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Tentative key to robber fly (Diptera: Asilidae) subfamilies based on pupal cases

D. STEVE DENNIS[1,3] & JEFFREY K. BARNES[2]

[1]*1105 Myrtle Wood Drive, St. Augustine, FL 32086-4838, USA. E-mail: dstevedennis@msn.com*
[2]*Department of Entomology, University of Arkansas, 319 Agriculture Building, Fayetteville, AR 72701, USA. E-mail: jbarnes@uark.edu*
[3]*Corresponding author*

Abstract

Subfamily keys for pupal cases of Asilidae are currently based on 5 taxa, Asilinae, Dasypogoninae, Megapodinae, Laphriinae and Leptogastrinae. Analysis of recently published adult morphological data and DNA sequence data suggests that the family consists of 14 subfamilies. A tentative key based on known pupal cases is provided for 10 of these subfamilies: Asilinae, Brachyrhopalinae, Dasypogoninae, Dioctriinae, Laphriinae, Leptogastrinae, Ommatiinae, Stenopogoninae, Stichopogoninae and Willistonininae. It is difficult to distinguish between Brachyrhopalinae and Dasypogoninae pupal cases because so many characteristics overlap. There are no described pupal cases for 4 subfamilies: Bathypogoninae, Phellinae, Tillobromatinae and Trigonomiminae. Morphological data are available for only approximately 10% of the genera and 2% of the species of Asilidae.

Key words: Immature Diptera, Insecta, Brachycera, Asiloidea, Asilidae, robber fly, pupal cases, subfamily key

Introduction

According to Dikow (2003), Latreille (1802) established the family Asilidae in 1802. Since then the subfamily classification has changed considerably with the addition of new subfamilies and with tribes being elevated to subfamily status based primarily on morphological data. From the late 1830s through the mid 1960s, various authors subdivided the family into 2–5 subfamilies. In the early 1970s, Papavero (1973) proposed eight subfamilies: Apocleinae, Asilinae, Dasypogoninae, Laphriinae, Laphystiinae, Ommatiinae, Stenopogoninae, and Trigonomiminae. Depending on the taxonomist, up to an additional four subfamilies were added by the early 2000s: Atomosinae, Dioctriinae, Megapodinae and Stichopogoninae (Artigas & Papavero 1988; Bybee *et al.* 2004; Dikow & Geller-Grimm 2004; Geller-Grimm 2003, 2004; Lehr 1969, 1977, 1996).

Bybee *et al.* (2004) presented the first formal analysis of molecular evidence for phylogenetic relationships among the Asilidae and recognized 10 subfamilies: Apocleinae, Asilinae, Dasypogoninae, Laphriinae, Laphystiinae, Leptogastrinae, Ommatiinae, Stenopogoninae, Stichopogoninae and Trigonomiminae. Most recently Dikow (2009a, b) used both morphological and DNA sequence data to recognize 14 subfamilies: Asilinae, Bathypogoninae, Brachyrhopalinae, Dasypogoninae, Dioctriinae, Laphriinae, Leptogastrinae, Ommatiinae, Phellinae, Stenopogoninae, Stichopogoninae, Tillobromatiinae, Trigonomiminae and Willistonininae.

Because of the lack of detailed descriptions of asilid pupal cases, subfamily classification based on pupal cases has not kept up with that based on adults. Dennis *et al.* (2008a) commented that, for at least Nearctic pupal cases, a subfamily and subfamily-group classification was most useful. They used the subfamilies Laphriinae and Leptogastrinae and the groups Asilinae-group and Dasypogoninae-group.

In the present study, we evaluate known Asilidae pupal cases to develop a tentative key based on Dikow's (2009a, b) 14 subfamilies.

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Materials and Methods

Specimens described in Dennis and Knutson (1988), Dennis and Lavigne (1976), and Dennis *et al.* (2008a, b), and other morphological literature were used to develop the tentative subfamily key. The information in the literature used here includes written descriptions, drawings and photographs evaluated as shown in Table 1. We tested the key using real pupal cases.

TABLE 1. References used to develop the tentative key for Asilidae subfamilies based on pupal cases.

SUBFAMILY/GENUS/SPECIES	REFERENCE
ASILINAE	
Alcimus rubiginosus Gerstaecker, 1871	Engel & Cuthbertson (1934)
Aneomochtherus perplexus (Becker, 1923)	Zinov'eva (1959, as *Neomochtherus*)
Antipalus varipes (Meigen, 1820)	Musso (1978)
Asilus barbarus Linnaeus, 1758	Séguy (1927)
Asilus sericeus Say, 1823	Bromley (1946), Dennis *et al.* (2008a), Malloch (1915, 1917)
Blepharotes coriarius (Wiedemann, 1830)	Weber & Lavigne (2004)
Colepia ingloria (MacLeay, 1827)	Daniels (1987)
Colepia malleola (Walker, 1849)	Daniels (1987)
Colepia rufiventris (Macquart, 1838)	Daniels (1987)
Didysmachus picipes (Meigen, 1820)	Melin (1923, as *Dysmachus forcipula* Zeller,1840)
Dysmachus hamulatus (Loew, 1854)	Musso (1978)
Dysmachus trigonus (Meigen, 1804)	Lundbeck (1908)
Dystolmus kiesenwetteri (Loew, 1854)	Musso (1978, as *Eutolmus*)
Echthistus rufinervis (Meigen, 1820)	Zinov'eva (1959)
Efferia aestuans (Linnaeus, 1763)	Bromley (1946, as *Erax*); Dennis *et al.* (2008a), Malloch (1917, as *Erax*)
Efferia benedicti (Bromley, 1940)	Dennis *et al.* (2008a), Dennis & Lavigne (1976)
Efferia frewingi Wilcox, 1966	Dennis *et al.* (2008a), Dennis & Lavigne (1976)
Efferia helenae (Bromley, 1951)	Dennis *et al.* (2008a), Dennis & Lavigne (1976)
Efferia maculatus Scopoli, 1763	Malloch (1917)
Efferia triton (Osten Sacken, 1887)	Dennis *et al.* (2008a)
Eutolmus rufibarbis (Meigen, 1820)	Esipenko (1967)
Gibbasilus arenaceus Londt, 1986	Londt (1986)
Machimus annulipes (Brullé, 1832)	Kurkina (1979)
Machimus atricapillus (Fallén, 1814)	Melin (1923), Séguy (1927), Zinov'eva (1959)
Machimus erythocnemius (Hine, 1909)	Dennis *et al.* (2008a), Scarbrough & Kuhar (1995)
Machimus fimbriatus (Meigen, 1804)	Séguy (1927)
Machimus gonatistes (Zeller, 1840)	Zinov'eva (1959)
Machimus lecythus (Walker, 1849)	Dennis *et al.* (2008a)
Machimus notatus (Wiedemann, 1828)	Bromley (1946, as *Asilus*), Dennis *et al.* (2008a), Malloch (1915, 1917 as *Asilus*)
Machimus occidentalis (Hine, 1909)	Dennis *et al.* (2008a), Dennis & Lavigne (1976, as *Machimus* sp. either *callidus* (Williston, 1893) or *occidentalis* (Hine, 1909))
Machimus paropus (Walker, 1849)	Dennis *et al.* (2008a), Scarbrough & Kuhar (1995)
Machimus pilipes (Meigen, 1820)	Musso (1978)

continued next page

TABLE 1. (continued)

SUBFAMILY/GENUS/SPECIES	REFERENCE
Machimus rusticus (Meigen, 1820)	Musso (1978)
Machimus snowii (Hine, 1909)	Dennis *et al.* (2008a), Scarbrough & Kuhar (1995)
Machimus sp., Loew, 1849	Séguy (1927)
Mallophora atra Macquart,1834	Dennis *et al.* (2008b)
Mallophora bomboides (Wiedemann, 1828)	Dennis *et al.* (2008a)
Mallophora fautrix Ostern Sacken, 1887	Dennis *et al.* (2008a)
Mallophora leschenaultii Macquart, 1838	Dennis *et al.* (2008a)
Mallophora orcina (Wiedemann, 1828)	Dennis *et al.* (2008a)
Mallophora ruficauda (Wiedemann, 1828)	Dennis & Knutson (1988), Copello (1927, 1942)
Mallophora sylveirii Macquart, 1838	Dennis & Knutson (1988)
Megaphorus guildiana (Hine, 1885)	Dennis *et al.* (2008a), Dennis & Lavigne (1976, as *Mallophorina*)
Neoepitriptus setosulus (Zeller, 1840)	Musso (1978, as *Eptriptus*)
Neoitamus cyanurus (Loew, 1849)	Lundbeck (1908), Melin (1923)
Neoitamus socius (Loew, 1871)	Melin (1923)
Neomochtherus angustipennis (Hine, 1909)	Knutson (1972)
Neomochtherus aquitanus Tsacas, 1964	Musso (1978)
Neomochtherus geniculatus (Meigen, 1820)	Brauns (1954, as *Cerdistus*)
Pamponerus germanicus (Linnaeus, 1758)	Melin (1923), Séguy (1927)
Philonicus albiceps (Meigen, 1820)	Brauns (1954), Melin (1923), Séguy (1927)
Promachus bastardii (Macquart, 1838)	Dennis *et al.* (2008a)
Promachus vertebratus (Say, 1823)	Davis (1919), Dennis *et al.* (2008a), Malloch (1915, 1916, 1917)
Proctacanthella cacopiloga (Hine, 1909)	Dennis *et al.* (2008), Dennis & Lavigne (1976)
Proctacanthus hinei Bromley, 1928	Dennis *et al.* (2008a)
Proctacanthus micans Schiner, 1867	Dennis *et al.* (2008a), Dennis & Lavigne (1976)
Proctacanthus milbertii Macquart,1838	Dennis *et al.* (2008a), Malloch (1915, 1917)
Proctacanthus philadelphicus Macquart, 1838	Bromley (1946), Dennis *et al.* (2008a), Malloch (1917)
Proctacanthus rufus Williston, 1885	Dennis *et al.* (2008a)
Rhadiurgus variabilis (Zetterstedt, 1838)	Melin (1923)
Satanas gigas (Eversmann, 1855)	Zinov'eva (1959)
Tolmerus cingulatus (Fabricius, 1781)	Melin (1923)
Triorla interrupta (Macquart, 1834)	Dennis *et al.* (2008a)
Triorla striola (Fabricius, 1805)	Dennis & Knutson (1988)
Zosteria fulvipubescens (Macquart, 1850)	Daniels (1987)
Zosteria sydneensis (Macquart, 1838)	Daniels (1987)
BRACHYRHOPALINAE	
Ceraturgus cruciatus (Say, 1823)	Bromley (1946), Malloch (1917)
Ceraturgus fasciatus Walker, 1847	Dennis *et al.* (2008a)
Chrysopogon sp. near *fasciatus* Ricardo, 1912	Lavigne, R.J. (pers. comm., drawing in S.J. Paramonov file at Australian National Insect Collection in Canberra, Australia)
Cyrtopogon lateralis (Fallén, 1814)	Melin (1923), Séguy (1927)
Heteropogon macerinus (Walker, 1849)	Dennis *et al.* (2008a)
Heteropogon wilcoxi James, 1934	Dennis *et al.* (2008a), Dennis & Lavigne (1976)

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TABLE 1. (continued)

SUBFAMILY/GENUS/SPECIES	REFERENCE
Holopogon venustus (Rossi, 1790)	Musso (1978)
Leptarthus brevirostris (Meigen, 1804)	Parmenter (1952, as *Isopogon)*
DASYPOGONINAE	
Comantella fallei (Back, 1909)	Dennis *et al.* (2008a), Dennis & Lavigne (1976)
Dasypogon diadema (Fabricius, 1781)	Musso (1978)
Diogmites discolor Loew, 1866	Bromley (1946), Malloch (1917, as *Deromyia*)
Diogmites misellus Loew, 1866	Bromley (1946), Dennis *et al.* (2008a)
Diogmites neoternatus (Bromley, 1931)	Dennis *et al.* (2008a)
Diogmites winthemi (Wiedemann, 1921)	Malloch (1915, 1917, as *Deromyia*; per Dennis & Knutson (1988), adult specimens appear to be *Diogmites misellus* Loew, 1866 and not *D. winthemi*)
Diogmites vulgaris Carrera, 1947	Dennis & Knutson (1988)
Pseudoras distendens (Wiedemann, 1828)	Knutson (1976, as *Doryclus*)
DIOCTRIINAE	
Dioctria atricapilla Meigen, 1804	Melin (1923)
Dioctria bicincta Meigen, 1820	Musso (1978)
Dioctria hyalipennis (Fabricius, 1794)	Brauns (1954), Melin (1923), Séguy (1927)
Dioctria rufipes (DeGeer, 1776)	Brindle (1968)
Dioctria sp. Meigen, 1803	Lundbeck (1908)
LAPHRIINAE	
Andrenosoma atrum (Linnaeus, 1758)	Brauer (1883), Dufour (1850, as *Laphria atra* Fabricius,1805), Musso (1967, 1978), Perris (1870, as *Laphria atra* Fabricius, 1805)
Andrenosoma bayardi Seguy, 1952	Musso (1967, 1978)
Andrenosoma albopilosum Villeneuve, 1911	Oldroyd (1939)
Choerades caucasicus Richter & Mamajev, 1971	Richter & Mamajev (1971)
Choerades fulva (Meigen, 1804)	Brauns (1954, as *Epholkiolaphria*)
Choerades gilva (Linnaeus, 1758)	Brauns (1954, as *Epholkiolaphria*), Lundbeck (1908), Melin (1923), Perris (1870), Séguy, (1927) (all as *Laphria*)
Choerades ignea Meigen, 1820	Melin (1923, as *Laphria*)
Choerades marginata (Linnaeus, 1758)	Hennig (1952), Melin (1923) (both as *Laphria*)
Hyperechia bifasciata Grünberg, 1907	Thorpe (1927)
Hyperechia bomboides (Loew, 1851)	Tsacas *et al.* (1970)
Hyperechia consimilis (Wood, 1874)	Thorpe (1927)
Hyperechia marshalli Austen, 1902	Engel & Cuthbertson (1934)
Hyperechia nigripennis (Wiedemann, 1830)	Engel (1929)
Hyperechia xylocopiformis (Walker, 1849)	Thorpe (1927)
Lampria bicolor (Wiedemann, 1828)	Dennis *et al.* (2008a)
Laphria aimatis McAtee, 1919	Dennis *et al.* (2008a)
Laphria ephippium (Fabricius, 1781)	Melin (1923)
Laphria flava (Linnaeus, 1761)	Melin (1923)

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TABLE 1. (continued)

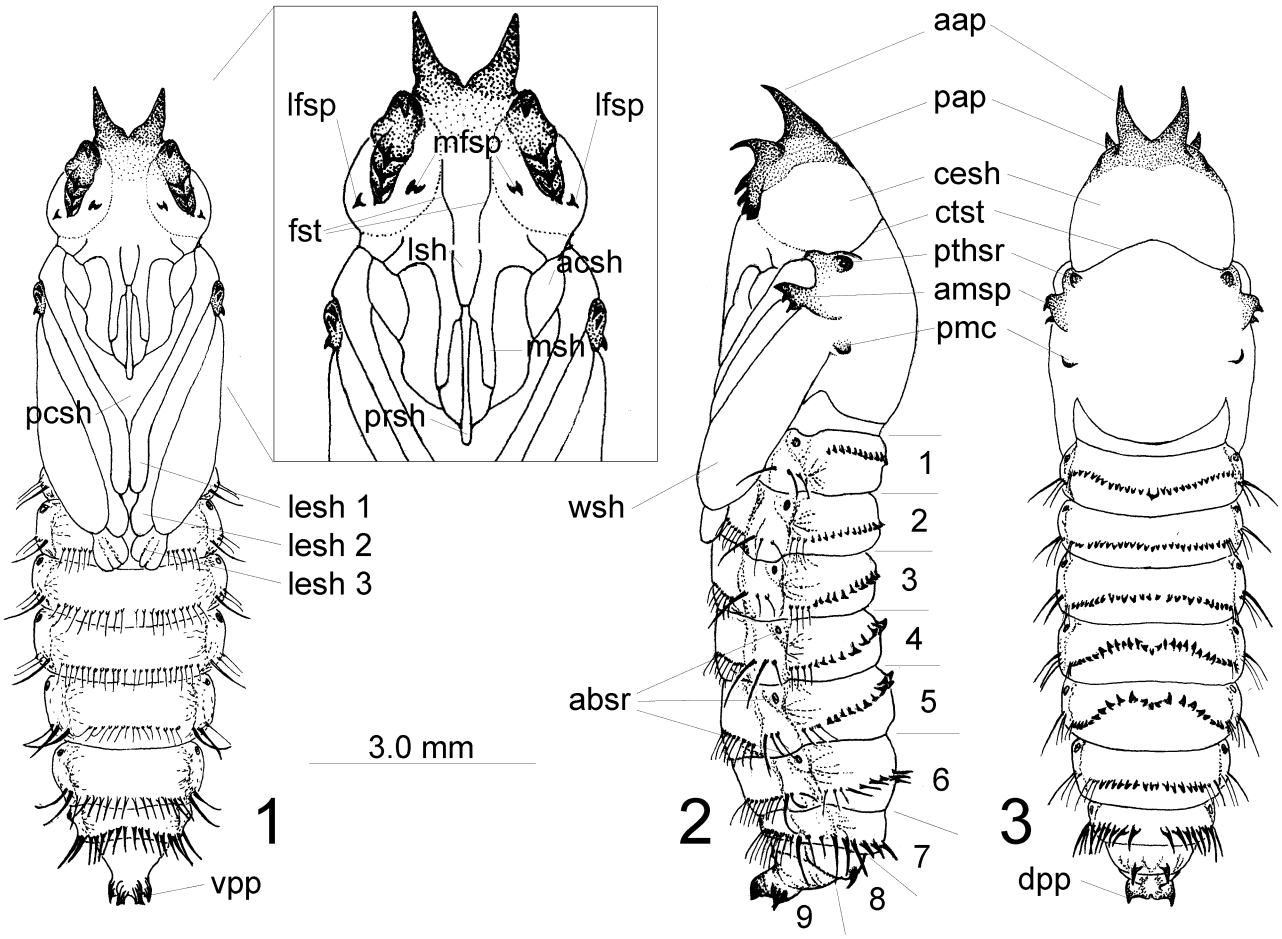
SUBFAMILY/GENUS/SPECIES	REFERENCE
Laphria flavicollis Say, 1824	Dennis *et al.* (2008a)
Laphria gibbosa (Linnaeus, 1758)	Melin (1923), Séguy (1927)
Laphria index McAtee, 1919	Bullington (1986), Dennis *et al.* (2008a)
Laphria rapax Osten Sacken, 1877	Bullington (1986)
Laphria sackeni (Banks, 1917)	Dennis *et al.* (2008a)
Laphria sericea Say, 1823	Bullington (1986), Dennis *et al.* (2008a)
Laphria thoracica Fabricius, 1805	Bromley (1946), Dennis *et al.* (2008a), Greene (1917, as *Dasyllis*)
Laphystia carnea Hermann, 1906	Krivosheina (1973)
Pogonosoma maroccanum (Fabricius, 1794)	Séguy, 1927
Proagonistes austeni Bromley, 1930	Engel (1932)
LEPTOGASTRINAE	
Apachekolas tenuipes (Loew, 1862)	Dennis *et al.* (2008a)
Leptogaster cylindrica (DeGeer, 1776)	Brauns (1954), Esipenko (1973), Melin (1923), Séguy (1927), Zinov'eva (1959)
Leptogaster flavipes Loew, 1862	Bromley (1946), Dennis *et al.* (2008a), Malloch (1917)
Leptogaster guttiventris Zetterstedt, 1842	Melin (1923)
OMMATIINAE	
Ommatius gemma Brimley, 1928	Dennis *et al.* (2008a)
Ommatius orenoquensis Bigot, 1876	Cezar & Lamas (2010)
Ommatius tibialis Say, 1823	Dennis *et al.* (2008a)
STENOPOGONINAE	
Stenopogon inquinatus Loew, 1866	Dennis *et al.* (2008a); Dennis & Lavigne (1976)
Stenopogon rufibarbis Bromley, 1931	Dennis *et al.* (2008a)
STICHOPOGONINAE	
Lasiopogon cinctus (Fabricius, 1781)	Lundbeck (1908), Melin (1923), Séguy (1927)
WILLISTONININAE	
Willistonina bilineata (Williston, 1883)	Wilcox (1935)

Terminology for pupal case morphology follows that of Dennis *et al.* (2008a, b). This terminology is labeled on Figs. 1–3 for *Lampria bicolor* (Wiedemann, 1828). The pupal case of this species was selected because it shows most of the morphological features of asilid pupal cases.

The head, thorax and abdomen are easily distinguished. The head, with its ventral mouthpart sheaths and lateral eye sheaths, is separated from the thorax by a cephalothoracic suture (ctst) that passes just above the prothoracic spiracle (pthsr). It generally bears terminal anterior antennal processes (aap) that are curved ventrally. Each eye sheath has a posterior antennal process (pap) consisting of 3–6 basally fused hooks. The head ventrally has frontal sutures (fst) between the posterior antennal processes. In the Laphriinae, as shown on Fig. 1, the lower part of the facial area has median facial spines (mfsp) or lateral facial spines (lfsp). In the tribe Megapodini, there are ventral suborbital spines on each side of the head, anterior to the bases of the anterior coxal sheaths (acsh).

On the posterior part of the facial area are the mouthpart sheaths (Fig. 1). The labral sheath (lsh) is located medially and on either side are the maxillary sheaths (msh). The proboscial sheath (prsh) is located posterior to the labral sheath. On some pupal cases, a pair of small callosities is visible on either side of the labral sheath. Dennis *et al.* (2008a) indicated that these callosities apparently represent palpal sheaths.

The paired anterior coxal sheaths (acsh) are lateral to the maxillary sheaths. At the base of the anterior coxal sheaths is the posterior coxal sheath (pcsh), which usually covers the coxae of the hind legs. The fore leg sheaths (lesh 1) are on both sides of the anterior coxal sheaths. The second or mid (lesh 2) and third or hind (lesh 3) leg sheaths are lateral to the fore leg sheaths. The hind leg sheaths are mostly hidden by the wing sheaths (wsh), although their apices project beyond or posterior to the wing sheaths.



FIGURES 1–3. *Lampria bicolor* pupal case. 1, ventral view with enlargement of facial area; 2, lateral view with abdominal segments numbered; 3, dorsal view. Abbreviations: aap = anterior antennal process, absr = abdominal spiracle, acsh = anterior coxal sheath, amsp = anterior mesothoracic spine(s), cesh = compound eye sheath, ctst = cephalothoracic suture, dpp = dorsal posterolateral process, fst = frontal suture, lesh 1 = fore leg sheath, lesh 2 = mid leg sheath, lesh 3 = hind leg sheath, lfsp = lateral facial spine, lsh = labral sheath, mfsp = median facial spine, msh = maxillary sheath, pap = posterior antennal process, pcsh = posterior coxal sheath, pmc = posterior mesothoracic callosity, prsh = proboscial sheath, pthsr = prothoracic spiracle, vpp = ventral posterolateral process, wsh = wing sheath (after Dennis *et al.* 2008a).

The prothoracic spiracles (pthsr) are located on each side of the thorax at the anterior margin (Fig. 2). A pair of anterior mesothoracic spines (amsp) is usually located on each side of the thorax at the base of the mid leg sheaths or there may be a sclerotized edge on a callosity. A posterior mesothoracic spine is also usually located on a posterior mesothoracic callosity (pmc) at the base of each wing sheath.

As discussed in Dennis *et al.* (2008a, b), we recognize nine abdominal segments and abdominal processes consisting of spines and spurs as defined by Comstock (1925) and Daly *et al.* (1998). A spine is a rigid, immovable, thorn-like outgrowth of the cuticle that is not separated from it by a joint. It does not have a socket area of integumental weakness around its base. A spur is a moveable process of the cuticle that is connected to the body wall by a joint, and has a socket or integumental weakness or constriction around its base. Some spines also might be bristle-like, but a bristle is defined as an unicellular macrotrichium or seta connected with nerves and surrounded at the base by a membranous ring or socket called an alveolus (Daly *et al.* 1998; McAlpine 1981).

Typically abdominal segment 1 has a dorsal transverse row of spurs, and segments 2–7 have a dorsal transverse row of long spines alternating with short spurs. However, the known described pupal cases of species of Laphriinae lack discernible spurs (Dennis *et al.* 2008a) (Fig. 3). There are dorsolateral, lateral (posterior to the abdominal spiracles), and ventral bristle-like spines. Each of the first 7 abdominal segments has lateral abdominal spiracles (absr).

Abdominal segment 8 has a distinctive arrangement of dorsal, dorsolateral, lateral, and ventral spurs and spines (Figs. 1–3). Depending on the species, one or more of these groups might be absent. On some species the spiracles can be seen on segment 8, but they are often located more dorsally than on the other abdominal segments.

Abdominal segment 9 has a combination of dorsal posterolateral processes (dpp), ventral posterolateral processes (vpp) and ventromedial processes, and sometimes a distinct arrangement of tubercles or callosities. Male pupal cases can often be distinguished from female cases by a pair of enlarged midventral callosities.

Results and discussion

Up until Knutson (1972) described the pupa of *Neomochtherus angustipennis* (Hine, 1909), the majority of written descriptions of asilid pupal cases were not detailed enough for pupal case identification and did not follow a standard format. As a result, our research also relies on drawings and photographs to distinguish among pupal cases.

We developed the following tentative key to 10 of the 14 subfamilies based on the references shown in Table 1. Most information is available for the subfamilies Asilinae (29 genera and 66 species) and Laphriinae (7 genera and 28 species). Less is available for the Brachyrhopalinae (6 genera and 8 species), Dasypogoninae (4 genera and 8 species), Leptogastrinae (2 genera and 4 species), Dioctriinae (1 genus and 4 species), Ommatiinae (1 genus and 3 species), Stenopogoninae (1 genus and 2 species), and Stichopogoninae and Willistonininae (1 genus and 1 species each). Some pupal case descriptive information is based on genera and species previously placed in the Apocleinae + Asilinae, Laphriinae + Laphystiinae, and Leptogastrinae, that have not been formally placed in a subfamily taxon based on morphology and DNA sequence data. However, Dikow (2009a) indicates that they can still be placed in Asilinae, Laphriinae and Leptogastrinae, and so they are included in Table 1. Out of the 530 valid genera and 7003 species of Asilidae (Geller-Grimm 2011), there is published information on the pupal cases of only 53 genera (10.0%) and 125 species (1.8%) that can help identify pupal cases.

The pupal cases of most subfamilies can be distinguished from each other based on major characteristics, such as the presence or absence of anterior and posterior mesothoracic spines. However, based on available information for the Brachyrhopalinae and Dasypogoninae, it is difficult to tell the difference between their pupal cases.

The limited information for most subfamilies and the lack of information for four of the subfamilies emphasizes the need for more detailed pupal case descriptions. Information is not available for genera and/or species in the subfamilies Bathypogoninae, Phellinae, Tillobromatinae and Trigonomiminae, although these subfamilies are part of the Dasypogoninae group and they would be expected to be included in the subfamily key below (couplets 5 through 8).

The lack of pupal case information for these four subfamilies is probably due to their limited world distributions compared to other subfamilies. According to Dikow (2009b), the Trigonomiminae have a worldwide distribution, the Bathypogoninae are restricted to Australia and possibly South America, the Phellinae occur only in Australia and Chile, and the Tillobromatinae are found in southern Africa and South America.

Tentative key to Asilidae subfamilies based on known pupal cases

1 Anterior antennal processes dorsoventrally flattened and joined at base or tuberculate and poorly developed; posterior antennal processes palmate or represented by only a ridged callosity; dorsum of thorax with 4 bristle-like structures forming corners of a square or rectangle; abdominal segments dorsally with anterior row of short spines and posterior row of hair-like processes longer than the length of each segment; abdominal segments laterally and ventrally with hair-like processes longer than the length of each segment; abdominal segment 9 with 1 pair of terminal processes . . . . . Leptogastrinae

\- Anterior antennal processes long, acuminate; posterior antennal process consisting of 3–6 basally fused, horn-like, hook-like or elongate antler-like processes; dorsum of thorax with 0, 2 or 4 bristle-like structures; abdominal segments dorsally with spines and/or spurs, lacking long bristle-like or hair-like processes; abdominal segments laterally and ventrally with spines shorter than length of each segment; abdominal segment 9 with 2–6 pairs of terminal processes. 2

2 Abdominal segments 1–7 lacking discernable dorsal spurs; lower facial area with median or lateral spines; posterior antennal

processes consisting of 3– 6 confluent hooks that are sometimes elongate and antler-like with alternating long and short hooks; abdominal segment 9 with or without ventral posterolateral processes larger and/or broader than dorsal posterolateral processes . . . . . Laphriinae

- Abdominal segment 1 with dorsal transverse row of long spurs; segments 2–7 with or without dorsal row of long spurs alternating with short spines; lower facial area without median or lateral spines; posterior antennal processes usually consisting of only 3 confluent hooks but if 4–6, then hooks short to long and narrow; abdominal segment 9 with ventral posterolateral processes smaller than dorsal posterolateral processes 3

3 Head with posterior antennal processes consisting of 3–6 hooks; abdominal segment 9 with dorsal posterolateral and ventral posterolateral processes curved dorsally, the ventral ones curved toward dorsal ones, or processes straight to curved dorsally; midventral callosities not tuberculate 4

- Head with posterior antennal processes consisting of 3 hooks; abdominal segment 9 with dorsal posterolateral processes curved or pointed dorsally and ventral posterolateral processes generally pointed ventrally or in opposite direction of dorsal ones; midventral callosities, when present, usually tuberculate with sclerotized tip 9

4 Abdominal segments lacking alternately long spurs and short spines dorsally; some abdominal segments, in particular anterior ones, sometimes with short medial spines; abdominal segments lacking ventral bristle-like spines; anterior and posterior mesothoracic spines absent . . . . . Willistonininae

- Some abdominal segments, in particular anterior ones, with alternately long spurs and short spines dorsally; abdominal segments with or without short, medial spines; some abdominal segments with or without ventral bristle-like spines; anterior and/or posterior mesothoracic spines present 5

5 Abdominal segments without ventral bristle-like spines; anterior mesothoracic spines present; posterior mesothoracic spine absent. . . . . Stenopogoninae

- Abdominal segments with or without ventral bristle-like spines; anterior and/or posterior mesothoracic spines present 6

6 Anterior antennal process usually with basal bristle dorsally; thorax with 2 bristles on dorsum; anterior mesothoracic spines absent or callosity with sclerotized edge; posterior mesothoracic callosity with spine or ridge-like with spine; abdominal segment 1 with 8 long spurs dorsally; segments 2–7 with alternating long spurs and short spines dorsally, becoming subequal on posterior segments. . . . . Dioctriinae

- Anterior antennal process with or without basal bristle dorsally; thorax with or without bristles on dorsal surface; anterior mesothoracic spine(s) present; posterior mesothoracic callosity smooth to grooved or rugulose, sometimes with bristle-like spine; abdominal segment 1 with 6–30 (usually 10–16) long spurs dorsally; segments 2–6 with alternating long spurs and short spines dorsally, becoming subequal on posterior segments; segment 7 with or without alternating long spurs and short spines dorsally 7

7 Anterior antennal process without basal bristle dorsally; thorax with bristles on dorsal surface; anterior and posterior mesothoracic spines present; abdominal segments lacking ventral bristle-like spines; abdominal segment 1 with long, dorsal spurs; these spurs apically bent or curved, with saw tooth-like edge . . . . . Stichopogoninae

- Anterior antennal process with or without basal bristle dorsally; thorax with or without bristles on dorsal surface; anterior and/or posterior mesothoracic spines present and sometimes bristle-like; dorsal spurs of abdominal segment 1 straight to recurved, lacking saw tooth-like anterior edge 8

8 Abdominal segment 1 with 12–30 dorsal spurs; abdominal segments with ventral bristle-like spines; with lateral bristle-like spines posterior to abdominal spiracles; abdominal segment 8 with 4–10 dorsal spurs on each side of midline. Dasypogoninae

- Abdominal segment 1 with 10–18 dorsal spurs; abdominal segments with or without ventral bristle-like spines; with or without lateral bristle-like spines posterior to abdominal spiracles; abdominal segment 8 with 1–4 dorsal spurs on each side of midline . . . . . Brachyrhopalinae

9 Anterior antennal processes joined basally; anterior and posterior mesothoracic spines absent; posterior mesothoracic callosity with sclerotized ridge(s) or margin . . . . . Ommatiinae

- Anterior antennal processes not joined basally; anterior mesothoracic spines absent but with or without posterior mesothoracic spine; posterior mesothoracic callosity smooth to rugose. . . . . Asilinae

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