CONOPIDAE (THICK-HEADED FLIES) 62

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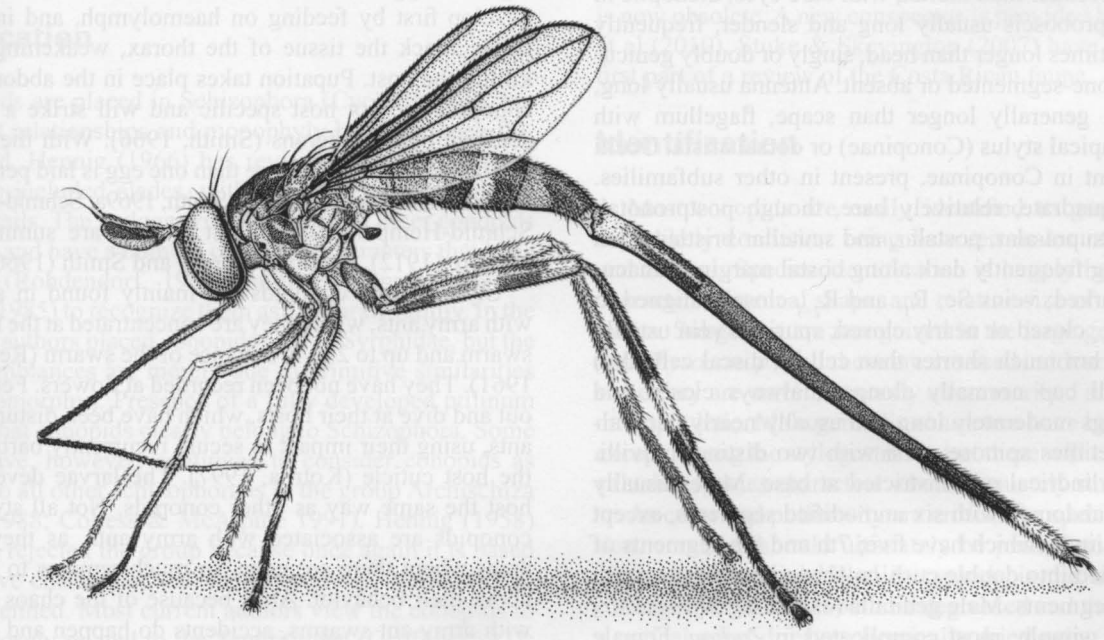
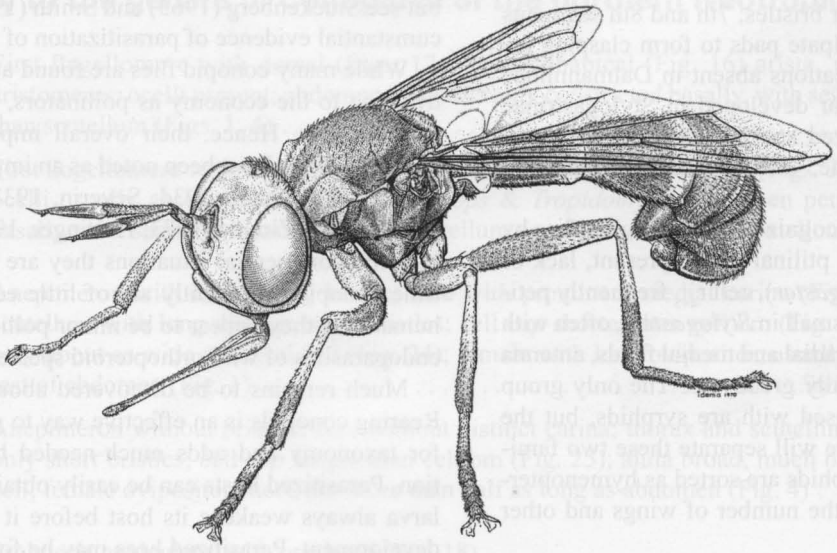


1 *Stylogaster* ♀



2 *Physoconops* ♀

Figs. 62.1–2. Females of (1) *Stylogaster stylosus* Townsend, (Skevington & Dang, 2002, fig. 6) and (2) *Physoconops brachyrhynchus* (Macquart), (Nearctic, MND, fig. 54.1).

Diagnosis

Small to large (body length 2.5–30.0 mm) flies (Figs. 1–2). Relatively bare and elongate, usually tomentose and colored black and yellow, reddish-brown or blackish, often with striking resemblance to their common hosts, wasps and bees. Head large, broader than thorax, with bare eyes, dichoptic in both sexes; proboscis usually long and slender, frequently two or more times longer than head, singly or doubly geniculate; palpus one-segmented or absent. Antenna usually long, with pedicel generally longer than scape, flagellum with short, thick apical stylus (Conopinae) or dorsal arista. Ocelli usually absent in Conopinae, present in other subfamilies. Thorax subquadrate, relatively bare, though postpronotal, notopleural, supra-alar, postalar, and scutellar bristles often present. Wing frequently dark along costal margin or maculate or unmarked; veins Sc, R_1, and R_{2+3} closely aligned to costa, cell r_{4+5} closed or nearly closed, spurious vein usually present, cell bm much shorter than cell br, discal cell (dm) elongate, cell cu*p* normally elongate, always closed and petiolate. Legs moderately long and usually nearly bare, although sometimes spinose; tarsi with two distinct pulvilli. Abdomen cylindrical or constricted at base. Males usually with shorter abdomen with six unmodified segments, except for Dalmanniinae, which have five; 7th and 8th segments of males modified into double cushion-shaped process beneath 5th and 6th segments. Male genitalia (excluding *Stylogaster*) symmetrical, simple, most complicated in *Zodion*. Female with seven visible abdominal segments, 8th appearing to form tip of abdomen; 5th prominently produced ventrally in form of theca in myopines, except in *Myopa* where this may be replaced by tuft of hairs or bristles; 7th and 8th segments prolonged and lined with palpate pads to form clasping organ and theca, these modifications absent in Dalmanniinae and Stylogastrinae; ovipositor developed in Stylogastrinae and Dalmanniinae. Sclerotized spermathecae present, two in Conopinae and Myopinae, one in Dalmanniinae and Stylogastrinae.

Conopid flies are easily recognized among higher flies by a combination of characters: ptilinal suture present, lack of distinct bristles (except *Stylogaster*), cell r_{4+5} frequently petiolate; cell cu*p* usually large (small in *Stylogaster*), often with short spurious vein between radial and medial fields, antenna and proboscis elongate, usually greatly so. The only group that conopids may be confused with are syrphids, but the well-developed ptilinal suture will separate these two families. Many conopids and syrphids are sorted as hymenopterans, but obviously differ in the number of wings and other characters.

Biology

Two different biologies are found among the conopids. Most conopids are endoparasites of social Hymenoptera, bees and wasps. Stylogastrine conopids are endoparasites of orthopteroids, specifically of cockroaches and crickets (Smith & Cunningham-van Someren, 1985; Woodley & Judd, 1998).

Most conopid flies are found at flowers, where mating takes place and, in many cases, females find suitable hosts in which to lay their eggs. Females attack their hosts by inserting their eggs into the dorsum of the abdomen. The larvae develop first by feeding on haemolymph, and in their last instar attack the tissue of the thorax, weakening and then killing the host. Pupation takes place in the abdomen. Most conopids are not host specific and will strike a variety of aculeate hymenopterans (Smith, 1966). With the exception of *Stylogaster*, where more than one egg is laid per host, only one adult is known to emerge (Smith, 1969a; Schmid-Hempel & Schmid-Hempel, 1989). Host records are summarized by Meijere (1912), Freeman (1966), and Smith (1966).

Stylogastrine conopids are mainly found in association with army ants, where they are concentrated at the front of the swarm and up to 2 m in advance of the swarm (Rettenmeyer, 1961). They have not been recorded at flowers. Females seek out and dive at their hosts, which have been disturbed by the ants, using their impact to secure recurrently barbed eggs in the host cuticle (Kotrba, 1997). The larvae develop in the host the same way as other conopids. Not all stylogastrine conopids are associated with army ants, as they occur in areas where there are none, so much remains to be learned about their behavior. Also, because of the chaos associated with army ant swarms, accidents do happen and other non-orthopteroid species appear to be attacked, such as tachinids, other *Stylogaster*, and the ants themselves. No successful rearing, however, has been noted from these other victims, but see Stuckenberg (1963) and Smith (1969b, 1979) for circumstantial evidence of parasitization of Diptera.

While many conopid flies are found at flowers, thus contributing to the economy as pollinators, they are also parasites of bees. Hence, their overall importance is perhaps balanced. They have been noted as an important pest of honey bees (VanDuzee, 1934; Severin, 1937; Jamieson, 1941; Smith, 1966; Zimina, 1973; Huttinger, 1974; Mei, 1999), so in some commercial situations they are harmful. Stylogastrine conopids apparently are of little economic interest to humans, as they appear to be minor pollinators and are only endoparasites of wild orthopteroid species.

Much remains to be discovered about conopid biology. Rearing conopids is an effective way to generate specimens for taxonomy and adds much-needed biological information. Parasitized hosts can be easily obtained as the conopid larva always weakens its host before it completes its own development. Parasitized bees may be found at the entrance to their hives or nest or may remain in the field overnight. These parasitized host bees may be simply collected and kept, and with a little luck adult conopids will emerge. In addition to rearing, a variety of collecting methods are useful for capturing adult conopids. Malaise traps are the best type of trap to use, while hand collecting at flowers, on hilltops

(Mei et al., 2010), at army ant swarms (*Stylogaster* only), and by sweeping are also effective.

Accounts of the immature stages of conopids are widely scattered in the literature, but Ferrar (1987) gives a summary and Woodley & Judd (1998) provide additional information on *Stylogaster*.

Classification

Conopids are placed in Schizophora (Cyclorrhapha), but their exact relationships and monophyly have not been fully resolved. Hennig (1966) has reviewed the relationships among the included clades, with Camras (1994) providing further details. The stylogastrines differ from other conopids in biology and have a number of distinct characters that have led some (Rohdendorf, 1964; Smith & Cunningham-van Someren, 1985) to recognize them as a separate family. In the past, most authors placed conopids next to Syrphidae, but the close resemblances are merely due to primitive similarities (symplesiomorphy). Presence of a fully developed ptilinum indicates that conopids clearly belong to Schizophora. Some authors have, however, continued to consider conopids as the sister to all other schizophorans in the group Archischiza (Chvála, 1988; Colless & McAlpine 1991). Hennig (1958) and others rejected the group because once again it is based on primitive characters, and the sister group, Muscaria, remains undefined. Most current authors view the conopids to be most closely related to the Tephritoidea (Griffiths, 1972; McAlpine, 1989; Korneyev, 2000).

Nearly 800 extant species of Conopidae have been described. They are grouped into four extant subfamilies (Conopinae, Dalmanniinae, Myopinae, Stylogastrinae), plus the fossil subfamily Palaeomyopinae, eight tribes, and 47 genera. All subfamilies, five tribes, 14 genera, and 212 species are found south of the United States. A catalog to the Neotropical species was provided by Papavero (1971), but it is now obsolete. A new conspectus is provided by Thompson et al (2010). Stuke & Skevington (2007) have provided the first part of a review of the Costa Rican fauna.

Identification

Most conopids are easily identified to genus, with the only likely confusion being between males of *Parazodion* and *Zodion*. Species identification is largely based on color characters, antennal shape, and relative size of antennal segments. Subgenera are recognized in the large genera *Conops* and *Physoconops*, but these are not used in identification keys since they are currently poorly circumscribed and not clearly monophyletic. Male genitalic characters have been neglected except among the stylogastrines, but these will certainly yield valuable species characters when adequately studied.

As color and pollinosity are critical for species identification, conopids should ultimately be pinned and dried. Pinning fresh material killed in cyanide is the best. Material collected in alcohol should be degreased and then dried with a critical point drier or chemically dried using ethyl acetate or HMDS.

Key to the genera of Conopidae of the northern Neotropical Region

1. First flagellomere with dorsal (Figs. 17–19) or subapical (Fig. 16) arista, with two or three aristomeres; ocelli present; abdomen not noticeably constricted basally, with segment two broader than scutellum (Figs. 1, 4) 2

– First flagellomere with short, thick apical arista, with three aristomeres (Figs. 3, 5, 6, 12–15, 20); ocelli usually absent (except in *Physoconops* & *Tropidomyia*); abdomen petiolate, constricted basally, with segment 2 narrower than scutellum or rarely as broad as scutellum (Fig. 3) 6

2. Anepimeron with long strong bristle; face with prominent medial carina (Fig. 16); thorax and scutellum with long distinct black bristles; cell cu*p* shorter than cell bm (Fig. 24); alula narrow, only about as wide as costal cell (Fig. 24); female with long ovipositor, usually about as long as rest of abdomen (Fig. 1) . . . . . *Stylogaster* Macquart

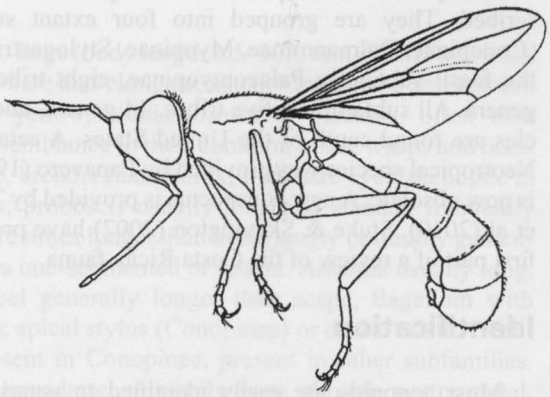
– Anepimeron without bristles; face without distinct carina; thorax and scutellum without or with only short bristles; cell cu*p* longer than cell bm (Fig. 25); alula broad, much broader than costal cell; female ovipositor short, not more than half as long as abdomen (Fig. 4) 3

3. Proboscis geniculate, with one bend (Fig. 18) 4

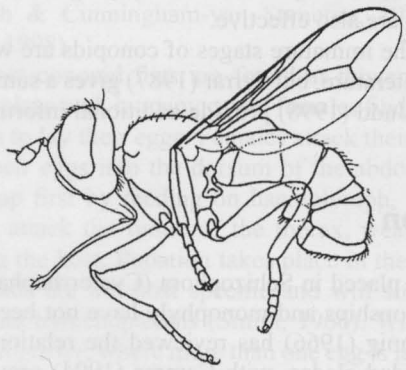
– Proboscis doubly geniculate, with two bends (Fig. 17) 5

4. Ovipositor of piercing type (Fig. 10); male with five unmodified pre-genital segments (Figs. 11) . . . . . *Parazodion* Kröber

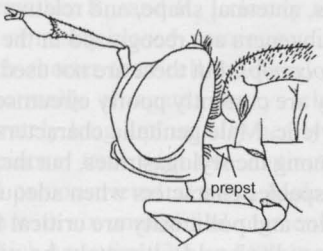
– Ovipositor of clasping type (Fig. 26); male with six unmodified pre-genital segments . . . . . *Zodion* Latreille



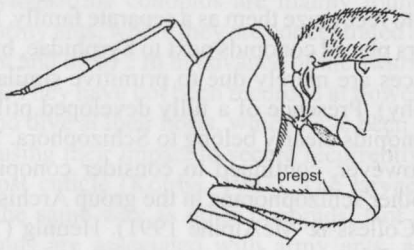
3 *Physoconops* ♂



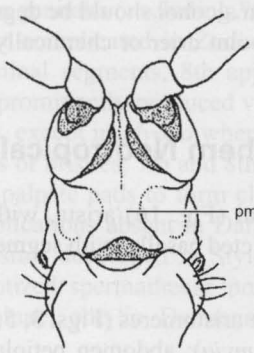
4 *Zodion* ♀



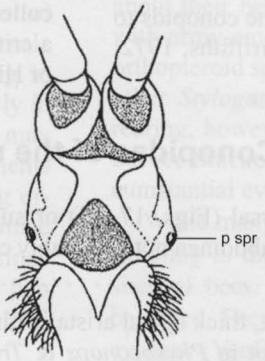
5 *Physocephala*



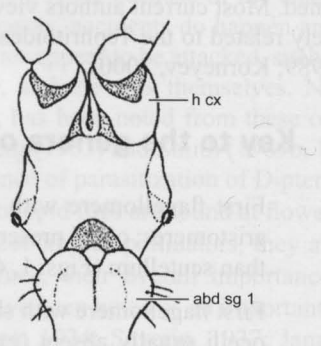
6 *Conops*



7 *Physocephala*



8 *Physoconops*



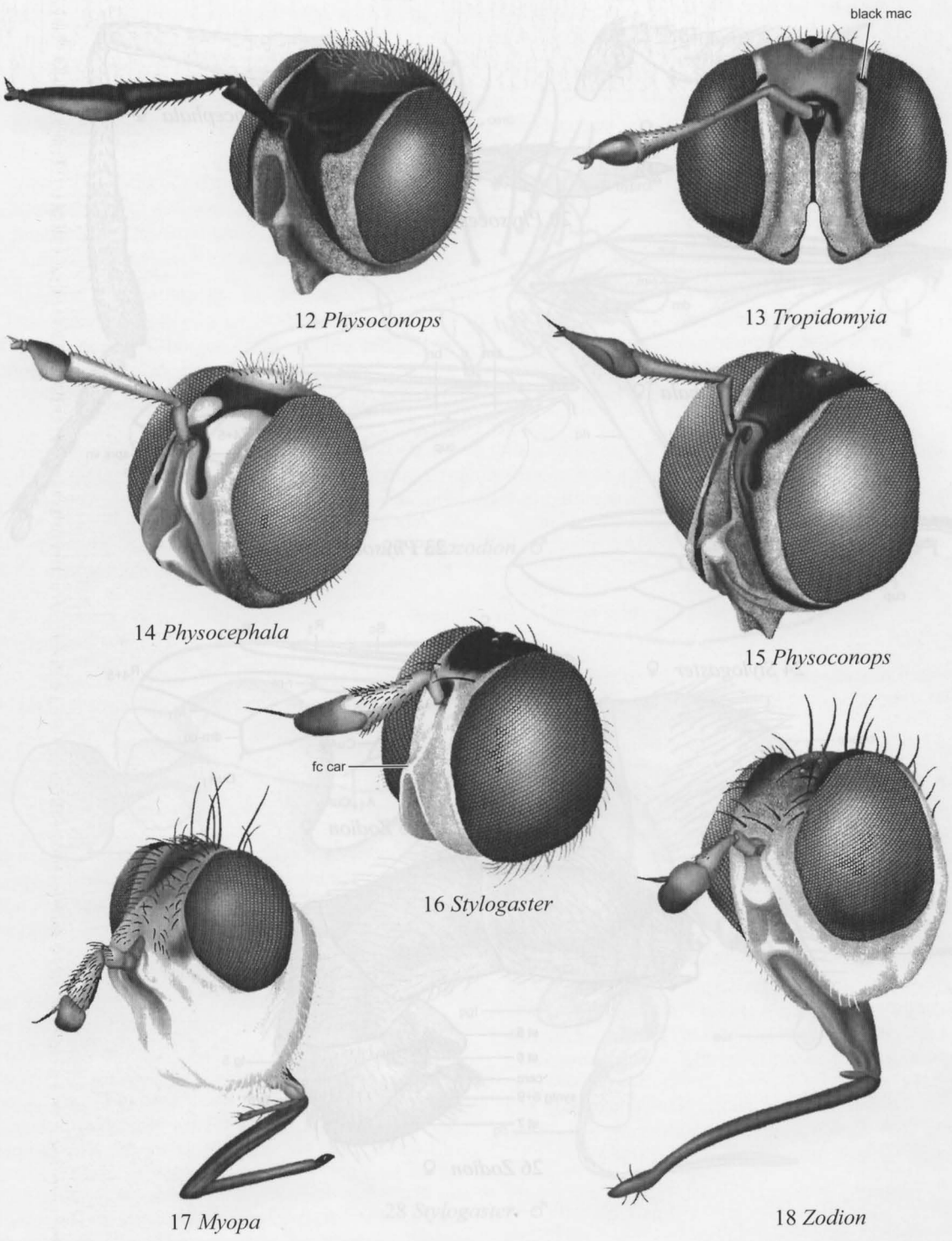
9 *Physoconops*

10 *Parazodion* ♀

11 *Parazodion* ♂

Figs. 62.3–11. Adults, heads, thoraces, and abdomens; lateral view of male of (3) *Physoconops bulbirostris* (Loew); lateral view of female of (4) *Zodion americanum* (Wiedemann); lateral view of head and anterior portion of thorax of (5) *Physocephala inhabilis* (Walker); and (6) *Conops nobilis* Williston; posteroventral view of metathorax, hind coxae (below), and base of abdomen (above) of (7) *Physocephala inhabilis* (Walker); (8) *Physoconops sylvosus* (Williston); and (9) *Physoconops ornatifrons* (Kröber); lateral view of apex of abdomen of female (10) and male (11) of *Parazodion schmidti* Kröber (Kröber, 1927, fig. 11). Figures 3–9 illustrated by T. Litwak.

Abbreviations: abd sg 1, abdominal segment 1; h cx, hind coxa; pmtcx brg, postmetacoxal bridge; prepst, proepisternum; p spr, posterior (thoracic) spiracle.



12 *Physoconops*

13 *Tropidomyia*

14 *Physocephala*

15 *Physoconops*

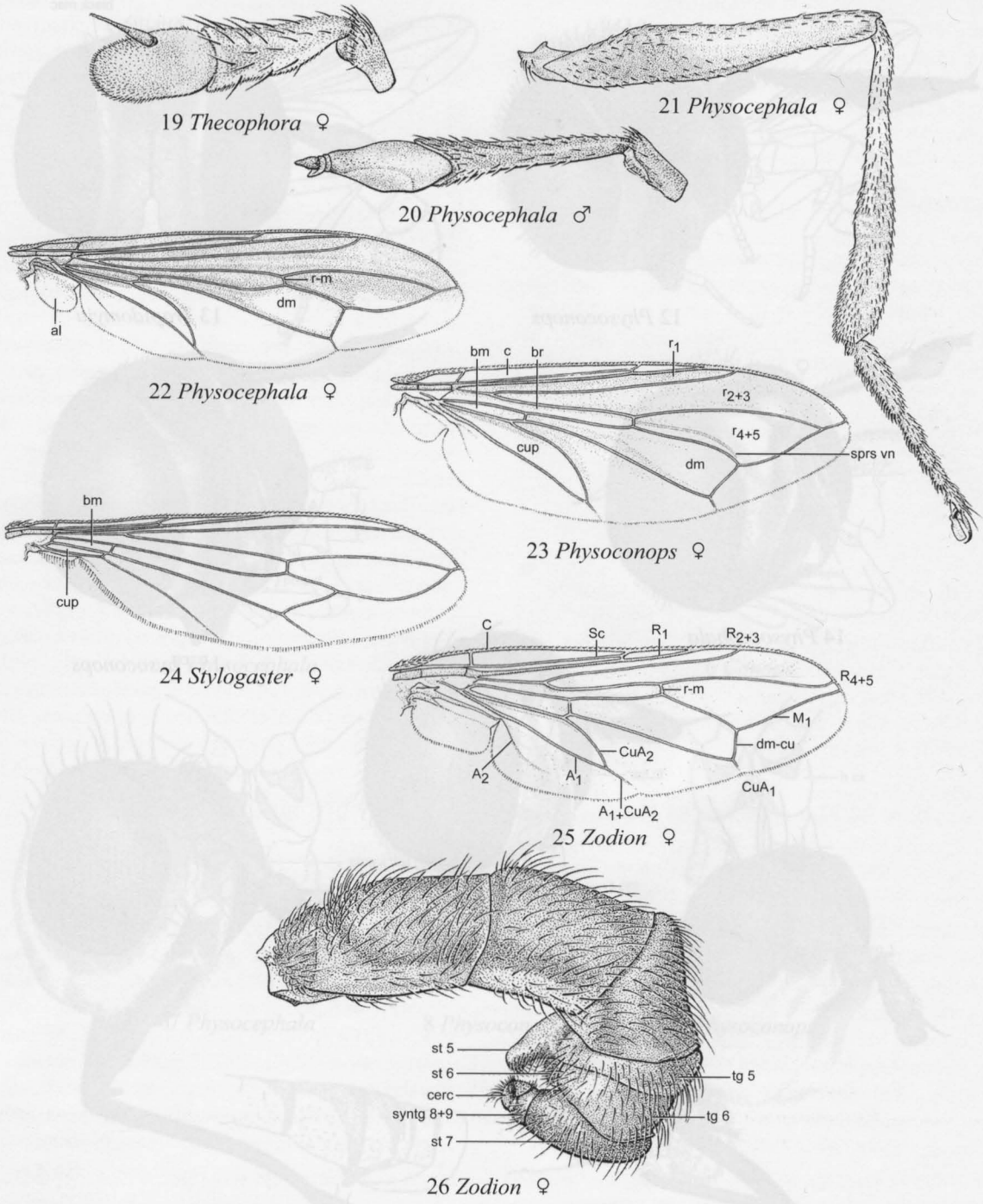
16 *Stylogaster*

17 *Myopa*

18 *Zodion*

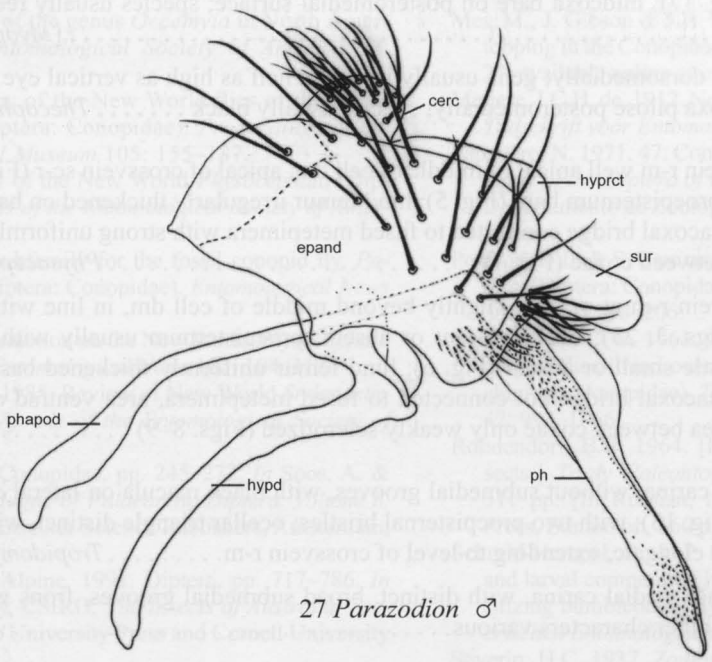
Figs. 62.12–18. Heads: anterolateral view of (12) *Physoconops sylvosus* (Williston); anterior view of (13) *Tropidomyia bimaculata* Williston; anterolateral view of (14) *Physocephala inhabilis* (Walker); (15) *Physoconops ornatifrons* (Kröber); (16) *Stylogaster stylosus* Townsend; (17) *Myopa fasciata* Coquillett; and (18) *Zodion americanum* (Wiedemann). Figures 12–18 illustrated by T. Litwak.

Abbreviations: fc car, facial carina; black mac, black macula.

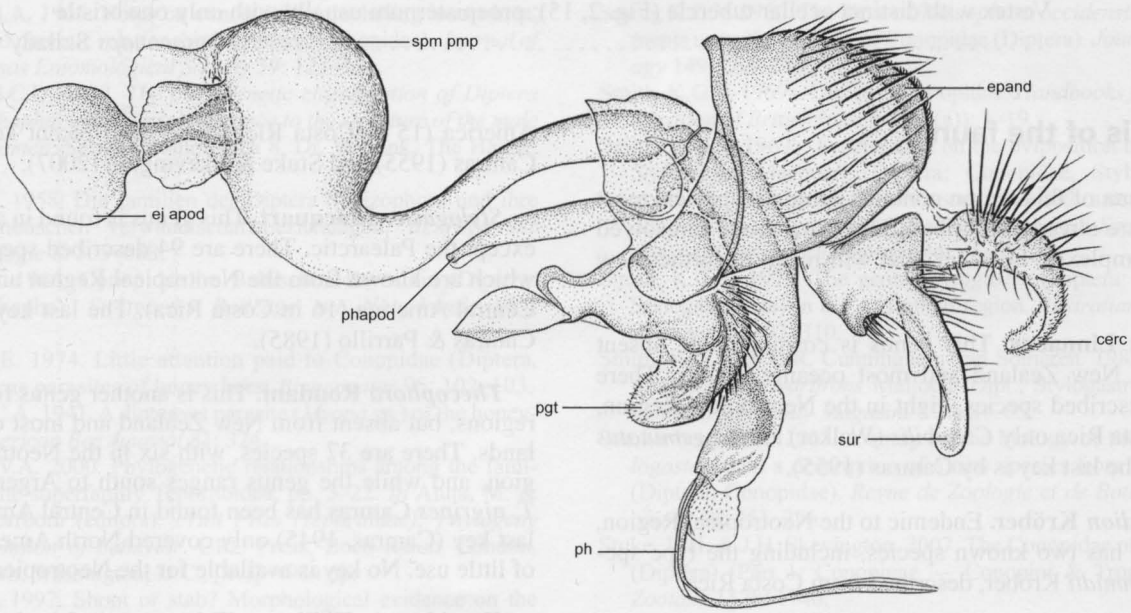


Figs. 62.19–26. Antennae, leg, wings, and female abdomen: lateral view of antenna of (19) *Thecophora occidensis* (Walker), (Nearctic, MND, fig. 54.6); and (20) *Physocephala furcillata* (Williston), (Nearctic, MND, fig. 54.7); posterior view of right hind leg of (21) *Physocephala texana* (Williston), (Nearctic, MND, fig. 54.5); dorsal view of wing of (22) *Physocephala texana* (Williston), (Nearctic, MND, fig. 54.8); (23) *Physoconops fronto* (Williston), (Nearctic, MND, fig. 54.9); (24) *Stylogaster neglecta* Williston, (Nearctic, MND, fig. 54.10); and (25) *Zodion obliquefasciatum* (Macquart), (MND, fig. 54.13); lateral view of abdomen of female of (26) *Z. perlongum* Coquillett, (Nearctic, MND, fig. 54.16).

Abbreviations: al, alula; cerc, cercus; sprs vn, spurious vein; st, sternite; syntg, syntergite; tg, tergite.



27 *Parazodion* ♂



28 *Stylogaster* ♂

Figs. 62.27–28. Male terminalia: lateral view of (27) *Parazodion schmidti* Kröber and (28) *Stylogaster neglecta* Williston, (Nearctic, MND, fig. 54.18). Figure 27 illustrated by T. Litwak.

Abbreviations: cerc, cercus; ej apod, ejaculatory apodeme; epand, epandrium; hypd, hypandrium; hyprct, hypoproct; pgt, postgonite; ph, phallus; phapod, phallapodeme; spm pmp, sperm pump; sur, surstylus.

5. Propleuron bare dorsal to proepisternal bristles; gena usually at least half as high as vertical eye diameter (Fig. 17); midcoxa bare on posteromedial surface; species usually reddish brown; Mexico, Chile. . . . . [*Myopa* Fabricius]

– Propleuron pilose dorsomedially; gena usually less than half as high as vertical eye diameter (as in Fig. 18); midcoxa pilose posteromedially; species usually black . . . . . *Thecophora* Rondani

6. Wing with crossvein r-m well apical of middle of cell dm, apical of crossvein sc-r (Fig. 22); ocelli absent (Fig. 14); proepisternum bare (Fig. 5); hind femur irregularly thickened on basal one-third (Fig. 21); postmetacoxal bridge connected to fused metepimera with strong uniformly sclerotized portion running between coxae (Fig. 7). . . . . *Physocephala* Schiner

– Wing with crossvein r-m at or only slightly beyond middle of cell dm, in line with or basal to crossvein sc-r (Figs. 3, 23); ocelli present or absent; proepisternum usually with at least one bristle, rarely bristle small or absent (Fig. 6); hind femur uniformly thickened basally, thickest medially; postmetacoxal bridge not connected to fused metepimera, area ventrad of bridge not sclerotized and area between coxae only weakly sclerotized (Figs. 8–9) 7

7. Face with medial carina, without submedial grooves, with black macula on lateral edge of frons adjacent to eye (Fig. 13); with two proepisternal bristles; ocellar triangle distinct, with two ocelli (Fig. 13); cell cu*p* elongate, extending to level of crossvein r-m. . . . . *Tropidomyia* Williston

– Face with indistinct medial carina, with distinct, broad submedial grooves, frons without black macula (Fig. 15); other characters various. 8

8. Vertex without ocellar tubercle; proepisternum usually with more than one bristle (Fig. 6). . . . . *Conops* Linneaus

– Vertex with distinct ocellar tubercle (Fig. 2, 15); proepisternum usually with only one bristle . . . . . *Physoconops* Szilady

Synopsis of the fauna

The fauna of this region contains about 60 species, most of which are already described. There are some unresolved species complexes, however, that will result in further new species.

***Conops* Linnaeus.** This genus is cosmopolitan, absent only from New Zealand and most oceanic islands. There are 168 described species, eight in the Neotropical Region, and in Costa Rica only *C. nobilis* (Walker) and *C. geminatus* Camras. The last key is by Camras (1955).

***Parazodion* Kröber.** Endemic to the Neotropical Region, this genus has two known species, including the type species, *P. schmidti* Kröber, described from Costa Rica.

***Physocephala* Schiner.** This genus is cosmopolitan, except absent from New Zealand and most oceanic islands. Of 133 species, 31 are found in the Neotropical Region, with eight in Central America (seven in Costa Rica). The latest keys are by Camras (1996, see also 1957) and Stuke & Skevington (2007).

***Physoconops* Szilady.** Found in most regions, except absent from the Palearctic and Australian Regions, *Physoconops* has 62 species, 49 found in Neotropical Region and 16 in Central America (15 in Costa Rica). The most recent keys are by Camras (1955) and Stuke & Skevington (2007).

***Stylogaster* Macquart.** This genus is found in all regions, except the Palearctic. There are 94 described species, 70 of which are known from the Neotropical Region and 24 from Central America (16 in Costa Rica). The last key is that of Camras & Parrillo (1985).

***Thecophora* Rondani.** This is another genus found in all regions, but absent from New Zealand and most oceanic islands. There are 37 species, with six in the Neotropical Region, and while the genus ranges south to Argentina, only *T. nigripes* Camras has been found in Central America. The last key (Camras, 1945) only covered North America and is of little use. No key is available for the Neotropical Region.

***Tropidomyia* Williston.** This genus is found in most regions, except the Nearctic and Australian Regions. There are seven species, two of which are found in the Neotropical Region, of which *T. bimaculata* Williston occurs in Costa Rica. The last key was that of Camras (1955).

***Zodion* Latreille.** *Zodion* species are found in all regions, but are absent from New Zealand and most oceanic islands. Of 57 species, 32 are found in the Neotropical Region and about eight in Central America (seven in Costa Rica). The last key was in Pearson & Camras (1978).

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