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Definition of four belonging families (Insecta: Diptera: Nematocera: Tipulomorpha).

Carlos Henrique Marchiori[1]

1 Instituto Federal Goiano

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

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

Nematocera is popularly known as “mosquitoes” Most species do not directly interfere in the daily lives of humans. Its biology is related to the structure of natural environments, such as the induction of galls in plants (family Cecidomyiidae), fungi and decomposing organic matter (Mycetophiliformia), flowers (Bibionidae, Tipulidae) and aquatic environments (Limoniidae, Trichoceridae, Chironomidae, Scatopsidae). Some groups, such as Chironomidae and Mycetophilidae, are used as indicators of the quality of natural environments and their changes. The adult nematoceran live in open fields, foliage, forests, mangroves, caves, deserts, and savannas, but are normally quite dependent on humidity. Larvae are often associated with fungi and decomposing organic matter [1-4].

Tipulomorpha including the families Cylindrotomidae, Pediciidae, Tipulidae, and Limoniidae constitutes one of the largest subgroups of Diptera, with more than 15000 species described and five hundred genres and subgenres. The Pediciidae family is the sister group to the other Tipulomorpha families; Limnophilinae is considered paraphyletic concerning all subgroups of Tipulomorpha except Pediciidae and Tipulidae is considered paraphyletic concerning Cylindrotomidae. The morphological characters are richly illustrated in a standardized way. Character illustrations are useful for the comparative study and identification of various species, subgenera, and even genera in Tipulomorpha [4-7]

There are representatives of this infraorder in all biogeographic areas of the planet, being one of the most species-rich groups of Diptera. It is estimated that there are more than 15,000 species of more than three hundred genera described in the world, with records of more than 1,500 species in North America north of Mexico and 3,400 in Mexico, Central and South America. Despite this, they have only registered the Mexican Republic 323 species belonging to fifty-two genera from three families, some of them described in years before the Biologia Centrali-Americana or in this work [4-9].

Family Cylindrotomidae

They are mostly large flies of around 11 to 16 mm and yellowish to pale brown. They have long, thin antennae with sixteen segments; The wings, legs, and abdomen are very long (Figure 1) [8-9].

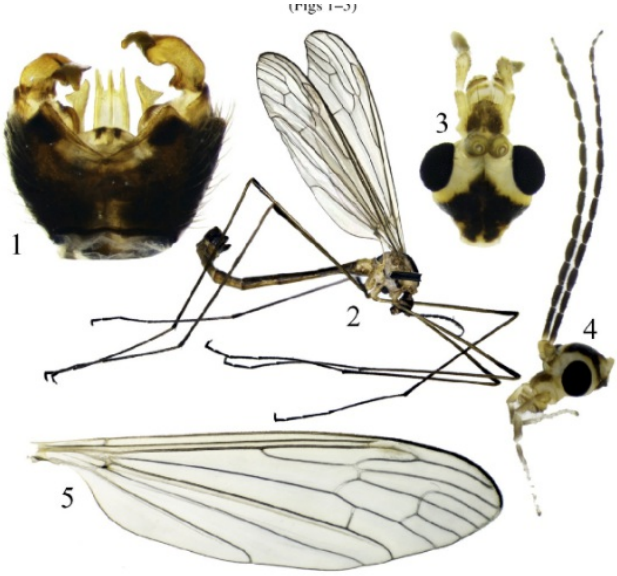

Figure 1 figs 1–5. *Cylindrotoma distinctissima distinctissima* (Meigen, 1818) from Kopaonik Mountains (Serbia); 1 – dorsal view of male hypopygium, 2 – habitus, 3 – dorsal view of the head (antennae removed), 4 – lateral view

Source: https://www.semanticscholar.org/paper/First-record-of-Cylindrotoma-distinctissima-1818)-Kolcs%C3%A1r-T%C3%B6r%C3%B6k/af87fb6bcbe468e13bdd76e112a9aae7bc4a739e/figure/0

The larvae are phytophagous (except the genus *Cylindrotoma* Macquart, 1834). They are found in terrestrial, aquatic, and semi-aquatic mosses. Larvae of the genus *Cylindrotoma* live on various flowering plants. Adults are found in moist wood and habitats (Figures 2-3) [10-12].

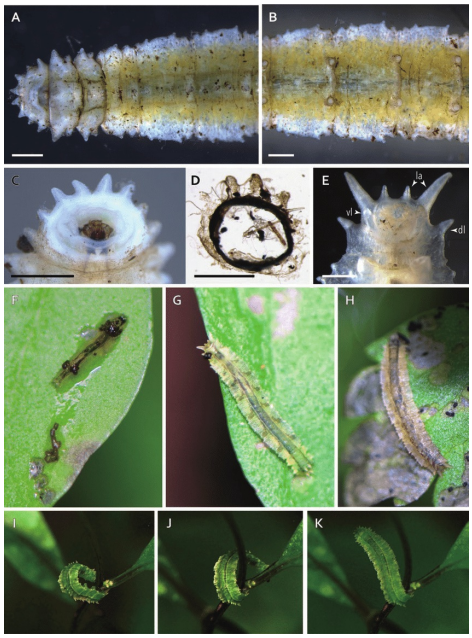

Figure 2 Biology and morphology of Alexander 1919. (A) Anterior body of the final instar; body color faded due to ethanol preservation: anteriormost part of prothorax to abdominal segment III, dorsal view. (B) Abdominal segments III-V showing

pairs of lobes, ventral view. (C) Thick prothoracic integument in which the larval head is covered, which constitutes a 'suction cup'. (D) Crown-shaped material covering the larval prothoracic integument, which is composed of silk and debris. (E) Anal segment, ventral view. (F) Second-instar larva carrying its fecal pellets on the dorsal and lateral sides of the integument. (G) Early-instar larva with green hue and grey pigmentation on the dorsal segments. (H) Late instar larva with brown hue. (I-K) Snapshots showing a sequence of the looping locomotion of a late-instar larva when

Source: https://www.researchgate.net/figure/Biology-and-morphology-of-Cylindrotoma-japonica-A-Anterior-body-of-the-final-instar_fig12_347913815

Figure 3 Eggs of Cylindrotominae (Cylindrotomidae). (A) *Liogma brevipecten* Alexander 1932, dorsal (left) and ventral sides (right); micropyle at the distal end (black arrowhead) and possess a lateral adhesive region (white arrowhead). (B) *L. brevipecten* on the lower side of a liverwort thallus of*Conocephalum conicum* L. (Conocephalaceae). (C) *Triogma kuwanai* (Alexander, 1913) on a dicot shoot

Source: https://www.semanticscholar.org/paper/Moss-mimesis-par-excellence%3A-integrating-previous-Imada/02286c5af71f0ba84096a70d55ab199f7ef894b1/figure/1

Subfamily Cylindrotominae: Genus: *Cylindrotoma* Macquart, 1834, *Diogma* Edwards, 1938, *Liogma* Osten Sacken, 1869, *Phalacrocera* Schiner, 1863 and *Triogma* Schiner, 1863.

Subfamily Stibadocerinae: Genus: *Stibadocera* Enderlein, 1912, *Stibadocerella* Brunetti, 1918, *Stibadocerina* Alexander, 1929 and *Stibadocerodes* Alexander, 1928.

Until now there were two records for the family Cylindrotomidae in the Iberian Peninsula, both corresponding to the species *Cylindrotoma distinctis*sima (Meigen, 1818) in the province of Lugo: in Cabana Vella, Sierra de Ancares, and Moreda, Serra do Courel. The larva of *Phalacrocera replicata* (Linnaeus, 1758) has long, filiform, non-toothed dorsal processes arranged in a double row, some of them bifid; two ventral lobes in the anal segment completely black on the dorsal side and a head that retracts completely into the thorax. The two specimens found presented assorted colors, one being browner than the other, which conforms to the characteristics described for the *P. replicata* larva, which copies the color of its preferred substrate (mosses and herbaceous plants). The immature stages of *P. replicata* are truly aquatic,

while those of *Cylindrotoma* Macquart, 1834 are terrestrial [12-14].

Cylindrotoma distinctissima (Meigen, 1818).

Limnobia distinctissima distinctissima Meigen, 1818. Synonyms and Combinations ≡ *Limnobia distinctissima distinctissima* Meigen, 1818 = *Cylindrotoma brevicornis* (Zetterstedt, 1838) = *Cylindrotoma tenebrarum* Krogerus, 1937 = *Tipula brevicornis* Zetterstedt, 1838.

Subfamily: Cylindrotominae. Genus: *Cylindrotoma* Macquart, 1834. Species: *Cylindrotoma distinctissima.* Subspecies: *Cylindrotoma distinctissima distinctissima* (Meigen, 1818). **Distribution:** Austria, Belarus, Belgium, Bulgaria, Croatia, Czech Rep., Denmark, Estonia, Finland, France, Germany, Great Britain, Hungary, Ireland, Italy, Lithuania, Luxembourg, Netherlands, Norway, Poland, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine; Russia: Turkey (Asiatic part: Manisa); Russia: WS (Siberia, Altay), (Siberia, Primorskiy kray, Sakhalin, Kuril Is); Kazakhstan; Mongolia [15-16].

Family Limoniidae

They all have their hind pair of wings reduced to pin-shaped structures called halteres which function as gyroscopes to maintain balance in flight. Most feed on liquids, including nectar and blood. Species of Limoniidae usually keep their wings closed while those of Tipulidae usually keep them open. Members of the genus *Chionea* Dalman, 1816. (snow flies) are wingless. They are lightly built flies with long legs and long antennae (Figure 4) [17-19].

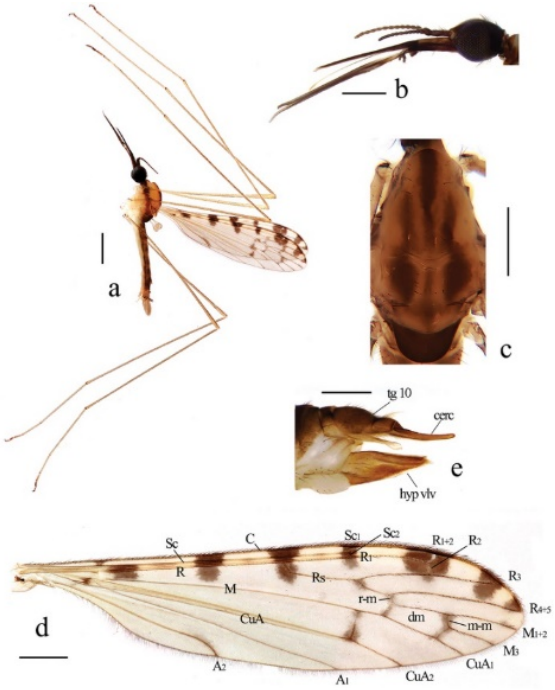

Figure 4 *Geranomyia jiulongensis* sp. nov. a Male habitus, lateral view b head, lateral view c thorax, dorsal view d wing e ovipositor, lateral view. Scale bars: 1.0 mm (a); 0.5 mm (b–d); 0.2 mm (e)

Source: https://zookeys.pensoft.net/article/49557/

Its larvae are aquatic or semi-aquatic, colonizing various environments, from deposits of plant material on the banks of streams, lakes, and swamps, bromeliad phytotelmata, to hygrometric surfaces. Some species live in pockets of gelatinous material produced by the larva itself. They tolerate salinity and pollution, some species live in marine intertidal zones. Larvae feed on algae and decaying material, and rare species are predators, such as many Limnophilinae. There are troglobite species. Pupae usually are found in marginal habitats (Figures 5A-5C) [20-21].

Figure 5A *Antocha* Osten Sacken, 1860 and **Figure 5B** Larva *Hexatoma,* Latreille, 1809. Limoniid crane flies. **Figure 5C** Pupae of the Limoniidae family

Source: https://www.macroinvertebrates.org/taxa-info/diptera-larva/limoniidae and https://www.diptera.info/forum/viewthread.php?thread_id=28256&pid=126079

Several species have evolved to feed on different food sources, so there may be phytophagous, saprophagous, mycetophagous, and predatory species [21-22].

Canada, USA (Alaska, south to Alta, Calif and Colo); Andorra, Austria, Belgium, Bosnia-Herzegovina, Bulgaria, Croatia,

Czech Rep., Denmark, Finland, France (incl. Corsica), Germany, Great Britain, Greece (see citations for islands), Hungary, Ireland, Italy (incl. Sardinia, Sicily), Lithuania, Luxembourg, Malta, Montenegro, Netherlands, North Macedonia, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain (incl. Balearic Is [Mallorca], Canary Is [La Palma]), Sweden, Switzerland, Turkey (European part: Istanbul, Kirklareli), Ukraine; Russia: (Kaliningradskaya oblast), North Caucasus (Krasnodarskiy kray); Morocco (Rif, High Atlas), Algeria, Tunisia; Georgia, Armenia, Azerbaijan, Turkey (Asiatic part), Cyprus, Israel; Russia: WS (Altay), (Kamchatka, Sakhalin, Kuril Is); Kazakhstan (east); North Korea, South Korea, Japan (Hokkaido, Honshu, Shikoku) [23-25].

Limoniidae is an exceptionally large family, with around 10,500 species described in 133 genera. These flies are found in humid places throughout the world and many species form dense clusters in suitable habitats.

Subfamilies: Architipulinae (Handlirsch, 1906) †, Chioneinae, Rondani, Dactylolabidinae Limnophilinae and Limoniinae.

Genus: *Adelphomyaria* Alexander, 1920, *Chionea*, and *Limonia* Meigen, 1803.

Genus: *Geranomyia* Haliday, 1833, *Elephantomyia* Sacken, 1860, and *Toxorhina* Loew, 1850 (Brazil).

Species: Five species of Antochini, belonging to three genera were known from the Korean peninsula. Three species of the genus *Antocha* Sacken, 1860: *Antocha (Antocha) bifida* Alexander, 1924 and *Antocha (Antocha) Integra* Alexander, 1940 were known from South Korea, and North Korea, *Antocha (Antocha) gracillima* Alexander, 1925 was known only from South Korea. *Elliptera jacoti* Alexander, 1925 and *Limnorimarga limoni*oides (Alexander, 1945) [26-28].

Family Limoniidae of Nicaragua.

Subfamily Limoniinae.

Erioptera (Mesocyphona) bivalves Alexander 1967.

Distribution: Nicaragua (Sandy Village: typus).

Erioptera (Mesocyphona) immaculate i Alexander 1913.

Distribution: Mexico, Guatemala, Nicaragua (Zelaya: Bluffields: typus), Guyana.

*Erioptera (Mesocyphona) pachyrh*ampha Alexander 1967.

Distribution: Nicaragua (Sandy Village: typus).

Erioptera sp. = *Polymeda* sp.

Distribution: Nicaragua (Zelaya)

Limonia (Geranomyia) sp.

Distribution: Nicaragua (Managua).

Lemon (Rhipidia) domestic Sacken 1859 = *Domestic rhipidia* Sacken 1859.

Distribution: USA, Cuba, Jamaica, Puerto Rico, Dominica, Nicaragua, Guyana, Venezuela, Brazil, and Bolivia.

Orimarga sp.

Distribution: Nicaragua (Zelaya).

Limonia phragmitidis (Schrank, 1781) [29-30]

Crane flies (Diptera, Tipuloidea) from the southern Neotropical.

Dicranomyia Stephens, 1829.

Geranomyia Haliday, 1833.

Gonomyia (Neolipophleps) Alexander, 1947.

Gonomyia (Paralipophleps) Alexander, 1947.

Molophilus Curtis, 1833.

Polymera Wiedemann, 1821.

Polymera obscura Macquart, 1838.

Distribution: Argentina, Bolivia, Brazil, Guyana, Mexico, Panama, and Peru.

Polymera inornata Alexander, 1913.

Geographical distribution: Guyana.

Rhipidia Meigen, 1818.

Rhipidia domestica amazonensis Osten Sacken, 1860.

Geographical distribution: East Brazil.

Symplecta (Symplecta) Meigen, 1830.

Symplecta (Symplecta) cana (Walker, 1848).

Geographic distribution. Canada, U.S.A., Guatemala, and Mexico.

Symplecta (Trimicra) pilipes (Fabricius, 1787) [29-30].

Family Pediciidae

Known for their long legs and sometimes confused with biting insects, crane flies, often called giant gnats or gnats, are

unfoundedly feared. They do not sting and they don't hurt us. This group of Diptera (flies) is called Tipuloidea and includes four families, but only 3 of these are already registered in Portugal. It is one of the most numerous groups of dipterans with more than 15630 species in the world. More than 370 species are known in the Iberian Peninsula, so it is suspected that there are still many species to be recorded in the fauna of Portugal that have gone unnoticed by scientists [31-32].

By identifying the DNA barcodes of insect species, it was already possible to add 27 species to the national fauna in 2020. Through the study of 412 specimens collected in various regions of Portugal, including the archipelagos of Madeira and the Azores, they added- 7 new species added to the national inventory [33-34]

Most of these species have a brownish color, but some species stand out for their vibrant yellow and black patterns. In the larval stage, many of these insects are found in aquatic habitats, while others occur in areas with high humidity, such as manta rays. Adults are characterized by setose eyes, their ommatidia being surrounded by abundant trichiae. Usually, they have short, 10–17 segmented antennae. All legs bear well-developed tibial spurs. The wings, sometimes reduced, are usually well-developed, spotted, or unicolored. Wing vein Sc1 is usually long, often reaching well beyond the distal branching of Rs. The vein Sc2 is usually situated before the base of Rs (Figure 6) [35-39].

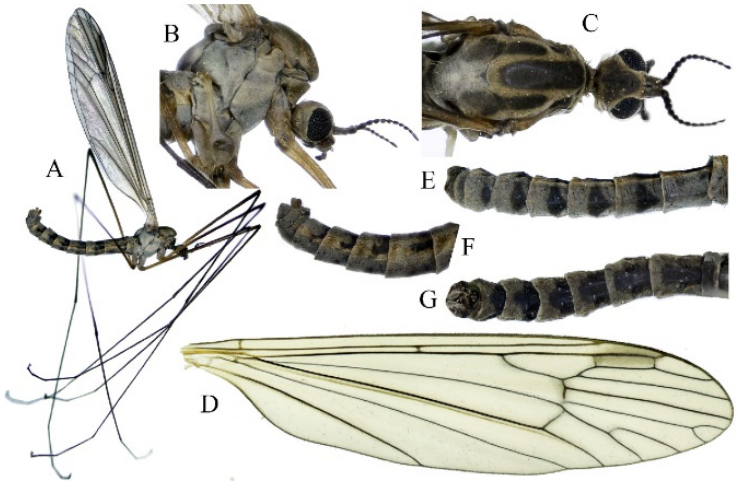

Figure 6 *Dicranota (Paradicranota) landrocki* Czizek, 1931: A – habitus lateral view; B – thorax and head lateral view; C – thorax and head dorsal view; D – right-wing, E–F – abdomen: E – ventral view; F – lateral view; G – dorsal view. Photos were taken from a specimen collected in Gârbău Valley, Cluj-Napoca, Romania, 15.04.2017

Source: Levente P, Kolcs ET, Lujza K. New faunistic records of Pediciidae (Diptera, Insecta) from Europe. journal Entomologica Romanica. 2018. https://api.semanticscholar.org/CorpusID:134596168

The larvae of the family Pediciidae are hemicephalic, metapneunistic with two or five spiracular lobes. Larvae of*genus Ula* Haliday, 1833, develop in fungi and are mycetophagous, while larvae of other genera are predators with huge mandible, developing in water or wet soil near it (Figure 7) [35-39].

Figure 7 Larva hairy-eyed crane flies Pediciidae

Source: https://www.macroinvertebrates.org/taxa-info/diptera-larva/pediciidae

Crane fly adults may resemble giant mosquitoes, which often causes fear and agitation in people when they are attracted to lights on warmer nights. Some species can cause damage, as when present in high numbers, their larvae feed on roots causing appreciable damage to agriculture (Figure 8) [35-39].

Figure 8 *Tricyphona schummeli* Edwards 1921

Source: Pictures © 2003, 2011 J.K. Lindsey and https://www.commanster.eu/Commanster/Insects/Flies/SpFlies/Tricyphona.schummeli.html

It is registered in North America, followed by the Eastern Palearctic and Oriental Regions. Distinctly fewer species are known from the Western Palearctic. The family is poorly represented in the Neotropics and in the Australasian/Oceanian Region. These crane flies are missing from the Afrotropic [35-39].

The family Pediciidae is composed of two subfamilies, the exceedingly small Ulinae and the large Pediciinae, where most species are included. The subfamily Ulinae has wings covered with abundant macrotrichiae, while in the Pediciinae, the wing cells have no macrotrichiae [35-39].

Pediciidae of Korea.

Genus: *Dicranota* Zetterstedt, 1838, *Heterangaeus* Alexander, 1925, *Nasiternella*, Wahlgren, 1904, *Pedicia* Latreille, 1809

and *Tricyphona* Zetterstedt, 1837.

Some records of Limoniidae and Pediciidae (Diptera) from Portugal and Spain.

Dicranota (Paradicranota) pallens Lackschewitz, 1940.

Distribution: Albania, Austria, Bulgaria, Czech Republic, Germany, Italy, Poland, Romania, Slovakia, Spain and Switzerland; North Caucasus.

Tricyphona (Tricyphona) immaculata (Meigen, 1804).

Distribution: Europe (unrecorded from Portugal); Transcaucasia, Türkiye, Lebanon; West Siberia; Central Asia. First records for Portugal.

The Craneflies of continental Portugal (Diptera, Limoniidae, Pediciidae, Tipulidae) including 28 species new for Portugal.

Pediciidae, Subfamily Pediciinae.

Dicranota (Ludicia) iranensis (Alexander, 1975).

Distribution: Disjunct, in the west, known from Portugal, Spain, and Sicily, in the east of the North Caucasus, Georgia, Armenia, Azerbaijan, eastern Türkiye (Rize), and Iran.

Pedicia (Amalopis) occulta (Meigen, 1830).

Distribution: Widespread in the Westpalaearctic, including Andorra, Spain, and Portugal.

*Tricyphona (Tricyphona) imm*aculata (Meigen, 1804).

Distribution: Widespread in Palaearctic, including Andorra, Spain, and Portugal [40-41].

Family Trichoceridae

Family Trichoceridae, or winter cherry flies, are of the order Diptera with long, thin, and delicate insects, superficially similar in appearance to the Tipulidae, Tanyderidae, and Ptychopteridae. The presence of ocelli distinguishes Trichoceridae from other families (Figure 9) [42-33].

Figure 9 Winter crane fly - *Trichocera* sp. and Winter crane fly – *Trichocera* sp.

Sources: Groton MA, https://pbase.com/tmurray74/image/105960622 and https://bugguide.net/node/view/11225

Large lateral eyes, equipped with two or three ocelli (absent in Tipuloidea) and antennae made up of sixteen poorly differentiated segments, except the basal ones. The thorax has a complete transverse suture as in Tipuloidea but in a U-shape. The legs are long and slender, with development in the length of the femurs and tibias. Membranous wings, long and narrow but wide compared to the rest of the body, lie horizontally on the abdomen and overlap. Long dumbbells. The abdomen is thin and cylindrical, in the male it has two processes equal to the caudal end, in the female it is fusiform due to the conformation of the last urites organized in such a way as to constitute a replacement ovipositor, curved downwards (Figure 10) [44-45].

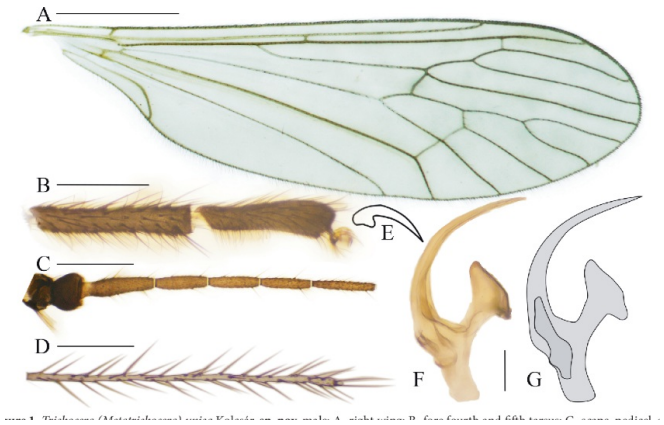

Figure 10 *Trichocera (Metatrichocera) unica* Kolcsár, sp. nov. male genitalia. Dorsal view: A- photograph; B- schematic illustration, ventral view; C- photograph; D- schematic illustration. Lateral view: E- photograph; F- schematic illustration; G- close view of apical part of gonostylus

Sources: DOI:10.3906/ZOO-1709-24 and Corpus ID: 89797484

The larvae of the Trichoceridae are terrestrial and colonize humid soils and, more generally, humid and rotting organic substrates: Trichoceridae larvae are found in plant residues, in animal excrements, on fungal mycelia, on poorly preserved foodstuffs, in nests of birds and the burrows of rodents, etc. Occasionally they can also behave as phytophagous, but, they are scavenger insects with a tendency to develop on substrates of vegetal origin. In the islands of southern New Zealand, Trichoceridae larvae have also been found in penguin guano (Figure 11).

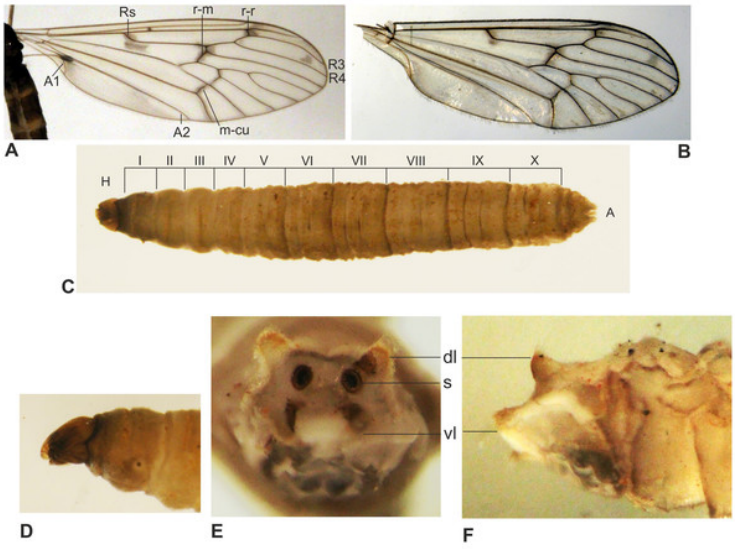

Figure 11 Identification of *Trichocera maculipennis* Meigen, 1818 a). (A) wing of the specimen from the Polish Antarctic Arctowski Station, Admiralty Bay; (B) for a comparison, a wing of the specimen from terra typica (Austria, cave; the middle part seems misshaped because the wing is dry). Larva: arrangement of segments (C); a characteristic, elongated, and strongly sclerotized head capsule; anterior spiracle (D); scheme of anal end with four anal lobes surrounding two large spiracles, in posterior (E) and lateral (F) view. Abbreviations: dl, dorsal lobe; s, spiracle; vl, ventral lobe

Sources: Photo: E Krzemińsk and https://peerj.com/articles/5408/

The adults have habits like those of the Tipulomorpha in general: they are found mainly in humid and cool environments. There are frequent reports of adults of Trichoceridae in dark environments, such as caves, cellars, and tree hollows. In many species, males tend to gather in swarms, at different periods according to latitude: in warmer regions, flights occur in autumn or spring and sometimes also in winter, while in colder regions they occur in summer. The prerogative of finding active adults even in the middle of winter explains the common names attributed by the Anglo-Saxons to this family, winter crane flies or winter gnats. In the warmer months, in the less cold regions, these insects go into aestivation, at the adult or larval stage (Figure 12). [45-49].

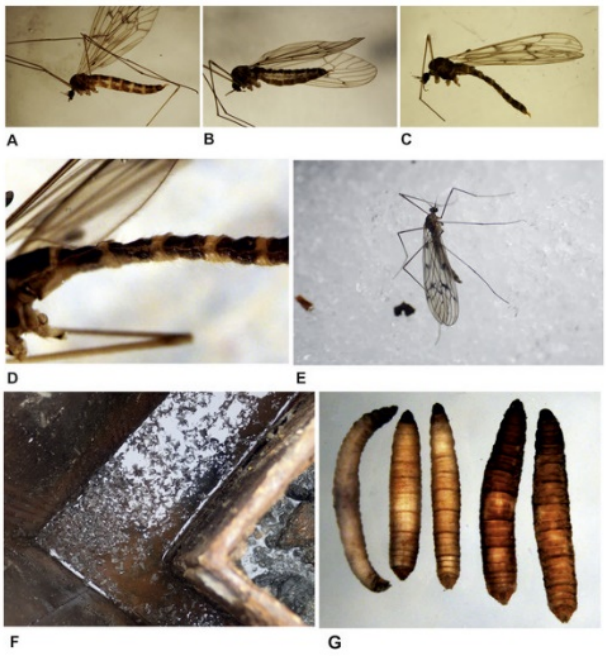

Figure 12 *Trichocera maculipennis* Meigen, 1818 from the Polish Antarctic Arctowski Station, Admiralty Bay. Various stages of female maturity: a young female with eggs not fully developed yet (A); a mature female filled with ripe eggs (B); and an old female devoid of eggs (C). (D) striped abdomen, posterior margins of segments are lighter. (E) a female on snow, in the vicinity of the sewage. (F) swarming on the substrate surface. (G) larvae: on the left, a possibly third instar, remaining larvae are fourth instars in various sizes; note the dark brown color gradually developing together with age (size) from left to right. from the Polish Antarctic Arctowski Station, Admiralty Bay)

Sources: Photo: E Krzemińska (A–D, G) and E Przepiórka (E–F), Photo: E Krzemińska (A–D, G), E Przepiórka (E–F) and https://peerj.com/articles/5408/

The family has a wide distribution in the temperate regions of both hemispheres but with a predominant concentration in the Holarctic region. There are numerous endemics. Its distribution also extends to the eastern region but is limited to regions bordering the Palearctic (northern India and Himalayan regions) in southern Mexico, in the region of Michoacán, and described by Trichoceridae in tropical regions. The Falkland Islands and South Georgia, Australia, and New Zealand have a large Palearctic-Nearctic distribution [50].

The Trichoceridae is another family of Diptera. The Trichoceridae is included in the order Diptera, class Insecta, principal Arthropoda, and kingdom Animalia. The Trichoceridae family includes 161 species, according to the Catalog of Life.

Genus: *Diazosma* Bergroth, 1913, *Nothotrichocera,* Alexander, 1926, *Paracladura* Brunetti, 1911 and *Trichocera* Meigen 1803.

In Europe, there are around fifty species, of which six are reported to be present in Italy. The Italian species all belong to the *Trichocera* genus:

Trichocera annulata Meigen, 1818, *Trichocera forcipula* Nielsen, 1920, *Trichocera hiemalis* Meigen, 1804, *Trichocera*

implicata Dahl, 1976, *Trichocera japonica* Matsumura, 1915, *Trichocera maculipennis* Meigen, 1818, *Trichocera major* Edwards, 1921, *Trichocera parva* Meigen, 1804, *Trichocera regelationis* (Linnaeus, 1758) and *Trichocera dancera* (Harris, 1776) [51-53].

Trichocera hiemalis **(winter plume mosquito).**

Winter mosquitoes.

Characteristics: Small mosquitoes, 6-7 mm, resembling small crane flies.**Mouthparts reduced**. **Prevent:** In the Netherlands and Belgium with about ten species. **Way of life**: Although they swarm during most of the year, it is especially noticeable on warm winter days, which is how they got their name. **Larvae** are soil-dwelling under decaying organic matter [54-55].

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