SAPROXYLIC AND OTHER INVERTEBRATES FROM AN UPLAND WOODLAND ON THE FRINGES OF BODMIN MOOR, CORNWALL

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ABSTRACT

A baseline study of the invertebrates associated with veteran trees was carried out in part of an area of upland hill farm that is being included in a rewilding scheme. The study site is an oak woodland along the valley of the Bedalder River, on the fringes of Bodmin Moor. Flight interception trapping across the 2021 field season produced 228 species of Diptera including a very notable 114 species of fungus gnat. Seven of these Diptera have conservation status in Britain including one Near Threatened. One species is also new to the British list although believed to be an overlooked native – *Sciophila arizonensis* Zaitzev (Mycetophilidae). The Coleoptera proved to be much less interesting, with just 42 species trapped and including three Nationally Scarce species. The Diptera included 87 species which are at least in part saproxylic and the Coleoptera included 22 saproxylics. The final total of saproxylic species for this upland fringe woodland is therefore in excess of 100 species which is an impressive total for the situation.

INTRODUCTION

Bodmin Moor is an upland granite area of England reaching about 420 m altitude at Bronweneley, "swallows' hill" in Cornish, better-known today as Brown Willy. The head waters of the various rivers which eventually form the Fowey River drain southwards. The mosaic of ancient wood pastures, parklands and woodlands of the lower Fowey valley have been identified as a hotspot for saproxylic beetles (Alexander, 1993 & 2004) but little was known about the upper reaches. A rewilding project planned for an upland hill farm in the higher catchment of the Fowey River – Cabilla Manor Farm in Cardinham civil parish – provides a rare opportunity to carry out a baseline survey of saproxylic invertebrates associated with veteran trees in this interesting area before any significant changes in management have occurred. The farm lies within the tributary valley of the Bedalder River and the woodland study site forms a deep ravine at about 170–180 m.

The current focus of Cabilla Manor Farm is on 'restoration, retreat and research'. The restoration programme is designed to enhance Cabilla's natural environment by slowly reintroducing key ecosystem engineers, such as beaver, bison, wild boar, Eurasian wild cat and pine marten, while respectfully supporting the wild growth of the flora and fauna. The rewilding started in summer 2020 with the introduction of beavers to an enclosure within a wooded tributary stream valley. The owners are committed to studying the effects of nature on human physiology and the impact the ecosystem engineers have on the land. UK farming, especially on the uplands, is about to go through its most drastic period of change in more than 80 years. These farms tend to draw 80–90% of their income from subsidies (predominantly from the EU) and a never-ending obsession with efficiency has resulted in a reduction of jobs and opportunities for the local rural community. Cabilla Cornwall hopes to change this by providing a template that can be used to restore soil and animal health, while

also creating jobs and injecting opportunities back into the rural economy (information from www.cabillacornwall.com).

Cabilla Manor Wood SSSI straddles the main river valley and includes a long section of riverside woodland dominated by veteran oak trees *Quercus robur*. The terrestrial invertebrate fauna of the SSSI was virtually unknown but two exploratory forays in 2020 found the Nationally Scarce *Orchesia minor* Walker (Col., Melandryidae). The wood-decay mycota was found to be moderately diverse for such a moorland fringe situation with beefsteak fungus *Fistulina hepatica* fruiting from at least one of the older oak trees. The SSSI was designated in 1989 and comprises a block of 15.1ha of woodland, although linked both upstream and downstream with further areas of riverside woodland. The core of the wooded slopes has clearly had a long history of exploitation for timber products – there are long abandoned mine workings within the woodland and close by – and is currently dominated by straggly oaks of relatively low girth mixed with plentiful hazel. However, veteran oak standards feature along the southern edge and follow the immediate riverside areas upstream. Although the SSSI schedule describes the wood as having "coppiced ancient sessile oak *Quercus petraea* woodland dominant" there are limited signs of coppice stools and all of the oaks examined have proved to be pedunculate oak *Q. robur*. The site appears to have been designated primarily for the presence of both native species of filmy ferns on wet rock overhangs and for mosses.

Material and Methods

The focus of the study methodology was on flight interception trapping, to provide a relatively standard and objective approach which might be used for long-term monitoring of the impacts of planned changes in land management. The flight traps used were of a standard four-bottle design (Alexander *et al.*, 2016). The dates adopted for operation of the traps were: setting up, 1 April; samples taken 18 May and 28 July, with final samples taken and trap dismantling on 8 November. The traps were therefore operated for six months across the full field season in 2021. Five traps were used in total (Table 1) – the number reflecting the availability and accessibility of veteran trees with suitable wood-decay features as well as time limitations. The first four traps were positioned at between 2 and 3 m height against tree trunks whereas the fifth trap was necessarily placed at a lower height (1m approx) as the top of the trunk selected had snapped away (see Fig. 1).

The fieldwork was carried out by KNAA and the Diptera samples were passed to PJC for identification.

Results and Discussion

A total of 289 species of terrestrial invertebrate were found in the course of the 2021 sampling and these have been identified to at least genus level, most to species level. A total of ten of these currently have conservation or equivalent status, and these include one British Red List species (Table 2).

These categories are simplified to some extent as some have only been assessed under the earlier JNCC Guidelines (Falk, 1991; Hyman, 1992). A programme of updating is under way by the nature conservation agencies, applying IUCN Red List categories at a regional (GB level) as well as retaining the JNCC categories of Nationally Rare (NR) and Nationally Scarce (NS). The present situation with regard to species status is complex to describe, hence the approach taken has been to simplify it as much as possible.

Fig. 1. Trap 1 on live oak tree with vertical strip of trunk with exposed dead heartwood possibly an old lightning strike? The bracket fungus *Fistulina hepatica* fruited here in 2020.

It is interesting to compare these broad results with those for a similar study of another upland site, Thorneythwaite Fell in the Lake District National Park (Alexander, Chandler & Pankhurst, 2019) – see Table 3. At Thorneythwaite the species total was 496 overall, the majority from flight traps. A total of 35 species with conservation status were found using ten rather than five flight interception traps. The greater richness of the Lake District site almost certainly reflects the difference in scale as the site was much more extensive and formed part of a larger system of ancient wood pasture and woodland – Borrowdale. The trees were also older and larger as land management – wood pasture – had favoured veteran trees, through pollarding. In contrast, Cabilla Manor Wood has had a history of gross exploitation for mining activities. Both sites proved similar however in being far richer in Diptera than Coleoptera, and this is almost certainly a feature of upland wood pastures and woodlands, where stable relatively high humidity and general wetness of the local climate tends to favour a much wider range of Diptera. The proportion of fungus gnat species in the totals was also broadly similar.

Saproxylic Coleoptera were found to be relatively poorly represented at both sites, at least partly a reflection of the upland situation where tree growth is limited by the relatively cold and wet climate.

Diptera

The Diptera were clearly the most outstanding group found at Cabilla during 2021 and are accordingly assessed first. Of the species total of 228 species trapped exactly

Table 1. Details of flight trap locations in Cabilla Manor Wood SSSI

Trap No.	GPS location of oak tree	Girth of tree (m)	Fruiting fungi	Other features
1	SX14952 69571	2.83	*Fistulina hepatica*	live tree with vertical strip of trunk with exposed dead heartwood – old lightning strike?
2	SX15032 69554	2.77	*Hymenochaete rubiginosa*	live tree with trap by snapped branch stub
3	SX14861 69817	3.00	*H. rubiginosa*	live tree with rot-hole and exposed dead heartwood
4	SX14791 70016	2.92	none	live tree with snapped branch stub
5	SX14812 70023	3.19	none	large snag with extensive red-rotten heartwood

Table 2. Number of terrestrial invertebrates with conservation or equivalent status

Status	Coleoptera	Diptera
New to British List		1
Red Data Book categories		
Near Threatened		1
JNCC categories		
Nationally Scarce/Notable	3	5
Total	3	7

Table 3. Comparison of invertebrate survey results for Cabilla Manor Wood with Thorneythwaite Fell

Feature	Cabilla	Thorneythwaite
Gross totals:		
Total number of invertebrate species recorded in one field season	289	496
Total number of species with conservation or equivalent status	10	35
Total number of Diptera in flight traps	228	353
Total number of fungus gnats	114	167
Fungus gnats as percentage of total Diptera	50	47
Total number of Coleoptera	42	89
Saproxylic totals:		
Total Diptera species which are at least partially saproxylic	87	107
Number of saproxylic Coleoptera qualifying for Saproxylic Quality Index calculation	16	48
Number of saproxylic Coleoptera qualifying for calculation of Index of Ecological Continuity	0	4

Table 4. List of Diptera with conservation status found during the 2021 flight trapping.

Family and Species	British Status	Catch totals and trap situation
Mycetophilidae		
Mycetophila immaculata (Dziedzicki)	NS	2m 1f trap 4, April/May
Phronia electa Dziedzicki	NS	1m trap 4, April/May
Sciophila antiqua Chandler	NT	4m trap 4, April/May
S. arizonensis Zaitzev	New to GB	2m trap 4, April/May
S. buxtoni Freeman	NS	several males trap 4, April/May
Trichonta nigritula Edwards	NS	2m trap 4, April/May; 1m May/July
Muscidae		
Phaonia villana Robineau-Desvoidy	NS	2f trap 2, May/July 1m 2 f trap 4, April/May

half of the species identified were fungus gnats (most Phoridae and some Nematocera were not determined). By comparison, Thorneythwaite Fell had produced 353 species of which 167 (47%) were fungus gnats, and so a similar high representation. Half of the Diptera catch being fungus gnats appears characteristic of flight interception trapping, especially in upland situations.

The list of Diptera species from Cabilla with conservation or equivalent status is presented in Table 4.

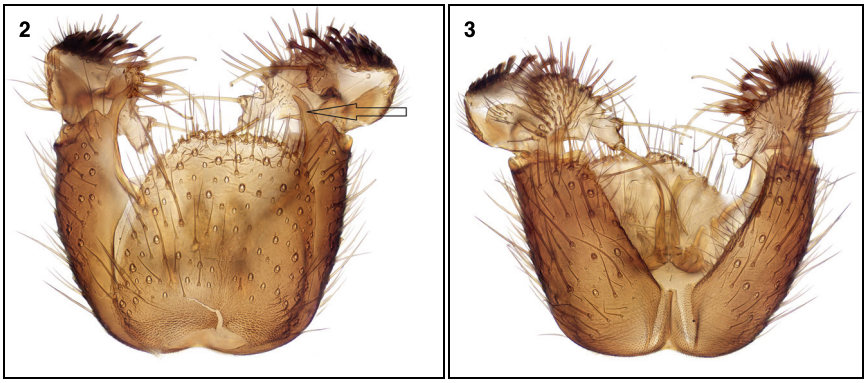
It is immediately obvious that trap 4 was by far the most productive in interesting species, catching examples of all of the species with conservation status. One of the species, *Phaonia villana*, was additionally found in trap 2. Trap 4 had been hung in a shady position against a moss-covered tree trunk and beneath a more-or-less horizontal, moss-covered section of an oak branch the end of which had broken off. The tree was on an old Cornish hedge over an extensive area of wet seepage immediately above the river. The situation was therefore especially sheltered, shady and with more-or-less constant high humidity.

Sciophila Species

An exceptional seven species of *Sciophila* were taken by trap 4 alone.

Sciophila arizonensis Zaitzev, 1982 was described from the USA (Arizona) and Canada (Ontario and British Columbia). Having seen specimens from France and Switzerland, PJC recorded it as new to Europe in *Fauna Europaea* (2005). This was based on specimens from France, Var, Île de Port Cros, reared from larva, 21.x.1963, 1♂, L. Matile; Switzerland, Ticino, Angone/Anzonico, 21–31.viii.1981, 1♂, G. Bächli. Matile (1964) recorded rearing *S. limbatella* Zetterstedt, 1852 from larvae on a fallen pine trunk at Port Cros, so this may have been from the same source.

Zaitzev (2006) recorded it from the Far East of Russia, a male collected in 2–4.ix.2005 by Malaise trap at Lazovskii Natural Reserve, Primorskii krai; he figured the genitalia, commenting that it slightly differed from type specimens in the apically more rounded shape of tergite IX and in absence of a long bristle on the medial margin of the gonocoxite basal to a pointed process (arrowed in Fig. 2), which is a distinguishing character of *S. arizonensis* from other *Sciophila* species. The Cabilla specimens (Figs 2–3) have the tergite apically more truncated as in the original 1982 figure, but also lack the long gonocoxal bristle.



Figs 2–3. Male genitalia of *Sciophila arizonensis* Zaitzev: 2, dorsal view, arrow indicates pointed process of gonocoxites; 3, ventral view.

Ševčík (2005) recorded it from the Czech Republic (three localities from 1998 to 2002). Salmela & Kaunisto (2015) recorded one male collected in a Malaise trap in the period 8.viii–9.ix.2014 at Pyhä-Luosto National Park, Ostrobothia borealis in Finland; they said the Finnish locality was an "iron-rich spring-fed brook on an ecotone between a pine mire and a luxuriant riparian forest" (photo of Malaise trap location in their article).

Great Britain can now be added to the countries where this Holarctic species is known to be present. Cabilla is one of only eleven places on the planet where this species is known to be present. Its ecology remains obscure.

The Near Threatened *Sciophila antiqua* Chandler, 1987 was described from Scadbury Park (TQ4570), Chislehurst, Kent, 21.vii.1985, 1 male around dead wood in overgrown parkland. There are 4 other British records from three hectads:

Sydling's Copse (SP5509), Oxfordshire, 18.vii–16.vii.1991, Malaise trap, Keith Porter.

Wicken Fen (TL560705), 18.ix.1993, Ivan Perry.

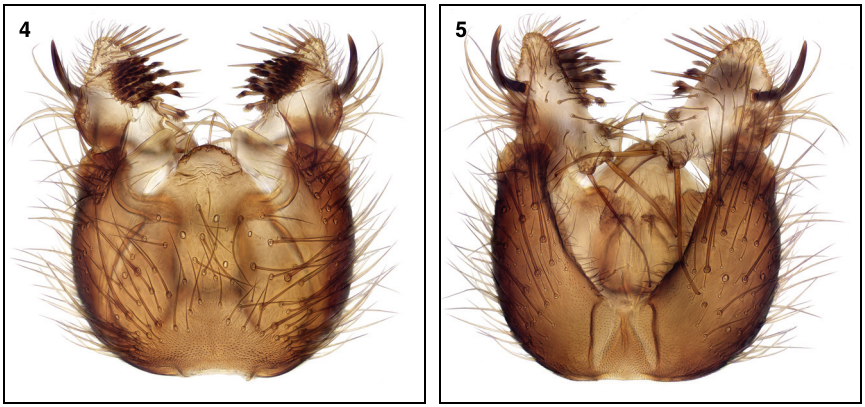
Lye Valley Fen (SP5405), Oxfordshire, 5.vi.2008, reared from *Trametes versicolor* with a male of *S. hirta* Meigen, Judy Webb.

Flitwick Moor (TL046952) Beds, 25.iii.2017, Ivan Perry.

It had been recorded from Finland under the name *S. hebes* Johannsen, 1910, an allied North American species, and was reared in Finland from the polypore *Amylocystis lapponica* growing on spruce (Komonen *et al.* 2001). Ševčík (2005) recorded it in 1999 at a floodplain forest in the Czech Republic and (2010) reared it in 2003 from the saproxylic agaric *Pleurotus pulmonarius*. So it can be considered as polyphagous on saproxylic fungi and no obvious reason for its rarity. Kjærandsen *et al.* (2007) recorded it from Sweden, and Kjærandsen & Søli (2020) recorded it from Norway. It resembles *S. hebes* in the presence of a strong spine on the gonostylus, and three long bristles apically on tergite 9, but has the tergite more elongate and narrowed apically (Figs 4–5).

A line drawn from Wicken Fen to Cabilla Manor Wood passes close to the Bedfordshire and Oxfordshire sites (see map, Fig. 6).

The Nationally Scarce *S. buxtoni* Freeman, 1956 is another poorly-known species (Falk & Chandler, 2005) but fortunately with a number of rearing records, all from



Figs 4–5. Male genitalia of *Sciophila antiqua* Chandler: 4, dorsal view; 5, ventral view.

annual-fruiting bracket fungi – *Daedaleopsis confragosa, Trametes gibbosa, T. versicolor* and *Laetiporus sulphureus*, all widespread species exploiting dead broad-leaved wood. Records have come from sites across the south and south-east of England (Kent, Surrey, Essex, Bucks and Norfolk) and so Cornwall is a considerable extension to its known range and a first upland situation.

The other *Sciophila* species trapped were *fenestella* Curtis, *hirta* Meigen, *lutea* Macquart and *nonnisilva* Hutson, all relatively frequent. Two of these, *S. hirta* and *S. lutea*, are polyphagous in a wide range of saproxylic and terrestrial fungi; *S. fenestella* was reared in Finland by Jakovlev (2011) from the polypore *Rhodonia placenta* on a burned spruce stump, while *S. nonnisilva* was obtained by Zaitzev (1994) from fungal mycelium on rotten wood, and it has also been reared from the saproxylic fungus *Auricularia auricula-judae* (Chandler, 1993).

Other Diptera of Interest

Trichonta nigritula is a species of wet woodland, carr and fen, although its larval biology is unknown. It is best known from lowland sites in south-eastern England but has been found widely in more upland situations in recent years.

Only fourteen species of cranefly (Tipulidae & Limoniidae) were trapped including uncommon or localised species such as the saproxylic *Dictenidia bimaculata* (L.) and *Dicranomyia quadra* (Meigen), the latter a species of woodland streams. *D. bimaculata* is a scarce species in the county, with records from at least five other sites, all in VC2. Sites are either riparian woodland or historic parkland. This may be the first county record for *D. quadra*.

The Coleoptera

The relative paucity of saproxylic beetles and especially species with conservation status appears to be characteristic of upland woodland and wood pastures. The three Nationally Scarce species found at Cabilla (see Table 5) are all associated with smaller items of dead and decaying wood, small branches and twigs and this almost certainly reflects the site's history of exploitation for the local mines. No species with

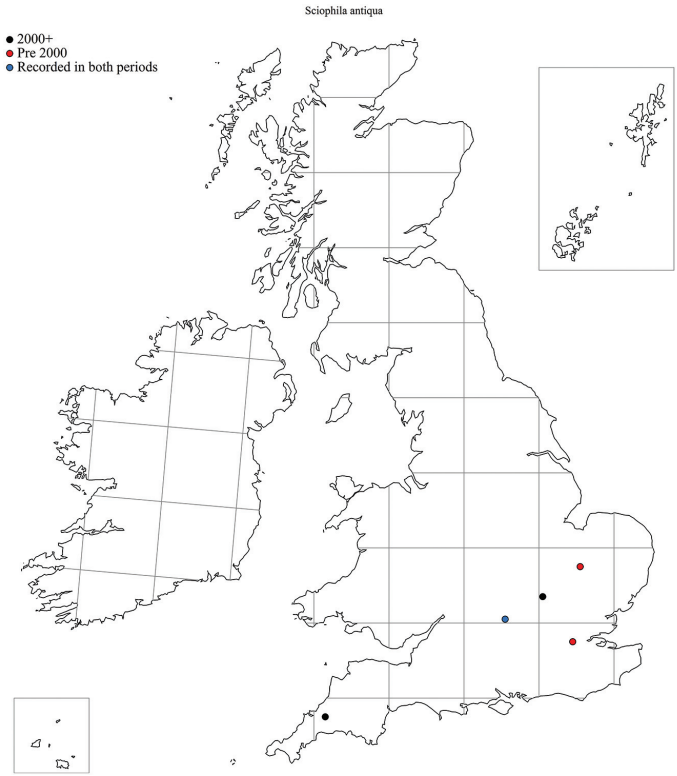


Fig. 6. Distribution map of *Sciophila antiqua* including Cabilla Manor Wood.

an association with ecological continuity of veteran trees and large items of decaying wood (Alexander, 2004) were found here on this occasion.

The presence of such flightless weevils as *Acalles ptinoides* and *Kyklioacalles roboris* in flight traps is an anomaly and reflects the trunk-side situation chosen for the traps. These species are active over the exposed wood surfaces and a few manage to drop into the preservative solution. Both have been shown to be characteristic of

Table 5. List of Coleoptera with conservation status found during the 2021 flight trapping.

Family and Species	British Status	Catch totals and trap situation
Melandryidae		
Orchesia minor Walker	NS	One in trap 2 in July and November
Curculionidae		
Acalles ptinoides(Marsham)	NS	One in trap 1 in November
Kyklioacalles roboris (Curtis)	NS	One in trap 5 in July

ancient woodlands on the Continent (Buse, 2012) although *A. ptinoides* – in Britain at least – is capable of exploiting woody stems of dwarf shrubs and so may be present on long-established heathlands as well as in ancient woodlands. *Orchesia minor* is also characteristic of ancient woodlands.

Other Invertebrates

While the catch was dominated by Diptera and to a lesser extent Coleoptera, there were also a good range of other groups represented. Five specimens of Giant lacewing *Osmylus fulvicephalus* (Scopoli) were taken in trap 4 and two aculeate Hymenoptera taken were *Crossocerus podagricus* (Vander Linden) and *Vespa crabro* L., one specimen each. Six species of barkfly were found including the recent arrival in Britain, *Chilenocaecilius ornatipennis* (Blanchard). Another exotic species, the New Zealand landhopper *Arcitalitrus dorrieni* (Hunt) was taken in three out of the five traps, further evidence that this species has the ability to climb high up tree trunks in Britain (Alexander, 2010). While flight traps are not designed for molluscs, *Balea sarsi* Phillippi, *Oxychilus alliarius* Miller and juvenile *Cepaea* were all taken in small numbers.

Since its first detection in the county in 1950, the landhopper has spread across much of the county and beyond, although remains very localised in VC 2. Its ability to climb tree trunks is well-known in its native range but was first demonstrated in Britain only recently, in Lanhydrock Park (Alexander, 2010). Giant lacewing is virtually confined in the county to the Bodmin Moor area, otherwise only known from a few north coastal valleys. *Balea sarsi* is a specialist feeder on epiphytes and so a typical feature of the aerial fauna of trees.

Site Assessment & Long-Term Monitoring

Saproxylic Coleoptera are the only group where site assessment has been taken beyond simple species-richness and presence or absence of rare species. Both the Index of Ecological Continuity (IEC) and the Saproxylic Quality Index (SQI) suggest that, at present, site quality for saproxylic beetles is relatively low at Cabilla. Only 16 of the saproxylic beetle species recorded by the trapping qualify for use in calculating the Saproxylic Quality Index (SQI), which is too few for a reliable site assessment (Fowles et al, 1999). The calculated Saproxylic Quality Score is 39 which produces a SQI of 243.8. This figure is substantially below that considered to be of national site quality and compares poorly with the county elite sites of Lanhydrock and Boconnoc Parks. It is however the starting point for this rewilding project and has the potential to increase or decrease in relation to changing circumstances. The wood has not been significantly impacted by any of the early start-up developments of the wilding project and so it will be interesting to see how the SQI responds as the project develops.

In contrast no species used for calculation of the IEC were found in the traps. The IEC is however a cumulative Index and may take a number of years of recording activity to generate a reliable site assessment. An IEC of zero is a minimum figure as some species present may have been overlooked. *Orchesia undulata* Kraatz (Col., Melandryidae) was noted in the wood during exploratory surveys in 2020 and so is such an example. The IEC is therefore currently a minimum of 1.

These SQI and IEC values form a baseline for future long-term monitoring as the wilding project progresses. It is by no means certain at present that the present minimum intervention approach to woodland management will continue in the SSSI

part of the hill farm but changes in the surrounding landscape may also have an impact on the woodland fauna.

It is more problematic to predict how the Diptera data might be used for monitoring purposes. The presence and performance of species with conservation status is probably the most reliable approach. Figures of gross species-richness may vary in relation to the situations selected for flight trapping. Trap 4 in 2021 produced the most interesting catch and the most abundant species total in comparison with the other four traps. With one in five traps proving an exceptional catch this does demonstrate the impact of stochastic influences.

Other groups of invertebrates could be incorporated into the monitoring programme. The terrestrial mollusc fauna has the potential to have significant interest in the wood and is a high priority for investigation. Light trapping of moths may also reveal some additional interests.

Conclusions

A baseline survey of Cabilla Manor Wood SSSI using flight interception traps has been very revealing. Diptera have been shown to be a key interest and especially fungus gnats. The discovery of a fungus gnat new to the British List has been a particular highlight of the study. Saproxylic Coleoptera may not be especially species-rich at present but offer the calculation of two Indices which may form a reliable means of assessing change in site quality over time. Other groups of invertebrates – ancient woodland molluscs and moths, for example – could usefully be brought into the research programme for this very interesting site. Overall, the 2021 trapping programme can be considered a success.

Acknowledgements

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References

Alexander, K. N. A. 1993. The deadwood fauna of Cornwall. *British Journal of Entomology and Natural History* **6**: 97–101.

Alexander, K. N. A. 2004. Revision of the Index of Ecological Continuity as used for saproxylic beetles. *English Nature Research Report* No. **574**.

Alexander, K. N. A. 2009. The wood-decay invertebrates of the Lanhydrock Estate, East Cornwall: a site of high nature conservation value but with no legal protection. *British Journal of Entomology and Natural History* **22**: 61–70.

Alexander, K. N. A. 2010. The landhopper *Arcitalitrus dorrieni* (Hunt) (Crustacea: Amphipoda) up a parkland tree in Cornwall. *Bulletin of the British Myriapod and Isopod Group* **24**: 39–40.

Alexander, K. N. A. 2019. *Chilenocaecilius ornatipennis* (Blanchard) (Psocodea: 'Psocoptera': Paracaeciliidae) continues to expand across western Britain and Ireland. *Entomologist's Monthly Magazine* **155**: 212–213.

Alexander, K. N. A., Chandler, P. J. & Pankhurst, M. 2019. Saproxylic and other invertebrates from an upland wood-pasture – Thorneythwaite Fell in the Lake District National Park. *British Journal of Entomology and Natural History* **32**: 311–320.

Alexander, K. N. A., Bengtsson, V. J., Jansson, N. & Smith, J. P., 2016. The role of trees outside woodland in providing habitat and ecological networks for saproxylic invertebrates. Part 1 Designing a field study to test initial hypotheses. *Natural England Commissioned Report* **NECR225a**: 1–107.

Buse, J. 2012. "Ghosts of the past": flightless saproxylic weevils (Coleoptera: Curculionidae) are relict species in ancient woodlands. *Journal of Insect Conservation* **16**: 93–102.

Chandler, P. J. 1987. Notes on British fungus gnats of the smaller families and subfamilies (Diptera, Mycetophiloidea). *Proceedings of the British Entomological and Natural History Society* **20**: 105–118.

Chandler, P. J. 1993. New rearing records of fungus gnats (Diptera: Mycetophilidae and allied families). *Dipterists Digest* (*First Series*) **13**: 29–35.

Chandler, P. J. 2005. Fauna Europaea: Bolitophilidae, Diadocidiidae, Ditomyiidae, Keroplatidae, Mycetophilidae In: de Jong, H. (Ed.) Diptera: Nematocera. Fauna Europaea version 1.2, http://faunaaeur.org

Falk, S. 1991. A review of the scarce and threatened flies of Great Britain (part 1). *Research & survey in nature conservation* No. **39**. Peterborough: JNCC.

Falk, S. J. & Chandler, P. J. 2005. A review of the scarce and threatened flies of Great Britain. Part 2: Nematocera and Aschiza. JNCC *Species Status* No.2.

Falk, S. J., Ismay, J. W. & Chandler, P. J. 2016. A Provisional Assessment of the Status of Acalyptratae flies in the UK. *Natural England Commissioned Reports*, **Number217**.

Falk, S. J. & Pont, A. C. 2017. A Provisional Assessment of the Status of Calypterate flies in the UK. *Natural England. Commissioned Reports*, **Number 234.**

Fowles, A. P., Alexander, K. N. A. & Key, R. S. 1999. The Saproxylic Quality Index: evaluating wooded habitats for the conservation of dead-wood Coleoptera. *The Coleopterist* **8**: 121–141.

Hyman, P. S. (Updated by Parsons, M. S.) 1992. A review of the scarce and threatened Coleoptera of Great Britain. Part 1. *UK Nature Conservation* No. **3**. Joint Nature Conservation Committee.

Jakovlev, J. 2011. Fungus gnats (Diptera, Mycetophiloidea) associated with dead wood and wood growing fungi: new rearing data from Finland and Russian Karelia and general analysis of known larval microhabitats in Europe. *Entomologica Fennica* **22**: 157–189.

Kjærandsen, J., Hedmark, K., Kurina, O., Polevoi, A. V., Økland, B. & Götmark, F. 2007. Annotated checklist of fungus gnats from Sweden (Diptera: Bolitophilidae, Diadocidiidae, Ditomyiidae, Keroplatidae and Mycetophilidae). *Insect Systematics & Evolution, Supplement* **65**: 1–165.

Kjærandsen, J. & Søli, G. E. E. 2020. Updated checklist of Norwegian Mycetophilidae (Diptera) with 92% DNA barcode reference coverage. *Norwegian Journal of Entomology* **67**: 201–234.

Komonen, A., Siitonen, J. and Mutanen, M. 2001. Insects inhabiting two old growth forest polypore species. *Entomologica Fennica* **12**: 3–14.

Matile, L. 1964. Diptères Fungivoridae récoltés dans l' Île de Port Cros (Var). *Cahiers des Naturalistes, N.P.* **20**: 5–10.

Salmela, J. & Kaunisto, K. 2015. Additions to the list of Finnish Bibionomorpha (Diptera, Nematocera). *Biodiversity Data Journal* **3**: 228: 1–22.

Ševčík, J. 2005. New records of *Sciophila* Meigen from the Czech and Slovak Republics (Diptera: Mycetophilidae). *Casopis Slezského zemského Muzea, Opava* **54**: 69–74.

Ševčík, J. 2010. Czech and Slovak Diptera associated with fungi. Silesian Museum, Opava, 112 pp.

Zaitzev, A. I. 1982. Gribnye komary roda *Sciophila* Meig. (Diptera, Mycetophilidae) Golarktiki. [Holarctic fungus gnats of the genus *Sciophila* Meig.]. Nauka, Moscow, 75 pp. [In Russian].

Zaitzev. A. I. 1994. [*Fungus gnats of the fauna of Russia and adjacent regions*]. Part 1: 288 pp. Moscow [in Russian].

Zaitzev, A. I. 2006. New and little known species of the subfamily Sciophilinae (Diptera, Mycetophilidae) from Russian Far East. *Far Eastern Entomologist* **161**: 1–4.