“Dagger flies” (Insecta: Diptera: Empedidae).

Carlos Henrique Marchiori[1]

1 Instituto Federal Goiano

Potential competing interests: No potential competing interests to declare.

Co-authors: Marco Vinícios de Oliveira Santana[2] and Klebert de Paula Malheiros[3].

[2-3]Instituto Marco Santana, Goiânia, Goiás, Brazil.

The cosmopolitan Family Empididae belongs to the Suborder Brachycera. Infraorder Muscomorpha. Empidoidea section. Cyclorrhapha section. Including more than 4 thousand described species in the world, it is estimated that the total diversity will exceed 7.5 thousand species, being one of the largest families of Diptera. They constitute the superfamily Empidoidea together with Dolichopodidae (Long-legged flies), which have only rare representatives with semi-aquatic larvae. Empidoidea is represented in the Neotropics by about 52 species (out of a total of 660 in the world) [1-3].

Adults Empididae rarely exceed 10 mm, and have great morphological diversity, usually elongated and blackish. Well-developed, long mouthparts, hence its name “dagger flies”. The fly of the Empididae family has a brownish-brown abdomen, and its wings appear slightly brown and cloudy. The female’s abdomen is gray and her wings are pale. The size of adults is small to medium, rarely exceeding 10 mm in length. Adults are easily recognized, mainly by the characteristic wing venation (M1 ending behind the wing apex; costa usually extending beyond the wing apex; anal cell closed away from the wing margin or absent), and by the predatory appearance. The head is spherical, loosely connected with the thorax and eyespots are present. In most genera, the proboscis, adapted for sucking, extends under the head, can be short or long, and is usually rigid. The thorax is elongated and narrow, usually small, and the legs are usually slender (Figures 1-2) [3-7].

In the Empididae family, males of this species build a delicate silk cocoon, equal in size to themselves, and gather with other males of their species, flying all together so that they are easily seen. They fly within this “cloud” in circles. From time to time a female fly, of the same species, enters the group and flies close to each male until it chooses a mate. She accepts the offered silk balloon as it climbs over her. Thus, the two leave the group to finish the copulation [7-9].

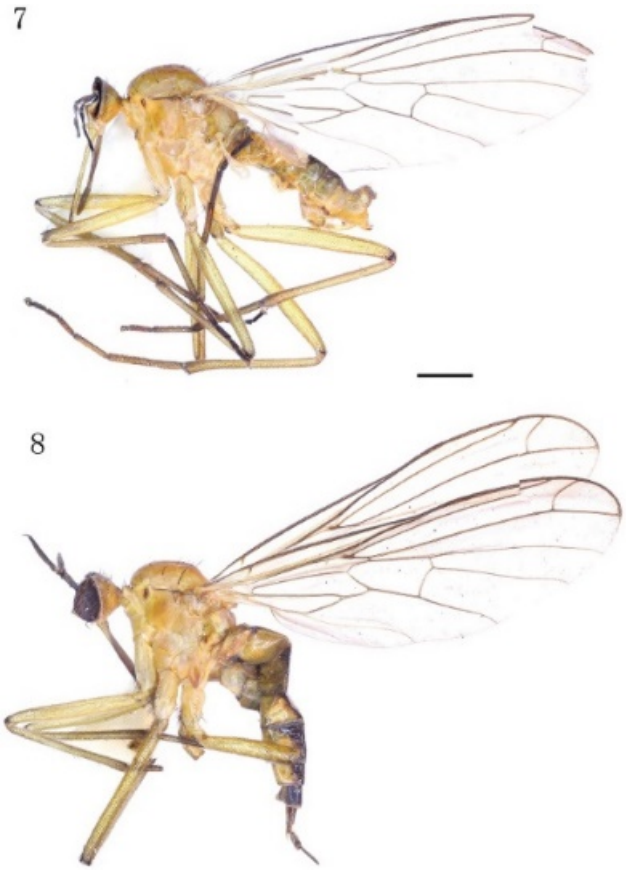

Figure 1. *Empis (Xanthempis) suhi* sp. nov., habitus, lateral view. **7.** Male **8.** Female. Source: Zhou J, Shamshev I, Kwon Y, Yang D. Species of the subgenus *Empis (Xanthempis)* from South Korea (Diptera, Empididae). ZooKeys; 2018; 769: 145-155

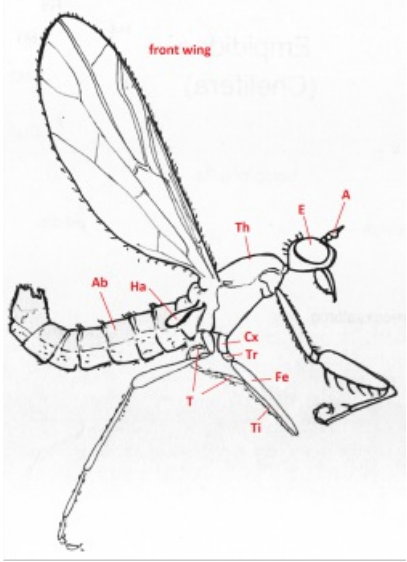

Figure 2. A = antenna, Ab = abdomen, AS = apical spike/spur, Ce = cercus, Cx = coxa, E = eye, Fe = femur, Fl = flagellum, Ha = halter, O = ocellus, Pb = probiscus, Pc = pedicel, T = tarsus, TC = tarsal claw, Ti = tibia, Sa = scales.

Source: https://batsdiet.com/arthropod-morphology/diptera

When *Hilara sartor* Becker, 1888 (Diptera: Empididae) was first observed, little was understood about the reason for the balloon. Why did copulation depend on the offering of that gift of silk? Comparing the reproductive behavior of other species of this family, it was possible to understand this type of situation. Many Empididae display an elaborate courtship and transfer a nuptial gift to the female that is nothing more than another insect that serves as food for her (Figures 3-4) [9-11].

Figure 3. Caption Dance flies mating. Male (top) and female (bottom)*Empis tessellata* Fabricius, 1794 flies on a plant stalk. The male has presented the female with a prey item as a gift and is now suspending his mate and the prey from the plant stalk by a single leg (upper center). Source: Credit DR. John Brackenbury/science photo library.

Figure 4. Reproductive behavior of *Platypalpus bicornis* Melander, 1927. adults are predators of other insects, particularly Diptera. The act of capturing the prey is an essential factor for successful copulation in some genera and they perform a courtship ceremony. The male captures the prey and uses this food as bait to attract the female, typical behavior. eating habits play a role essential in the mating process. Sources: Photo by S.A. Marshall and photo by E.M. Fisher.

Considering another species of empidid fly,*Rhamphomyia nigrita* Zetterstedt, 1838 (Diptera: Empididae), as an example of a primitive (original) mating system, it was observed that in the male, the eyes are divided into two regions: large ommatidia (lens/external facets) in the upper 2/3 of the eye. This morphological difference in the female reports a specialization in hunting. They capture mosquitoes and donate them to their partners so that they allow them to mate. However, if the prey is too small, the males themselves end up serving as food for her [11-14].

Figure 4. *Rhamphomyia nigrita* Zetterstedt, 1838 (Diptera: Empididae). Source: https://evolsyst.pensoft.net/article/49537/.

The Empididae then began to weave the cocoon so that the female would take longer to reach the prey, allowing time for copulation. Other species, then, with more “evolved” reproductive behavior, began to offer only the silk cocoon to the female, as in the case of the first species mentioned. The immature stages are little known. They can be aquatic, found on the ground, in rotten wood, or rarely in manure larvae are predators. Among all described species of the Empididae family, there is data on the biology of immature stages of some species (Figure 5) [14-17].

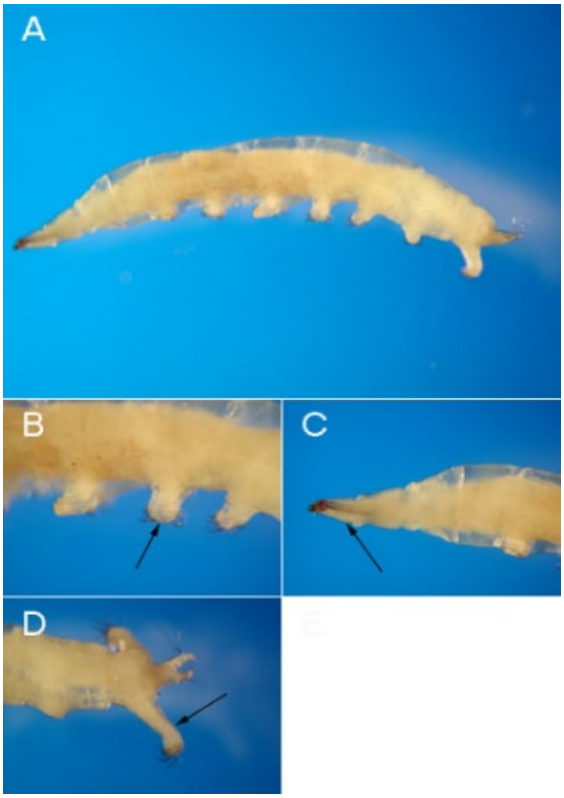

Figure 5. Most species of this Family have terrestrial larvae. The species with aquatic larvae are predators which are found living among the rocks at the bottom of swift streams or sometimes they inhabit the wet marginal areas of rivers and streams. The size of the aquatic dance flies at maturity is 2-7 mm. Dance fly (Empididae) pupa. Sources: Image; Stephen Moore and Source: https://i.ytimg.com/vi/YJdG-wVg8PM/maxresdefault.jpg.

Figure 6. (Predation) A, B, C, and D, Description: Empididae (Latreille, 1804) is a family of flies with over 3,000 described

species occurring worldwide in all the ecozones, but the majority are found in the Holarctic. They are mainly predatory flies like most of their relatives in the *Empidoidea and* exhibit a wide range of forms but are generally small to medium-sized, non-metallic, and rather bristly. Source: https://www.projectnoah.org/spottings/1739866008/fullscreen and Andrea46.

In general, members of this family are found in vegetation in damp places, on tree trunks, or on the surface of water. Some genera are found along the seashore, in the middle of the pebble, where they feed on small insects or other invertebrates. Adults are associated with population control of other arthropods, including dipterans themselves. Certain species are nectarivorous and promote plant pollination. Empididae is more abundant in damp places, especially in woods, along streams, and on the banks of ponds and lakes. As a rule, they are observed in foliage and grass, but many are limited to a few habitats such as tree trunks and small flowers [17-20].

Some species of Empididae.

Hilara Meigen, 1822. *Hilara irritans* Bezzi, 1909: **Diagnosis.** Dark brown to black with gray pruritus on pleura and thighs; bristly forehead and face; post-ocular bristles well developed, proclaiming over eye; short proboscis; I listen to no darker tracks; swollen first anterior tarsomere. **Geographic registration**. Chile.

Hilara perplexed Bezzi, 1909. **Diagnosis.** Dark brown with gray bristly forehead and face; post-ocular bristles large, proclaiming over the eye; short proboscis; listen with darker longitudinal bands; conspicuous thoracic bristles; swollen first anterior tarsomere; pale yellow palp and halter; Hind femur with reddish-brown spiny ventral bristles on distal half. **Geographic registration**. Peru.

Hilara perturbans Bezzi, 1909. **Diagnosis.** Dark brown with gray bristly forehead and face; post-ocular bristles large, sloping over the eye; short proboscis; brown palp and light-yellow halter; conspicuous thoracic bristles; listen with somewhat inconspicuous dark longitudinal bands; swollen first anterior tarsomere; Hind femur with spiny ventral bristles on distal half. **Geographic registration**. Chile and Peru.

Hillary Collin (1960). *Hilara aberrans* Bezzi, 1909. **Diagnosis.** Black with denser gray on mesopleura and thighs; ocellar bristles subequal to post-ocellar ones; listen with black, velvety longitudinal bands, distinct in a certain light; anepisternum and inconspicuous bristles; brown wing with slightly darker base; tenuous pterostigma; descending R5 vein; distinct CuP vein; distinct A1 vein. **Geographic registration**. Bolivia.

Hilara Abnormis Bezzi, 1909

Diagnosis. Black with denser gray on mesopleuron and thighs; listen, in a certain light, with velvety black longitudinal bands in the vicinity of the postpronotal lobe; episternum and with small, inconspicuous bristles; all tibiae and posterior femur with long bristles; wing with light brown infuscation; tenuous pterostigma; descending R5 vein; distinct CuP vein; distinct A1 vein, almost complete; A2 evanescent; male terminalia with the sclerotic apex of hypandrium, well developed. **Geographic registration**. Peru [20-25].

Rhamphomyia longicauda Loew, 1861, is a species of fly in the dancing fly family (Empididae). The scientific name of the

species was first published in 1861 by Loew. **Colors:** Black. Habitat: forest; riverside area; vegetation; ground.**Bite/Sting**: Not reported. Allergy trigger: Not reported. Non-poisonous: Yes. *Rhamphomyia longicauda* is non-toxic and does not normally pose a threat to human health. *Phyllodromia melanocephala* is a species of fly in the Empididae family. It is found in the Palearctic.

Empis livida Linnaeus,1758. It is a large midge whose spherical head, large eyes, and long proboscis are characteristic. Both forager and predator, it inhabits hedgerows, edges, parks, and gardens.

Systematic Position: Insect, Diptera, Brachycera, Empididae family. The genus *Empis* Linnaeus, 1758, has more than 180 species in Europe. The English baptized these Diptera "dance flies", and "dancing flies" about the courtship dance of the males. Shape, appearance: it is a gnat whose main characteristics are long legs, a globular head, and a downward curved trunk. The thorax bears three longitudinal black bands. The wings have two upper veins arising from the discal cell which do not reach the wing margin. The males have a brown abdomen, wings tinged with brown, and contiguous eyes, they have a developed external copulatory apparatus. Females have a gray abdomen and hyaline wings; their anterior femur has rows of flattened bristles forward and on the posteroventral surface.

Color: brown (males) or gray (females). **Behavior:** Males perform courtship dances before mating. Distribution area, status: it is a northern European species, and it is absent from the Mediterranean area. **Habitat**: the livid *Empis* is one genus of bocage and wood edges, it is also found in gardens surrounded by hedges. **Observation period:** it is visible from April to the end of summer, with a peak in June to July.

Biology: Food: it is a species that gathers pollen from Rosaceae, Asteraceae, and Apiaceae, the giant hogweed *Heracleum spondylium* L. (Apiaceae). Its diet is, however, supplemented by the predation of other insects. Giant hogweed, *H. spondylium*. **Reproduction**: Males of the genus *Empis* perform courtship dances during which they offer prey to the female and mate while she consumes it. Larvae develop in moist soil, leaf litter, humus, and decaying vegetation, there they eat larvae, scale insects, and mites. *Empis* is a genus of dipterous insects, long-legged predatory flies in the family Empididae.

Habitat: around the hedge; wet soil and litter, Food sources for adults. The male in some species preys on weaker insects and drinks nectar; other males cannot eat. The female only eats food brought by potential mates. Larvae Food Sources: The larva feeds on small insects. Bite/Sting: Not reported

Allergy trigger: Not reported. **Non-poisonous**: Yes. *Empis livida* is non-toxic and does not normally pose a threat to human health. There's no need to worry too much. **Phytophagous**: Yes. *Empis livida* feeds on plants and usually doesn't cause much of a problem. However, if you notice the number getting bigger, you need to take it seriously. **Predatory:** Yes. *Empis livida* e., 1748. usually feeds on other arthropods and does not have a direct impact on plants [25-30].

References

[1] Pape T, Blagoderov V, Mostovski MB. Order Diptera Linnaeus, 1758. Animal biodiversity: An outline of higher-level classification and survey of taxonomic richness. Zootaxa: 2011; 3148: 1-237.

[2] Tremblay E. Applied Entomology. 3st ed. Napoli: Liguori Editore. 2005.

[3] Sinclair BJ, Cumming JM. The morphology, higher-level phylogeny, and classification of the Empidoidea (Diptera). Zootaxa. 2006; 1180: 1-172.

[4] Roskov Y, et al. Species 2000 & ITIS Catalog of life species 2000: 1st ed. Leiden: Naturalis. 2013.

[5] Hamada N, Nessimian JL, Querino RB. Aquatic insects in the Brazilian Amazon: Taxonomy, biology and ecology. 1st ed. Manaus: Editora do INPA. 2014.

[6] Mendonça MN. Taxonomic and phylogenetic study of *Porphyrochroa* Melander, 1928 (Diptera, Empididae) from the Brazilian Amazon [P.h.D. dissertation]. Manaus: Universidade Federal da Amazonia; 2007.

[7] Watts M, Winkler IS, Daugeron C, Carvalho CJ, Turner SP, Wiegmann BM. Where do the Neotropical *Empidini lineages* (Diptera: Empididae: Empidinae) fit in a worldwide context? Molecular Phylogenetic and Evolution. 2016; 95: 67-78.

[8] Molina OS, Gil-Azevedo LH. Comments on the association of immatures of *Hemerodromia* (Diptera, Empididae) and *Simulium* (Diptera, Simuliidae), and the first record of this association in the Atlantic Forest (Brazil). Acta Tropica. 2016; 163: 7–8.

[9] Mendonça MN. New species of *Porphyrochroa* Melander (Diptera: Empididae) from Paraná, Brazil, and key to Brazilian species from southern and south-eastern Brazil. Journal of Natural History. 2010; 44(9–10): 615–624.

[10] Koroiva R, Fonseca-Gessner AA, Valente-Neto F, Roque FO. Relationship between morphological characteristics of submerged trunks and occurrence of saproxilophilous dipteran larvae in a stream in semideciduous Atlantic Forest in southeastern Brazil [Internet]. São Lourenço: Anais do IX Congresso de Ecologia do Brasil; ©2009 [cited 2024 Jan 02]. Available from https://www.seb-ecologia.org.br/revistas/indexar/anais/2009/index.html.

[11] Elberling H, Olesen JM. The structure of a high latitude plant-flower visitor system: The dominance of flies. Ecography. 1999; 22: 314-323.

[12] Brown BV, Borkent A, Cumming JM, Wood DM, Woodley NE, Zumbado MA. Manual of Central American Diptera: 1st ed. Ottawa: NRC Research Press. 2009.

[13] Brown BV, Borkent A, Cumming JM, Wood DM, Woodley NE, Zumbado MA. Manual of Central American Diptera: 1st ed. Ottawa: NRC Research Press. 2010.

[14] Marshall SA, Kirk-Spriggs AH, Muller BS, Paiero SM, Yau T, Jackson MD. Key to Diptera Families – Adults. In: Kirk-Spriggs AH, Sinclair BJ, eds. Manual of Afrotropical Diptera. Introductory chapters and keys to Diptera families. 1st ed: Pretoria: South African National Biodiversity Institute; 2017. p. 267–355.

[15] Moulton JK, Wiegmann BM. The phylogenetic relationships of flies in the superfamily Empidoidea (Insecta: Diptera).

Molecular Phylogenetics and Evolution. 2007; 43(3): 701-713.

[16] Smith-Ramírez C, Martinez P, Nuñes M, González C, Armesto JJ. Diversity, flower visitation frequency and generalism of pollinators in temperate rain forests of Chiloé Island, Chile. Botanical Journal of the Linnean Society. 2005; 147: 399-416.

[17] Wolff D, Meve U, Llede-Schumann S. Pollination ecology of Ecuadorian Asclepiadoideae (Apocynaceae): How generalized are morphologically specialized flowers? Basic and Applied Ecology. 2008; 9: 24-34.

[18] Rafael JA, Cumming M. The Neotropical genera *Macrostomus* Wiedemann and *Porphyrochroa* Melander (Diptera, Empididae, Empidinae). Revista Brasileira de Zoologia; 2004; 21: 439-448.

[19] Pinheiro M, Abrão BE, Harter-Marques B, Miotto STS. Floral resources used by insects in a grassland community in Southern Brazil. Revista Brasileira de Botânica. 2008; 31(3): 469-489.

[20] Smith KGV. Family Empididae. In: Evenhuis NL, eds. Catalog of the Diptera of the Australasian and Oceanian Regions. 1st ed. London: British Museum Natural History; 1989. p. 431– 442.

[21] Smith KGV. Family Empididae. In: Crosskey RW, eds. Catalogue of the Diptera of the Afrotropical region. 1st ed. London: British Museum Natural History; 1980. p. 431–442.

[22] Carvalho CJB. Diptera Linnaeus, 1758. In: Rafael JA. Insects of Brazil: Diversity and taxonomy. 1st ed. Ribeirão Preto: Holos; 2012. p. 701-735.

[23] Marchiori CH. Parasitoids of Diptera were collected in the urban area of Goiânia, Goiás, Brazil. Qeios. 2019; 40(1/2): 43-47.

[24] Mendonça MN. Taxonomic and phylogenetic study of *Porphyrochroa* Melander, 1928 (Diptera, Empididae) from Brazilian Amazon [P.h.D. dissertation] Manaus: National Institute of Research of the Amazon – INPA; 2007.

[25] D'ávila M. Floral visitor insects in cerradão and cerrado sensu stricto areas in the State of São Paulo. [P.h.D. dissertation]. São Paulo: Universidade de São Paulo, ESALQ; 2006.

[26] Moulton JK, Wiegmann BM. The phylogenetic relationships of flies in the superfamily Empidoidea (Insecta: Diptera). Molecular Phylogenetics and Evolution. 2007; 43(3): 701-713.

[27] Sinclair BJ, Cumming JM. The morphology, higher-level phylogeny, and classification of the Empidoidea (Diptera). Zootaxa. 2006; 1180: 1-172.

[28] Rafael JA. Revision of Neotropical species of Empididae (Diptera) described by Mario Bezzi. VII. The species described in *Hilara* Meigen. Revista Brasileira de Entomologia. 2011; 55(3): 317–326.

[29] Reichhoff-Riehm. Insects [Internet]. Paris: France Leisure; @1983 [2024 Jan 22]. Available from https://www.quelestcetanimal.com/dipteres/lempis-livide/.

[30] Reichert LMM. The importance of Diptera as floral visitors: a literature review [Internet]. Pelotas: Academic work Graduation in Biological Sciences from the Federal University of Pelotas; @2010 [cited 2024 Jan 02]. Available from ttps://www2.ufpel.edu.br/prg/sisbi/bibct/acervo/biologia/2010/leici_reichert_2010.pdf.

[31] Brittai C, Bommarco R, Vighi M, Settele J, Potts SG. Organic farming in isolated landscapes does not benefit flower-visiting insects and pollination. Biological Conservation. 2010; 143: 1860-1867.