.
Wheatfen, Norfolk	TG325056	Nature reserve in the Broads National Park with reedbeds, wet woodland and drainage dykes.
Wicken Fen, Cambridgeshire	TL563704	Extensive reedbed habitat.

Host-range and distribution: *Eupatorium cannabinum*, commonly referred to as hemp-agrimony, is a perennial herb found on base rich soils in a wide range of damp or wet habitats, including marginal vegetation by ponds, rivers and canals, tall-herb fen, fen-meadows, marshes, wet woodland, mires and wet heath. It is infrequent in dry habitats, but may be found in dry woods and on hedge banks, on waste ground and even on dry chalk banks.

Etymology: It is with great pleasure that I name *Melanagromyza moatesi* after Graham Moates, who discovered its puparia, went to great lengths to obtain material from various sites across eastern England and has shown a keen interest in the larval stage of the Agromyzidae in recent times.

Additional comments

With its distinctive genitalia, *Melanagromyza moatesi* sp. n. is relatively easy to separate from other *Melanagromyza* spp. with similar key morphological features, although females may pose more of a problem. As the host plant is relatively common in most parts of Britain, it will be interesting to see if this species is present elsewhere, or if it is genuinely restricted to the eastern parts of the country. Only two parasitoids were reared; ♀ *Chorebus cylindricus* (Telenga, 1934), a known parasitoid of *Melanagromyza* species and ♀ *Sphegigaster nigricornis* (Nees, 1834), a species whose group have been reared from *Melanagromyza*, though not commonly (Charles Godfray *pers. comm.*).

Type material: Holotype ♂ ENGLAND, West Suffolk, V.C. 26, SWT Lackford Lakes TL801708 (52.306042 0.64051110), emerged 13 March 2019, ex puparium collected G. Moates, 30 January 2019. Pinned, with its puparium in a gelatin capsule and genitalia preparations in Euparal pinned below the specimen. Deposited at Natural History Museum, London.

Paratypes: 2♂ [England, Fairhaven, TG366135, coll. G. Moates 23 March 2019, emerged 17 April 2019 – specimen not dissected / England, Betty's Fen, TM016791, coll. G. Moates 11 March 2019, emerged 09 April 2019] and 2♀ [England, Thorpe Woodlands, TL944841, coll. G.

Moates 22 February 2019, emerged 18 March 2019], NHM London; 1♂ [England, Wicken Fen, TL563704, coll. G. Moates 28 March 2019, emerged 14 April 2019] and 1♀ [England, Fairhaven, TG366135, coll. G. Moates 23 March 2019, emerged 14 April 2019] in the private collection of Michael von Tschirnhaus (Germany); the remaining 25 specimens (not paratypes) in the private collection of BPW.



Fig. 13. *Melanagromyza moatesi* sp. n. male.

Acknowledgements

I am extremely thankful to Graham Moates for all his work gathering site information, his correspondence and allowing me to retain the reared specimens. I would also like to thank Dr Michael von Tschirnhaus (University of Bielefeld, Germany) for his considerable correspondence, Miloš Černý (Halenkovice, Czech Republic) for taking the time to examine and

provide his opinion on the specimen, Nigel Wyatt (NHM, London, U.K.) for the loan of type material and Professor Sir Charles Godfray (Oxford Martin School, Oxford, U.K.) for determining the parasitoids.

References

- Černý, M. 2007. Description of eight new species of Agromyzidae (Diptera) from North Korea, including new records. *Studia dipterologica* **14**(1), 209-229.
- Koçak, E. and Sasakawa, M. 2011. Two new species of *Melanagromyza* (Diptera: Agromyzidae), with descriptions of immature stages from *Heracleum* (Apiaceae) and new records from Turkey. *Entomological News* **121**(2010)(3), 262-266.
- Guglya, Yu. A. 2016. Four new species of the genus *Melanagromyza* (Diptera, Agromyzidae) from Ukraine. *Vestnik zoologii* **50**(5), 407-414.
- Pakalniškis, S.A. 1996. The Lithuanian Agromyzidae (Diptera). Description of 4 new species and other notes. *Lietuvos entomologu darbai. Lietuvos entomologu draugijos 30-mečiui, 1996* (= *Research of Lithuanian Entomologists. To the Thirty Years of Lithuanian Entomological Society, 1996*) pp 17-34. Institute of Ecology, Lithuanian entomological Society, Vilnius.
- Papp, L. and Černý, M. 2015 *Agromyzidae (Diptera) of Hungary*. Volume 1. Agromyzinae. 416 pp. Pars Ltd, Nagykövácsi.
- Sasakawa, M. 1961. A Study of the Japanese Agromyzidae (Diptera). Part 2. *Pacific Insects* **3**(2-3), 307-472.
- Sasakawa, M. 1988. The Agromyzidae (Diptera) of China (Part 4). *Proceedings of the Japanese Society of systematic Zoology* **38**, 51-56.
- Sasakawa, M. 1993. Notes on the Japanese Agromyzidae (Diptera), 1. *Japanese Journal of Entomology* **61**(1), 149-155.
- Sasakawa, M. 2015. Notes on the Japanese Agromyzidae (Diptera), 6. *Scientific Research of the Kyoto prefectural University, Life & environmental Sciences* **67**, 9-48.
- Shi, Li and Gaimari, S.D. 2015. Revision of the genus *Melanagromyza* in California, with descriptions of three new species (Diptera: Agromyzidae). *Zootaxa* **4005**(1), 1-102
- Spencer, K.A. 1966. A revision of European species of the genera *Melanagromyza* Hendel and *Hexomyza* Enderlein, with a supplement on the genus *Ophiomyia* Braschnikov. *Beiträge zur Entomologie* **16**(1/2), 3-60.
- Spencer, K.A. 1971. Notes on a revision of the British Agromyzidae (Diptera), including the description of 14 new species. *Entomologist's Gazette* **22**(3), 141-195.
- Spencer, K.A. 1973. *Agromyzidae (Diptera) of Economic Importance*. 418 pp. Series entomologica Volume 9. Dr. W. Junk B.V., The Hague.
- Spencer, K.A. 1974. Some Agromyzidae (Diptera) from Israel. *Israel Journal of Entomology* **9**, 141-157.
- Spencer, K.A. 1976. *The Agromyzidae (Diptera) of Fennoscandia and Denmark*. Fauna entomologica scandinavica, **5**(in two parts), 1-304, 305-606.
- Spencer, K.A. 1977. A revision of the Australian Agromyzidae (Diptera). *Western Australian Museum Perth Special Publication* **8**, 3-255.
- Spencer, K.A. 1990. *Host Specialization in the World Agromyzidae (Diptera)*. xii + 444 pp. Kluwer Academic Publishers, continued as Springer Science + Business Media Netherlands.
- Spencer, K.A. and Steyskal, G.C. 1986. Manual of the Agromyzidae (Diptera) of the United States. *United States Department of Agriculture, Agricultural Research Service: Agriculture Handbook* **638**, 1 + VI + 478 pp.

- Warrington, B.P. 2018. *Melanagromyza galegae* sp. n. (Diptera, Agromyzidae) from Hull, East Yorkshire, Great Britain. *Dipterists Digest (Second Series)* **25**, 119-131.
- Wenn, C.T. 1985. Notes on three new stem miners (Diptera: Agromyzidae). *Entomotaxonomia* **7**(2), 109-113.
- Zlobin, V.V. 2005. A new species of *Melanagromyza* feeding on giant hogweed in the Caucasus (Diptera: Agromyzidae). *Zoosystematica rossica* **14**(1), 173-177.

Appendix: Summary of measurements (numbers refer to ocular micrometer reading) taken from 19♂ and 13♀.

Sex	ors	ori	Eye: jowl	Vein M ₃₊₄ ratio	M ₃₊₄ ult. to penult.	Costal sections 2 : 3 : 4	dc	acr at front	acr at 1 st dc	Lunule with furrow	Pores on spiracles	
											L	R
♂	2	4	12:04	15:12	0.80	30:07:06	2	10	6	Y	23	25
♂	2	4	16:05	19:11	0.58	31:06:05	2	10	5	Y	24	25
♂	2	4	17:06	11:08	0.73	20:05:04	2	10	6	Y	24	26
♂	2	3	15:05	20:15	0.75	40:10:09	2	10	8	Y	25	23
♂	2	4	13:04	19:11	0.58	28:07:07	2	10	6	Y	24	27
♂	2	4	14:05	10:07	0.70	20:05:04	2	10	6	N	27	26
♂	2	4	14:05	15:11	0.73	29:07:06	2	10	6	Y	25	29
♂	2	3	14:05	18:14	0.78	35:08:07	2	10	6	Y	26	29
♂	2	3	12:04	16:12	0.75	31:07:06	2	10	6	Y	25	23
♂	2	3	14:04	11:08	0.73	32:07:06	2	10	6	Y	24	23
♂	2	3	14:04	14:10	0.71	30:07:07	2	10	6	Y	-	-
♂	2	4	15:05	13:10	0.77	26:07:06	2	10	6	Y	-	-
♂	2	3	20:06	16:13	0.81	34:08:06	2	10	6	N	-	-
♂	2	4	16:06	24:18	0.75	41:11:10	2	10	6	N	-	-
♂	2	3	18:06	17:13	0.76	35:08:08	2	10	6	N	-	-
♂	2	4	18:06	18:13	0.72	35:09:07	2	10	6	Y	-	-
♂	3	3	21:07	19:14	0.74	41:10:09	2	10	6	Y	-	-
♂	3	3	14:04	18:14	0.78	37:09:08	2	10	6	Y	-	-
♂	2	4	12:04	15:12	0.80	32:08:07	2	10	6	Y	-	-
♂	2	5	12:05	12:09	0.75	25:06:05	2	10	6	Y	24	23
♂	2	4	15:05	12:09	0.75	23:06:05	2	10	6	Y	23	23
♂	2	3	16:05	19:14	0.74	38:09:08	2	10	6	Y	24	26
♂	2	4	12:04	11:11	1.00	31:07:06	2	10	6	Y	26	23
♂	2	4	19:06	16:14	0.88	36:09:08	2	10	6	Y	24	25
♂	2	3	18:05	20:15	0.75	41:10:09	2	10	6	N	26	24
♂	2	3	16:05	12:10	0.83	27:06:06	2	10	6	N	23	25
♂	2	3	20:06	12:09	0.75	37:09:08	2	10	6	Y	28	24
♂	2	4	19:06	13:10	0.77	28:07:06	2	10	6	Y	27	24
♂	2	4	14:04	18:15	0.83	38:09:09	2	10	6	Y	26	25
♀	3	4	14:04	19:15	0.79	39:10:08	2	10	6	Y	-	-
♀	3	3	13:03	15:12	0.80	30:08:07	2	10	6	Y	-	-
♀	2	3	13:04	19:14	0.74	42:10:08	2	10	6	N	-	-

***Achyrolimonia neonebulosa* (Alexander) (Diptera, Limoniidae) – a new crane fly for the British List** – On 25 September 2019, photographs of a male specimen of *Achyrolimonia neonebulosa* (Alexander, 1924) were posted on the Dipterists Forum website by MJ (Fig. 1). The adult fly had emerged from its pupa (Fig. 2) on 24 September in Bradwell (V.C. 25, East Suffolk, TG5004), from the compost of a plant pot containing an imported plant of *Sarracenia* (a carnivorous pitcher plant) which was purchased from South View Nurseries, Beccles Road, Fritton, Great Yarmouth (V.C. 25, TG4801) on 29 August 2019.



Figs 1-2, *Achyrolimonia neonebulosa*: 1, dorsal view of male; 2, pupa (Photo MJ).



Figs 3-4, posterior abdomen: 3, *Achyrolimonia neonebulosa*; 4, *A. decemmaculata* (Photo JK).

The assumption is that the larva must have been present in the compost which was imported from the Netherlands, although there are a number of other logical possibilities. It is worth noting that the first Dutch record in January 2005 was from a glass house in Naaldwijk used for growing orchids (Oosterbroek, P. 2009. New distributional records for Palearctic Limoniidae and Tipulidae (Diptera: Craneflies) mainly from the collection of the Zoological Museum, Amsterdam. *Zoosymposia* 3, 179-197). The section where the carnivorous plants are housed in South View Nurseries also houses orchids and so *A. neonebulosa* may be established there, and in other nurseries, and be populating other pots as well.

The specimen was identified from the male genitalia which contrast strongly with the established British species, *A. decemmaculata* (Loew, 1873) (Figs 3-4). The wing pattern is similar to *A. decemmaculata* (Figs 5-6) and it is well worth examining the genitalia of any specimens previously identified as *A. decemmaculata* (Fig. 5) in case there has been a misidentification.



Fig 5. *Achyrolimonia neonebulosa* wing (Photo MJ).



Fig. 6. *Achyrolimonia decemmaculata* wing (Photo JK).

This is the first British record for this species, which in nature inhabits woodland. It has a very widespread (Holarctic) distribution, and records range from the United States (Massachusetts) across Europe and Asia to China and Japan – **MICHAEL JAMES**, 41, Holly Avenue, Bradwell, Great Yarmouth, Norfolk NR31 8NL, and **JOHN KRAMER**, 31, Ash Tree Road, Oadby, Leicester LE2 5TE

***Sciapus pallens* (Wiedemann) (Diptera, Dolichopodidae) new to Britain**

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Summary

Sciapus pallens (Wiedemann, 1830) has been recorded from the Wildlife Garden of the Natural History Museum in London, which is the first British record of this species. Sixteen male specimens were caught in a Malaise trap in the summer of 2018. A review of earlier Malaise samples found a single male that was caught in May 2013. It therefore seems likely that a population has been present since at least 2013 and has increased in size over time.

Introduction

Sixteen males of *Sciapus pallens* (Wiedemann, 1830) were found in a Malaise trap sample from the Wildlife Garden of the Natural History Museum in London (TQ265790). These specimens were collected between 18 June and 16 July 2018. The same sample contained 377 *Sciapus platypterus* (Fabricius, 1805) consisting of 175 males and 202 females. No female *Sciapus pallens* were present in the sample. This discovery prompted a review of other Malaise trap samples from the same location and found a single male that was caught between 22 and 29 May 2013. Once again *Sciapus platypterus* was common in the sample although the precise number of individuals was not counted. A Malaise trap had been occasionally set for short periods in the same location between 2013 and 2019. No more *Sciapus pallens* were found in other samples that had already been processed; however, it is possible more specimens may be found in samples yet to be sorted into taxonomic groups.

Identification

Specimens were provisionally identified as *Sciapus pallens*, using an unpublished key to British *Sciapus* produced by Martin Drake. This key includes notes on the males, based on Meuffels and Grootaert (1990), of some non-British species and states that “*pallens* has fourth joint of front tarsus milky white, slightly broadened and laterally compressed, antennae yellow with third joint brown at tip dorsally, front coxa with yellow hairs and without bristles even at tip, hypopygium organ X very slender”. This description matches the Wildlife Garden specimens (Figs 1-5) and the same identification was arrived at by keying them out in Parent (1938), Meuffels and Grootaert (1990) and Grichanov and Negrobov (2014). In addition, Martin Drake and Marc Pollet both examined specimens from the Malaise sample and confirmed they were *Sciapus pallens*.

In the key to British Dolichopodidae (d’Assis-Fonseca 1978) male *S. pallens* runs to couplet 3 (page 82) which separates *S. loewi* (Becker) (= *S. contristans* (Wiedemann)) and *S. wiedemanni* (Fallén). Male *Sciapus pallens* can be distinguished from both these species by the 4th front tarsomere (white and flattened) and by the absence of bristles on the front coxae. The fore tarsi of *S. contristans* are unmodified and the 4th tarsomere of *S. wiedemanni* has an obvious apical lobe projecting past the base of the 5th tarsomere. *Sciapus contristans* and *S. wiedemanni* also have erect pale bristles on the upper half of the front coxae, which are absent in *S. pallens*, although all three species have long pale hairs on the fore coxae.

Females of *Sciapus pallens* were not caught in the Malaise trap so are not covered in detail here; however, like the males they have yellow antennae with a brown tip to the third segment, a broad face and heavy dusting over the body giving them a dull metallic appearance. Any female

Sciapus with this combination of characters should be checked as they could potentially be *S. pallens*.



Fig. 1. Adult male *Sciapus pallens* from the NHM Wildlife Garden.



Fig.2. *Sciapus pallens* dorsal habitus.



Fig. 3. *Sciapus pallens* face.



Fig. 4. *Sciapus pallens* hypopygium.

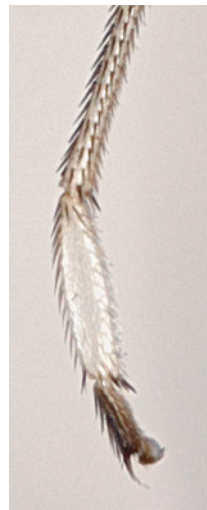


Fig. 5. *Sciapus pallens* fore tarsus.



Fig. 6. Wildlife Garden habitat where *Sciapus pallens* was captured, note the Darwin Centre of the Natural History Museum in the right background.

Distribution

Sciapus pallens has a reasonably wide distribution but appears to be either scarce or under-recorded across its range. In the Palaearctic, this species occurs across Western and Central Europe from the Azores to Israel and Ukraine, and in the Nearctic it ranges from Michigan to North Carolina (Negrobov 1991, Grichanov and Negrobov 2014). Most European records of *Sciapus pallens* are from around the Mediterranean, but a few records have been made closer to Britain. An old record exists for Belgium and more recently *S. pallens* was collected from Jersey in 1988 by Dr W.J. Le Quesne (St Peter, Le Marais de Saint Pierre, 7.ix.1988). This record from the Channel Islands is mentioned in an unpublished manuscript on the Dolichopodidae of Jersey, drafted by the late Peter Dyte, who wrote:

Although S. pallens has not been reported from mainland Britain, it is known from France. However, it appears to be rare. The only French locality given by Parent (1938) is Calvados, and that record seems to be based on a single specimen taken by Poisson at Caen at the end of June 1927 (Poisson 1927; Mercier and Parent 1928). There is also an even older record from Villers-la-Ville, Belgium (about 20 miles SE of Bruxelles) (Collart 1935). Other European records appear to be from the Mediterranean. I took a male at Cap d'Ail, Alpes Maritimes, France on 14.iv.1960, and there are also records from the Balearics, Greece and Yugoslavia. The species was described from New York, and is now known from five states on the eastern seaboard of the U.S.A. It sometimes occurs indoors.

Habitat

As the ecology of *Sciapus pallens* is largely unknown, it may be useful to describe the environment in which these specimens were captured. The Wildlife Garden occupies an area of approximately 4000 m² and contains a mosaic of lowland habitat types (Honey *et al.* 1998). The Garden was completed and opened to the public in 1995 and has been actively managed to encourage local biodiversity since that time. The *Sciapus pallens* specimens were caught in an open thicket of young trees on the boundary of a wildflower meadow and a hedgerow (Fig. 6).

The thicket consists of young ash *Fraxinus excelsior* and hornbeam *Carpinus betulus* trees with lesser burdock *Arctium minus* and bedstraws *Galium* sp. growing beneath them. The dominant grasses of the meadow are Yorkshire fog *Holcus lanatus*, perennial rye-grass *Lolium perenne*, rough meadow-grass *Poa trivialis*, false brome *Brachypodium sylvaticum* and crested dog's-tail *Cynosurus cristatus*, while the dominant forbs are meadow cranesbill *Geranium pratense*, bulbous buttercup *Ranunculus bulbosus*, white clover *Trifolium repens* and yellow-rattle *Rhinanthus minor*. The meadow is grazed by greyface Dartmoor sheep as part of its management. The hedge contains hawthorn *Crataegus monogyna*, rose *Rosa* sp., field maple *Acer campestre*, hazel *Corylus avellana*, holly *Ilex aquifolium* and sycamore *Acer pseudoplatanus*. A mature Lombardy poplar *Populus nigra* 'italica' lies in the hedge line close to where the Malaise trap was set. The preponderance of mature London plane *Platanus x hispanica* around the site perimeter produces a heavy leaf fall in the autumn but this is mostly cleared away by staff and volunteers as part of the Garden's management plan.

Discussion

Sciapus pallens is clearly established in the Wildlife Garden and might be expected to occur at other sites in London. The Wildlife Garden's location is arguably isolated. Although there are a number of green spaces relatively close-by (Hyde Park is 650 m away), their wildlife value may be variable and the intervening architecture in this part of London is typically five to six storeys high. Despite this, recording efforts over the past two decades have shown that a number of scarce and interesting species has been able to reach and colonise the Wildlife Garden, including

other species new to Britain (Ware *et al.* 2016). Although *Sciapus pallens* is generally scarce across its range it seems to have a good dispersal ability to be able to reach the Wildlife Garden. Higher local temperatures generated by London's heat island effect may have encouraged the establishment of a population in South Kensington (Howard, 1833; Oke *et al.* 2017).

The larvae of *Sciapus pallens* appear to be unknown and according to Smith (1989) the only British *Sciapus* species to have had its larvae described is *S. platypterus*, which were in the "ground below leaves" in a beech forest (Lundbeck 1912). Given the abundance of *S. platypterus* in the same Malaise sample as *S. pallens*, it could be possible they have a similar ecology; the larvae living in the top layer of the soil or in the leaf litter where they would almost certainly be predated on other invertebrates (d'Assis-Fonseca 1978). Obviously more investigation is needed to clarify the habitat requirements of *S. pallens*.

Acknowledgements

Thanks go to Martin Drake and to Marc Pollet for confirming the identification of *Sciapus pallens* and to Andrew Godfrey who kindly dug out and forwarded a copy of Peter Dyte's Jersey manuscript. As always thanks to the Wildlife Garden staff and volunteers who manage the site and facilitate biological recording there. All images of *Sciapus pallens* are of one individual specimen (NHMUK 012810486) and are copyright of the Trustees of the Natural History Museum, London.

References

- d'Assis-Fonseca, E.C.M. 1978. Diptera Orthorrhapha Brachycera Dolichopodidae. *Handbooks for the Identification of British Insects* **9** (5). Royal Entomological Society, London.
- Collart, A. 1935. Les Dolichopodides (Dipt.) de la collection de Jacobs. *Bulletin du Musée royal d'histoire naturelle de Belgique* **11**(17), 1-15.
- Gričanov, I. and Negrobov, O.P. 2014. Palaearctic species of the genus *Sciapus* Zeller (Diptera: Dolichopodidae). *All-Russian Institute of Plant Protection RAAS* **13**, 1-85.
- Honey, M.R., Leigh, C. and Brooks, S.J. 1998. The fauna and flora of the newly created Wildlife Garden of The Natural History Museum, London. *The London Naturalist* **77**, 17-47.
- Howard, L. 1833. *The climate of London: deduced from meteorological observations made in the metropolis and at various places around it*. Harvey and Darton, London.
- Lundbeck, W. 1912. *Diptera Danica. Part IV Dolichopodidae*. G.E.C. Gad, Copenhagen.
- Mercier, L. and Parent, O. 1928. Dolichopodidae (Diptères orthorrhapha brachycera) de Normandie et plus particulièrement du Calvados – Liste complémentaire. *Bulletin de la Société Linnéenne de Normandie. Série 7* Volume **10**, 85-91.
- Meuffels, H.J.G. and Grootaert, P. 1990. The identity of *Sciapus contristans* (Wiedemann, 1817) (Diptera: Dolichopodidae), and a revision of the species group of its relatives. *Bulletin de L'Institut Royal des Sciences Naturelles de Belgique, Entomologie* **60**, 161-178.
- Negrobov, O.P. 1991. Family Dolichopodidae. In Soós, Á. and Papp, L. (Eds) *Catalogue of Palaearctic Diptera. Vol. 7, Dolichopodidae–Platyezidae: 11-139*. Budapest: Akadémiai Kiadó.
- Oke, T.R., Mills, G., Christen, A. and Voogt, J.A. 2017. *Urban Climates*. Cambridge University Press, Cambridge.
- Parent, O. 1938. Diptères Dolichopodidae. *Faune de France* **35**. Paul Lechevalier et Fils, Paris.

- Poisson, R. 1927. Sur la présence de *Sciopus pallens* Wied. (Diptère Dolichopodidae) et de *Microdon* Meig. (Diptères Syrphidae) dans le département du Calvados. *Bulletin de la Société Linnéenne de Normandie*. Série 7 Volume **10**, 86-88.
- Smith, K.G.V. 1989. An Introduction to the immature stages of British flies. *Handbooks for the Identification of British Insects* Vol. **10** Part 14. Royal Entomological Society, London.
- Ware, C., Lowe, M. and Sivell, D. 2016. Further developments of the flora and fauna of the Wildlife Garden at the Natural History Museum, London: twenty years of species recording. *The London Naturalist* **95**, 45-159.

Meoneura neottiophila* Collin (Diptera, Carnidae) attracted to a giant puffball *Calvatia gigantea

— During 2019, I have made three visits to record Diptera in the churchyard of All Saints parish church (SU808545) at Fleet, Hampshire. On the second of these visits, on 12 July, two giant puffballs *Calvatia gigantea* were present, growing about 2 metres apart in open areas adjacent to graves. On the one furthest from the church, it was noticed that a number of very small black insects were running about rapidly in a random fashion over its surface. Three of these were netted and were later identified as males of the carnid *Meoneura neottiophila* Collin. On the subsequent visit on 17 October, the puffball nearer the church was still present, though now decayed, but there was no sign of the one that had attracted the flies.

While, like other species of *Meoneura*, *M. neottiophila* has mainly carrion feeding larvae, and has also been reared from bird nests, there have been several previous observations of an association with fungi, and it was recorded to have been reared from the bolete *Leccinum scabrum* in Finland by W. Hackman and M. Meinander (1979). Diptera feeding as larvae on macrofungi in Finland. *Annales Zoologici Fennici* **16**, 50-83).

I have previously reported this species to be present in numbers on oyster mushrooms *Pleurotus* species (1998. *Acartophthalmus bicolor* Oldenberg and *Meoneura neottiophila* Collin (Diptera, Acartophthalmidae and Carnidae) on *Pleurotus* caps. *Dipterists Digest (Second Series)* **5**, 29) and on dryad's saddle *Polyporus squamosus* (2002. Another fungus association for *Meoneura neottiophila* Collin (Diptera, Carnidae). *Dipterists Digest (Second Series)* **9**, 158). On both occasions only males were observed, and I suggested that they may be using the fungus caps as an assembly site, possibly connected with courtship, though in the absence of females this could not be confirmed. A photograph of a male of *M. neottiophila* has been placed on the *Diptera.info* site by Nigel Jones, with the comment that several were walking on a *Polyporus* fungus in Shropshire on 25 July 2017; this was at Haughmond Hill (SJ540134), deciduous woodland at the edge of a conifer plantation, and the fungus was *P. squamosus* growing from a cut sycamore trunk, lying on the ground – the 3 or 4 specimens caught were males (Nigel Jones *pers. comm.*).

J. Roháček and J. Ševčík (2013. Diptera associated with sporocarps of *Meripilus giganteus* in an urban habitat. *Central European Journal of Biology* **8**(2), 143-167) found this species to be common on *M. giganteus* sporocarps in parks within the Czech city of Opava; their rearings from this fungus did not include any carnids. Of 28 specimens caught at two locations over three visits, all but one were males, further supporting the above conclusions.

All the fungi on which adults have been observed are soft textured saproxylic species, while the one fungus from which rearing has taken place is terrestrial.

I thank Julie Locke for her assistance during my visits to the churchyard, and for encouraging me to investigate the insect fauna there, also Nigel Jones for information on his record – **PETER J. CHANDLER**, 606B Berryfield Lane, Melksham, Wilts SN12 6EL

The conopid fly *Myopa morio* Meigen (Diptera, Conopidae) new to the Belgian fauna

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Summary

Myopa morio Meigen, 1804 is recorded as new to Belgium. Its separation from allied species is discussed.

Introduction

During a spring excursion of the authors in the Belgian Ardennes, there were lots of *Myopa* species present. FvdM remarked that he caught, years back, a very small and entirely black *Myopa* species. After examining the specimen, we could identify it as *Myopa morio* Meigen, 1804, a new species for the Belgian fauna.

Recognition

Myopa morio is an entirely black species with a partly silver dusted body (Fig. 1). Therefore it does not resemble the other brown to red coloured *Myopa* Fabricius, 1775 species found in North-West Europe, excepting *Myopa occulta* Wiedemann in Meigen, 1824 (Fig. 2). Both these black *Myopa* species could be confused with *Thecophora* Rondani 1845 and *Myopotta rubripes* (Villeneuve, 1909). These differ from the two *Myopa* among other characters in having larger eyes and a proboscis that clearly extends beyond the mouth cavity.

The differences between the two black *Myopa* species are not always immediately obvious from photographs of live specimens. Therefore, we present a habitus photograph of collected specimens of the two species. A key based on Chvála (1965) is given to aid identification. Additionally, we present photographs illustrating the presence or absence of bristle rows on the femora.

Key to the black bodied *Myopa* species of Belgium

- 1a Gena with sparse long whitish hairs (Fig. 1); femora not thickened and without ventral rows of stout bristles (Fig. 3); palp short (shorter than second segment of proboscis); cell R₄₊₅ usually open at wing margin. Anal cell short..... *Myopa morio* Meigen, 1804
- 1b Gena bare (Fig. 2); femora thickened (Fig. 2) and with two ventral rows of stout black, short bristles at the ventral side (Fig. 4); palp as long as second segment of proboscis; cell R₄₊₅ usually closed at wing margin. Anal cell longer
..... *Myopa occulta* Wiedemann in Meigen, 1824

Material examined

1 ♀, 5-5-2005, lamb 1972; 165157-88357, Namur, Fagnolle, leg. F. Van de Meutter, col. E. de Bree

1 ♀, 4-5-2014, lamb 1972; 147642-84626, Hainaut, Étang de Virelles, leg. et. col. F. van de Meutter

1 ♀, 12-4-2017, lamb 1972; 147267-84637, Hainaut, Étang de Virelles, leg. et. col. J. Mortelmans

Distribution

In Europe, the species is known from Austria, Croatia, Czech Republic, France, Germany, Hungary, Italy, The Netherlands, Poland, Portugal, Slovakia, Spain, Switzerland, Turkey and Ukraine. Outside Europe, the species is reported from Armenia, Iran, Kyrgyzstan and Russia (Chvála 1961, Stuke *et.al.* 2012, Stuke 2017).

The capture of one specimen in the Netherlands is curious. Van Aartsen (1997) reported a single specimen from the Sint-Pietersberg in Maastricht with a date of 8 June 1995. Van der Goot (1977) mentioned in his key: “highly unlikely to occur in the Netherlands.” The specimen was caught with a Malaise trap (B. Brugge *pers. comm.*). That same trap yielded another species of Conopidae which is associated with forest habitats: *Leopoldius coronatus* (Rondani 1857). That species has been caught also in bordering Belgium (Bree *et. al.* 2015). Remarkable then that *M. morio* has, up to now, not been sighted in Belgium.



Fig. 1. Habitus of *Myopa morio*, Belgium 5.v.2005.



Fig. 2. Habitus of *M. occulta* from Greece.

Biology

The Dutch specimen from the Sint-Pietersberg has, among Dutch dipterists, been attributed to hilltopping, a behaviour where males of a species assemble on hilltops, and occupy a territory and await females. Mei *et. al.* (2010) reported on this behaviour in Conopidae. They mention *M. morio* as appearing not to be a hilltopping species.

All of the Belgian specimens were caught on the flowers of hawthorn *Crataegus monogyna* in deciduous forest or at the forest edge. Nothing is known about the immature stages. *Myopa morio* presumably is, like all known Belgian Conopidae, an obligate endoparasitoid of Hymenoptera.



Fig. 3. Hind femur, anterior view of *M. morio*, Belgium, 5.v.2005.



Fig. 4. Hind femur, anterior view of *M. occulta* from Greece (slightly tilted so that the two ventral bristle rows are visible).

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References

- Aartsen, B. van 1997. Nieuwe en zeldzame vliegen voor de Nederlandse fauna (Diptera). *Nederlandse Faunistische Mededelingen* **7**, 7-10.
- Bree, E. de, Smit, J.T. and Mortelmans, J. 2014. Blaaskopvliegen van het genus *Leopoldius* in de Benelux (Diptera: Conopidae). *Nederlandse Faunistische Mededelingen* **43**, 55-66
- Chvála, M. 1965. The Czechoslovak species of the subfamilies Myopinae and Dalmanniinae. *Acta Universitatis Carolinae-Biologica*, Praha **65**, 93-149.
- Goot, V.S. van der. 1977. Roof- en blaaskopvliegtentabel. Vierde, gewijzigde druk. Jeugdbondsuitgeverij.
- Mei, M., Gibson, J.F. and Skevington, J.H. 2010. Observations on hilltopping in thick-headed flies (Diptera Conopidae). *Journal of Insect Science* **10**(27), 1-15.
- Stuke, J.-H. 2017. *World Catalogue of Insects* **15**: Conopidae (Diptera). Koninklijke Brill NV, Leiden, The Netherlands.
- Stuke, J.-H., Van Eck, A., Pennards, G. and Almeida, J.M. 2012. The Conopidae (Diptera) of mainland Portugal. *Boletín de la Sociedad Entomológica Aragonesa (S.E.A.)* **51**, 191-194.

Dipterists Day Exhibits 2019 – compiled by Editor from exhibitors' notes

Details are given here only of exhibits that did not also appear at the 2019 Exhibition of the British Entomological and Natural History Society.

BLOXHAM, M.G. Anthomyiidae of the Sandwell Valley: the *Chirosia* species. Seven *Chirosia* species found in the Sandwell Valley were exhibited. These flies are believed to be closely associated with ferns and the survey area contains a band of deciduous woodland, from which eleven fern species have been recorded. The gentle north facing aspect of the woodland ensures a degree of constant humidity favouring these plants. It is therefore not surprising that a substantial group of *Chirosia* species has been found. The display included males of *Chirosia albitarsis* (Zetterstedt), *C. betuleti* (Ringdahl), *C. flavipennis* (Fallén), *C. grossicauda* Strobl, *C. histicina* (Rondani), *C. nigripes* Bezzi and *C. similata* (Tiensuu). Of these, *C. betuleti* will probably be most familiar to dipterists, the larvae causing obvious distorted and knotted terminal shoots of *Dryopteris* fronds as they feed. Much remains to be discovered about the life histories of several *Chirosia* species – including that of *C. similata* – a scarce species recorded in two separate woodland compartments here. The exhibitor was indebted to Michael Ackland for confirming the identity of the first specimen in 1981. It is significant to note that Steven Falk also recorded it in a similar setting at Edgbaston Park SSSI in 2009. The possibilities of discovering more about its life history are therefore enhanced in the general area.

DRAKE, C.M. Some uncommon and interesting Diptera from the Dipterists Forum summer field meeting based at Stirling, 2019. A selection of nationally rare, scarce or threatened species, and one introduced species, were shown. Several species were recorded from more than one site but data for only the displayed specimen is given here. Unless given otherwise, the collector was C.M. Drake and the specimens were males. **Rhagionidae:** *Chrysopilus erythrophthalmus* Loew ♀, Kippenrait Glen, NS795997, V.C. 87, 28.vi.2019, on mossy boulders in the stony Wharry Burn running through a woodland gorge; the fourth Scottish record (Harvey, M.C. 2018. Provisional atlas of soldierflies and allies – draft version, www.brc.ac.uk/soldierflies-and-allies/). **Asilidae:** *Dioctria oelandica* (Linnaeus) ♀, Blackwater Marshes, NN543060, V.C. 87, 22.vi.2019, oak wood; there are few Scottish records, clustered in central Scotland (Harvey *op. cit.*). **Hybotidae:** *Ocydromia melanopleura* Loew, Creag Mhor, Arrochymore, NS410918, V.C. 86, 25.vi.2019, shore of Loch Lomond and adjacent oak wood with seepages; a predominantly Scottish species. **Empididae:** *Hilara diversipes* Strobl, Edinchip Wood, NN583224, V.C. 88, 23.vi.2019, from the stony Kendrum Burn in deciduous woodland; a predominantly Scottish species. *Rhamphomyia obscura* (Zetterstedt), Flanders Moss, NS619977, V.C. 87, 27.vi.2019, swept from bare wet peat and tiny pools in deer tracks on raised mire; a predominantly Scottish species. *Rhamphomyia trigemina* Oldenberg, Stronvar Marshes, NN534205, V.C. 87, 23.vi.2019, swept from lake transition *Carex* marsh and wet meadow; a Near Threatened Scottish species. **Dolichopodidae:** *Argyra auricollis* (Meigen), Edinchip Wood, NN582222, V.C. 88, 23.vi.2019, J. Mousley, from the Kendrum Burn, a small stream in a wet wood; found mainly in Scotland where records are concentrated in the centre of the country. *Dolichopus maculipennis* Zetterstedt, Ben Lawers, NN5838, V.C. 88, 24.vi.2019, J. Mousley; a rare montane specialist found at base-rich seepages at high altitude, particularly around Ben Lawers which is its main stronghold. *Dolichopus nitidus* Fallén, Balmaha, NS4290, V.C. 86, 25.vi.2019, J. Mousley, marsh at the edge of Loch Lomond. *Hydrophorus rufibarbis* Gerstäcker, Ben Lawers, NN5838, V.C. 88, 24.vi.2019, J. Mousley; a species of montane pools. *Medetera ambigua* (Zetterstedt), Stirling University, NS811964, V.C. 86, 25.vi.2019, on oak or lime trunks on the university campus; previous Scottish records are from the Highlands. *Micropygus vagans* Parent, Stirling University, NS811964, V.C. 86, 25.vi.2019, emergent vegetation at a lake shore on the university campus; this immigrant from New Zealand has spread rapidly in northern Britain and was found widely during the Stirling meeting. *Rhaphium elegantulum* (Meigen), Blackwater Marshes, NN543059, V.C. 87, 22.vi.2019, R.J. Wolton, *Carex* marsh at lake edge; Scottish records are concentrated in the centre of Scotland and Speyside, and it was particularly frequent at Blackwater Marshes. *Rhaphium lanceolatum* Loew, Brig O'Turke Mires, NN540066, V.C. 87, 22.vi.2019, seepage in birch scrub and *Menyanthes* mire; most British records are from the northern half of Scotland, and the records are the most southern in Scotland although it is found sparingly in England and Wales; Near Threatened. *Syntormon aulicus* (Meigen), Bothkennar Lagoons, NS922831, V.C. 86, 26.vi.2019, in the grassy edge with *Juncus* of a brackish lake; on the northern edge of its range in mid Scotland. *Syntormon bicolorcellus* (Zetterstedt), Stirling University, NS811964, V.C. 86, 25.vi.2019, emergent vegetation at lake shore on the university campus; this is the first record for Scotland although it is frequent from Cumbria southwards. **Micropezidae:** *Cnodacophora stylifera* (Loew), ♀, Tomdachoille, NN963553, V.C. 88, 28.vi.2019, beaver-pond and swamp in alder and sallow woodland by the River Tummel; a rare species with most records from Speyside but few in the Perthshire area. **Psilidae:** *Chyliza annulipes* Macquart, Edinchip Wood, NN583224, V.C. 88, 23.vi.2019, from the stony Kendrum Burn in deciduous woodland; a scarce species with very few Scottish records. **Sciomyzidae:** *Pteromicra pectorosa* (Hendel), Blackwater Marshes, NN544058, V.C. 87, 22.vi.2019, *Carex* swamp at lake edge, hypopygial mount confirmed its identity; this appears to be the first record for Scotland for this rare fly, known sparingly from Yorkshire southward in England and Wales; a second male was found at

the nearby Brig O'Turke Mires (NN540066) on the same day. **Scathophagidae: *Acanthocnema glaucescens*** (Loew), Linn Mill, Black Devon River, NS928930, V.C. 87, 26.vi.2019, stony river in wooded gorge; a scarce species with very few Scottish records. *Acanthocnema nigrimana* (Zetterstedt), Edinchip Wood, NN583224, V.C. 88, 23.vi.2019, from the stony Kendrum Burn in deciduous woodland; a scarce species with very few Scottish records. *Cordilura atrata* (Zetterstedt), ♀, Stronvar Marshes, NN534205, V.C. 87, 23.vi.2019, from lake transition *Carex* marsh and wet meadow; a rare Scottish species.



Exhibit by Jenni Wilding (photo by the exhibitor).

WILDING, J. The display, "Come 'fly' with me" (the prize winning exhibit at this event), followed on from last years "Learning to 'fly' " display, showing her journey into the world of Diptera. This included some of her fly photographs from this year, as well as some photographs that illustrated how she is starting to branch out into learning about more fly families. This had been greatly aided by purchase of a microscope, with which the included photographs of crane fly anatomy had been taken. Some of the most helpful experiences had been the various training courses she had attended, both with FSC Biolinks, and the BENHS. At one of these courses she found *Keroplatus testaceus* Dalman (Keroplataidae) on a window at Preston Montford Field Centre that turned out to be the third record for V.C. 40; the included pictures showed the marvellous antennae that this fly is endowed with. Her favourite find in 2019 was *Hybomitra distinguenda* (Verrall) (Tabanidae), a first for the Sandwell Valley area; the photograph of the lovely eyes of this fly was kindly provided by Mike Bloxham. Also shown was *Phasia hemiptera* (Fabricius) (Tachinidae), to display its most beautiful metallic blue wings; she had found this species twice in 2019, once in Cambridge, and once at RSPB Sandwell Valley, which was the first record for the reserve.

The association of the pNS kleptoparasitic satellite fly *Miltogramma germari* Meigen (Diptera, Sarcophagidae) with the pantaloon bee *Dasygoda hirtipes* Fabricius (Hymenoptera, Melittidae)

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Summary

A close association of the pNS kleptoparasitic satellite fly *Miltogramma germari* Meigen, 1824 (Sarcophagidae, Miltogramminae) with the solitary bee *Dasygoda hirtipes* Fabricius, 1793 (Melittidae) at five sites in Norfolk is recognised for the first time and documented. Observations at these sites indicate that this fly is the only dipteran kleptoparasite of this bee, and that the much more common *M. punctata* Meigen, 1824, does not parasitise it, despite spatial and temporal overlap. Aggregations in Norfolk of two other solitary bees, *Megachile leachella* Curtis, 1828, and *Anthophora bimaculata* Panzer, 1798, that have been reported as possible hosts of *M. germari* in Britain and continental Europe were also studied, and evidence of their associations obtained so far is presented. The national picture for *M. germari* is reviewed.

Introduction

The European Miltogramminae (Pape 1987, Povolný and Verves 1997) comprises seventeen genera, eight of which have been recorded in Britain (*Amobia*, *Macronychia*, *Metopia*, *Miltogramma*, *Oebalia*, *Pterella*, *Senotainia*, *Taxigramma*). All sixteen British miltogrammine species are kleptoparasites of solitary bees and/or solitary wasps. Several species parasitise both bees and wasps. For example, *Amobia signata* Robineau-Desvoidy, 1820, attacks *Andrena cineraria* Linnaeus, 1758, *Andrena haemorrhoea* Fabricius, 1781 and *Osmia bicornis* Linnaeus, 1758, as well as several eumenid and sphecoid wasps. Those species using solitary wasps exploit diverse paralysed prey items which include aphids, weevils, spiders, grasshoppers and caterpillars. The range of feeding strategies of *Miltogramma* species larvae in the nests of bees is not yet fully understood (O'Toole 2010). It is known that they kill or predate the host single egg or larva at an early stage, and then feed on the pollen and nectar stores as kleptoparasites. It is not clear if more than one *Miltogramma* larva can be present in one host nest cell, nor how host populations are impacted.

A characteristic of some adult miltogrammines is their satellite or shadowing behaviour in which a female fly tracks a prey-carrying wasp or pollen-laden bee at close quarters (5 – 30 cm) and follows it directly behind back to its nest. This tracking involves instantaneous adjustments by the fly to the flight manoeuvres of its host, which can include sudden diversionary movements. Patient nest attendance awaiting the departure of the host bee (Figs 1 and 2) is typical.

Only two *Miltogramma* species have been recorded in Britain, *M. punctata* Meigen, 1824 and *M. germari* Meigen, 1824. Fauna Europaea (fauna-eu.org) currently lists another sixteen *Miltogramma* species for mainland Europe. In Britain, *M. punctata*, a kleptoparasite of the plasterer bees *Colletes daviesanus* Smith, 1846, *C. fodiens* Geoffroy, 1785, *C. halophilus* Verhoeff, 1944 and *C. succinctus* Linnaeus, 1758, as well as of sphecoid wasps, is common and widespread. *Miltogramma germari* has pNationally Scarce status and was considered by Falk and Pont (2017) to be “Extremely scarce and localised, with several post-1960 localities scattered widely over the known range. A decline seems to have occurred, as earlier records were relatively frequent”. In this paper we describe the occurrence of *M. germari* with *D. hirtipes* at five sites in Norfolk: Leziate, Lynford Arboretum, Brandon, Weeting Heath NNR and Weybourne.



Fig. 1. Female *M. germari* attending a *D. hirtipes* nest at Leziate, 24.vii.2019.

Sites

The small Leziate aggregation (TF6727319063, 6-10 nests in 2017-2019) lies within a complex of flooded sandpits (high-purity Leziate Sandstone once extracted for glass manufacture), with slopes and small cliffs that are largely bare of vegetation and hosting aggregations of *Megachile leachella*, *Philanthus triangulum* Fabricius, 1775, *Ammophila pubescens* Curtis, 1836 and *Ammophila sabulosa* Linnaeus, 1758. These slopes are fringed with birch scrub and pines, and nearby (e.g. TF67111910) there are small areas of *Calluna vulgaris* which attract *Colletes succinctus* and *Andrena fuscipes* Kirby, 1802, the former parasitised by *M. punctata* at Leziate. The two wasps are parasitised primarily by *Metopia argyrocephala* (Meigen, 1824) group miltogrammines. Thus far, this is the only one of the five sites studied at which there is very close proximity (within tens of metres) between the respective bee-host aggregations of the two *Miltogramma* species, and both fly species are present.

At Lynford, a large aggregation (60+ nests in 2019) centred on TL825947 is within a popular public space that lies on the northern margin of the arboretum in several hectares of recently scarified bare ground comprising fine sands with sparse vegetation. *Philanthus triangulum* and *Ammophila pubescens* also nest in this area.

The aggregation at Brandon (TL793318736, 14 nests in 2019) lies on a narrow sandy track running parallel and close to the E-W railway line. It is bordered by pines and is typical Breckland habitat.

The Weybourne site (TG10304378, 30+ nests in 2018 and 2019) is composed of glacial outwash sands and gravels alongside the coastal path. Nests were situated on sloping ground facing south and east a few metres above sea level. Pollen sources available to *Dasygaster hirtipes* included ragwort *Jacobaea vulgaris* and field sowthistle *Sonchus arvensis*.

At Weeting Heath NNR, in the heart of Breckland, the aggregation is in the visitor car park (TL7577988045). This aggregation (20+ nests in 2018 and 2019) is now cordoned off in July and August to protect the nests and to provide a spectacle for visitors. No other bees or wasps are associated with this site.



Fig. 2. Female *M. germari* awaiting departure of a female *D. hirtipes* from her nest. The fly entered the nest immediately after the bee had departed. Weybourne 21.vii.2019.

Thus far, we have found no evidence of shared hosts between the two *Miltogramma* species, despite the close spatial proximity of aggregations of their respective hosts at Weybourne and Leziate. Our experience in Norfolk has been that neither species is present in large numbers at bee aggregations. Typically, fewer than ten flies are present at any one time, even at larger aggregations (200+ nests) such as those of the sea aster bee *Colletes halophilus* (*M. punctata*) at Holme Dunes NNR and Morston saltmarshes. We dissected 22 female *M. punctata* parasitising

Colletes halophilus in Norfolk (Holme Dunes NNR and Morston saltmarshes) and have found loads of up to 75 larvae. Quantifying the impact of these flies upon their host bee populations is a challenging task that requires emergence traps to be set and nests to be excavated.



Fig. 3. Dorsal views of female and male *M. punctata* and *M. germari*. The scale bar is 2mm for all images. Upper pair is female *M. punctata* (left) and female *M. germari* (right). Lower pair is male *M. punctata* (left) and male *M. germari* (right). Inset in lower left photo is the right fore tarsus of *M. punctata*, showing long setulae arising from tarsomere 4, absent in male *M. germari*. The differences in dorsal abdominal patterns are a useful field character for recognising possible *M. germari*. Tergites 3 and 4 of *M. punctata* have three well-defined black spots along their hind margins, whereas these spots are absent in *M. germari*, which has a shifting pattern consisting of black and silver patches that varies with viewing angle. Specimens taken from Brandon (♀ *M. germari*), Weeting Heath (♂ *M. germari*), Holme Dunes NNR, Norfolk (♂ *M. punctata*), Dersingham Bog NNR, Norfolk (♀ *M. punctata*).

Identification

The identification of *Miltogramma germari* was made with reference to Pape (1987). We have found that, in most cases, both sexes of *M. germari* are noticeably smaller than their *M. punctata* counterparts (a few small specimens *M. punctata* were found). Diagnostic features separating *M. germari* and *M. punctata* are illustrated in Figs 3, 4 and 5. The male of *M. germari* can be separated in the field from that of *M. punctata* by the absence of long setulae on its front tarsi (Figs 3 and 4). The abdominal patterns of the two species are also quite different (Fig. 3), as are the colours of the pedicel and postpedicel, which are extensively yellow in *M. germari* and almost entirely black in *M. punctata*. In *M. germari* the appearance of the abdominal pattern varies considerably with viewing direction, as seen in Figs 1, 3 and 5. The appearance of the abdominal pattern of tergites 2-4 in *M. germari* varies from being an inverted “white-black/black-white”

motif (Figs 1 and 5a) to broad dark transverse bands (Fig. 3). The distinctness of the black marginal spots on T3 and T4 of *M. punctata* can also appear muted when viewed from some angles, but the pattern is usually clearly different from that of *M. germari*. Thus, there are good field characters to assist the recognition of both species. The definitive feature, only visible microscopically, that distinguishes females of these two species is the presence (*M. punctata*) or absence (*M. germari*) of long erect setulae on the suprasquamal ridge (Fig. 5). This difference is also present in males. Both sexes of *M. punctata* and *M. germari* have orange patches at the sides of T2-T4 that are only apparent when viewed directly from the side, as is shown for *M. germari* in Fig. 4.

Having secured a possible specimen of *M. germari*, care should be taken to check that it is distinguished from non-British *Miltogramma* species of continental Europe, all of which lack setulae on the suprasquamal ridge in both sexes. Consequently, collecting voucher specimens is desirable. Illustrations and keys to species of European *Miltogramma* were given by Pape (1987) and Povolný and Verves (1997). We also point out that the pNS miltogrammine *Pterella grisea* Meigen, 1824, a kleptoparasite of *Cerceris arenaria* Séguéy, 1941, bears a close resemblance to *Miltogramma* species, but, unlike these, it has obvious vibrissae that can be seen with a hand lens.



Fig. 4. Left lateral view of a male *M. germari* showing orange patches on tergites 2, 3 and 4, that are less apparent when viewed dorsally. The front tarsi lack the long setulae of male *M. punctata*. Scale bar is 1 mm. Specimen collected at Leziate 24.vii.2019.

Miltogramma germari and *Dasypoda hirtipes*

Pape (1987) did not list *D. hirtipes* among the hosts of *M. germari*, which are given as *Anthophora* and *Megachile* species. In continental Europe, *D. hirtipes* is attacked by *M. oestracea* (Fallén,

1821) whose European hosts also include members of the genera *Anthophora*, *Megachile* and *Cerceris* (Pape 1987, Povolný and Verves 1997, Westrich 2018). Falk and Lewington (2015) gave “*Miltogramma* species” as the only kleptoparasites of *D. hirtipes*, but they did not elaborate upon the species involved or whether or not this refers to the two British *Miltogramma* species specifically.

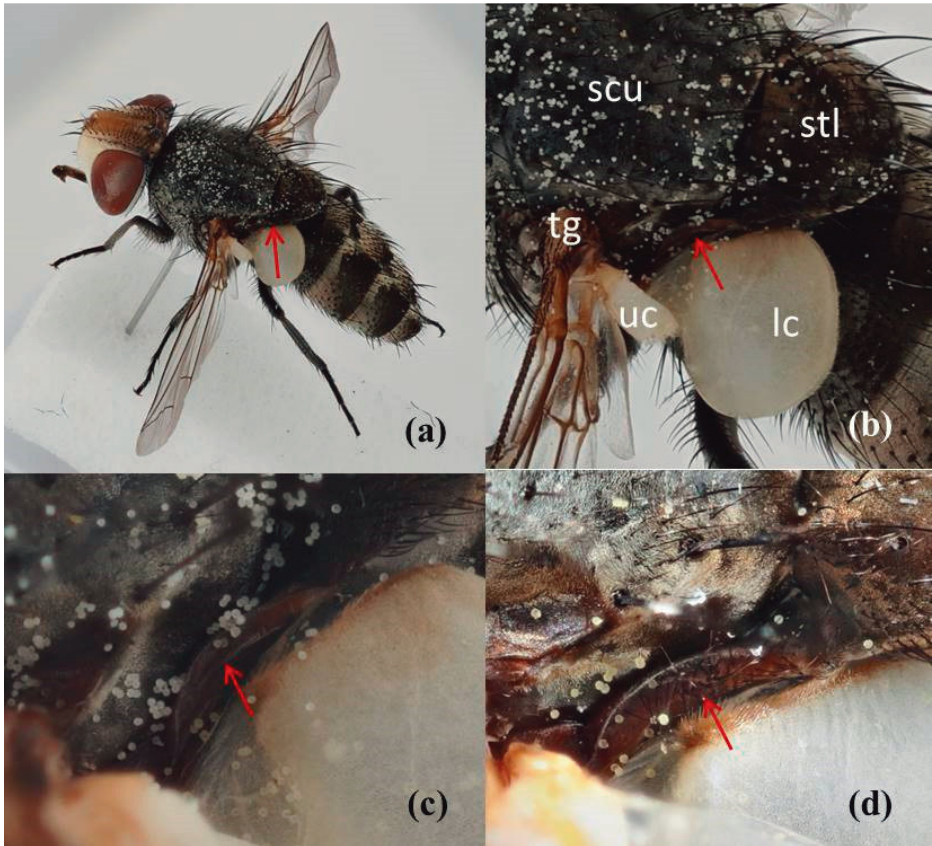


Fig. 5: (a), female *M. germari* specimen with red arrow indicating the position of the suprasquamal ridge just above the left calypter; (b), closer view of the suprasquamal ridge, *scu* scutum, *stl* scutellum, *lc* lower calypter, *uc* upper calypter; (c), close-up of the ridge showing its strap-like and hairless character; (d), the suprasquamal ridge of a female *M. punctata* showing characteristic dense clusters of long black setulae.

The association of *D. hirtipes* with an unspecified *Miltogramma* species was recognised long ago by Gardner (1901) who wrote “This genus [*Dasypoda*] does not seem to be prey to any inquiline bees, but it has an enemy in a small Dipteran of the genus *Miltogramma*, whose grubs nourish themselves at the expense of the larvae of the bee”. Interestingly, he also comments that this bee was “Formerly very abundant on Wallasey sandhills, but apparently not there now. Inland at Sale and valley of the Bollin”. There is also a single northern record of it in the NBN

database, reporting its collection by F.H. Day in 1910 from the Caldew valley near Carlisle (NY390530). These localities are far beyond the currently known range of *D. hirtipes*, and so it seems that this bee has been lost from its former northern sites.

Recently, Wood (2015) observed a *Miltogramma* closely tracking a female *D. hirtipes* at Witley Common, Surrey (22.vii.2014). The fly was not caught, but photographs taken suggest *M. germari*.

The first clear indication of an association of *D. hirtipes* specifically with *M. germari* was an observation reported by Welch and Owens (2017, NBN record 6432554) of a female shadowing a flying pollen-laden bee at Leziate, Norfolk (TF67331897) on 4.viii.2017. The fly voucher was confirmed as *M. germari* by Daniel Whitmore. On the same day, two small aggregations of *D. hirtipes* (5 and 7 nests) were found at Leziate (TF67281906) by MDW, but no fly activity at the nests was observed at the time.

The earliest record of *M. germari* in the NBN database is of two females taken by E.C.M. d'Assis-Fonseca at Deal in Kent (TR3754) on 7.viii.1950. As of 7.xi.2019 there are 53 NBN records covering only 19 hectads. MDW also examined all British specimens of *M. germari* in the NHM collection in order to check provenance, dates and for any information relating to associated hosts. The fifty-nine specimens (27♂♂, 32♀♀) come from ten localities: Kenfig Burrows NNR, Oxwich NNR (Gower), Sandwich Bay (Kent), Studland and Godlingston Heath NNR (Dorset), Christchurch Harbour and Hengistbury Head (Dorset), Braunton Burrows NNR (Devon), the New Forest (Hampshire), Berrow (Somerset), Tubney (Oxon), and Constantine Bay (Cornwall). Annual dates range from 20.vi – 26.viii. The oldest record is from 1909, the most recent from 1977. Only 13 of the specimens correspond to NBN records. Three collectors (C.J. Wainwright, E.C.M. d'Assis-Fonseca and G.M. Spooner) accounted for all but eight NHM specimens. In no case were any observations of bee or wasp hosts noted.

We have obtained another 14 records of 36 individuals (9♂, 27♀) at seven Norfolk sites and one in Cornwall (1♂, Upton Towans, Hayle, SW57824118, 13.vii.2018), increasing the number of hectads to 22. Of these 36 specimens, 24 were seen in association with *D. hirtipes*. Six males and two females were recorded on 18.vii.2019 at two aggregations of the leafcutter bee *Megachile leachella* at East Hills, Holkham, Norfolk (6♂, 1♀ at TF93084609 and 1♀ at TF92924610). The two other specimens (1♂ at Upton Towans and 1♂ at Grimston Warren NNR, TF67812168) were not associated with a host when caught.

In 2018, Vanna Bartlett (VB) contacted NWO about finding an aggregation of 30+ *D. hirtipes* nests in the car park at Weeting Heath NNR (TL7577988045). We have subsequently (21.vii.2018) observed *M. germari* (2♂, 7♀) attending this aggregation and those at Leziate (currently nine nests), Weybourne (30+ nests), Brandon (12 nests) and Lynford Arboretum (60+ nests).

At Leziate in 2019, there was a small aggregation of eight *D. hirtipes* nests (TF6728019064, the same location as in 2017) within 70 m of an aggregation (TF6724919006) of 20+ nests of *Megachile leachella*, within which was a single *D. hirtipes* nest. Four female *M. germari* were recorded at the *Dasypoda* aggregation, while at the mixed aggregation two *M. germari* females were observed very briefly shadowing incoming *M. leachella* females, with one then turning its attention to the single *D. hirtipes* nest as this bee approached heavily laden with pollen.

On a visit to Lynford Arboretum (TL82439467) on 23.viii.2019, primarily to study kleptoparasite activity at solitary wasp aggregations on recently scarified strips, we found an aggregation of 23 *D. hirtipes* nests at TL82479467. It was 14:10 hrs and there was no bee activity at these nests. We observed the Lynford aggregation for only 35 minutes, as we knew that *D. hirtipes* activity had likely ceased for the day (Owens 2018), and after 25 minutes MDW netted a female *Miltogramma* species sitting by a nest entrance on the mound of excavated sand. The

abdominal tessellation seen by hand lens indicated *M. germari*, and microscopical examination confirmed this identification.

On 28.viii.2019, MDW returned to Lynford Arboretum (09:25-12:05 hrs) and revisited the aggregation discovered five days earlier, this time finding six active female *D. hirtipes* and two *M. germari* females waiting within 1cm of nest entrances. He also found two more aggregations near the first one (TL82509468 and TL82479468), altogether forming a strip 10 m wide and 110 m long centred on TL8245947. Totals of 31 open and 35 closed nests were counted. The closed nests were inferred as being those of *D. hirtipes* on the basis of size and shape, although holes were completely covered over with sand. This is by far the largest *D. hirtipes* aggregation found during this study.

At Weybourne (TG1029643783), *M. germari* was observed at an aggregation of about 30 *D. hirtipes* nests on many occasions, with up to six flies being present at one time. A fly usually waited near or on the spoil around a nest. On entry of a pollen-laden *D. hirtipes*, the female fly waited outside until the bee departed (for 18 minutes on one occasion), immediately entering as the bee flew out. Larvipositing flies were inside a nest for as little as a second. In addition to shadowing behaviour, female *M. germari* were observed basking on bare ground at 06.30 hr and taking nectar from ragwort in the afternoon. There were several *Megachile leachella* at this site, some within a metre of *D. hirtipes* nests, but no shadowing of the former bee by *Miltogramma* species was observed during several hours of observation.

Whenever we observed a *D. hirtipes* aggregation at the five Norfolk sites, even a small one as at Leziate, *M. germari* was present. We have yet to find evidence of *M. punctata* using this bee despite both flies occurring within tens of metres of each other at aggregations of their different solitary-bee hosts at Leziate.

The phenologies of the two fly species based upon our Norfolk records are: *M. punctata* ♂♂ 1.vii to 26.ix, ♀♀ 24.vii to 10.x; *M. germari*: ♂♂ 8.vii to 24.vii, ♀♀ 18.vii to 28.viii. Overall, there is considerable temporal overlap, but *M. punctata* has a longer season due to the late appearance of one of its hosts, *Colletes halophilus*, which also explains the recording of *M. punctata* for much longer than is the case for *M. germari*. We will describe our field studies of *M. punctata*/*Colletes* species in a separate paper.

Other potential hosts of *M. germari* in Norfolk

Anthophora bimaculata Panzer 1798

Pape (1987) noted that in continental Europe *M. germari* parasitises *Anthophora* and *Megachile* species, although individual species are not mentioned. Falk and Lewington (2015) gave *M. germari* as a likely kleptoparasite of *Anthophora bimaculata*.

Being aware of our studies of dipteran kleptoparasites of solitary bees, VB contacted NWO about having observed a *Miltogramma* species at an aggregation of 20+ nests of *Anthophora bimaculata* at Santon Downham (TL8180188207), near Brandon. The flies were observed perched on stones, flying low over the nest aggregation and entering nests 'a few times'. *Anthophora bimaculata* females were seen repeatedly entering and leaving nests at the site, although not the actual holes entered by the flies. No *D. hirtipes* or their nests were found at the site. VB passed on two female *Miltogramma* vouchers taken at this aggregation to MDW, who identified these as *M. germari*.

With the aim of clarifying the significance of these two *M. germari* specimens relative to *A. bimaculata*, we visited the Santon Downham aggregation on 23.viii.2019 (11:30-13:30 hrs). The weather was hot (26 °C), sunny (0/8) and still. We found 25 *A. bimaculata* nests and seven active bees, including four pollen-laden females. Apart from a few *Metopia argyrocephala*-group females attending nearby solitary wasp nests, there was no kleptoparasitic dipteran activity during two hours of observation.

Megachile leachella Curtis 1828

On 18.vii.2019, we collected six male and one female *M. germari* at a large active aggregation (80+ nests) of *Megachile leachella* in the fore-dune upper beach at East Hills, Holkham Dunes NNR (TF93084609). Two female *M. germari* were also observed waiting at nest entrances of *M. leachella*, though none was seen to enter (little systematic watching was done). One also shadowed a female *Coelioxys inermis* Kirby, 1802, other individuals of which we had seen entering *M. leachella* nests. One male *M. punctata* was also found, most likely associated with a *Colletes* species also seen. *Dasygaster hirtipes* occurs at East Hills in small numbers, but no aggregations of this bee have been found yet, with only brief searches being possible due to limited accessibility to East Hills (boat crossings needed). A female *D. hirtipes* was found on the same day near this aggregation, and the possibility of mixed aggregations of the two bees at East Hills, as occurs at Leziate, cannot be excluded.

The national picture for *M. germari* and *D. hirtipes*

How widespread is the association of *M. germari* and *D. hirtipes*? As already mentioned, *D. hirtipes* has apparently been lost from its northern sites long ago (Gardner 1901). NBN and NHM records lie south of a line from Anglesey to The Wash. Given the widespread distribution of the bee over southern England and Wales (411 records, 104 hectads as of 29.viii.2019), there are far fewer records of the fly (53 records, 37 sites, 17 hectads as of 29.viii.2019).

With the exception of our records, none of the NBN records for *M. germari* notes an association with this bee or indeed any host. We note that 35 records (12 hectads) of *M. germari* are shown on the Essex Field Club website, of which seven are in the Thames Gateway, a well-documented area for *D. hirtipes*. However, these records are not in the NBN database. There is considerable overlap between the distributions of records of *M. germari* and *D. hirtipes*, particularly at “hotspots” of the bee such as the coasts of Dorset and South Wales, the Thames Gateway and the East Anglian Brecks.

It seems unlikely that the Norfolk occurrences are particularly special in regard to the association, as similar habitats occur throughout the British range of *D. hirtipes*. We have never found *M. punctata* using *D. hirtipes* in Norfolk, despite their spatial and temporal proximity, and so we think it likely that sightings of a *Miltogramma* species shadowing this bee will relate to *M. germari*. Hence, it would seem likely that *M. germari* has been overlooked, given the widespread occurrence of *D. hirtipes*, perhaps because bee recorders, in general, have not identified the species of associated dipteran kleptoparasites as part of the record.

Conclusions

Our study appears to be the first to demonstrate conclusively that the *Miltogramma* species using *D. hirtipes* in Britain is *M. germari*, and that the association is likely to be a very strong one. Furthermore, we have never observed *M. punctata* or another dipteran kleptoparasite in association with this bee. We have also found good circumstantial evidence for *M. germari* using *Megachile leachella* (East Hills) and, with the assistance of VB, a strong indication for it using *A. bimaculata* (Santon Downham). *Dasygaster hirtipes* is currently at the northern limit of its British range in Norfolk (Owens 2017). Its distribution is likely to extend northwards with climate change. The strong presence of *M. germari* in Norfolk may be a recent phenomenon, as the first record for Norfolk is from Winterton-Horsey Dunes SSSI on 23.vii.2003.

For a significant and frequently encountered family, the Sarcophagidae (61 British Isles species) are very under-recorded in the British Isles compared with more popular families, a situation perhaps exacerbated by the absence of a national recording scheme. Confirmed or unconfirmed records are now submitted to NBN via iRecord. The Calypterate status review of Falk and Pont (2017) listed 21 sarcophagid species as having conservation status and another four

as being “Data Deficient”. Thus, 40% of British Sarcophagidae have a designated conservation status. Seven of the 25 listed species belong to the subfamily Miltogramminae.

In the 2017 status review, the under-recorded nature of this family is apparent in the accounts for individual species in which phrases such as “possibly overlooked due to the relatively low levels of recording in this group” (e.g. accounts for *Agria affinis* Fallén, 1817; *Agria mamillata* Pandellé, 1896; *Blaesoxipha erythrura* Meigen, 1826; *Sarcophaga jacobsoni* Rohdendorf, 1937), and “It may be overlooked by the relatively low level of recording in this group”, e.g. the accounts for *Sarcophaga albiceps* Meigen, 1826 and *Sarcophaga villeneuvei* Böttcher, 1912.

Our investigation of *M. germari*, a pNS species, suggests that many other members of the British Sarcophagidae would benefit from much greater levels of recording to inform on their national status. In particular, more collaboration between hymenopterists and dipterists would allow considerable progress to be made in evaluating the conservation status and ecological requirements of kleptoparasitic flies. A further motivation is the possibility of encountering miltogrammines new to Britain at solitary bee and wasp aggregations.

Acknowledgments

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References

- Falk, S. and Lewington, R. 2015. *Field Guide to the Bees of Great Britain and Ireland*. Bloomsbury.
- Gardner, W. 1901. A list of the Hymenoptera-Aculeata so far observed in the counties of Lancashire and Cheshire with notes on the habits of the genera. *Proceedings of the Liverpool Biological Society* **15**, 402-403.
- O’Toole, C. 2010. Associations of Diptera with other Animals and Micro-organisms: Ants, bees and wasps (Aculeate Hymenoptera). pp 335-346. In Chandler, P.J. (Ed.) *A Dipterist’s Handbook* (2nd Edition). *The Amateur Entomologist*, Volume **15**.
- Owens, N. 2017. *The Bees of Norfolk*. Pisces Publications.
- Owens, N. 2018. Some observations on pollen collection by the Pantaloon Bee *Dasypoda hirtipes* (Hymenoptera, Apidae) in Norfolk. *Transactions of the Norfolk and Norwich Naturalists Society* **51**(1), 45–55.
- Pape, T. 1987. *The Sarcophagidae (Diptera) of Fennoscandia and Denmark*. Fauna Entomologica Scandinavica, Volume 19. Brill.
- Povolný, D. and Verves, Y. 1997. The Flesh-Flies of Central Europe (Insecta, Diptera, Sarcophagidae). *Spixiana, Zeitschrift für Zoologie*, Supplement **24**.
- Welch, M.D. and Owens, N.W. 2017. The nationally scarce cleptoparasitic satellite fly *Miltogramma germari* Meigen (Sarcophagidae) in Norfolk. *Transactions of the Norfolk and Norwich Naturalists Society* **51**, 9-13.
- Westrich, P. 2018. *Die Wildbienen Deutschlands* p. 251. Ulmer, Stuttgart.
- Wood, T. 2015. A note on the satellite fly (Diptera: Miltogramminae) avoidance behaviour in the bee *Dasypoda hirtipes*. *BWARS Newsletter* Spring **2015**, p. 11.

Summary of the current knowledge of *Angioneura acerba* (Meigen) and *Angioneura cyrtoneurina* (Zetterstedt) (Diptera, Calliphoridae) in Britain with new records

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Summary

Previously published records of *Angioneura acerba* (Meigen, 1838) and *Angioneura cyrtoneurina* (Zetterstedt, 1859) (Diptera, Calliphoridae) are given and new records are reported. The morphological structure of the adults is described. The available knowledge of biology and habitat is assessed. Distribution maps of all currently known records are provided. The conservation status of both species is discussed.

Introduction

Both species in the genus *Angioneura* are poorly known, with very few recent records (Chandler and Denton 2004; Coldwell 2011; Grayson 2014; Horsfield 2017, 2018). Falk and Pont (2017) listed the status of *Angioneura acerba* as ‘Data Deficient’ and *Angioneura cyrtoneurina* as ‘provisionally Vulnerable’.

Angioneura cyrtoneurina larvae are parasitoids of the snail *Oxyloma sarsii* (Esmark, 1886) (Cepelák and Rozkošný 1968; Rognes 1991). Snails infested by the fly larvae climb up plants, while unaffected individuals stay on the ground. This change of behaviour allows infested specimens to be distinguished. Infestation results in the death of a host and pupation usually occurs outside the shell (Cepelák and Rozkošný 1968). *Angioneura cyrtoneurina* has been collected from marsh, fen and damp woodland (Chandler and Denton 2004; Falk and Pont 2017). In Fennoscandia and Denmark it was recorded in June and August (Rognes 1991) and in Britain from June to August.

The biology of *Angioneura acerba* is still unknown. A species of land snail is a likely host, given the biology of related species (Chandler and Denton 2004). This fly has been collected from marsh habitats at inland sites (Ackland 1967; Chandler and Denton 2004; Horsfield 2018; S. Falk *pers. comm.*) and a coastal site (Horsfield 2017). British records are from June to September, while in Fennoscandia and Denmark it was collected from May to October (Rognes 1991).

Identification

Angioneura species are rather nondescript flies, in the field not dissimilar to many small anthomyiids and muscids. They belong to the calliphorid subfamily Melanomyinae, characterised by bare calypters, lack of coxopleural streak, short prementum and bare suprasquamal ridge. They can be distinguished from other non-metallic Melanomyinae by a bare proepisternal depression and lunula, notopleuron with 1-2 hairs or bare, 2 pairs of marginal bristles on the scutellum, 1 pair of presutural acrostichal bristles (or absent), weak prealar bristle (at most the size of hind notopleural bristle), and posterior thoracic spiracle fairly round, not horizontally flattened.

The two *Angioneura* species can be reliably separated using a number of characters. *Angioneura acerba* (Fig. 1) is brownish grey, with calypters not diverging strongly from the

scutellum. The prosternum is hairy, parafacialia with few small black hairs in upper part. The costa is bare dorsally beyond the junction with R_1 and vein A_1+CuA_2 is short, ending well before the wing margin.

Angioneura cyrtoneurina (Fig. 2) is darker than *A. acerba*, with a black base colour. The lower calypter diverges strongly from the scutellum – as in *Melanomya nana* (Meigen, 1826) and flies in the family Rhizophoridae (woodlouse flies). The prosternum is bare and there are no small black hairs in the upper part of the parafacialia. The costa is hairy dorsally well beyond the junction with R_1 ; also vein A_1+CuA_2 is long, ending very close to the wing margin. The male genitalia of both species are distinctive (Rognes 1991, Sivell in prep.).



Fig. 1. *Angioneura acerba*, Natural History Museum, London (BM1948-488). Photograph O. Sivell, courtesy of Angela Marmont Centre for UK Biodiversity at the Natural History Museum in London. © Trustees of the Natural History Museum, London.

The new records

A single male of *Angioneura acerba* was swept from common reed (*Phragmites australis*) at the transition from *Salix* scrub to reed-bed at the edge of Village Lake, North Cave Wetlands Yorkshire Wildlife Trust reserve (SE883382) on 21 August 2018. The site was only acquired by the Yorkshire Wildlife Trust in 2000, and Village Lake had been excavated for gravel in 1994. Prior to this, it was a low-lying plain under agricultural management, farmed for cereals and root crops like sugar beet and potatoes (Crossley 2014).

Two additional records of *Angioneura acerba* have been provided by S. Falk: a single female from Napton, Warwickshire (SP454614) – swept from spring-fed marshland in an abandoned quarry on 4 August 2017. Several males and females were swept from valley mire with lateral seepages at Sutton Park (Longmoor Valley), Warwickshire (SP093960) on 7 July 2018.

Two males of *Angioneura cyrtoneurina* were collected by C.M. Drake at Hickling Broad, Norfolk (TG42892167) on 28 June 2008. One was swept off reed over a choked ditch, and the other was collected in a vacuum sampler. The survey was done for the Broads Authority, although the *Angioneura* record got no mention in the report (Lott *et al.* 2010).



Fig. 2. *Angioneura cyrtoneurina*, Natural History Museum, London (NHMUK012809102). Photograph O. Sivell, courtesy of Angela Marmont Centre for UK Biodiversity at the Natural History Museum in London. © Trustees of the Natural History Museum, London.

A single male of *Angioneura cyrtoneurina* was collected by I. Andrews at Millington Pastures SSSI on the Yorkshire Wolds (SE841529) on 27 August 2015. It has been confirmed by A. Grayson (*pers. comm.*) as the first record for East Yorkshire. The site is a spring-fed valley bottom, giving rise to a calcareous marsh community containing narrow-leaved water-parsnip *Berula erecta*, marsh marigold *Caltha palustris*, hoary willow-herb *Epilobium parviflorum*, water cress *Nasturtium officinale* and brooklime *Veronica beccabunga* (Natural England SSSI designation). The fly was collected after being seen settled on top of a plant of hoary willow-herb close to the edge of a small spring-fed stream.

All specimens from these four recent records were identified using Rognes (1991) and Sivell (in prep.).

Distribution mapping

The records of both species are displayed on distribution maps in Fig. 3. (*Angioneura acerba*) and Fig. 4. (*Angioneura cyrtoneurina*). Each location has been numbered and details of every record can be found in Table 1. The distribution maps have been created using ArcGIS ArcMap 10.6 and gb-outlines_2763872 shapefile (GB National Outlines [SHAPE geospatial data], Scale 1:250000, Tiles: GB, Updated: 8 June 2005, Ordnance Survey (GB)) from digimap.edina.ac.uk. The records have been mapped using longitude and latitude derived from spatial data available using gridreferencefinder.com. If available, grid references have been used. For remaining sites

the location name (town, village, county) has been georeferenced. All locations are approximate. A. Godfrey's record had no site information except that it was in Lancashire, hence it has been mapped as laying within the centre of that county and the location is inaccurate.

Table 1. Previously published and new records of *Angioneura acerba* (Meigen, 1838) and *Angioneura cyrtoneurina* (Zetterstedt, 1859) in Britain.

<i>Angioneura acerba</i> (Meigen, 1838)				
No	Date	Location	Recorder	Source
1	12/07/1966	East Oxford, Oxfordshire	D.M. Ackland	Ackland 1967
2	07/07/2003	Kennet Floodplain, Berkshire, SU6671	P.J. Chandler	Chandler and Denton 2004
3	?	Lancashire	A. Godfrey	Coldwell 2011
4	2007	Godmanchester, Cambridgeshire	Unknown	Falk and Pont 2017
5	16/07/2008 04/08/2008	Stony Moors, New Forest, Hampshire, SZ213995	S. Falk	Falk and Pont 2017 Falk <i>pers. comm.</i>
6	10/08/2011 25/09/2011	Between Dodworth and Higham, South Yorkshire	J.D. Coldwell	Coldwell 2011 Grayson 2014
7	02/06/2012	Old Moor, South Yorkshire, SE4202	J.D. Coldwell	Grayson 2014
8	11/08/2012	Adwick Washland, South Yorkshire, SE4702	J.D. Coldwell	Grayson 2014
9	03/09/2015	Longniddry Bents, Scotland, NT4376	D. Horsfield	Horsfield 2017
10	01/07/2017	Luffness near Aberlady, NT476806	D. Horsfield	Horsfield 2018
11	04/08/2017	Napton, Warwickshire, SP454614	S. Falk	
12	07/07/2018	Sutton Park, Longmoor Valley, Warwickshire, SP093960	S. Falk	
13	21/08/2018	Village Lake, North Cave Wetlands Yorkshire Wildlife Trust reserve, SE883382	I. Andrews	
<i>Angioneura cyrtoneurina</i> (Zetterstedt, 1859)				
14	1928 1932 1952	Horning Ferry, Norfolk	Unknown	Invertebrate Site Register - England (1738-2005) Falk and Pont 2017

15	1983	Chippenham Fen, Cambridgeshire	Unknown	Invertebrate Site Register - England (1738-2005) Falk and Pont 2017
16	2001	Minsmere RSPB Reserve, Suffolk	M. Edwards	Chandler and Denton 2004
17	16/06/1945	Wick, Hampshire	C.J. Wainwright coll.	NHMUK012809102 Falk and Pont 2017
18	08/07/1966	Westbere, Kent	Pres. by C.H. Andrewes	NHMUK012809101 Falk and Pont 2017
19	16/06/2003	Sheffield Bottom, Berkshire, SU640697	J. Denton	Chandler and Denton 2004
20	31/08/2003	Kennet Floodplain, Berkshire, SU6671	P.J. Chandler	Chandler and Denton 2004
21	28/06/2008	Hickling Broad, Norfolk, TG42892167	C.M. Drake	
22	27/08/2015	Millington Pastures SSSI on the Yorkshire Wolds, SE841529	I. Andrews	Falk and Pont 2017

Discussion

Falk and Pont (2017) assigned a Data Deficient status to *Angioneura acerba* based on 1966-2008 records. The data published by Coldwell (2011) and Grayson (2014) were likely overlooked. Since then further records have been confirmed, including first records for Scotland (Horsfield 2017, 2018), Warwickshire (Falk *pers. comm.*) and a further record for Yorkshire. In recent years the number of records of *A. acerba* has increased considerably – likely due to an increase in recording effort, as well as better access to identification and recording tools, such as iRecord, the Calliphoridae, Rhiniidae and Polleniidae Recording Scheme and new identification keys (Falk 2016, Sivell in prep.).

An attempt has been made to assess the species using criteria for IUCN Red List Categories (IUCN 2012a, 2012b). As with the Dolichopodidae (Drake 2018) the majority of the criteria could not be applied due to a lack of sufficient data. There is no evidence of a species decline – on the contrary, it has been found at sites from which it has not been recorded previously, despite continuous, long term survey effort (e.g. Napton, Sutton Park – S. Falk *pers. comm.*). It has only been collected from marsh habitats, there has been no extensive targeted survey conducted to date, it is an easily overlooked species – and yet there are 15 incidental records from 13 sites over the last 20 years. In the authors' opinion, *Angioneura acerba* is under-recorded and not sufficiently studied for a status to be assigned to it with confidence. A Data Deficient status may still be appropriate for *A. acerba*; however, the increase in recent records suggests a provisional Near Threatened status may better represent the reality on the ground pending increased recording in marsh habitats.

Angioneura cyrtoneurina has been given a provisionally Vulnerable status based on 1928-2003 records and a single 2015 record (Falk and Pont 2017). Assuming the latter is the same record as one given in this article by I. Andrews, the only previously unknown record is of two specimens collected by C.M. Drake in 2008. The information gathered here supports a Vulnerable status for this species.

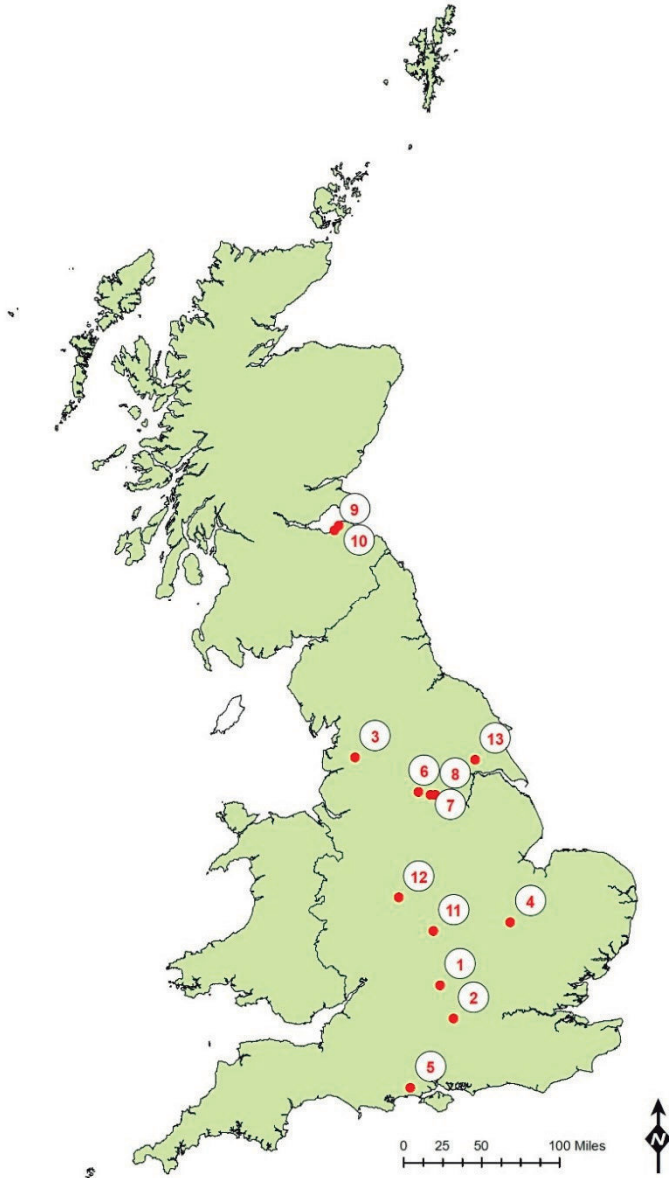


Fig. 3. Distribution map of *Angioneura acerba* (Meigen, 1838). The record details and references can be found by number in Table 1.

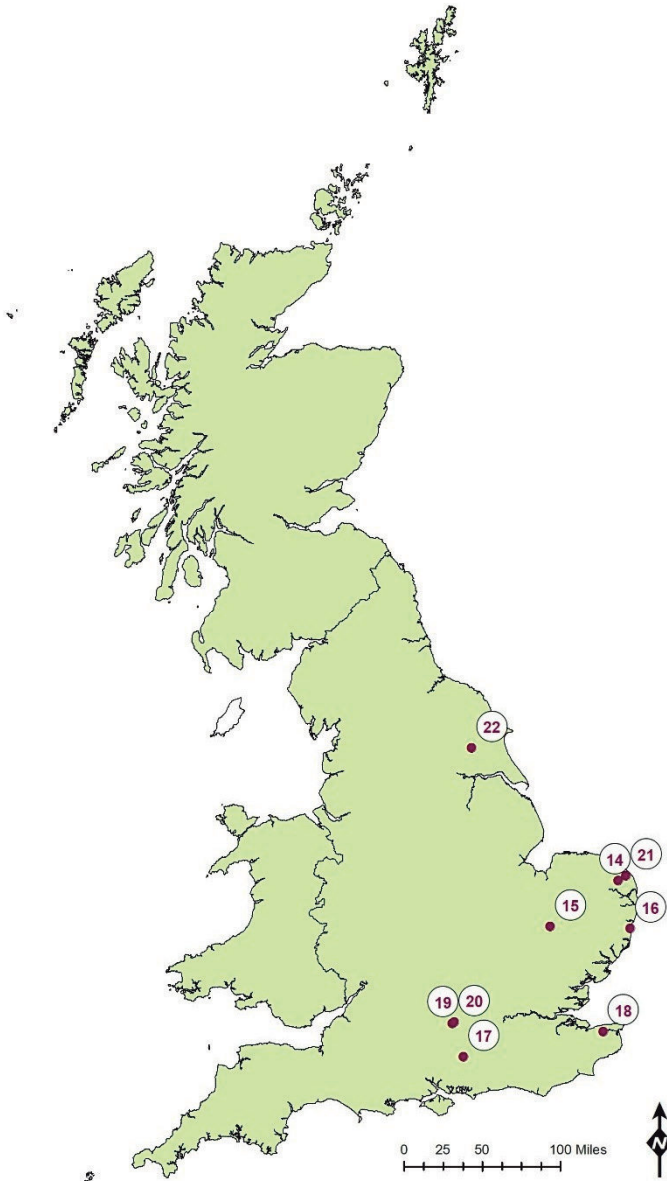


Fig. 4. Distribution map of *Angioneura cyrtoneurina* (Zetterstedt, 1859). The record details and references can be found by number in Table 1.

Acknowledgements

The authors are grateful to Andrew Grayson, Yorkshire Recorder for Diptera, for confirming the first record of *A. cyrtoneurina* for East Yorkshire; Martin Drake and Steven Falk for sharing their records and additional information; Chris Raper, Florin Feneru and Christina Fisher, Angela Marmont Centre for UK Biodiversity at the Natural History Museum in London for providing the access to stacking equipment; Duncan Sivell, David Horsfield and Peter Chandler for their valuable comments.

References

- Ackland, D.M. 1967. *Angioneura acerba* (Meigen, 1838) (Diptera, Calliphoridae) new to Britain. *Entomologist* **100**, 122-123.
- Cepelák, J. and Rozkošný, R. 1968. Zur Bionomie der Art *Angioneura cyrtoneurina* Zetterstedt 1859 (Rhinophoridae, Diptera). *Acta Zootechnica University of Agriculture in Nitra* **17**, 181-191.
- Chandler, P. and Denton, J. 2004. Recent records of some rare snail-killing flies (Diptera, Calliphoridae) from Berkshire. *Dipterists Digest (Second Series)* **11**, 110.
- Coldwell, J.D. 2011. Some Scarce Diptera from the Barnsley Area in 2011 Including Nine Species New to Yorkshire. *Sorby Record* **47**, 16-18.
- Crossley, R. 2014. The Dolichopodid flies of North Cave Wetlands, a former sand and gravel quarry. *The Naturalist* **139**.
- Drake, C.M. 2018. A review of the status of the Dolichopodidae flies of Great Britain - Species Status No.30. *Natural England Commissioned Reports* **195**.
- Falk, S. 2016. British Blowflies (Calliphoridae) and Woodlouse Flies (Rhinophoridae) Draft online key: <http://www.stevenfalk.co.uk/files/21577/testkeyto britishblowflies132016.pdf>
- Falk, S. and Pont, A. 2017. A Provisional Assessment of the Status of Calyprate flies in the UK. *Natural England, Commissioned Reports* **234**.
- Grayson, A. 2014. Additions and corrections to the Yorkshire Diptera list (part 5). *The Naturalist* **139**(1085), 14-22.
- GB National Outlines [SHAPE geospatial data], Scale 1:250000, Tiles: GB, Updated: 8 June 2005, Ordnance Survey (GB), Using: EDINA Digimap Ordnance Survey Service, <<https://digimap.edina.ac.uk/>>, Downloaded: 2019-01-15 12:27:25.355
- Horsfield, D. 2017. *Angioneura acerba* (Meigen) (Diptera, Calliphoridae) found in Scotland. *Dipterists Digest (Second Series)* **24**, 146.
- Horsfield, D. 2018. A second record of *Angioneura acerba* (Meigen) (Diptera, Calliphoridae) from the East Lothian coast, Scotland. *Dipterists Digest (Second Series)* **25**, 175.
- IUCN. 2012a. *IUCN Red List Categories and Criteria: Version 3.1*. Second edition. Gland, Switzerland and Cambridge, UK: IUCN. iv + 32pp.
- IUCN. 2012b. *Guidelines for Application of IUCN Red List Criteria at Regional and National Levels: Version 4.0*. Gland, Switzerland and Cambridge, UK: IUCN. iii + 41pp.
- Lott, D.A., Drake, C.M. and Lee, P. 2010. *Broads Fen Invertebrate Survey*. Broads Authority, Norwich
- Rognes, K. 1991. *Blowflies (Diptera, Calliphoridae) of Fennoscandia and Denmark*. Fauna Entomologica Scandinavica **24**. Leiden-New York-København-Köln: Brill.
- Sivell, O. (in prep.). Blow flies (Diptera: Calliphoridae, Rhiniidae, Polleniidae) of Britain. *Handbooks for the Identification of British Insects*.

More craneflies (Diptera, Tipuloidea) from the Ravin de Valbois National Nature Reserve, France

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Summary

As a continuation of the work done in 2017 and 2018 (Kramer and Langlois 2019), further visits were made to the Ravin de Valbois for three days each in both June and September 2019. 41 cranefly species were recorded, 23 species were newly recorded for the Ravine (current total, 91), and three of these, *Tasiocera robusta* (Bangerter, 1947), *Paradelphomyia ecalcarata* (Edwards, 1938), and *Dicranomyia lutea* (Meigen, 1818) were new to the French fauna. In addition, details of two species listed in our previous paper, *Erioptera verralli* Edwards, 1921 and *Molophilus lachschewitzianus* Alexander, 1953, are also recorded here as new to France.

Location

The ravine is in eastern France, about 20km south-east of Besançon. For details of the location, and a description of the physical factors of the Ravin de Valbois, see Kramer and Langlois (2019). Collecting was carried out in sectors 3, 7 and 8, near the stream, with its mossy boulders and wet woody debris, and with adjacent wet woodland and seepages from the Jurassic Limestone cliffs.

Materials and methods

Visits were made from 25-27 June and from 23-26 September 2019 and collections were made by the authors using hand-nets. Voucher specimens were carded or preserved in 70% ethanol. Identification and photomicroscopy were carried out by JK.

Results

List of Cranefly species captured in the Ravin de Valbois 25-27 June 2019.

* Species new to the Ravine. ** Species new to the French Fauna.

Tipulidae (3)

Nephrotoma quadrifaria (Meigen, 1804)

Tipula lunata Linnaeus, 1758

Tipula (unidentified female)

Scleroprocta pentagonalis (Loew, 1873)

Tasiocera robusta (Bangerter, 1947)**

Limoniidae – Dactylobabinae (1)

Dactylobabia transversa (Meigen, 1804)

Pediciidae (1)

Pedicia littoralis (Meigen, 1804)*

Limoniidae - Limnophilinae (7)

Austrolimnophila ochracea (Meigen, 1804)

Austrolimnophila unica (Osten-Sacken, 1869)*

Epiphragma ocellare (Linnaeus, 1761)

Paradelphomyia ecalcarata (Edwards, 1938)**

Paradelphomyia senilis (Haliday, 1833)*

Phylidorea abdominalis (Staeger, 1840)*

Limoniidae – Chioneinae (9)

Ellipteroides lateralis (Macquart, 1835)*

Ellipteroides limbatus (von Roser, 1840)*

Ilisia occoecata Edwards, 1936*

Molophilus appendiculatus (Staeger, 1840)

Molophilus cinereifrons de Meijere, 1920*

Molophilus corniger de Meijere, 1920*

Molophilus undulatus Tonnoir, 1920*

Prionolabis hospes (Egger, 1863)

Limoniidae - Limoniinae (16)

Atypophthalmus inustus (Meigen, 1818)*

Dicranomyia aquosa Verrall, 1886*

Dicranomyia chorea (Meigen, 1818)

Dicranomyia conchifera (Strobl, 1900)

Dicranomyia didyma (Meigen, 1804)*

Dicranomyia lutea (Meigen, 1818)**

Dicranomyia fusca (Meigen, 1804)

Elliptera omissa Schiner, 1863*

Limonia dilutior (Edwards, 1921)

Limonia flavipes (Fabricius, 1787)

Limonia hercegovinae (Strobl, 1898)

Limonia nubeculosa Meigen, 1804

Limonia phragmitidis (Schränk, 1781)

Limonia trivittata (Schummel, 1829)*

Lipsothrix errans (Walker, 1848)*

Lipsothrix remota (Walker, 1848)

Total species – 37

Species newly recorded in the ravine – 18

New records for France - 3

List of cranefly species captured in the Ravin de Valbois 25-27 September 2019

*** Species new to the Ravine.**

Tipulidae

Tipula benesignata Mannheims, 1954*

Limoniidae

Ormosia albitibia Edwards, 1921*

Rhypholophus bifurcatus Goetghebuer, 1920*

Rhypholophus haemorrhoidalis (Zetterstedt, 1838)*

Neolimnomyia filata (Walker, 1856)

Limonia nubeculosa Meigen, 1804

Total 6 species, 4 of which were new to the Ravine.

Species new to France

As a result of the June 2019 survey of the Ravin de Valbois three species have been added to the list, making a total of 10 cranefly species newly recorded for France from 2017-2019. These are:

Tipulidae

Tipula bilobata Pokorný, 1887,

Tipula stigmatella Schummel, 1833

Limoniidae

Erioptera verralli Edwards, 1921

Molophilus lackschewitzianus Alexander, 1953

Molophilus variispinus Starý, 1971

Rhabdomastix subparva Starý, 1971

Tasiocera robusta (Bangerter, 1947)

Paradelphomyia ecalcarata (Edwards, 1938)

Dicranomyia lutea (Meigen, 1818)

Lipsothrix nervosa Edwards, 1938

In addition, a second record for France has been obtained for *Tipula mutila* Wahlgren, 1905 (cf. Kramer 2012). *Tipula trifascingulata* Theowald, 1980 and *Lipsothrix errans* (cf. Kramer 2008) have been recorded in France for a third time (Kramer 2014).

Notes on the identification, distribution and ecology of some newly recorded species (Ref: Catalogue of the Craneflies of the World, Oct. 2019).

***Tipula benesignata* Mannheims, 1954**

Specimen nos. 19/034 male, 23.ix.2019, Sect. 3 and 19/050 male, 24.ix.2019, Sect. 8.

Tipula benesignata is widely distributed across the Palaearctic Region (Oosterbroek 2019). It has been recorded from Greece to Scandinavia, and a number of sites in France (Auvergne, Alps) but not in the British Isles (Soós and Papp 1992). Andrey Przhiboro has done some detailed work on the habitat (Przhiboro 2003) and the biology (Przhiboro 2009) of the larvae of *T. benesignata*, which live in the wet mosses at the margins of streams and lakes. Larval instars 3-4 were observed in the laboratory to project their bodies half way out from the substrate and actively consume the mosses in which they live. When gut contents were examined three components were found in roughly equal amounts: 1, mosses; 2, parts of cuticle of pupae of a ceratopogonid; 3, conifer pollen grains. Bits of other plants and ceratopogonid adults were also found. This gives some indication of how these moss-dwellers fit into the ecology of the ravine.

***Ellipteroides limbatus* (von Roser, 1840)**

Specimen nos. 19/034 female, 19/035 male. Collected 27 May 2019, Sector 3. Figs 1a, 1b.

The male and female genitalia are diagnostic. The ovipositor of the female is reduced to blunt lobes, and is therefore distinctive. This simple structure implies that the eggs are deposited, perhaps onto moss, rather than injected below the soil. The male hypopygium is superficially similar to that of *E. alboscuteclatus* (von Roser, 1840).

A rarely recorded local species in Britain, *Ellipteroides limbatus* is a typical occupant of limestone ravines with seepages. In central Europe, it is widely distributed from the Italian Alps to S.E. Russia, Turkey and Ireland. In England it occurs together with *Ellipteroides alboscuteclatus* (Blythe 2010), and so this is another species of *Ellipteroides* to look out for in the ravine. In Britain, *E. limbatus* was first recorded in Wales by Stubbs (1977) in a ravine, Nant Sere, in the Brecon Beacons and it is interesting that *Molophilus corniger*, *M. curvatus* Tonnoir, 1920, *M. variispinus* Starý, 1971, *Dicranomyia aquosa* and *Lipsothrix nervosa* Edwards, 1938 were also present at this Welsh site. Other seepage species present in the Ravin de Valbois include *Dicranomyia aquosa*, three species of *Dactylolabis*, *Elliptera hungarica* Madarassy, 1881 and *E. omissa*. Calcicole species in addition to the above include *Molophilus corniger*, *M. lackschewitzianus*, and *Paradelphomyia ecalcarata*.

***Erioptera verralli* Edwards, 1921.**

Specimen no. 18/022. Collected 2.v.2018, pm. Ravin de Valbois, sector 7, from stream margin. Fig. 2.

The shape of the male styles is diagnostic. It is widespread in Europe, ranging from the Italian Alps to Russia, but not in Scandinavia. In Britain the type locality is in Dove Dale on the Carboniferous Limestone of the 'White Peak' district, Derbyshire. It occurs locally in England and Wales and is a species of shaded stream margins on calcareous soils.

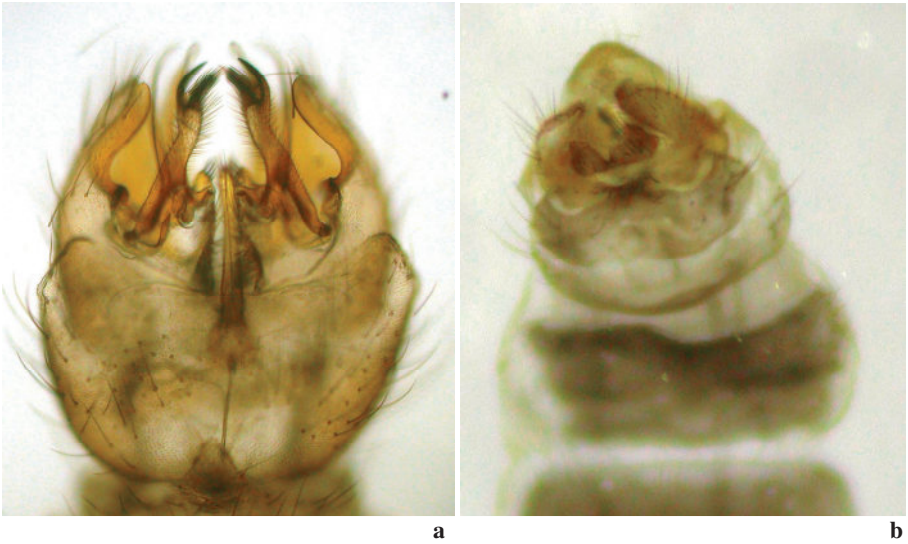


Fig. 1. *Ellipterooides limbatus*: a, male hypopygium; b, female ovipositor.



Fig. 2. *Erioptera verralli*, male hypopygium.

***Molophilus lackschewitzianus* Alexander, 1953**

Identified from Malaise trap samples. TM 3 (damp woodland just downstream from the waterfall) 2.vi.2019, 1 male. TM 1 (dry woodland, high on slope at top of gorge), 15.vii.2019, 1 male. Figs 3a, 3b.

The male hypopygium is diagnostic. In Europe, its distribution extends from Switzerland to south-western Russia and Turkey, and north to Denmark. This is another species associated with calcareous soils, and in Britain there are some 20 records. JK has recorded this from a wooded valley in Leigh Woods, near Bristol, situated on Carboniferous Limestone.



Fig. 3. *Molophilus lackschewitzianus*, male hypopygium: a, viewed from above; b, viewed from the side.

***Molophilus tirolensis* Hancock 2005**

Specimen nos: males 18/28, 18/030. Females, 18.003, 18/004, 18/018. Figs 4a – 4d.

A number of specimens of a black *Molophilus* were hand netted in the field on 3 May 2018, by sweeping a patch of nettles (*Urtica* species) by the stream (Le ruisseau de Valbois) beneath a rocky over-hang. The presence of nettles often indicates that the area has been used by animals as a shelter. The bodies of male and female specimens were uniformly black. Wing length = 5.0mm and the halteres yellow. Coxae and trochanters dusky yellow; proximal third of femora yellow grading to dark grey distally. Tibiae and tarsi dark. The cerci of the female ovipositor are strongly curved upward, yellow distally grading to brown at the base. Sternal valves slightly upturned, brown.

The hypopygium of the male is similar to that illustrated by Hancock (2005) and although the upper style is bent at an obtuse angle rather like a hockey stick, no trace of the 'heel', or short broad bifurcation, on this style can be seen on the specimen from the Ravin de Valbois. This variation occurs in other members of this species (Jaroslav Starý *pers. comm.*). The holotype was captured on 5 May 1969 from the margin of a rocky stream in Austria by B.H. & M.C. Cogan and R.I. Vane-Wright. Specimens were also captured by C. Dufour on 25 May 1994 in the Département of Doubs, France (Hancock 2005), and by the author on 28 May 2007 in the Gorge de Bruyant near Laus-en-Vercours (Lambert Grid: 856.2022). This latter record was also from the margin of a mountain stream through a limestone gorge.

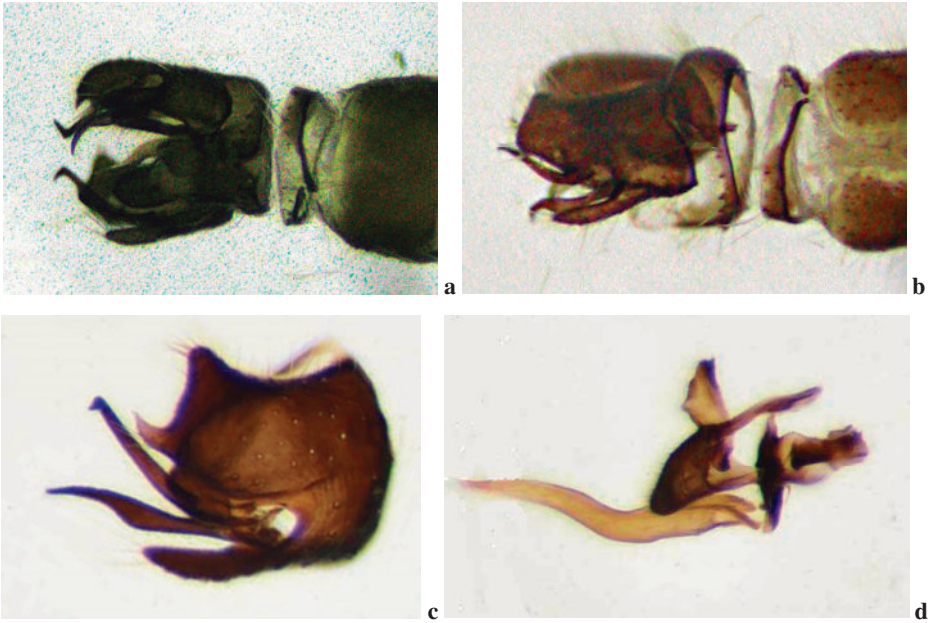


Fig. 4. *Molophilus tirolensis*, male hypopygium: a, view from below; b, lateral view; c, dissected half, lateral view; d, aedeagal complex, lateral view.

***Tasiocera robusta* (Bangerter, 1947)**

Tube no. 95. Collected by DL. 27 June in Sector 7, and on 25 June 2019, Sector 8, both near the stream. Figs 5a, 5b.

A very small dark species. Dissection of the hypopygium revealed the characteristic genital apodeme. The larvae are unknown, but probably aquatic. In Europe, it has been recorded in the south from Switzerland and Greece and as far north as Britain, where it is widespread but rarely recorded. Previously, two species of *Tasiocera* have been identified in France – the pale *Tasiocera fuscescens* (Lackschewitz, 1940) and the dark *T. murina* (Meigen, 1818).

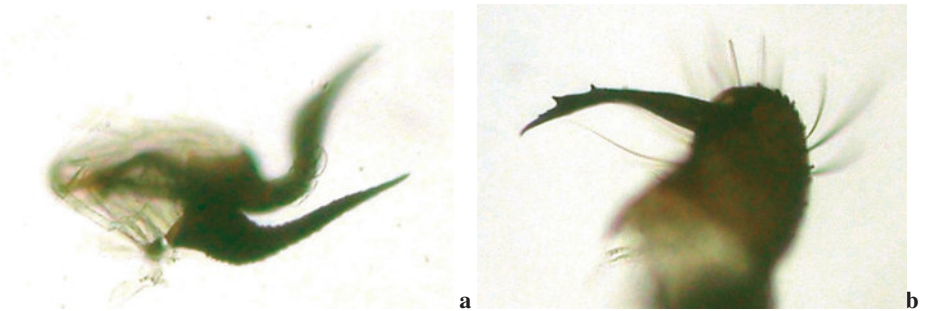


Fig. 5. *Tasiocera robusta*: a, male genital apodeme; b, male coxite and style.

***Paradelphomyia ecalcarata* (Edwards, 1938)**

Specimen no. 19/08 – male. Collected 25 June 2019, Sector 8. Figs 6a, 6b. New to France.

No stripes are present on the prescutum and so, with the lateral arms on the apodeme, these specimens are identified as *P. ecalcarata*. The lateral arms are thickened, as described by Starý (2019).

The larvae of this genus are found in wet woody debris, which is abundant in the stream. In Europe it ranges from Switzerland in the south to SE Russia in the east. In Britain it is widespread but very local. The type locality is Llangollen in north Wales, on Carboniferous Limestone. *Paradelphomyia nielseni* (Kuntze, 1919) and *P. senilis* (Haliday, 1833) have also previously been identified in France.

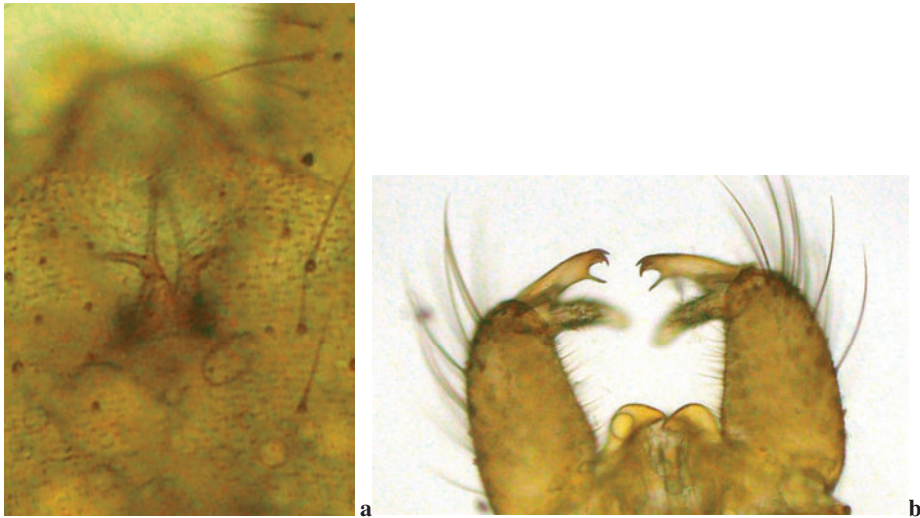


Fig. 6. *Paradelphomyia ecalcarata*: a, male genital apodeme; b, male outer style.

***Dicranomyia lutea* (Meigen, 1818)**

Specimen no. 19/016 – male. Collected 26/06/19, Sect. 7. Figs 7a – 7d.

Despite this species being described some 200 years ago *D. lutea* is not currently listed in the French fauna in the Catalogue of Craneflies of the World (Oosterbroek 2019). For a long time it was often subsumed under *D. mitis*. Although there are records in Pierre's key of 1924, here it was possibly a case of misidentification. Edwards (1938) named it as *D. mitis* var. *lutea* (Meigen) and it has recently been re-described as a species (Starý and Stubbs 2015, p. 330). The more elongated inflated style and relative lengths of the rostral spines on this inflated outer style place these specimens in the *mitis*-, rather than the *chorea*-group. The overall colour is yellow, with body and wings barely marked and with a very pale pterostigma. Vein Sc is without macrotrichia, tarsomeres 4 and 5 are approximately equal in length and the rostral spines are situated closely together. There is a very slight darkening of the femora distally. In the population in the Ravin de Valbois the antennae and palps are dark.

The typical habitat, as described by Starý and Stubbs (2015), is: 'mainly on well-drained clay or limestone soils. It is absent on acid soils, can be present under mesotrophic conditions, but shows greatest affinity to mild or strong calcareous situations, preferring scrub edges associated with calcareous grassland. The species can occur within woodland, but rarely in

numbers.' The ravine habitat conforms to that description with respect to the calcareous situation, and shaded wet woodland predominates in the locations where it was found most abundantly. Differing taxonomic opinions and nomenclature changes make the distribution of this species difficult to plot and it is not listed as a species in the Palaearctic Catalogue (Soós and Papp 1992). It is widely distributed in Britain and probably widespread in Europe. (Starý and Stubbs 2015)

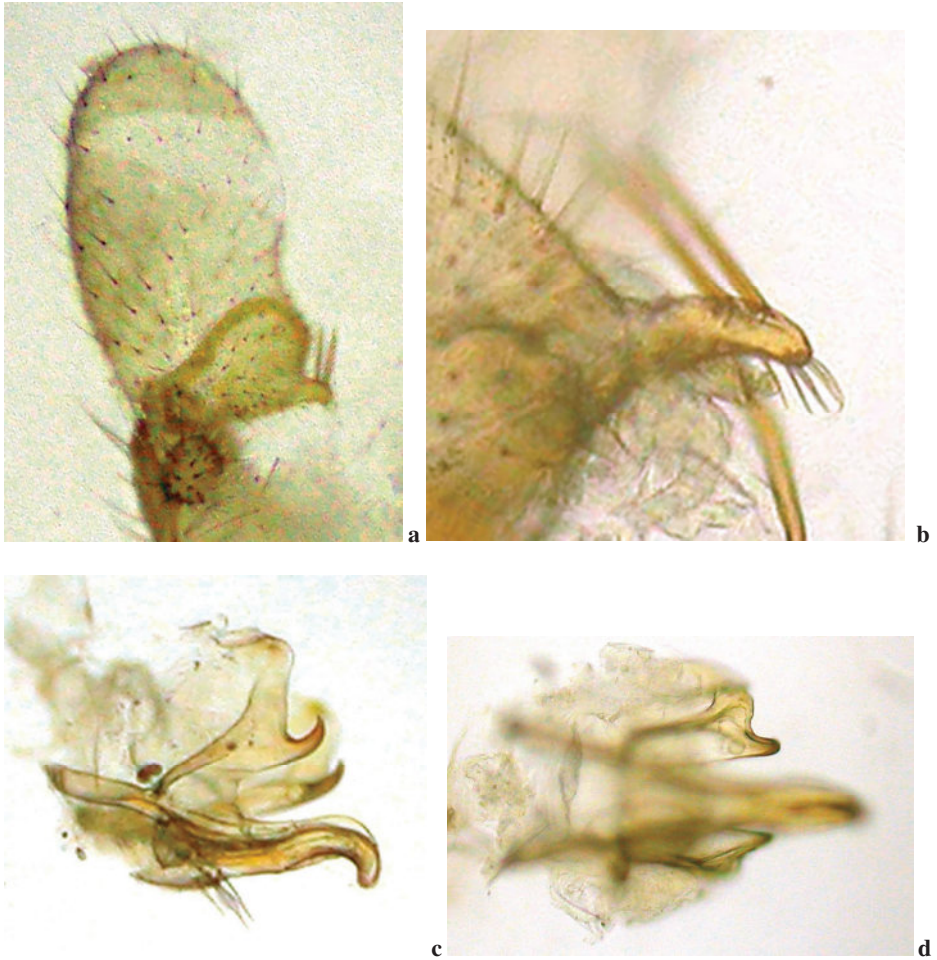


Fig. 7. *Dicranomyia lutea*, male: a, coxite and styles; b, rostrum and spines; c, aedeagus and parameres, lateral view; d, aedeagus and parameres, ventral view.

***Lipsothrix errans* (Walker, 1848)**

Specimen no. 19/014 – male. Collected 26/06/19, Sect. 7. Fig 8.

The specimen lacked a stigma and had terminal dark rings on the tibia and so keyed out to *L. errans* (Stubbs 2001). The genital apodeme was dissected out and is diagnostic. This species was also recorded as larvae in wet wood in the Reserve Naturelle National de la Forêt de la

Massane, France (Pyrenées Orientales) (Rotheray and Horsfield 2003). As mentioned by Kramer and Langlois (2019), with the large amounts of wet woody debris in the streams it was perhaps not surprising that *Lipsothrix errans* was found by the Ruisseau Valbois in June. In addition to La Massane, it has also been found in a similar habitat – in the limestone ravine on the approach to the Cirque de Môme (Kramer 2008). In Europe, it has a more northerly distribution being present in Scandinavia (Olsen *et al.* 2018), across Russia and south to the Italian Alps, but is absent from Greece. In Britain, it has been recorded locally in Wales, northern England and Scotland.

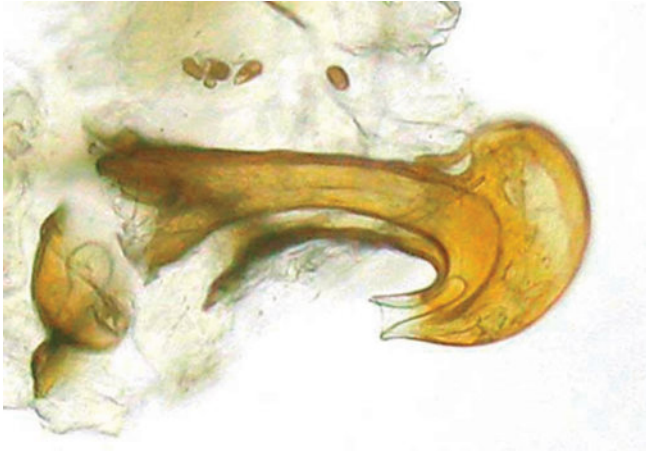


Fig. 8. *Lipsothrix errans*, male apodeme.

Discussion

23 crane fly species have been added to the list for the Ravin de Valbois from the June and September expeditions, bringing the total to 91 species. Of this total, 11 species have been newly recorded in France.

Ravin de Valbois is currently humid for most of the year, with mosses growing on the rocks and on living and dead trees, often at several metres height. This rare and fragile moss flora is an important component of this National Nature Reserve and during this period of climate change could be vulnerable to long periods of drought. It supports a number of very local tipulid crane flies such as *Tipula stigmatella* (cf. Kramer 2017), *T. mutila* (cf. Kramer 2012), *T. trifascingulata* (cf. Kramer 2014), *T. benesignata* and *T. cheethami* Edwards, 1924.

Acknowledgements

Thanks from JK to the Langlois and Ravenot families for their friendly hospitality and to DL and Frédéric Ravenot for their company during the field work. DL would like to honour the memory of Jean-Claude Robert, Professor at the University of Science of Besançon who died in 2014, and who advised him to study Tipulidae as vital elements of the ecology of the Ravin de Valbois. Also, many thanks to Pjotr Oosterbroek and Jaroslav Starý for their very helpful comments.

References

- Blythe, M. 2010. *Ellipteroides* Craneflies (Diptera: Limoniidae) in the Wyre Forest. pp 34-37. Wyre Forest Study Group Review 2010.

- Hancock, E.G. 2005. Notes on *Molophilus* (Diptera, Limoniidae) including the description of a new European species. *Entomologists Monthly Magazine* **141**, 59-63.
- Heaver, D. 2005. The ecology of *Ellipteroides alboscuteellatus* (von Roser, 1840) (Diptera, Limoniidae) in England. *Dipterists Digest (Second Series)* **13**, 67-86.
- Kramer, J. 2008. A second record for *Tipula (Emodotipula) gomina* Dufour 2003. *Dipterists Digest (Second Series)* **15**, 12.
- Kramer, J. 2012. *Tipula (Pterelachisus) mutila* Wahlgren (Diptera, Tipulidae) new to France and its status in Britain. *Dipterists Digest (Second Series)* **19**, 155-156.
- Kramer, J. 2014. A second record of *Tipula (Pterelachisus) trifascingulata* Theowald (Diptera, Tipulidae) new to France. *Dipterists Digest (Second Series)* **21**, 55-58.
- Kramer, J. 2015. A review of the genus *Paradelphomyia* Alexander (Diptera, Limoniidae) in Britain. *Dipterists Digest (Second Series)* **22**, 43-57.
- Kramer, J. 2017. A first record of *Tipula (Mediotipula) stigmatella* Schummel (Diptera, Tipulidae) in France. *Dipterists Digest (Second Series)* **24**, 161-163.
- Kramer, J. and Langlois, D. 2019. Craneflies (Diptera, Tipuloidea) of the Ravin de Valbois, France. *Dipterists Digest (Second Series)* **26**, 83-95.
- Olsen, K.M., Oosterbroek, P., Boumans, L. and de Jong, H. 2018. Forty species of limoniid craneflies new to Norway, with an annotated list of Nordic Pediciidae and Limoniidae, including distributional data (Diptera, Tipuloidea). *Norwegian Journal of Entomology* **65**, 127-174.
- Oosterbroek, P. 2019. Catalogue of the Craneflies of the World (Diptera, Tipuloidea: Pediciidae, Limoniidae, Cylindrotomidae, Tipulidae). <http://ccw.naturalis.nl> [accessed July and September 2019].
- Pierre, C. 1924. Faune de France 8, Diptères: Tipulidae. Office Central de Faunistique, Paris.
- Przhiboro, A.A. 2003. New records of crane-flies from NW Russia, with ecological notes on some species (Diptera: Tipulidae, Limoniidae). *Zoosystematica Rossica* **11**(2002), 361-366.
- Przhiboro, A.A. 2009. Two new records of Tipuloidea (Diptera) from a cold spring in NW Russia. *Zoosymposia* **3**, 229-233. Magnolia Press.
- Rotheray, G. and Horsfield, D. 2003. Reserve Naturelle de La Massane. Travaux 67. Inventaire des Diptères Saproxyliques de la Reserve Naturelle de la Massane. Report for the Association des Amis de La Massane.
- Soós, A. and Papp, L. 1992. Catalogue of Palaearctic Diptera, Vol. 1, Trichoceridae – Nymphomyiidae. Ed. Oosterbroek, P. Hungarian Natural History Museum
- Starý, J. 2019. Some notes on the genus *Paradelphomyia* Alexander (Diptera, Limoniidae) *Dipterists Digest (Second Series)* **26**, 57-60.
- Starý, J. and Stubbs, A.E. 2015. Five species under *Dicranomyia (Dicranomyia) mitis* (Meigen, 1830) (Diptera, Limoniidae). *Zootaxa* **3964**(3), 321-334.
- Stubbs, A.E. 1977. *Gonomyia (Protogonomyia) limbata* and *Molophilus variispinus* Starý (Diptera, Tipulidae) new to Britain from Wales. *Proceedings of the British Entomological and Natural History Society* **1977**, 100-103.
- Stubbs, A.E. 2001. Cranefly Recording Scheme. Test Keys for the Identification of British *Chioneinae*. Part 2, 17pp (circulated with Bulletin of the Dipterists Forum No. 52).

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