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FLOWER VISITATION BY ADULT SHORE FLIES AT AN INLAND SITE IN FLORIDA (DIPTERA: EPHYDRIDAE)

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Shore flies (Ephydridae) are small acalypterates whose larvae are usually aquatic or semi-aquatic. Adult feeding habits are varied and known for only a small proportion of species. Most adults consume algae or bacterial slurries, but some are predators on smaller arthropods, scavengers, or nectar feeders (Wirth et al. 1987). At the Archbold Biological Station in south-central Florida some adult ephydrids occur regularly on flowers. These species and their floral hosts are listed below.

The Archbold Biological Station (ABS), located in Highlands County, is near the south end of the Lake Wales Ridge, a distinctive sandy upland. During the rainy season (Jun-Oct) low areas on the Ridge accumulate water in extensive shallow ponds, more than 150 of which occur on the ABS. These ponds usually dry up in winter and spring. Their drying shores become zones of biological hyperactivity as oxygen becomes more available for plants and animals, stranded aquatic organisms die, algae become concentrated, and nutrients are released. Such edges are ideal for a variety of shore flies. Drying ditches and a permanent lake also produce ephydrids. About 45 species of ephydrids are known from the ABS, but there are probably many additional species. Only a small number of species are known to visit flowers at the ABS.

Specimens were collected with nets and aspirators from open flowers over a period of about 20 years. Over 150 species of plants were examined, of which only a small proportion attracted ephydrids. Only 1 or 2 representative specimens of each species were mounted from flowers of a single species of plant on a single day. These specimens are in the collection of the Archbold Biological Station. Most specimens were identified by the senior author, using taxonomic guides and ABS reference specimens identified by Willis Wirth, Wayne Mathis, and J. R. Vockeroth, all of whom examined the ABS ephydrid collection. Plants were identified by the senior author.

Annotated List of Flower-visiting Ephydridae at the ABS

Genus *Allotrichoma*. Some species of *Allotrichoma*, including the species listed below, were originally placed in the genus *Pseudohecamede* (Wirth et al. 1987). In a study of ephydrids of muddy shores, Thier & Foote (1980) found *Allotrichoma* sp. breeding in muskrat dung and dead snails. They suggest that larvae of this genus are scavengers.

Allotrichoma abdominalis (Williston). Many adults were seen on a scat or pellet of insect fragments in a wet flatwoods at the ABS; this species is probably a scavenger like the species studied by Thier & Foote (1980). If this species breeds in the corpses of stranded aquatic organisms, the seasonal ponds at the ABS are excellent habitats, as these ponds are on sandy substrates and often dry up rapidly at the end of the rainy season. *Allotrichoma abdominalis* belongs to a species group characterized by an elongate, pointed proboscis (Cresson 1942) that might be an adaptation for nectar feeding. The proboscis is superficially similar to that of *Olcella* species (Chloropidae), which often occur on flowers together with *A. abdominalis*. Most flower records are from plants near wet areas, but a few are from sites 0.5 km or more from wet areas. ABS records: Feb-Mar, May-Jun., Aug-Dec. General distribution: Atlantic and Gulf States, California, Neotropics (Wirth 1965).

Genus *Ceropsilopa*. The biology of *Ceropsilopa* species is apparently unknown. Two species occur in salt marshes in Florida (Rey & McCoy 1986).

Ceropsilopa adjuncta Cresson. This species has been collected at the ABS in the vicinity of ditches and also in dry scrub some distance from water. It visits a variety of flowers as well as the extra-floral nectaries of *Crotalaria pallida* Ait. ABS records: Feb-May, Aug, Oct-Nov. General distribution: Florida, Puerto Rico (Wirth 1965).

Ceropsilopa coquilletti Cresson. ABS records: Apr, Aug. General distribution: southern U.S., Neotropics (Wirth 1965).

Genus *Discocerina*. Members of this genus, like many other ephydrids, are usually found on muddy shores, where they feed on accumulations of microorganisms and finely particulate debris (Foote 1995).

Discocerina obscura Williston. At the ABS adults were collected from the muddy shore of a seasonal pond. ABS records: Jan, Mar-Apr, Nov. General distribution: New York through Florida, west into Texas, south through the Neotropics (Wirth 1965).

Discocerina obscurella (Fallén). At the ABS common along muddy shores of seasonal ponds; also found around rotten oranges on a wet lawn. Elsewhere, this widespread species occurs in a great variety of habitats, including dry, sandy areas, grassy depressions, and various types of

muddy shore habitats (Deonier 2002). ABS records: Jan-Apr, Aug-Dec. General distribution: Europe, North America, Neotropics (Wirth 1965).

Genus *Hydrochasma*. Members of this genus are associated with both inland and coastal marshes; *H. leucoproctum* (Loew) occurs in freshwater habitats (Thier & Foote 1980; Deonier 2002), and *H. buccatum* (Cresson) occurs along beaches and coastal marshes (Deonier 2002).

Hydrochasma incisum (Coquillett). At the ABS collected on flowers in the vicinity of ditches and seasonal ponds. ABS records: Feb-Mar, Sep-Oct. General distribution: Florida, Puerto Rico, Neotropics (Wirth 1965).

Genus *Hydrellia*. Members of this large genus are phytophagous (usually leaf miners) as larvae and predators on smaller arthropods as adults (Deonier 1971). We have not been able to identify to species ABS specimens of this taxonomically challenging genus.

Hydrellia sp. Most flower-visiting specimens were found near seasonal ponds or ditches, but a few were collected in upland sites at least 0.5 km from water. It is not known whether members of this genus visit flowers to consume nectar, or to prey on smaller arthropods, such as Ceratopogonidae, that also occur on flowers.

Genus *Mimapsilopa*. This is a largely tropical genus with one species in Florida (Mathis & Zatwarnicki 1998).

Mimapsilopa cressoni Lizarralde de Grosso. At the ABS this species has been found on flowers, usually near seasonal ponds. ABS records: Feb-Mar, Jun, Oct-Nov. General distribution: Florida, the West Indies, Guyana and Ecuador (Mathis & Zatwarnicki1998).

Genus *Nostima*. Species of this genus of tiny flies are sometimes swept from grassy areas (Foote 1995).

Nostima niveivenosa (Cresson). At the ABS this species was swept from *Aristida beyrichiana* Trin. & Rupr. in dry flatwoods habitats, and collected on flowers near moist or disturbed habitats. ABS records: Apr, Oct-Nov. General distribution: Florida and Neotropics (Wirth 1965).

Genus *Ochthera*. The raptorial forelegs of members of this genus are used to capture small arthropods (Clausen 1977). Two species are common at the ABS, one of which, *O. tuberculatus* Loew, has never been found on flowers, while the other, *O. exsculpta* Loew, occurs regularly on flowers. It seems probable that *O. exsculpta* is exploiting flowers as bait stations that attract insect prey.

Ochthera exsculpta Loew. At the ABS this species is usually found around permanent water. ABS records: Feb-Aug. General distribution: North Carolina through Florida, Mexico, Central America, and the Caribbean (Clausen 1977).

Genus *Psilopa*. Larvae of *Psilopa* species are leaf miners (Foote 1995). Adult feeding behavior is apparently unknown.

Psilopa dupla Cresson. This species can be swept from lawn grass at the ABS, but also occurs in dry natural areas. Elsewhere, this species is known from wet meadows (Deonier 2002). At the ABS specimens were found feeding on honeydew on *Carya floridana* Sarg., as well as on flowers. ABS records: Aug-Mar, May. General distribution: New Jersey south through Florida, west to Illinois and Texas; The Bahamas (Wirth 1965).

Genus *Ptilomyia*. Members of this genus are associated with algal mats and muddy shores of ponds and seacoasts (Deonier 2002).

Ptilomyia mabelae (Cresson). At the ABS this species is associated with both seasonal and permanent ponds. Individuals may be found on flowers 0.5 km or more from wet areas. This is one of a number of ephydrids that seems equally at home on tidal mud flats and the muddy margins of inland bodies of water (Deonier 2002). ABS records: Jan.-Nov. General distribution: Pennsylvania south through Florida, west to Texas, and Ecuador (Wirth 1965).

Genus *Scatella*. Species in this large and widespread genus are usually associated with muddy freshwater shores or tidal flats, or both (Sturtevant & Wheeler 1954). Some species are known to visit flowers (Sturtevant & Wheeler 1954).

Scatella stagnalis (Fallén). At the ABS this species usually occurs around the edges of seasonal or permanent ponds. Like some other ABS ephydrids, specimens sometimes appear at lights. This suggests that some species disperse to seasonal ponds at night. This widespread species occurs in both marine coastal and inland habitats (Deonier 2002), where its larvae feed on algae and decaying detritus (Thier & Foote 1980). There is a single ABS flower record for this species, and it seems probable that this species rarely visits flowers. ABS records: Oct-Mar, May-Jun. This species appears to be cosmopolitan (Wirth 1965).

Genus *Tylopsilopa*. Two Florida species, *T. atra* (Loew) and *T. antennalis* (Wirth), are virtually indistinguishable without dissecting and preparing the male genitalia (Wirth 1968). We have not attempted to identify ABS species, which appear to represent one or both of these similar species. Adult *Typopsilopa* species occur in marshes and wet meadows, and around piles of dead marsh plants (Deonier 2002). Larvae feed on decaying vegetation, and can be reared on cultures of yeasts and bacteria (Foote 1995).

Typopsilopa atra (Loew) or *antennalis* Wirth. Specimens were found at the edges of seasonal and permanent bodies of water. ABS records: Mar-Apr, Jun, Nov.

Floral Host Records for Ephydridae at the ABS

Baccharis halimifolia L. (Asteraceae): *Allotrichoma abdominalis*, *Discocerina obscurella*, *Hydrellia* sp., *Hydrochasma incisum*, *Mimapsilopa cressoni*, *Psilopa dupla*

Balduina angustifolia (Pursh) Robins (Asteraceae): *Hydrellia* sp.
Dalea feayi (Chapman) Barneby (Fabaceae): *Psilopa dupla*
Eriocaulon decangulare L. (Eriocaulaceae): *Allotrichoma abdominalis*
Eryngium cuneifolium Small (Apiaceae): *Allotrichoma abdominalis*, *Hydrochasma incisum*
Eupatorium capillifolium (Lamarck) Small (Asteraceae): *Hydrochasma incisum*
Euthamia caroliniana (L.) Greene ex Porter & Britton (Asteraceae): *Allotrichoma abdominalis*, *Discocerina obscurella*, *Mimapsilopa cressoni*, *Ptilomyia mabelae*
Garberia heterophylla (Bartram) (Asteraceae): *Allotrichoma abdominalis*, *Ceropsilopa adjuncta*, *Hydrochasma incisum*, *Nostima niveivenosa*
Ilex cassine L. (Aquifoliaceae): *Discocerina obscura*, *D. obscurella*, *Hydrellia* sp., *Hydrochasma incisum*, *Mimapsilopa cressoni*, *Psilopa dupla*
Iresine diffusa Humb. & Bonpl.ex Willd. (Amaranthaceae): *Allotrichoma abdominalis*, *Discocerina obscurella*, *Hydrochasma incisum*
Mikania cordifolia (L.f.) Willd. (Asteraceae): *Allotrichoma abdominalis*, *Psilopa dupla*
Paronychia americana (Nuttall) Fenzl ex Walp. (Caryophyllaceae): *Allotrichoma abdominalis*
Paronychia chartacea Fern. (Caryophyllaceae): *Allotrichoma abdominalis*, *Ceropsilopa adjuncta*
Phoradendron serotinum (Raf.) M. C. Johnst. (Viscaceae): *Ceropsilopa adjuncta*, *Discocerina obscurella*, *Psilopa dupla*
Polygonella gracilis (Nuttall) Meisn. (Polygonaceae): *Scatella stagnalis*
Polygonella myriophylla (Small) Horton (Polygonaceae): *Allotrichoma abdominalis*
Polygonella polygama (Vent.) Engelm. & Gray (Polygonaceae): *Allotrichoma abdominalis*, *Discocerina obscurella*, *Hydrellia* sp., *Hydrochasma incisum*, *Psilopa dupla*, *Ptilomyia mabelae*
Polygonella robusta (Small) Horton (Polygonaceae): *Allotrichoma abdominalis*, *Discocerina obscurella*, *Hydrellia* sp., *Ptilomyia mabelae*
Prunus angustifolia Marsh. (Rosaceae): *Allotrichoma abdominalis*, *Discocerina obscurella*, *Psilopa dupla*
Rhus copallina L. (Anacardiaceae): *Allotrichoma abdominalis*, *Discocerina obscurella*, *Ochthera exsculpta*
Sabal etonia Swingle ex Nash (Palmaceae): *Allotrichoma abdominalis*, *Hydrellia* sp., *Mimapsilopa cressoni*, *Ptilomyia mabelae*, *Typopsilopa* sp.
Salix caroliniana Michaux (Salicaceae): *Ceropsilopa adjuncta*, *Discocerina obscurella*, *Hydrochasma incisum*, *Mimapsilopa cressoni*, *Psilopa dupla*
Serenoa repens (Bartram) Small (Palmaceae): *Allotrichoma abdominalis*, *Ceropsilopa adjuncta*, *Discocerina obscurella*, *Ochthera exsculpta*, *Mimapsilopa cressoni*, *Psilopa dupla*, *Ptilomyia mabelae*, *Typopsilopa* sp.
Solidago fistulosa Ait. (Asteraceae): *Allotrichoma abdominalis*, *Ceropsilopa adjuncta*, *Discocerina obscurella*, *Psilopa dupla*, *Mimapsilopa cressoni*, *Nostima niveivenosa*
Solidago odora Ait. (Asteraceae): *Ceropsilopa adjuncta*, *C. coquilletti*, *Ptilomyia mabelae*
Syngonanthus flavidulus (Michaux) Ruhl. (Eriocaulaceae): *Allotrichoma abdominalis*, *Ptilomyia mabelae*

Among the flower-visiting ephydrids at the ABS, 9 of the 14 species are in the subfamily Psilopinae, 3 in the Notiphilinae, and 2 in the Parydrinae. It seems probable that flower-visiting is most frequently associated with species that colonize ephemeral aquatic habitats that require that the adult flies persist in or disperse through dry habitats. Many Psilopinae at the ABS seem to belong to this group of colonizers. Unfortunately, there are no other studies to provide comparisons of faunal composition of flower-visiting ephydrids.

The motivations of flower-visiting ephydrids at the ABS remain somewhat unclear. Species with an elongate, pointed labellum, such as *Allotrichoma abdominalis*, are probably specialized nectar feeders. The labellum of such species is superficially similar to that of flower-visiting Chloropidae of the genus *Olcella* and Milichiidae of the genus *Paramyia*, which often co-occur on flowers with ephydrids at the ABS. Species associated with honeydew at the ABS (*Psylopa dupla*) or extrafloral nectaries (*Ceropsylopa adjuncta*) are evidently attracted to sugars and probably nectivorous when found on flowers. Strongly predaceous species, however, such as *Ochthera exsculpta*, might be using flowers as bait stations that attract insect prey. Various other predatory insects at the ABS patrol flowers for prey, for example, Sphecidae of the genus *Oxybelus* (specializes on flies) and *Philanthus* (bee specialists) and the asilid *Mallophorina clausicella* (Macquart). Ephydrids on flowers at the ABS always occur together with a variety of other insects, some of which, such as Ceratopogonidae and Thysanoptera, could serve as prey for even the smallest ephydrids. We have not recorded ephydrids consuming pollen, but it is possible that they do so. We have no records from flowers that produce pollen only, such as species of *Hypericum*, and members of the Commelinaceae. Many insects at the ABS also visit flowers in search of mates; this is especially frequent among the Hymenoptera. We have no observations that suggest ABS ephydrids use flowers as mate-hunting sites.

The flowers visited by ephydrids at the ABS are distributed among 13 families of plants. Most ephydrid species visited flowers belonging to several genera and families. The floral hosts have compound inflorescenses or numerous small flow-

ers that are tightly grouped. All flowers produce nectar available to short-tongued flies, and the ephydrids are almost always accompanied by chloropids and milichiids, as well as other insects with longer tongues. Although ephydrids are sometimes common on flowers at the ABS, their effectiveness as pollinators remains dubious. Most of the plants visited by ephydrids are also visited by many other insects, some of which, such as bees, vespid wasps, syrphid and bombyliid flies, are probably much more effective pollinators. Saw palmetto (*Serenoa repens*), for example, is visited by several species of ephydrids at the ABS, but also by more than 100 species of larger insects that are more likely to be moving from flower to flower and plant to plant as they seek nectar or pollen. An ephydrid such as *Allotrichoma abdominalis* could probably get all the nectar it could consume from a single flower on a single spike of a saw palmetto inflorescence. Mistletoe (*Phoradendron serotinum*) might be an exception, as its small flowers are visited primarily by tiny flies such as ephydrids, chloropids, and milichiids. Elsewhere, ephydrids are known as major pollinators of aquatic plants such as *Cabomba caroliniana* Gray (Osborn et al. 1991) and *Nuphar* species (Lippok & Renner 1997; Nagasaki 2007). Ephydrids occasionally appear in lists of flower visitors on particular plants, such as dwarf mistletoe (Gregor et al. 1974).

We are especially grateful to the late dipterist Willis Wirth, frequent visitor to the ABS, who identified many species in the ABS collection and inspired our interest in the shore flies. We miss him. The collection also was reviewed by J. R. Vockeroth, and several additional species were recently identified by Wayne Mathis, who was most generous with his time during a short visit to the ABS. This study was supported by the Archbold Biological Station.

Summary

At an inland Florida site 14 species of Ephydridae are reported from flowers of 26 species of plants, representing 84 ephydrid-plant relationships, none of which had been reported previously. Most flower visitors belong to the subfamily Psilopinae. While some species appear to imbibe nectar, it is possible that ephydrids may visit flowers to prey on smaller visitors, especially other flies. There is no evidence that flowers are aggregation sites. It is unlikely that any of the 26 recorded host plants are dependent on ephydrids for pollination. This appears to be the first general survey of flower-visiting ephydrids at a site.

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