RELATIONSHIPS OF *EDMUNDSIUS* DAY (EPHEMEROPTERA: SIPHLONURIDAE), WITH NOTES ON EARLY INSTAR LARVAE AND EGGS

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Abstract.—The presence of the synapomorphic copulatory pouch in the alate females of the California genus *Edmundsius* Day confirms its placement in the Siphlonuridae *sensu stricto*. Superficially similar larval maxillae in *Edmundsius* and the Japanese genus *Dipteromimus* McLachlan (Dipteromimidae) are apparently convergent. The presence of the synapomorphic double gills 1 and 2 in the mature larvae of *Edmundsius* furthermore indicates placement in the Siphlonurinae *sensu stricto*. Young larvae can only be distinguished from those of *Siphlonurus* Eaton by the key character involving relative lengths of the claws, and the first description of the egg of *Edmundsius* shows it to be similar to those of *Siphlonurus*.

Key Words.—*Edmundsius*, higher classification, egg, copulatory pouch.

Many of the traditional subfamilies of Siphlonuridae and certain generic complexes within Siphlonurinae have recently been placed as separate families in the suborder Pisciforma (McCaflerty 1991b), or superfamily Siphlonuroidea (Kluge et al. 1995). For example, in the Holarctic Region, Ameletidae and Acanthametropodidae previously constituted a generic complex in Siphlonuridae and a separate subfamily of Siphlonuridae, respectively (e.g., see Edmunds et al. 1963). The previous siphonurid subfamily Isonychiinae, however, is now recognized as the family Isonychiidae in the suborder Setisura, or superfamily Heptagenioidea (McCaflerty 1991a, b). Transitions in higher classification with respect to the North American fauna were outlined in McCafferty (2001).

Kluge et al. (1995) removed the monobasic Japanese genus *Dipteromimus* McLachlan from the Northern Hemisphere family Siphlonuridae *sensu stricto* and placed it in a new family Dipteromimidae. These authors continued to include the monobasic California genus *Edmundsius* Day, the Holarctic genus *Parameletus* Bengtsson, the monobasic northeastern North American genus *Siphlonisca* Needham, and the essentially Holarctic genus *Siphlonurus* Eaton in the recently restricted concept of Siphlonuridae. Kluge et al. (1995) furthermore placed *Siphlonurus* in the restricted concept of a subfamily Siphlonurinae, and placed *Parameletus* and *Siphlonisca* in a new subfamily Parameletinae. The authors had not been able to study material of *Edmundsius*, and could not place it definitively in one of those subfamilies, but surmised it would be found to be a member of the Siphlonurinae *sensu stricto*.

Day (1953), however, had suggested that his genus *Edmundsius* was possibly related to *Dipteromimus* because the maxillary palps were similar in the two genera. This was based on the more complete description of *Dipteromimus* that had been given by Uéno (1931). Edmunds (personal communication) had continued to recognize this possibility in the absence of other comparative data, and had remained open to the possibility that *Dipteromimus* and *Edmundsius* were sister lineages.
Figure 1. *Edmundsius agilis* female adult, abdominal sternum 7 with underlying outline of copulatory pouch.

We have recently studied Day’s (1953) original larval, male and female subimagos and adult material, in addition to considerable new collections of larvae in different developmental phases from three counties in California. This has allowed us to confirm the family classification of *Edmundsius* and determine its subfamilial relationships based on the characters introduced by Kluge et al. (1995), to note important differences between early and late instar larvae, and to provide the first description of the egg stage.

**Higher Classification**

One of the characteristics that Kluge et al. (1995) identified as being associated with the restricted concept of Siphlonuridae can clearly be deemed a defining synapomorphy. It involves the presence of a sclerotized copulatory pouch (Fig. 1) [see also Figs. 9–14 (Kluge et al. 1995)] that is associated with the female adult. We have not seen this structure in any other alate females of Ephemeroptera, and therefore consider it a unique attribute of the Siphlonuridae. We confirmed the presence of this pouch in the alate female specimens of *Edmundsius* that we examined. As these specimens had been in alcohol preservative for some years, some clearing of the ventral abdominal cuticle had occurred and the pouch was easily observed through the outer wall of abdominal sternum 7. We also noted the presence of the pouch in the female subimago, although Kluge et al. (1995) had emphatically claimed that the copulatory pouch could only be found in adults and not subimagos. Our examination of *Siphlonurus* subimagos that had been preserved in alcohol for some time also indicated the presence of the copulatory pouch, and we presume this to be the case for the other Siphlonuridae. It may be that the longer times of preservation and associated clearing of our subimagos makes them more amenable to observing internal structures through the integument.

In any case, the shared presence of the female copulatory pouch clearly places *Edmundsius* in family Siphlonuridae, rather than Dipteromimidae. A characteristic of the genus *Dipteromimus* that might qualify as an autapomorphy is the development of
Figure 2. *Edmundsius agilis*, larval habitus.
a median process on the subanal plate of the female adult as described by Kluge et al. (1995). *Edmundsius* does not share such a characteristic. As Day (1953) had pointed out, *Edmundsius* and *Dipteromimus* do share a maxilla that has a relatively long palp compared to the galealacinia. We interpret this as a case of convergence, however, mainly because the long palps are fundamentally different in the two genera. In *Edmundsius*, segment 3 of the maxillary palp is very short compared to elongated segments 1 and 2, and in *Dipteromimus*, segment 2 is shortest [Fig. 9 (Day 1953) and Fig. 28E (Uéno 1931)].

With respect to subfamilial placement of *Edmundsius*, it is significant that middle to late instar larvae of *Edmundsius* share the double gills 1 and 2 with those of *Siphlonurus*, and this could be interpreted as a defining synapomorphy for the subfamily Siphlonurinae. We also have confirmed that *Edmundsius* female adults do not have abdominal sternum 8 medially extended anteriorly between the lobes of the copulatory pouch [Figs. 12–14 (Kluge et al. 1995)], a characteristic that could be interpreted as synapomorphic for the subfamily Parameletinae, being present in *Parameletus* and *Siphlonisca*. We therefore are able to place *Edmundsius* in the subfamily Siphlonurinae sensu stricto.

**Larval Variability**

Although mature larvae and adults of *Edmundsius* can be identified using the keys of Edmunds et al. (1976) and Edmunds & Waltz (1996), young larvae of *Edmundsius* and *Siphlonurus* cannot be distinguished in existing keys to North American genera in the same way. Middle to late instar larvae of *Edmundsius* have oval abdominal gills 1 and 2 (Fig. 2), whereas middle to late instar larvae of *Siphlonurus* have subtriangular gills 1 and 2 [Fig. 11.35 (Edmunds & Waltz 1995)]. These particular characteristics, however, are not applicable to young instar larvae because gill 1 and 2 are not developed (Fig. 3). The secondary characteristic of mid- and hindclaws being much longer than the foreclaws in *Edmundsius* (Fig. 2) does hold up in early to late instar larvae and can be used to
distinguish them from early to late instar larvae of *Siphlonurus*. The latter have mid-and hindclaws that are only slightly longer than the foreclaws.

**DESCRIPTION OF THE EGG**

The egg of *Edmundsius* (Figs. 4–5) is ovate and approximately 210 µm in length and 150 µm at its greatest width. The chorion has randomly scattered attachment discs, or what Koss & Edmunds (1974) more specifically have referred to as fiber coils with terminal fiber clusters. As such, the egg of *Edmundsius* appears very similar to those described and illustrated for *Siphlonurus croaticus* Ulmer by Studemann et al. (1988). They are also generally similar to all of the *Siphlonurus* eggs treated by those authors, as well as Kluge et al. (1995). This may possibly add credence to the classification of *Edmundsius* in the subfamily Siphlonurinae, although there is no indication whether such a chorion is synapomorphic or symplesiomorphic at this time.

**MATERIAL EXAMINED**

The following material of *E. agilis* Day were deposited in the following collections: The California Academy of Sciences, San Francisco, CA (CAS); Natural History Museum of Los Angeles County, Los Angeles, CA (NHLA); the Purdue Entomological Research Collection, West Lafayette, IN (PERC); and the University of California at Santa Barbara, Santa Barbara, CA (UCSB).

Figure 5. Whole egg of *Edmundsius agilis*. (Scale bar represents 50 μm).

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continued from page 99

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