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## **Review and analysis of information on the biology and morphology of immature stages of robber flies (Diptera: Asilidae)**

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## Abstract

Recent publications on the immature stages of robber flies (Asilidae) are reviewed and listed for the 14 currently recognized subfamilies (Asilinae, Bathypogoninae, Brachyrhopalinae, Dasyopogoninae, Dioctriinae, Laphriinae, Leptogastrinae, Ommatiinae, Phellinae, Stenopogoninae, Stichopogoninae, Tillobromatinae, Trigonomiminae, and Willistoninae). For the Phellinae there are only limited data on the pupal cases, and for the Tillobromatinae there are only limited data on the eggs (potential oviposition site in soil) and pupal cases. The recent literature is compared with pertinent pre-1972 publications.

**Key words:** Insecta, Diptera, Brachycera, Asiloidea, immatures, eggs, larvae, pupae

## Introduction

Robber flies are one of the largest families of Diptera with approximately 7,000 species (Geller-Grimm 2011a). Despite their widespread occurrence, there is still limited information on the immature stages. Irwin-Smith (1923) listed papers on the biology and morphology of immatures by genus and species. Hennig (1952) provided descriptive data on the immature stages based on two subfamilies and associated tribes: Asilinae (Leptogastrinae, Asilini) and Dasyopogoninae (Laphriini, Dasyopogonini). Knutson (1972) referred to papers not mentioned in the previous summaries and listed published morphological descriptions and figures for genera and species in four of the five subfamilies recognized by Hull (1962) (Asilinae, Dasyopogoninae, Laphriinae, Leptogastrinae). The Megapodinae were not included because of the absence of information on the morphology of immatures. Londt (1994) listed papers on egg morphology, larval behavior and morphology, and pupal morphology of Afrotropical Asilidae using a ten-subfamily classification (Apocleinae, Asilinae, Dasyopogoninae, Laphriinae, Laphystiinae, Leptogastrinae, Ommatiinae, Stenopogoninae, Stichopogoninae, Trigonomiminae). Lavigne *et al.* (2000) listed publications from 1840 to 1976 on the immature stages that were not included in previous papers, and reviewed robber fly oviposition sites, eggs, and larval habitat, food, and feeding. Dennis *et al.* (2008a) briefly reviewed the egg and larval stages, and provided more detailed information on the pupae, with descriptions of pupal cases based on Nearctic species of four subfamilies (Asilinae, Dasyopogoninae, Leptogastrinae, Laphriinae). They also compared subfamily treatments of Asilidae since 1962 that included five (Asilinae, Dasyopogoninae, Laphriinae, Leptogastrinae, Megapodinae) to 14 subfamilies (Asilinae, Bathypogoninae, Brachyrhopalinae, Dasyopogoninae, Dioctriinae, Laphriinae, Leptogastrinae, Ommatiinae, Phellinae, Stenopogoninae, Stichopogoninae, Tillobromatinae, Trigonomiminae, Willistoninae).

Lavigne (2011b) provided a broad review of eggs of robber flies; larval habitat, development, food and feeding; and pupae, taking into consideration 11 subfamilies (Asilinae, Bathypogoninae, Brachyrhopalinae, Dasyopogoninae, Dioctriinae, Laphriinae, Leptogastrinae, Ommatiinae, Phellinae, Stenopogoninae, Stichopogoninae).

Shortly after Knutson's (1972) publication, Papavero (1973) proposed an eight-subfamily classification (Apocleinae, Asilinae, Dasyopogoninae, Laphriinae, Laphystiinae, Ommatiinae, Stenopogoninae, and Trigonomiminae). An additional four subfamilies (Atomosinae, Dioctriinae, Megapodinae, Stichopogoninae) were added by other authors by the early 2000s.

Bybee *et al.* (2004) presented the first formal analysis of molecular evidence for phylogenetic relationships among the Asilidae and recognized 10 of the 11 subfamilies (Apocleinae, Asilinae, Dasyopogoninae, Laphriinae,