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LIFE HISTORY PARAMETERS AND NEW HOST RECORDS OF PHORID (DIPTERA: PHORIDAE) PARASITOIDS OF FIREFLIES (COLEOPTERA: LAMPYRIDAE)

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Abstract

Newly recorded lampyrid hosts of the Nearctic and Neotropical Region phorid *Apocephalus antennatus* Malloch are a species of the *Ellychnia corrusca* (L.) complex, *Lucidota atra* (Oliver), *Photinus marginellus* LeConte, and *P. pyralis* (L.). Records of *Ellychnia* sp. and *L. atra* are the first for non-luminescent hosts. Larvae of *A. antennatus* feed, leave the host and pupariate within 3–5 days of collection, and adults emerge 13–20 days later. The Neotropical Region phorid *A. insulanus* Borgmeier was reared from *Photinus* sp. in Peru, and has a similar life history.

Lloyd (1973) first recorded phorid parasites of fireflies, noting that *Apocephalus antennatus* Malloch was a parasitoid of a variety of luminous fireflies of the genera *Photinus* Laporte, *Photuris* Dejean and *Pyractomena* Melsheimer. Additionally, he indicated that the length of the parasitoid pupal stage was 9–22 days. Because no further information was available for this host–parasite system, I decided to rear fireflies and collect further life history data. This information will supplement a revision of phorids of the genus *Apocephalus,* subgenus *Mesophora* Borgmeier, the group to which *A. antennatus* belongs (Brown 1993).

Methods and Materials

Nearctic Region fireflies were collected on a total of eight occasions at the following localities: Illinois: Ogle Co., Oregon, Lowden State Park; Maryland: Frederick Co., Thurmont, Catoctin Mountain Park; Ohio: Muskingum Co., Zanesville, Dillon State Park; Virginia: Fairfax Co., Huntley Meadows Park, and Springfield. Neotropical Region fireflies were collected on two occasions in Peru at the Smithsonian Institution's Biological Diversity in Latin America (BIOLAT) field site at Pakitza, Zona Reserva Manu, Madre de Dios (described by Erwin 1990).

Adult fireflies were collected alive and placed into individual 3 dram vials. Each vial had a small wad of cotton at the bottom moistened with 3 drops of water to prevent desiccation, and a cotton plug at the open end. Vials were kept in a large, sealed plastic container with a large wad of moistened cotton, also to prevent drying. Vials were checked at least twice daily, and dead fireflies removed after parasitoid emergence. All fireflies were kept until they died. Date of parasitoid emergence from the host, and adult parasitoid emergence from puparia, were recorded. For the purposes of recording life history parameters, it was assumed that the fireflies were parasitized the same day that they were collected. Since all collected fireflies were active and apparently healthy (most

Table 1. Collection data for fireflies parasitized by *Apocephalus antennatus*.

Locality	# collected	# parasitized	% parasitized	Firefly species
Catoctin Mt. S.P., MD	12	1	8.3	*Lucidota atra*
Dillon S.P., OH	32	5	15.6	*Photinus pyralis*
Huntley Meadows, VA	16	4	25.0	*Photinus macdermotti* complex
Huntley Meadows, VA	26	5	19.2	*Photinus macdermotti* complex
Lowden S.P., IL	15	1	6.7	*Photinus marginellus*
Lowden S.P., IL	15	4	26.7	*Photinus pyralis*
Springfield, VA	6	1	16.7	*Ellychnia corrusca* complex
Springfield, VA	20	1	5.0	*Ellychnia corrusca* complex
Springfield, VA	42	1	2.4	*Photinus pyralis*

were males flashing in flight at dusk), and since there is so little variation in the apparent length of the larval period, this assumption is plausible.

Voucher specimens are in the collection of the Natural History Museum of Los Angeles County.

Results

Twenty-one fireflies parasitized by *A. antennatus* were collected; an additional three fireflies were parasitized by a tachinid fly, probably *Hyalomyodes triangulifer* (Loew) (Sabrosky and Braun 1970). The frequency of phorid parasitism for each of the eight firefly collections ranged from about 2–27% (Table 1). Each parasitized firefly had an average of 4.5 parasitoid larvae (SD = 2.0).

Life history parameters of *A. antennatus* fell into two ranges, separated by different temperature regimes. Specimens collected in Virginia and Maryland were reared under ambient temperatures for those regions and had a mean larval period of 3.5 days (n = 44, SD = 0.5) and a mean pupal period of 16.4 days (n = 26, SD = 0.5). Specimens from Illinois and Ohio were collected at the beginning of a more northerly collecting trip to Canada, and thus probably experienced cooler average temperatures. The mean larval period for the second group was 4.8 days (n = 51, SD = 1.0), and the mean pupal period 22.2 days (n = 24, SD = 0.9).

Life history data for *A. insulanus* were less complete; all specimens emerged from their hosts three days after collection, but none emerged from puparia as adults. The specific identity of the flies was determined from pharate adults dissected from puparia.

Discussion

These rearings produced the first host records for *A. antennatus* from *Photinus marginellus* LeConte, *P. pyralis* (L.), *Lucidota atra* (Oliver) and a species of the *Ellychnia corrusca* (L.) complex, supplementing the records of ten other firefly species given by Lloyd (1973). Also parasitized in my collections were adults of a species of the *Photinus macdermotti* Lloyd complex (Lloyd 1969); additionally, about 50 unidentified specimens of the genus *Photuris* were collected at Huntley Meadows, but none were parasitized. Of special interest are the records of parasitism of *L. atra* and *Ellychnia* sp., the first non-luminous species known to be attacked. Since these two species do not use light for

signalling mates, it seems unlikely that phorids use these courtship signals to locate their hosts.

The record of *A. insulanus* from a species of *Photinus* is the first host record for this species. Based on my phylogenetic analysis (Brown 1993), the closest relative of *A. insulanus* is *A. antennatus,* which also is a firefly parasite. Therefore, I assume that the common ancestor of these two species also attacked lampyrids.

Unfortunately, nothing is known of how the flies locate their hosts and at which life stage the beetles are parasitized, although I assume that adult beetles are attacked. Presumably, flies are attracted to adult beetles by olfactory cues, as adults of a distantly related species, *A. paraponerae* Borgmeier, are attracted to their hosts (Brown and Feener 1991).

Other members of subgenus *Mesophora* are known to attack diverse hosts: *A. borealis* Brues, a relatively primitive, Nearctic Region species, has been reared from a spider, bumble bees, and vespid wasps (Brown 1993), whereas *A. mortifer* Borgmeier was reared from a cantharid beetle, *Chauliognathus fallax* Germar, in Brazil (Borgmeier 1937). A plot of these life histories on the cladogram of species relationships of the group (Brown 1993) leads to the speculation that the common ancestor of some of these flies might be parasitoids of cantharoid beetles. More evidence is needed to substantiate this hypothesis.

There are currently 18 Neotropical Region and six Nearctic Region species of subgenus *Mesophora* for which no life history information exists. Interested workers are encouraged to use the simple rearing technique described above to collect and hold adult cantharoid beetles, including cantharids, lampyrids, lycids and phengodids, until parasitoids emerge.

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