



Revision of the *Empis* subgenus *Enoplempis* Bigot, east of the Rocky Mountains (Diptera: Empididae)

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Abstract

The *Empis* subgenus *Enoplempis* Bigot, east of the Rocky Mountains of North America is revised. A total of 19 species are recorded from this region including seven new species: *E. (En.) amytis* Walker, *E. (En.) appalachicola* Sinclair **sp. nov.**, *E. (En.) arthritica* Melander, *E. (En.) ctenonema* Melander, *E. (En.) enodis* Melander, *E. (En.) gladiator* Melander, *E. (En.) gulosa* Coquillett, *E. (En.) loripedis* Coquillett, *E. (En.) montywoodi* Brooks **sp. nov.**, *E. (En.) nodipoplitea* Steyskal, *E. (En.) nuda* Loew, *E. (En.) pectinata* Sinclair **sp. nov.**, *E. (En.) penicillata* Brooks **sp. nov.**, *E. (En.) prodigiosa* Cumming **sp. nov.**, *E. (En.) snoddyi* Steyskal, *E. (En.) stenoptera* Loew, *E. (En.) tridentata* Coquillett, *E. (En.) vockerothi* Cumming **sp. nov.**, *E. (En.) volsella* Sinclair **sp. nov.** The following new synonymies are designated: *E. (En.) longipes* Loew, *E. (En.) longeoblita* Steyskal, *E. (En.) deterra* Walley = *E. (En.) amytis*; *E. (En.) cacuminifer* Melander = *E. (En.)*

gulosa. Lectotypes are designated for the following species: *E. (En.) arthritica*, *E. (En.) cacuminifer*, *E. (En.) ctenonema*, *E. (En.) enodis*, *E. (En.) gladiator*, *E. (En.) loripedis*, *E. (En.) stenoptera* and *E. (En.) tridentata*. A key to eastern species is presented and distributions illustrated. The form of nuptial gift presentation displayed within this group, including the use of balloons (with or without prey) and unwrapped prey are indicated for species when known.

Key words: Diptera, Empididae, *Empis*, *Enoplempis*, dance flies, balloon flies, mating behaviours, North America

Introduction

Dance flies (Empididae: Empidinae) exhibit an interesting array of mating behaviours, including specialized mating swarms and transfer of insect prey and other items by males to females as nuptial gifts (Chvála 1976; Cumming 1994). They have been the subject of several detailed behavioural studies (e.g., Svensson & Petersen 1987; Svensson 1997; Sadowski *et al.* 1999; Funk & Tallamy 2000; LeBas *et al.* 2003, 2004; LeBas & Hockham 2005; Gwynne *et al.* 2007) exploring the process of sexual selection, and these have provided textbook examples of mating system variation (Thornhill & Alcock 1983; Slater 1999; Arnqvist & Rowe 2005). With at least 2,000 described species (Yang *et al.* 2007) and a range of variation for these behaviours, dance flies are an ideal system to study potential connections between mating behaviours, associated morphologies and enhanced rates of speciation. Nevertheless, like many complex radiations, empidine dance flies are poorly known both taxonomically and phylogenetically, and this has severely constrained study of their evolution.

Within the Empidinae, the diverse genus *Empis* L. contains over 740 described species that are distributed mostly in the Northern Hemisphere (Yang *et al.* 2007). Many southern hemisphere species currently assigned to *Empis* are now considered to be more basal members of the subfamily and are probably not congeneric (Daugeron *et al.* 2009). The majority of the remaining species are assigned to approximately 15 subgenera of *Empis* (Chvála 1994; Yang *et al.* 2007), with some (e.g., *Coptophlebia Bezzi*) considered to be paraphyletic or polyphyletic (Daugeron *et al.* 2011). The continued use and recognition of subgenera in this genus and the related genus *Rhamphomyia* Meigen needs further analysis.

The subgenus *Enoplempis* Bigot appears to be exclusively North American and its definition was expanded and refined by Melander (1928). There are currently 34 valid described species assigned to this subgenus (including the seven new eastern species described herein), which is usually characterized by modified male hind legs (projections and clusters of setae on the femur/tibia joint), and ventral tarsal spine-like setae. Six putative species of *Empis*, assigned to the subgenus *Enoplempis* Bigot, are known to form balloons of froth (with or without prey) prior to mating, rather than simply offering fresh insect prey to females (Figs 1A, B, D) [Note: species listed in Cumming (1994: 917) are now all assigned to this subgenus]. The balloon-making abilities of this group were first noted by Aldrich & Turley (1899), a behaviour otherwise only recorded for a few species of the genus *Hilara* Meigen (Cumming 1994) (see below under “Discussion”). In addition, some other species of *E. (Enoplempis)* are known to present unwrapped prey to females as nuptial gifts (e.g., *E. (En.) poplitea* Loew, see Alcock 1973). The range of variation in nuptial gift presentation displayed throughout the group is therefore of great interest.

This paper is the first of two revisions of the species belonging to this lineage, with the project divided into eastern and western Nearctic studies for practical and historical reasons. Only one species, *E. (En.) nodipoplitea* Steyskal, is distributed in both eastern and western North America, and is treated in both revisions.

Material and methods

This study is based on material borrowed from or deposited in the following institutions: American Museum of Natural History, New York, USA (AMNH); the Natural History Museum, London, UK (BMNH); California Academy of Sciences, San Francisco, USA (CAS); Crane Hollow Incorporated Collection, Laurelville, OH, USA (CHIC); Canadian National Collection of Insects, Ottawa, Canada (CNC); California State Collection of Arthropods, Sacramento, USA (CSCA); Colorado State University Insect Collection, Fort Collins, USA (CSUC); Cornell University Insect Collection, Ithaca, USA (CUIC); University of Guelph Insect Collection, Guelph, Canada (DEBU); Lyman Entomological Museum, McGill University, Ste-Anne-de-Bellevue, Canada (LEM); Museum of Comparative Zoology, Cambridge, USA (MCZ); Montana Entomological Collection, Montana State

observations on the courtship behaviour of *E. (En.) poplitea*, which involves typical male swarms and female choice, indicated that the characteristic subgeneric modifications found on the hind femur/tibia joint in this species are not used to grasp the female during copulation, but are used to rub the female's abdomen presumably providing tactile stimuli while mating.

This is the first of two revisions of the species of *E. (Enoplempis)* with the second paper dealing with the western Nearctic species of the subgenus. Completion of the large western revision will hopefully allow for an analysis of the phylogenetic relationships of all the included species at some level. In an unpublished thesis, Turner (2012) provided a preliminary molecular cladogram using several *E. (Enoplempis)* exemplar species, including tracing some mating behaviours (e.g., empty balloons, balloons containing prey, and unwrapped prey). This information combined with a morphological analysis of all the included eastern and western species, should allow for more rigorous hypotheses on phylogenetic relationships within the subgenus. Observations on known and as yet unpublished mating behaviours of *E. (Enoplempis)* can then be plotted on the resulting cladograms in an effort to better understand the evolution of these complex behaviours throughout the group.

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