

(REVIEW ARTICLE)



Description of the Clusiidae family

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Abstract

Rearing records suggest that most temperate species can be found in a number of different deciduous trees, but some Clusiidae have also been found in conifers, and larvae of *Sobarocephala* have been found in termite colonies, as well as decaying wood, found the larvae evidently associated with the burrows of coleopterous insects and to be relatively sluggish and slow moving. Clusiidae larvae are probably at least facultatively predaceous on larvae of other wood-boring insects. The objective of the manuscript was to describe the territorial behavior of the males and also the biological Clusiidae. This work consists of bibliographical research of scientific articles published in national and international academic scientific journals classified by the Coordination for the Improvement of Higher Education Personnel (CAPES). Document analysis was used as a data collection method to gather information on theoretical books, theses banks, university dissertations, documents and digital platforms websites such as HAL, SSRN and ResearchGate.

Keywords: Males; Territory; Larvae; Phylogeny; Decomposers

1. Introduction

Among the families of Diptera Schizophora, Clusiidae is part of the Acalyptratae, having been included in the Opomyzoidea. It is the most generalized family of this superfamily, especially with respect to the shape and arrangement of the bristles on the head, the structure of the antenna, wing spotting and venation, and some features of the terminalia males and females in general, their is wide acceptance of the family's monophyly (Figures 1-2) [1,2,3].



Sources: Photo by D.K.B. Cheung and <https://cjai.biologicalsurvey.ca/articles/lcm-14/>

Figure 1 *Clusia lateralis* (Walker, 1849)

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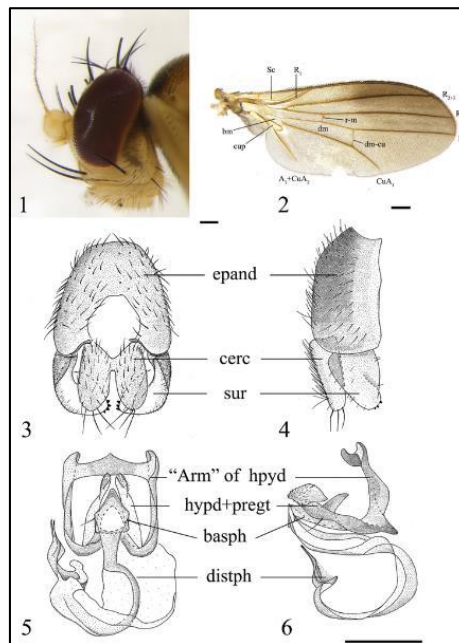


Source: <https://cjai.biologicalsurvey.ca/articles/lcm-14/>

Figure 2 *Sobarocephala lachnosternum* Melander and Argo, 1924

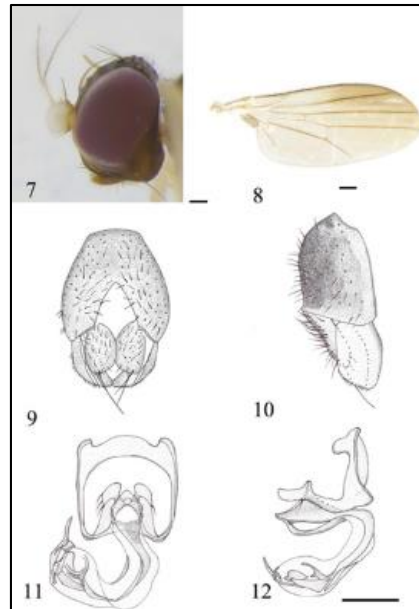
1.1. Description

The combinations of diagnostic characters that identify the family are an angled extension on the outer margin of the pedicel; dorsoapical arista (dorsobasal in similar families); a pair of vibrissae; post-ocellar bristles originating in the same local (more clearly separated in some representatives, absent in others); setous prosternum; complete subcosta; a subcostal break; from two to five fronto-orbital bristles, the anterior bristle sometimes inclined and, if there are four or five fronto-orbital bristles, the third is usually inclined and proclaimed; convergent inter-frontal bristles sometimes present; ocellar and post-vertical bristles divergent, usually small or absent (Figures 3-5) [4,5,6].



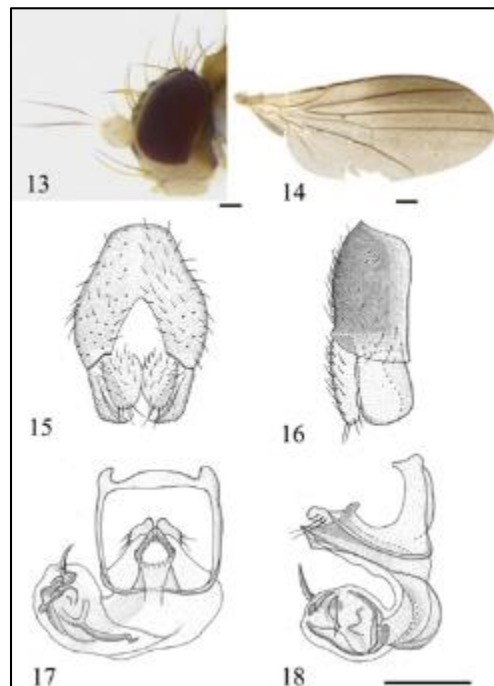
Source: <https://zookeys.pensoft.net/article/63696/>

Figure 3 *Czernyola luteigenis* sp. nov. (male) (1) head, lateral view (2) wing (3) epandrium, cerci, and surstyli, posterior view (4) epandrium, cerci, and surstyli, lateral view (5) hypandrial complex, posterior view (6) hypandrial complex, lateral view. Abbreviations: epand – epandrium; cerc – cerci; sur – surstylus; hypd – hypandrium; pregt – pregonite; basph – basiphallus; distph – distiphallus



Source: <https://zookeys.pensoft.net/article/63696/>

Figure 4 *Czernyola planipalpis* sp. nov. (male) (7) head, lateral view (8) wing (9) epandrium, cerci, and surstyli, posterior view (10) epandrium, cerci, and surstyli, lateral view (11) hypandrial complex, posterior view (12) hypandrial complex, lateral view



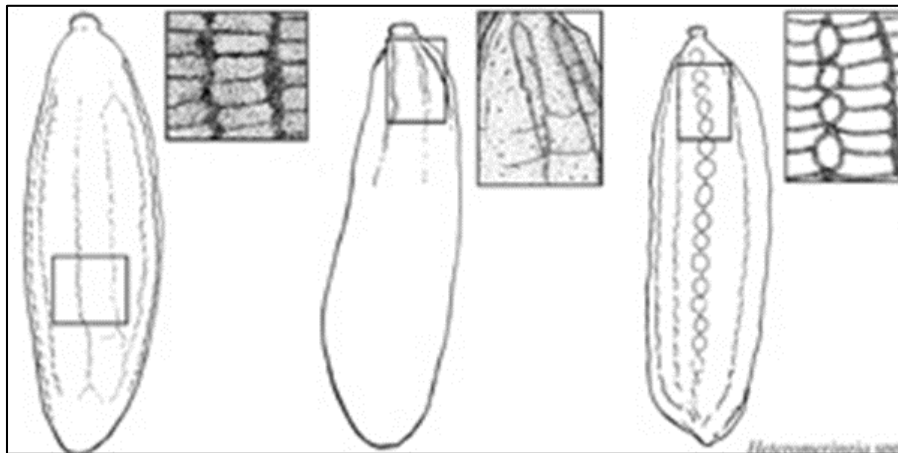
Source: <https://zookeys.pensoft.net/article/63696/>

Figure 5 *Czernyola shanxiensis* sp. nov. (male) 13 head, lateral view 14 wing 15 epandrium, cerci, and surstyli, posterior view 16 epandrium, cerci, and surstyli, lateral view 17 hypandrial complex, posterior view 18 hypandrial complex, lateral view

1.2. Bioecology

Clusiidae are usually found in damp, shady places, in woods, burrows and galleries built by other insects, under tree bark, among rotten fibers, in disintegrated tree trunks, but mainly near fallen trees. Most species are phytophagous, and

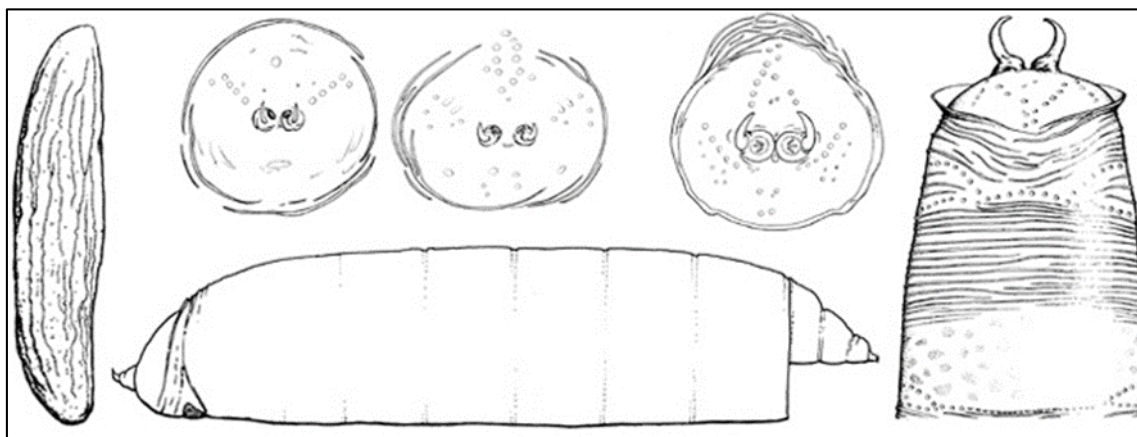
some feed on the nectar, sap, or feces of some birds. Selection of Clusiidae oviposition sites does not appear to be associated with any particular species of tree but is limited by "humidity, amount of shade, stage of wood decay, [and the] presence of mycelia of certain fungi" (Figure 6) [7,8,9].



Source: Source: <https://cjai.biologicalsurvey.ca/articles/lcm-14/>

Figure 6 *Heteromeriinae* spp. Eggs are translucent, usually three to four times longer than wide, and approximately as long as sternite 6 of the female (Lonsdale & Marshall, in press). Both ends are tapered (most pronounced anteriorly) and the micropyle is small and terminal. The surface of the egg is usually minutely tuberculate with (usually) no more than a dozen longitudinal wrinkles, but there are numerous departures from this generalized state

Rearing records suggest that most temperate species can be found in a number of different deciduous trees, but some Clusiidae have also been found in conifers, and larvae of *Sobarocephala* have been found in termite colonies, as well as decaying wood, found the larvae evidently associated with the burrows of coleopterous insects and to be relatively sluggish and slow moving. Clusiidae larvae are probably at least facultatively predaceous on larvae of other wood-boring insects (Figures 7-8) [7,8,9].



Source: <https://cjai.biologicalsurvey.ca/articles/lcm-14/>

Figure 7 Immature stages clockwise from left: egg, *Clusiodes pictipes* (Zetterstedt, 1855); puparium (posterior face), *Clusiodes johnsoni* Malloch, 1922; puparium (posterior face), *Clusiodes melanostomus* (Loew, 1964); puparium (posterior face), *Clusia occidentalis* Malloch, 1916; puparium (dorsal - posterior third), *C. occidentalis* and *C. johnsoni*

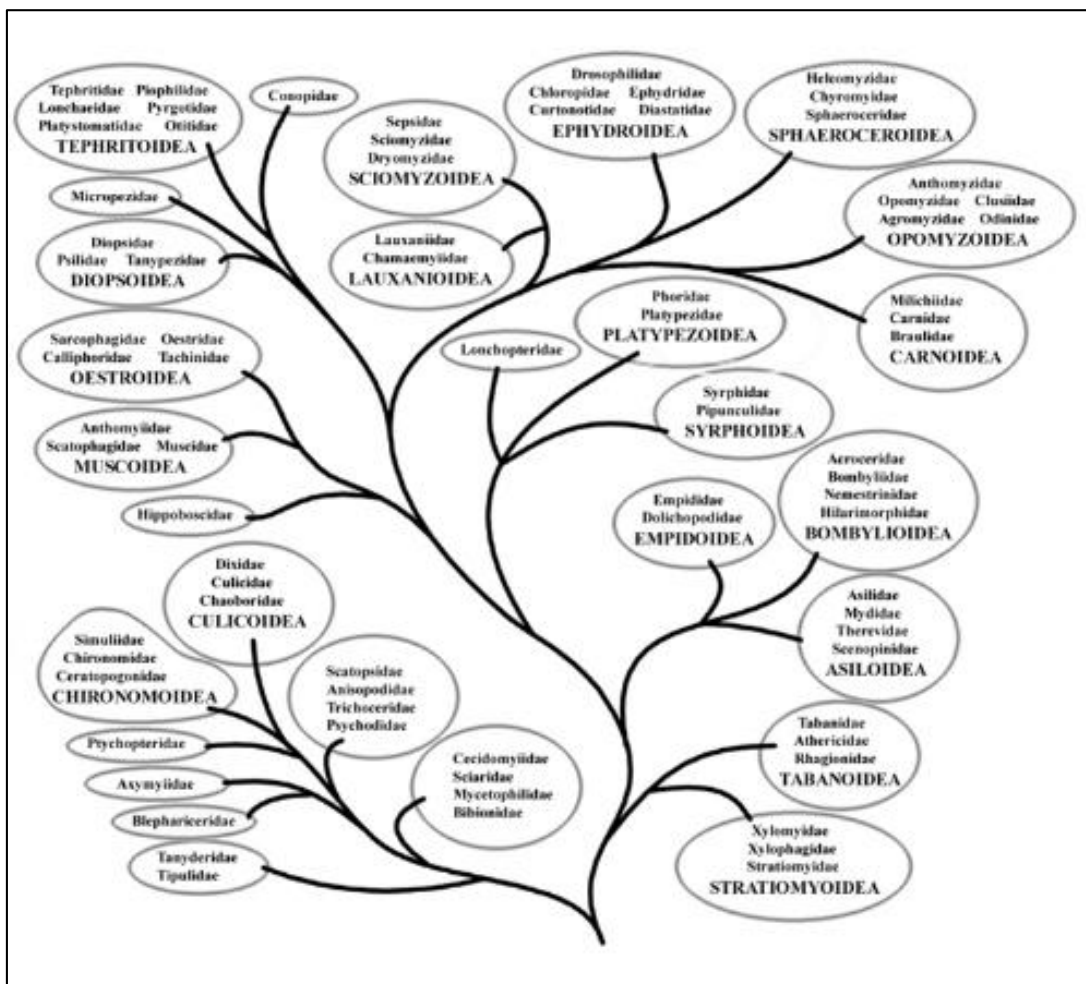
Species have been swept from grass or collected from foliage, logs and dead patches on tree trunks. North American adults appear to prefer mixed and deciduous forests sometimes associated with grass-dominated areas. Tropical species have often been collected along waterways in mossy, humid habitats. Species of *Heteromeriinae* seem to prefer more open forests and have been found in treefalls. Clusiidae have been known to feed on nectar, rotting vegetative matter, sap, and the dung of birds and mammals.



Source: <https://cjai.biologicalsurvey.ca/articles/lcm-14/>

Figure 8 Males establish dominance at a lek site, defending mating territories from other males. True lek king behavior has only been seen in the subfamily Clusiinae so far suggests that similar male agonistic behavior is more widespread in the family

1.3. Taxonomy



Source: <https://www.cedarcreek.umn.edu/insects/albumframes/dipteraframe.html>

Figure 9 Phylogenetic tree of Diptera or taxonomic tree of Diptera families: The monophyly of Diptera is generally accepted and exceedingly well supported, but there is still no consensus as to the resolution of this major insect group in higher-level monophyletic units. Indeed, there are several very species-rich dipterous taxa which represent well-corroborated monophyla: Brachycera, Muscomorpha and Schizophora. The phylogenetic relationships of these groups are presented here by considering the Diptera tree on a base-to-top approach

Clusiidae is composed of 22 genera and approximately 442 species, with distribution in all parts of the world, except in the African continent; in the Neotropical region, there are 10 described genera, with 363 species [9].

The family classification was revised, redefining the subfamilies, based mainly on male and female terminalia characters. Three subfamilies are now recognized within Clusiidae: Clusiinae, Clusiodinae and Sobarocephalinae all of which have representatives in the Neotropics [10].

The phylogenetic relationships between these two suborders are still controversial, although Nematocera is suspected to be paraphyletic. The suborder Brachycera consists of the infraorder Muscomorpha which encompasses species with larval forms commonly referred to as maggots. These larval forms are dominantly saprophagous and are morphologically soft-bodied with mouthparts modified into sclerotized hooks for feeding into host substrates. In almost all cyclorhaphan flies, pupation is internal, occurring within the puparium during the final larval instar stage [10,11,12].

1.4. Objective

The objective of the manuscript was to describe the territorial behavior of the males and also the biological and taxonomic behavior of the males of the Family Clusiidae.

2. Methods

This work consists of bibliographical research of scientific articles published in national and international academic scientific journals classified by the Coordination for the Improvement of Higher Education Personnel (CAPES). Document analysis was used as a data collection method to gather information on theoretical books, these banks, university dissertations, documents and digital platforms websites such as HAL, SSRN and ResearchGate.

3. Selected Manuscripts

3.1. Study 1

Clusiidae is a family of acalyptrate flies with worldwide distribution, they are small (between 3 and 6 mm), thin, yellow, or dark brown, and the wing is partially infuscated or hyaline. The second segment of the antennae has a triangular projection over the third segment when viewed from the outside, and the wing is usually partially infuscated. They have a cylindrical body, and round head, the vertical plate reaches the anterior margin of the fronds and the vibrissae on the head are large.

Adults of this family are rarely collected in grasslands, they are regularly collected in malaise and some are common on certain substrates and in certain microhabitats. Neotropical Clusiidae frequently occurs in mossy, moist habitats, and many species are attracted to mammalian dung deposits. Elsewhere, suspects are known to feed on nectar, rotting vegetation, and sap (Figure 10).



Source: <https://elter-ri.eu/news/malaise-trap-long-term-monitoring-flying-insects-was-installed-ramat-hanadiv-lter-site>

Figure 10 Malaise trap

Thus, a study of the fauna of Diptera was executed with emphasis on the suborder Brachycera in a forest fragment of the Batalhão de Infancia de Selva. The collections were done using two Malaise traps and two hanging fly traps in September and October 2017, and February and March 2018, one week in each month. After collection, all the material was identified to the family taxonomic level and then families were analyzed in abundance, the number of individuals.

During dry and wet seasons were captured 1379 dipterans of the suborder Brachycera of the following 28 families: Agromyzidae (1), Calliphoridae (2), Chloropidae (14), Clusiidae (5), Drosophilidae (138), Dolichopodidae (203), Ephydriidae (25), Hybotidae (10), Lauxaniidae (32), Lonchaeidae (5), Micropezidae (27), Milichiidae (39), Muscidae

(20), Neriidae (3), Perisclididae (10), Phoridae (463), Richardiidae (9), Ropalomeridae (4), Sarcophagidae (45), Sepsidae (8), Syrphidae (11), Sphaeroceridae (175), Stratiomyidae (64), Tabanidae (12), Tachinidae (25), Tephritidae (4), Ulidiidae (26), Xylomyidae (3). A new record of *Xanthacrona tuberosa* Cresson, 1908 of Ulidiidae was found in Brazil, and also a new record of the specimens of Xylomyidae in the Amazonas State [13].

3.2. Study 2

In order to increase the dipterological knowledge of Portugal, the results obtained after the identification of new material from that country are presented here. The material, which consists of only 70 specimens, belongs to three families (Clusiidae, Lauxaniidae and Psilidae), the second being the most abundant family.

The specimens were captured by the second author (RA), randomly, by means of mango (except a specimen caught with a yellow plate) in different districts Portuguese 21 species have been identified (MC-T det.) and numerous new records have been obtained for the Portuguese fauna, namely: a) 1 family (Clusiidae), 4 genera (*Clusiodes* Coquillet, 1904; *Peplomyza* Haliday, 1837; *Sapromyza* Fallén, 1810; and *Trigonometopus* Hendel, 1925 and 12 species are recorded for the first time from Portugal, and b) 1 species *Chamaepsila longipennis* (Seguy, 1936) is recorded for the first time from mainland Portugal. Likewise, the geographical distribution of some species in Portugal is considerably increased (Figures 11-15) [14].



Source: <https://en.wikipedia.org/wiki/Clusiodes>

Figure 11 Genus *Clusiodes* Coquillet, 1904



Source: <https://ukrbn.com/index.php?category=53537>

Figure 12 Genus *Peplomyza* Haliday, 1837



Source: https://uk.inaturalist.org/taxa/322713-Sapromyza/browse_photos

Figure 13 *Sapromyza* Fallén, 1810



Source: <https://www.inaturalist.org/taxa/625461-Trigonometopus>

Figure 14 Genus *Trigonometopus* Hendel, 1925



Source: <https://micropezids.myspecies.info/taxonomy/term/102>

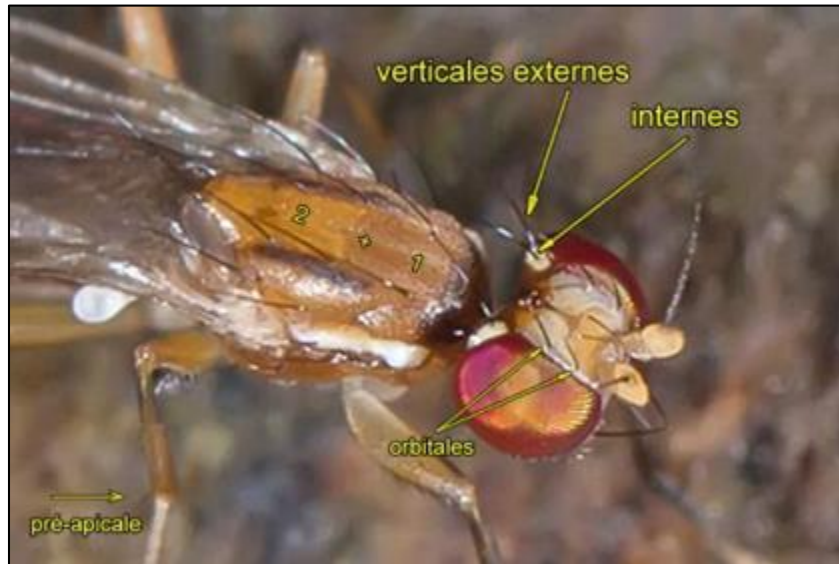
Figure 15 *Chamaepsila longipennis* (Seguy, 1936)

3.2.1. Clusiidae: A new genus and species for Portugal.

A new specie for Portugal.

Clusiodes verticalis (Collin, 1912).

Porto: Avintes (Vila Nova de Gaia). A new genus and species for Portugal (Figure 16).



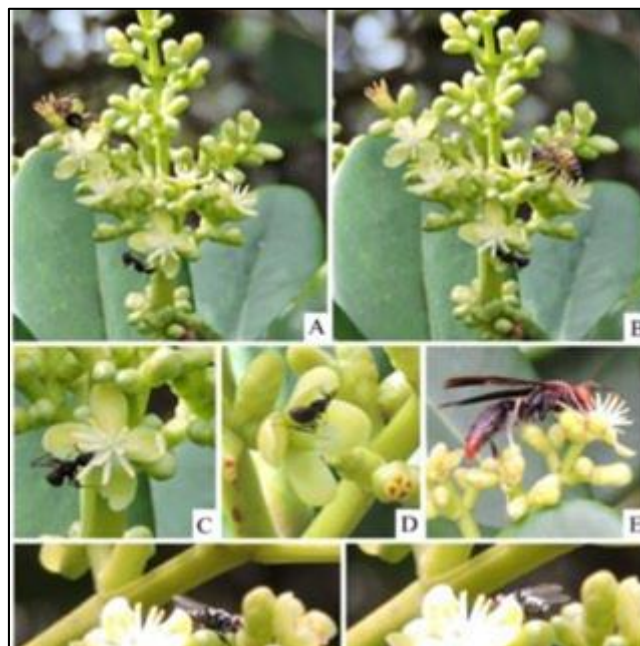
Sources: Jessica Joachim and <https://www.galerie-insecte.org/galerie/ref-240792.htm>

Figure 16 *Clusiodes verticalis* (Collin, 1912)

3.3. Study 3

The Clusiidae are small, uncommon, smoky-winged, or caf-marked mosquitoes. The body is yellowish or black. The larvae are found in decomposing wood and are capable of jumping.

Chaetoclusia bakeri Coquillett, 1904.



Source: https://www.researchgate.net/figure/29-Female-internal-genitalia-27-Chaetoclusia-bakeri-Coquillett-1904-28-C-furva_fig5_274476353

Figure 17 *Chaetoclusia bakeri* Coquillett, 1904

Distribution: Nicaragua (Chinandega: Typus; Grenada: Typus), Costa Rica.

Sobarocephala sp.



Source: <https://en.wikipedia.org/wiki/Sobarocephala>

Figure 18 *Sobarocephala* sp.

Distribution: Nicaragua (New Segovia, Carazo).

Collected on: Rutaceae: *Citrus*.

Clusia flava (Meigen, 1830)

Is a tv-vinegar described by Johann Wilhelm Meigen in 1830. *Clusia flava* is included in the genus *Clusia* and the family Clusiidae. The species is breeding in Sweden. No subspecies is listed in the catalog of life (Figure 19) [15,16].



Source: <https://www.earth.com/plant-encyclopedia/angiosperms/clusiaceae/clusia-palmicida/nl/>

Figure 19 *Clusia flava* (Meigen, 1830)

3.4. Study 4

Clusiidae: Two specimens behaved as if they were facing each other for some reason attraction to the female, fight over territory, and chemical communication for the food encounter. The encounter lasted a few seconds and one of the two flew away. *Clusiodes* sp: From what we have seen, in Diptera info and on other sites. I also think it is a case of territorial rivalry, frequent in this family (Clusiidae) and not a meeting/courtship between male and female. It is a case of territorial rivalry, frequent in this family (Clusiidae) and not a meeting/courtship between male and female (Figure 20) [17].

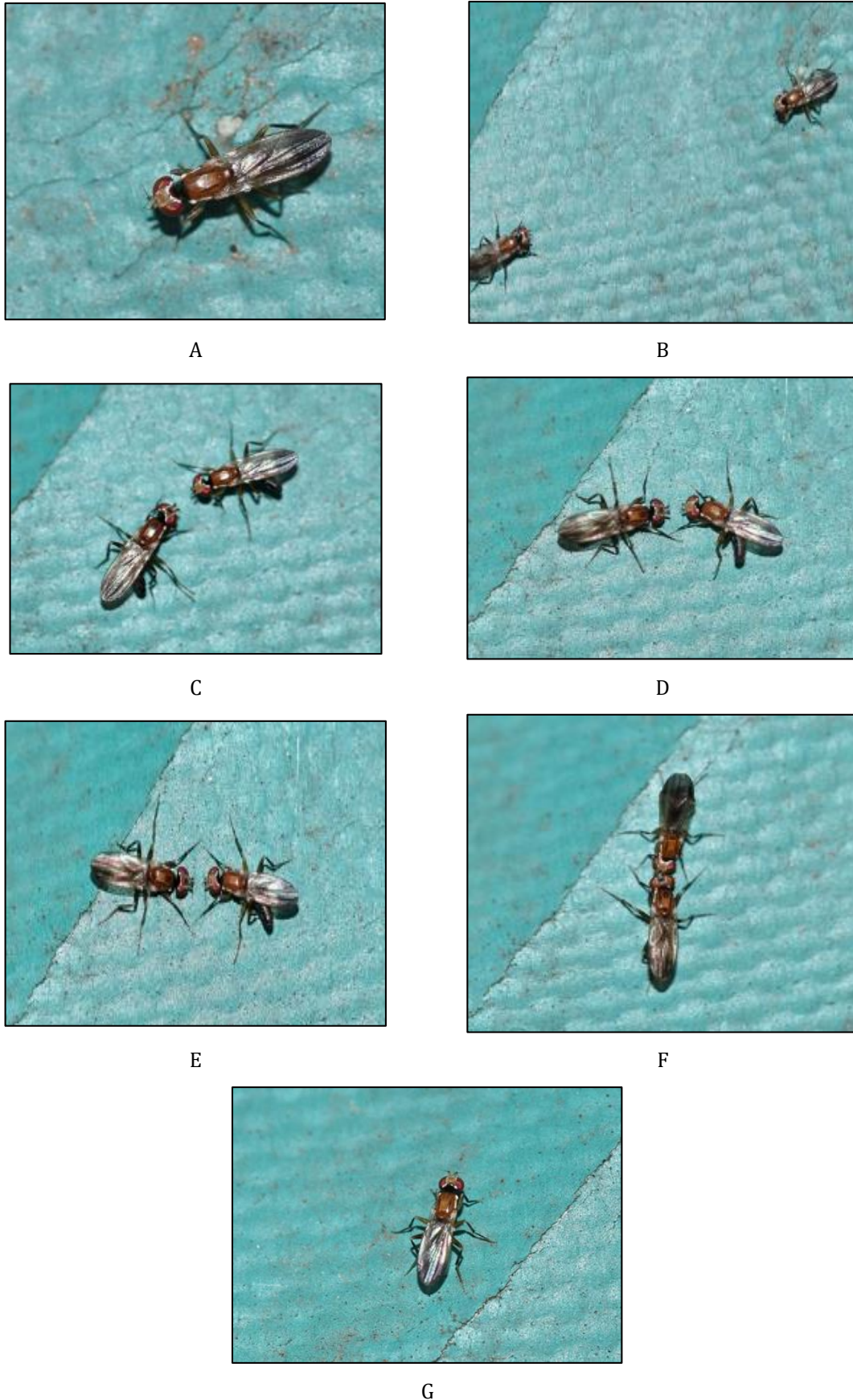


Figure 20 Sequence of photos of specimens of the Family Clusiidae, Genus *Clusiodes* in Italica: A- G. Clusiidae are among the few acalyprates that form leks. Males establish dominance at a lek site, defending mating territories (devoid of resources) from other males

4. Conclusion

Males establish dominance at a lek site, defending mating territories from other males. True lek king behavior has only been seen in the subfamily Clusiinae so far suggesting that similar male agonistic behavior is more widespread in the family. The monophyly of Diptera is generally accepted and exceedingly well supported, but there is still no consensus as to the resolution of this major insect group in higher-level monophyletic units. Indeed, there are several very species-rich dipterous taxa that represent well-corroborated monophyla: Brachycera, Muscomorpha and Schizophora.

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