

Biology, ecology and biogeography of Athericidae family (Hymenoptera: Athericidae)

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Abstract

Athericidae is a small family of flies with aquatic larvae, only 123 species are known, with two species registered in Brazil, *Suragina pacaraima* Rafael & Henriques, 1991 and *Xeritha plaumanni* Stuckenberg, 1966. They are flies very close to horseflies, including some hematophagous adults, such as *Suragina*. They are called in English "water snipe flies" or "ibis flies". The study aims to carry out the Biology, Ecology and Biogeography of Athericidae Family. In this study, quantitative and conceptual aspects were used. A selection of articles published from 1912 to 2021. Only complete articles published in scientific journals and expanded abstracts presented at national and international scientific events, Doctoral Thesis and Master's Dissertation were considered. Data were also obtained from platforms such as: Academia.edu, Frontiers, Qeios, Pubmed, Biological Abstract, Publons, Dialnet, World, Wide Science, Springer, RefSeek, Microsoft Academic, Science and ERIC.

Keywords: Dipteran; *Suragina pacaraima*; *Xeritha plaumanni*; Hematophagous adults; Larvae

1 Introduction

Athericidae is a small family of flies with aquatic larvae, only 123 species are known, with two species registered in Brazil, *Suragina pacaraima* Rafael & Henriques, 1991 and *Xeritha plaumanni* Stuckenberg, 1966. They are flies very close to horseflies, including some hematophagous adults, such as *Suragina*. They are called in English "water snipe flies" or "ibis flies" (Figures 1, 2 and 3) [1,2].



Figure 1 *Suragina*, aquatic larva photographed in Wimberley, Texas, USA. This genus is also found in Brazil; (Source: Photo by Robby Deans)

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Figure 2 *Suragina pacaraima* Rafael & Henriques, 1991; (Source: <https://www.insetologia.com.br/2019/09/possivel-mosca-atericidea-em-sao-paulo.html>)

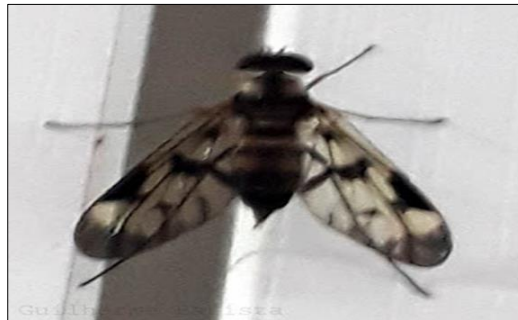


Figure 3 *Xeritha plaumanni* Stuckenberg, 1966; (Source: <https://www.insetologia.com.br/2019/09/possivel-mosca-atericidea-em-sao-paulo.html>)

1.1 Description

Adults are morphologically similar to Rhagionidae, have medium or small body, 5-10 mm in length, but without long bristles. The livery has colors ranging from black to yellowish. The head is dichotic in women and generally holotic in men. The antennae are upright, have a globular scape and pedicel, and a third kidney-shaped segment, bearing a stylet in a subapical position (Figures 4 and 5) [1,2,3].

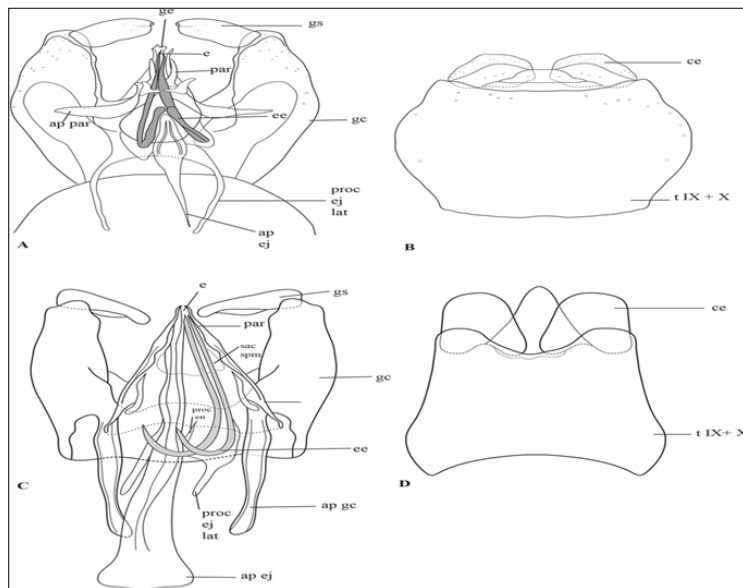


Figure 4 Male terminals. A, b: *Atherix variegata* Walker, 1848 (Athericidae). A: Hypogygium, b: Epandrium. c, d: *Scaptia* sp. (Tabanidae). c: Hypogygium, d: Epandrium. Abbreviations: ap and j = ejaculatory apodema; ap gc = gonocoxal apodemy; ap par = parameral apodemy; ce = siege; e = oedeagus; ee = endophalic extensions; ge = edeagal guide (=

ventral plate); gc = gonocoxyte; gs = gonostyle; par = paramer; proc ej lat = lateral ejaculatory process; proc en = endoedeagal process; sac spm = spermatic sac; t = tergite; (Source: https://www.researchgate.net/figure/FIGurA-2-Terminalia-masculina-A-b-Atherix-variegata-Athericidae-A-Hipogigio-b_fig1_262543391)

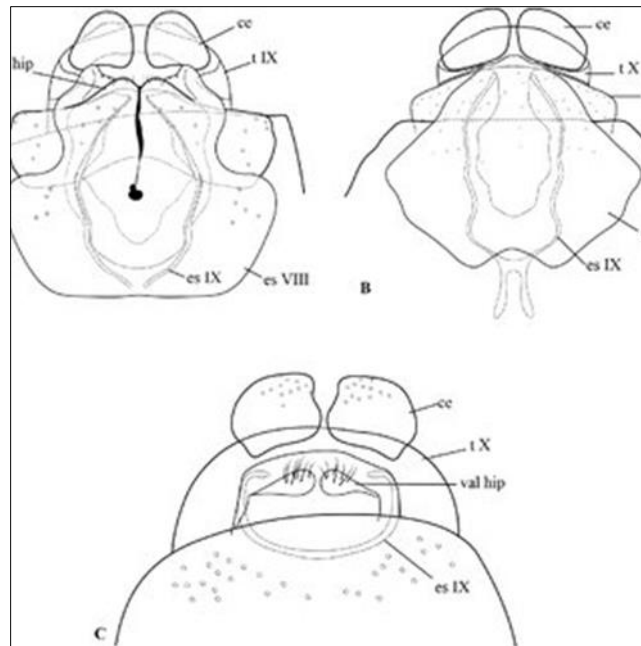


Figure 5 Female terminalia. A: *Suragin* sp. (Athericidae), ventral view. b: *Dasyomma* sp. (Athericidae), ventral view. c: *Scaptia* sp. (Tabanidae), ventral view. Abbreviations: ce = siege; es = sternite; hip val = hypoginial valve; t = tergite; (Source: https://www.researchgate.net/figure/FIGurA-8-Terminalia-feminina-A-Suragina-sp-Athericidae-vista-ventral-b-Dasyomma_fig7_262543391)

The legs are yellowish and have two spurs at the apex, middle and posterior tibiae; the tarsus is provided with arolium and pulvili. Wings are broad and well developed and often pigmented with darker bands; in the resting position, they are folded horizontally along the sides of the abdomen. The abdomen is yellowish in color, with pigmented transverse bands, darker in women (Figure 6) [1,2,3,4].

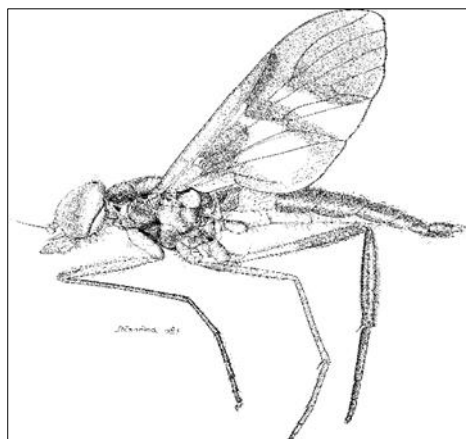


Figure 6 A new genus and species of Athericidae (Diptera: Tabanoidea) from Cape York Peninsula; (Source: [https://www.semanticscholar.org/paper/A-new-genus-and-species-of-Athericidae-\(Diptera%3A-Stuckenberg/3b51549529e13f605f21cbb81c6cf5e898d88194\)](https://www.semanticscholar.org/paper/A-new-genus-and-species-of-Athericidae-(Diptera%3A-Stuckenberg/3b51549529e13f605f21cbb81c6cf5e898d88194)))

The rib of the wing shows the developed coast along the entire margin. The radius is divided into 4 branches due to the absence of the R 2 + 3 bifurcation. The R 2 + 3 branch is relatively short and undergoes a curvature converging on the costal margin almost coinciding with the termination of the anterior branch (R 1). The R 4 and R 5 branches, on the other hand, end respectively before and after the wing apex. The media is divided into four branches, with the terminal

tracts of M 1, M 2 and M 3 originating at the distal end of the disc cell, and the fourth branch (M 4) at the bottom. The disc cell is well developed and long, the cup cell closed almost near the end of the wing, with a very short common segment A1 + CuA (Figure 7) [1,2,3,4,5].

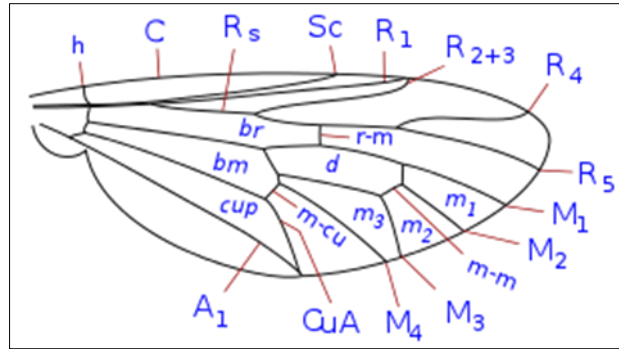


Figure 7 Wing rib diagram. Longitudinal ribs: C: rib; Sc: sub-coast; A: radio; M: medium; Cu: cubit; A: Anal. Transverse ribs: h: humeral; rm: radio-medial; mm: medial; m-cu: mid-cubital. Cells: d: disk; br: first baseline; bm: second baseline; m 1: second tail; m 2: rear third; m 3: hindquarter; cup: cell cup. The wing rib of the Athericidae is quite similar to that of the Rhagionidae and differs, at least in most cases, for some not very evident characters; (Source: <https://leben-in-portugal.info/wiki/Athericidae>)

The larva is apod, tapered in shape, with a very small head, progressively wider thoracic segments and an even wider abdomen, ending with two evident respiratory processes. It is even endowed with pseudo-legs in urites 1-7 and respiratory processes (one dorsal pair and one lateral pair), usually in urites 2-7, of which those of the last urites are particularly developed. The conformation can easily be misleading by confusing the cephalic end with the caudal end and vice versa. Larvae usually predators of other invertebrates, with very distinct appearance, having well-developed. These structures help anchor the larvae, which are found in rivers with currents and rocky substrate (Figures 8, 9, 10 and 11) [6,7,8].



Figure 8 larva is apod; (Source: <https://www.macroinvertebrates.org/taxa-info/diptera-larva/athericidae/atherix/dorsal>)

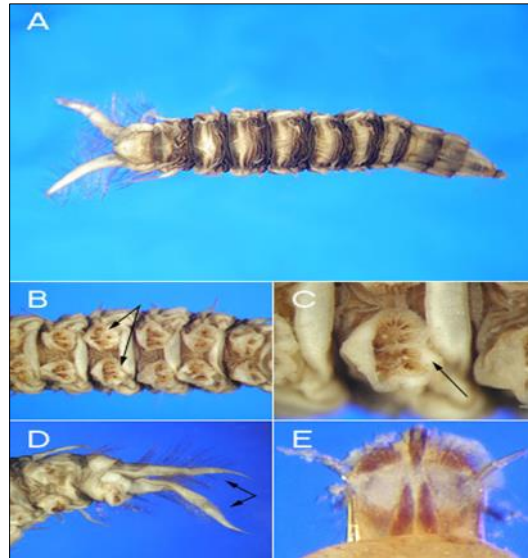


Figure 9 (A) The larvae of the watersnipe flies have abdominal segments containing ventral pairs of prolegs (B) bearing crochets (C) and terminal processes longer than the terminal prolegs (D). These terminal processes have distinctive hairs on them. The head capsule is well developed dorsally (E) with the sclerotized portions of the head capsule sometimes exposed (E). Genus *Atherix*: There is one genus of Athericidae, *Atherix*, found in North Dakota (and most of North America). The larvae are predators, eating other fly and mayfly larvae. They can be found in the riffle areas or vegetation of rivers and streams. Adults do not bite humans or animals; (Source: <https://www.waterbugkey.vcsu.edu/php/familydetail.php?idnum=7&f=Athericidae&ls=larvae>)

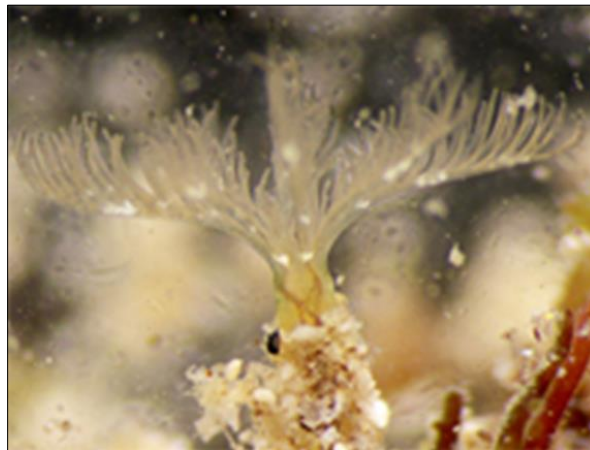


Figure 10 A catalog of Athericidae (Diptera) from Neotropical and Andean Regions | Zootaxa; (Source: <https://www.mapress.com/zt/article/view/zootaxa.4648.2.5>)

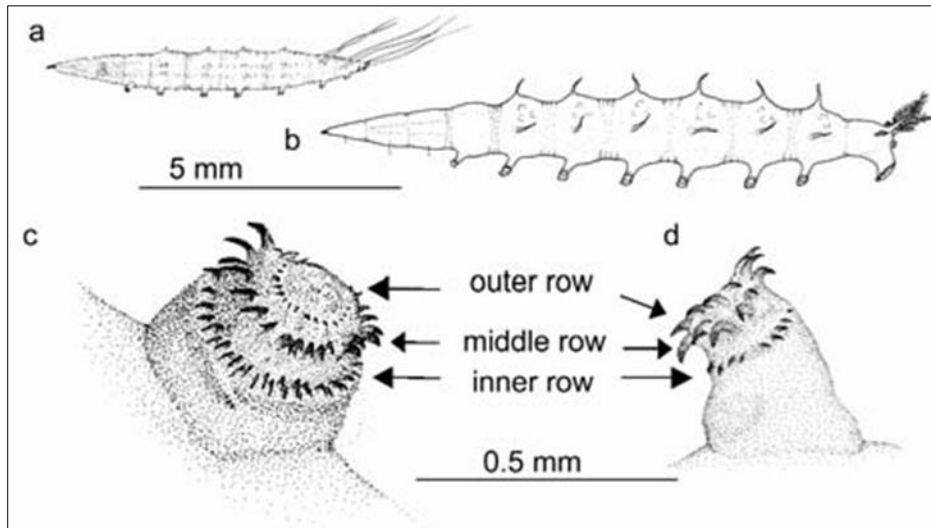


Figure 11 Athericidae. (a) *Atrichops crassipes* (Meigen1820), (b) *Ibisia marginata* (Fabricius, 1781), (c-d) row of hooks on the pseudopodia, (c) *Atherix ibis* (Fabricius, 1798), (d) *I. marginata*; (Source: https://www.researchgate.net/figure/Athericidae-a-Atrichops-crassipes-Meigen1820-b-Ibisia-marginata-Fabricius_fig14_43145343)

1.2 Life cycle

Instar analysis based on larval head capsule length and width reveals five instars. The growth rate of successive larval instars remains nearly constant around 1.4, thus following Brooks' rule. Larvae hatch in July and August; the first hibernation occurs mainly during the third instar [12].

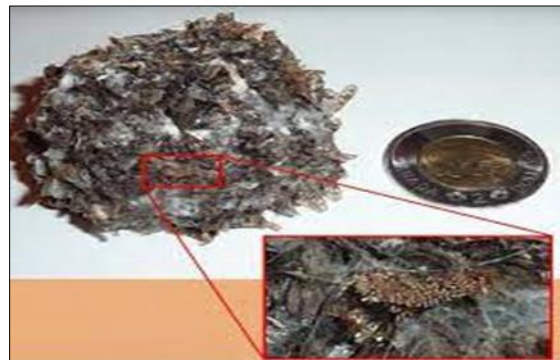


Figure 12 Bulk of flies (almost 6 cm wide) upside down, with close-up of an egg mass; (Source: <http://www.nadsdiptera.org/News/FlyTimes/issue63.pdf>)

Larvae develop to the fourth instar by the next summer and hibernate to second time as fifth instars. The last larval instar leaves the water at the end of May and pupates in the soil. The approximately two-months flight period of the imagines begins around the middle of June. Females lay their eggs on the undersides of leaves of littoral trees, from which the hatching larvae fall into the water (Figures 13, 14 and 15) [8,9].



Figure 13 Athericidae larva – *Atherix*; (Source: <https://bugguide.net/node/view/716796>)



Figure 14 larvae and egg envelopes; (Source: <http://www.nadsdiptera.org/News/FlyTimes/issue63.pdf>)

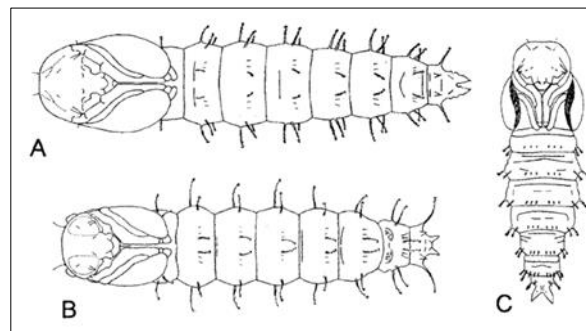


Figure 15 Pupae ventral views. A – *Suragina satsumana* Matsumura 1916; B – *Asuragina caerulescens* (Brunetti 1912); C – *Atrichops morimotoi* (Nagatomi, 1953); (Source: Nagatomi 1961)

1.3 Biology

Athericidae colonize forest environments. The larvae are aquatic and feed on the aquatic larvae of other insects, especially dipterans. Adults are found near waterways. In the genus *Atherix* a unique behavior of females in oviposition is known; in general, females lay their eggs en masse in vegetation that emerges from the water, then die. In some American and European species a gregarism is found in the oviposition phase: females tend to lay eggs by aggregating them to another oviposition; in this way, abundant clusters of such dimensions are formed, which can also incorporate the remains of thousands of dead females (Figure 16) [8,9,10].

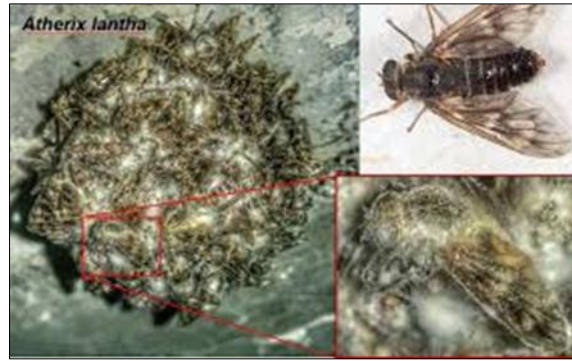


Figure 16 *Atherix lantha* Webb, 1977. A (left). Cluster. B (lower right). Close-up of one fly, showing the left wing. C (upper right). Close-up of a living fly, showing the wings; (Source: Photos by Catherine Riverin (A, B) and Steve Marshall (C))

The diet of adults is generally glycyphagic, with food base probably represented by the Rincoti honeydew. Females of the genus *Suragina* are instead hematophagous mammals and stingers, including humans [8,9,10].

1.4 Ecology

Adults feed mainly on nectar but some species feed on mammalian blood. Hematophagy has been demonstrated in adults *Suragina* and *Suraginella* and is suspected in other genera. The larvae do not feed during the first instar; after the first molt they become predators. The larvae typically feed on invertebrates or are saprophagous (Figure 17) [8,9,10].

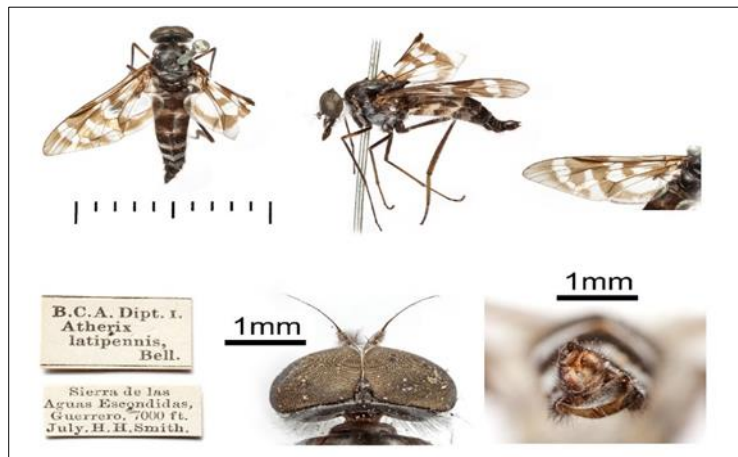


Figure 17 Hematophagy has been demonstrated in adults *Suragina*; (Source: <https://artsandculture.google.com/asset/suragina-latipennis-bellardi/4AHtWZ0fq8UWxw>)

The larvae have a very particular morphology. Its cephalic capsule is well developed dorsally; They have hooked abdominal pseudo legs. These structures help the movement of larvae without being carried away by water from their preferred habitat, rushing streams from the mountains. The larvae are predators of other aquatic invertebrates such as Phrygnae (Trichoptera). Adults have robust, conical abdomens, long legs, and sharp antennae. Males are sexually dimorphic with large eyes that meet at the top of the head (Figure 18) [8,9,10].



Figure 18 The larvae are predators of other aquatic invertebrates; (Source: <https://alchetron.com/Athericidae>)

Adults generally rest on the surface of leaves, near streams from which they emerge, or further away if they are looking for a blood meal. Athericids touch or feel the surface of leaves, a behavior that they share with the Tabanidae. In all species the eggs are laid at one time and the females die (Figure 19) [8,9,10].

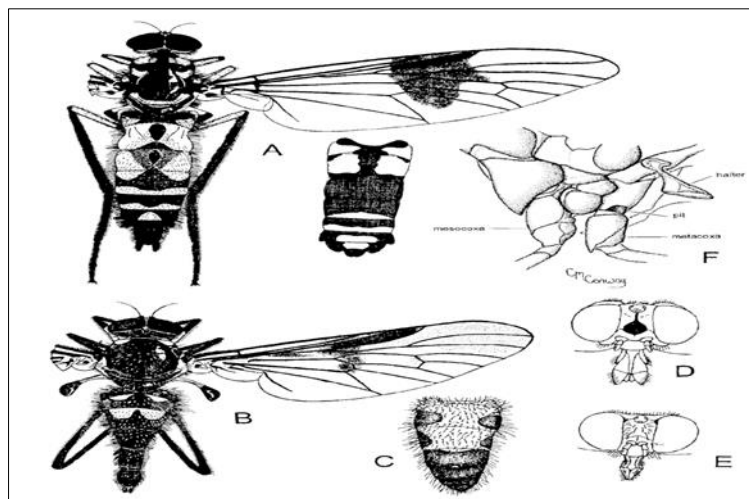


Figure 19 Adult features. A - *Suragina satsumana* Matsumura 1916, male and its female abdomen; B - *Atrichops fontinalis* male (Nagatomi, 1958); C - *A. fontinalis*, female abdomen; D - head of *Asuragina caerulescens* (Brunetti 1912) female; E - head of *A. fontinalis* female; (Source: https://www.researchgate.net/figure/Adult-features-A-Suragina-satsumana-male-and-its-female-abdomen-B-Atrichops_fig1_233727146)

1.5 Importance

The importance of the family resides mainly in the hematophagous diet of females of different species, similarly to the best known flies. Females are hematophagous in all species of the genus *Suragina*, but this behavior also occurs in some species of the genus *Dasyomma* and *Atrichops* [9,10].

According to direct statements, among the mod and other Amerindian populations in California, who lived from the harvest, it was customary to collect the abundant *Atherix* oviposition and use it as food, preparing a dish called Koo-chahbie. The insects were known by Modoc as Ha-libwah (Figure 20) [9,10].



Figure 20 Female water snipe flies clumping together for egg laying near water *Atherix ibis* (Fabricius, 1798), Athericidae, drawing. Abundant *Atherix* oviposition and use it as food, preparing a dish called Koo-chahbie; (Source: Photo by DeAgostini/Getty Images)

1.6 Biogeography

- *Atherix*: Palearctica: Europe, Japan, Russia, Morocco, and Algeria; Neotropical: Bolivia and Peru; Nearctic: USA and Canada; Eastern: Nepal.
- *Atrichops*: Palearctica: Europe, Greece and Turkey, and Japan; Afrotropical: Kenya; Nearctic: Oligocene 3.
- *Dasyomma*: Andean: Chile, Argentina; Australotempered: Australia and Tasmania.
- *Suragina*: Palearctic: Japan; Afro-tempered: South Africa; Afrotropical: Zimbabwe, Mozambique, Uganda, Madagascar, Cameroon, Nigeria, Congo; Neotropical: Northern Brazil and Mexico; Eastern: Myanmar, India, Vietnam, Malaysia, Sri Lanka, Philippines, China, Indonesia. - *Suraginella*: Australotemperate: Australia.
- *Xeritha*: Neotropical: South-Central Brazil [11].

1.7 Phylogeny, systematics and diffusion

Historically, the Athericidae were included, until the 70s, among the Rhagionidae of the Rhagioninae subfamily. From cladistic analysis, it appears that the Athericidae are in a phylogenetic relationship with the Tabanidae family, with which they form a monophyletic clade distant from the Rhagionidae family, which is positioned as the most primitive line. The cladogram below shows the positioning of Athericidae in order Diptera, suborder Brachycera and infraorder Tabanomorpha (Figure 21).

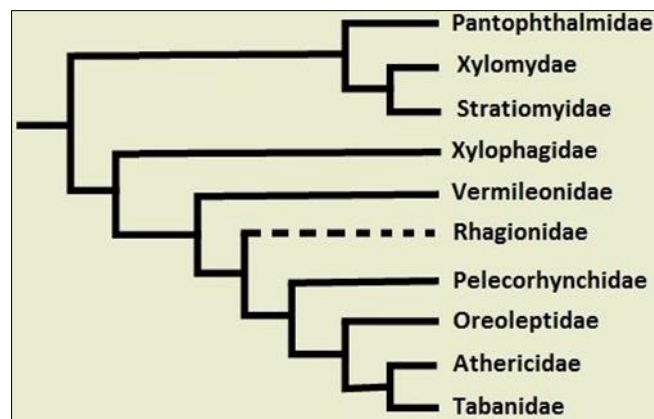


Figure 21 Cladogram of Lower Brachycera (modified from Yeates & Wiegmann, 2005); (Source: <http://tolweb.org/Brachycera/10500>)

1.7.1 Subfamilies and genus

There are more than 130 species in 12 genera. Two subfamilies have been described; Dasyommatainae contains only *Dasyomma* and all other living genera are in Athericinae.

1.7.2 1-Dasyommatainae: † *Dasyomma* Macquart, 1840

2-Athericinae: *Asuragina* Yang & Nagatomi, 1992, *Atherix* Meigen, 1803, *Atrichops* Verrall, 1909, *Ibisia* Rondani, 1856, *Microphora* Kroeber, 1840, *Pachybates* Bezzi, 1992, *Suragina* Walker, 1858, *Suraginella* Stuckenberg, 2000, *Trichacantha* Stuckenberg, 1955, *Xeritha* Stuckenberg, 1966, *Athericites* † Mostovski, Jarzembowski & Coram, 2003, *Succinatherix* † Stuckenberg, 1974 [12,13,14].

Objective

The study aims to carry out the Biology, Ecology and Biogeography of Athericidae Family

2 Methods

The method used to prepare this mini review was Marchiori 2021 methodology [15].

3 Studies conducted and selected

3.1 Study 1

The Athericidae family was created by Stuckenberg (1973) for some genera previously included in the Rhagionidae family, including *Suragina* Walker, 1860 and he placed it in Tabanoidea. Later, Nagatomi (1977, 1984) considered this arrangement to be natural. Athericidae members separate from other dipterans brachycerans by the combination of the following characteristics: closed cup cell, post-metaspiraculum "scale" present, reniform flagellum and tergite I frequently divided medially, especially in females. Female specimens of *Suragina* are hematophagous, attacking man and cattle (Figures 22 and 23).



Figure 22 *Suragina* Walker, 1860; (Source: <https://bugguide.net/node/view/293822>)

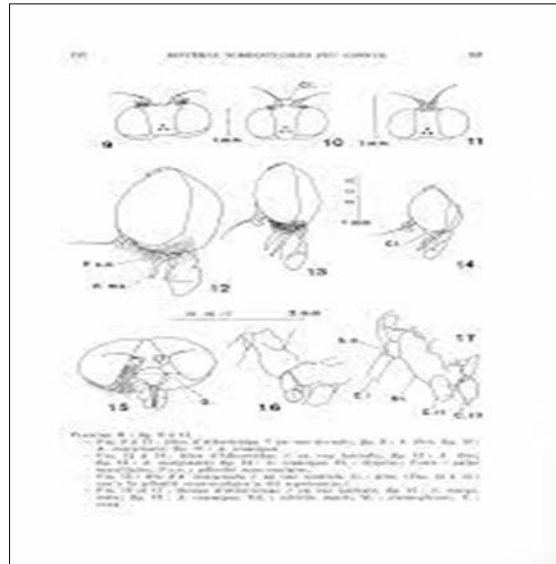


Figure 23 FIG. 9 to 11: head of Athericidae? in dorsal view; fig. 9: *A. ibis*; fig. 10: *A. marginata* (Fabricius, 1781); fig. 11: *A. crassipes*. - FIG. 12 to 14: lateral Athericidae d heads; fig. 12: *A. 1bis*; fig. 13: *A. marginata*; fig. 14: *A. crassipes*. Cl.: clypéus; P.mx.: maxillary palpation; P.s.o.: pilositis and subocular. - FIG. 15: head of *A. marginalized c?* in ventral view. G.: gene. (FIG. 12-15: The subocular pilositis has been shown.) - FIG. 16 and 17: chest of Athericidae <3 in lateral view; fig. 16: *A. marginata*; fig. 17: *A. crassipes*. S.D: dentate scleritis; St.: sternopleure; C.: thigh; (Source: <https://www.limnology-journal.org/articles/limn/pdf/1974/01/limn1974101p55.pdf>)

The genus *Suragina* had only three known species, distributed in Mexico and southwestern Texas in the United States. The three species were collected: *Suragina pacaraima*, sp. n., *Suragina longipes*, sp.n., *Suragina concinna*, sp.n. Specimens collected in the Serra Pacaraim north of Brazil, expands the distribution of the genus to South America and raises to four the species known in the New World [15].

3.2 Study 2

3.2.1 Water Snipe Flies (family Athericidae)

Athericidae is a small family of flies with aquatic larvae, only 123 species are known, with two species registered in Brazil, *Suragina pacaraima* Walker, 1860 and *Xeritha plaumanni*, Stuckenberg 1966. They are flies very close to horseflies, including some hematophagous adults, such as *Suragina*. They are called in English "water snipe flies" or "ibis flies" (Figures 24 and 25).



Figure 24 *Suragina* sp., aquatic larva photographed in Wimberley, Texas, USA. This genus is also found in Brazil; (Source: Foto de Robby Deans)



Figure 25 *Suragina concinna* (Williston, 1901); (Source: photographed in Uvalde County, Texas, USA. Photo by A. Flinn)

Larvae usually predators of other invertebrates, with very distinct appearance, having well-developed abdominal prolegs with hooks similar to crochet hooks. These structures help anchor the larvae, which are found in rivers with currents and rocky substrate [16].

3.3 Study 3

Athericidae and Rhagionidae Athericid flies, also named water snipe or ibis flies, and rhagionid flies, also named snipe flies, are medium-sized and sombrely coloured flies with slender bodies, long legs and often spotted wings. They are mostly predators of other insects, except some genera that are blood feeders, *Suragina* (Athericidae) in the Nearctic region, *Symphoromyia* (Rhagionidae) in western North America and *Spaniopsis* (Rhagionidae) in Australia. These flies have only one generation per year (Figure 26).



Figure 26 *Suragina* larvae; (Source: http://www.planetainvertebrados.com.br/index.asp?pagina=especies_ver&id_categoria=28&id_subcategoria=0&com=1&id=294&local=2)

Larvae prey generally on other insect larvae. *Suragina* larvae inhabit flowing water, whereas *Symphoromyia* larvae are usually found in wet soil, leaf mould and rotting wood. They prey on other insect larvae, earthworms and other soil fauna. *Symphoromyia* bites are very painful, especially on the head, causing a high degree of public nuisance. When abundant, snipe flies may cause large animals to seek shelter or to move to higher elevation where fly activity is reduced.

Pests and vector-borne diseases in the livestock industry implicated in the transmission of any pathogens. In California, snipe flies are active from April to mid-July; in Yellowstone, their biting activity peaks in July [17].

4 Conclusion

The importance of the family resides mainly in the hematophagous diet of females of different species, similarly to the best known flies. Females are hematophagous in all species of the genus *Suragina*, but this behavior also occurs in some species of the genus *Dasyomma* and *Atrichops*. Pests and vector-borne diseases in the livestock industry implicated in the transmission of any pathogens. In California, snipe flies are active from April to mid-July; in Yellowstone, their biting activity peaks in July.

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