Zootaxa 3900 (1): 050–076
www.mapress.com/zootaxa/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

http://dx.doi.org/10.11646/zootaxa.3900.1.3
http://zoobank.org/urn:lsid:zoobank.org:pub:3E15E243-E72D-45C9-BB2B-D202B43990A2

Development sites, feeding modes and early stages of seven European *Palloptera* species (Diptera, Pallopteridae)

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Abstract

Two hundred and ninety-eight rearing records and 87 larvae and puparia were obtained of seven species of *Palloptera* Fallén (Diptera, Pallopteridae), mainly in Scotland during 2012–2013. The third stage larva and puparium of each species were assessed morphologically and development sites and feeding modes investigated by rearing, observation and feeding tests. Early stages appear to be distinguished by the swollen, apico-lateral margins of the prothorax which are coated in vestiture and a poorly developed anal lobe with few spicules. Individual pallopteran species are separated by features of the head skeleton, locomotory spicules and the posterior respiratory organs. Five species can be distinguished by unique character states. Observations and feeding tests suggest that the frequently cited attribute of zoophagy is accidental and that saprophagy is the primary larval feeding mode with autumn/winter as the main period of development. Food plants were confirmed for flowerhead and stem developing species and rain is important for maintaining biofilms on which larvae feed. Due to difficulties in capturing adults, especially males, the distribution and abundance of many pallopteran species is probably underestimated. Better informed estimates are possible if early stages are included in biodiversity assessments. To facilitate this for the species investigated, a key to the third stage larva and puparium along with details on finding them, is provided.

Key words: flutter fly, abundance, cannibalism, larva, morphology, necrophagy, predation, puparium, saprophagy

Introduction

As currently understood, the Pallopteridae is a small family of acalypterate flies (Diptera) with about 60 species worldwide and recognized by combined rather than unique characters (Merz 1998). However, the taxonomic limits and relationships of the Pallopteridae have changed frequently (Czerny 1934, Hendel 1937, Hennig 1967, Morge 1967, Griffiths 1972, McAlpine 1987, Papp 2011, Wiegmann *et al.*, 2011). Colloquially, they are known as flutter flies due to the characteristic manner in which they move their wings while walking (Hennig 1967, McAlpine 1987, Merz 1998). Whether this behaviour is involved in epigamic display and courtship is unclear (Merz 1998).

Adults are found on Apiaceae and Asteraceae (Parmenter 1951, Martinek 1977) while others occur on dead wood (Morge 1967, Chandler 1991). They can also be found indoors on windows (Collin 1951, Greve 1993), are taken frequently in Malaise traps (Greve 1993) and may be more abundant than appreciated due to poorly studied habits of being crepuscular and secretive (Collin 1951, Morge 1967, Martinek 1977).

Martinek (1977) and Greve (1993) summarize what is known of species biology in Europe and Stubbs (1969) and Chandler (1991) do the same for species occurring in Britain. Several species have been reared but these data are frequently old and uncertain (Czerny 1934, Collin 1951, Merz 1998). In Europe, larval development sites include flowerheads of Asteraceae, stems of Apiaceae, bark of dead wood, grass tillers and conifer seed cones (Balachowsky and Mesnil 1935, Niblett 1946 and 1951, Nye 1958, Morge 1967, Stubbs 1969, Chandler 1991, Rotheray and MacGowan 1999, Koziol 2007). Larval feeding modes apparently include saprophagy, phytophagy and zoophagy (Morge 1956, Ferrar 1987). Some species appear to have mixed feeding modes and if zoophagy is involved, such species are considered beneficial for controlling harmful infestations of bark beetles (Curculionidae, Scolytinae) (Morge 1967, Martinek 1977, Ferrar 1987, Krivosheina 2006). However, mixed feeding modes require confirmation as misidentification and confused taxonomy may explain them (Chandler 1991).

 Accepted by D. Bickel: 7 Nov. 2014; published: 19 Dec. 2014

male *P. umbellatarum*. None of these specimens were caught between 1700–1800h. The earliest capture time was 0900h and the latest 2300h. Half the *P. umbellatarum* were caught between 0900–1500h and the other half between 1900–2300h. Only one other specimen was caught at the end of the day, a *P. ustulata* at 1900h. Hence these data, although low in numbers, suggest that pallopteran adults can be active throughout the day. Comparing these results with those of Lewis and Taylor (1965), *P. umbellatarum* and *P. ustulata* were most frequently caught, reflecting perhaps, the observations noted above, that females of these species are not confined to being low in thick vegetation.

Sampling problems such as these suggest that adult captures are a poor guide to distribution and abundance and that pallopterans are more common than currently estimated. Sampling protocols should take these issues into consideration and include early stages which overcome many of these problems. For the species investigated here, the appropriate period for sampling early stages is September to March. However, as so often when attempting to include early stages, the potential benefits of utilizing them is limited by lack of knowledge, particularly of how and where to find development sites and the means to identify larvae and puparia. For instance, despite much effort to find them, early stages of two apparently common species, *P. umbellatarum* and *P. ustulata*, were not found during this study and in Europe as well as the UK, there are other, scarce and rare species whose early stages await discovery.

Acknowledgements

I am grateful to Keith Bland, Peter Chandler, Geoff Hancock, Dave Horsfield, Richard Lyszkowski, Iain MacGowan and Ellen Rotheray for help, support and encouragement with this study and for discussion of the results. I am also grateful to Darren Mann for loan of material from the Oxford University Museum, Alan Watson Featherstone for access to the Trees for Life reserve at Dundreggan and to Pete Moore for access to the RSPB reserve at Ballinlaggin. Thanks finally, to David Russell of the Histology Laboratory, Glasgow University for preparing the larva in Fig 13.

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