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(REVIEW ARTICLE)

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Biodiversity of the Simuliidae family

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Abstract

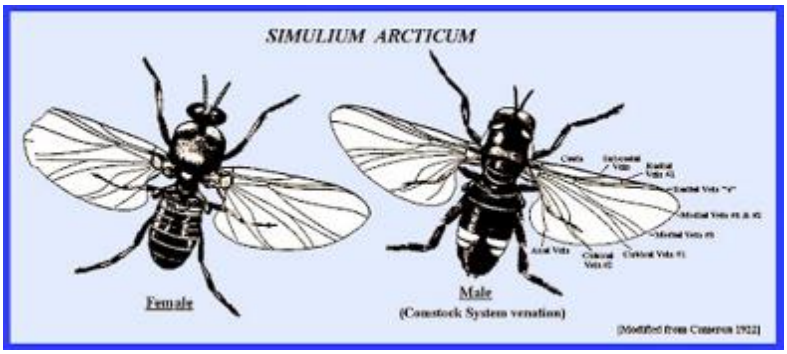
Simuliidae belong to the order Diptera, suborder Nematocera, Infraorder Culicomorpha, Superfamily Chironomoidea, and Family Simuliidae. They are known as "borrachudo" or "pium" in Brazil and as "black flies" in English-speaking countries. This study objective to report the characteristics of the Family Simuliidae. The research was carried out in studies related to quantitative aspects of the Family, Subfamily and Species (taxonomic groups) and conceptual aspects such as: biology, geographical distribution, species, life cycle, damage, economic importance, medicinal importance, biological aspects, and reproduction. A literature search was carried out containing articles published from 1950 to 2021. The mini-review was prepared in Goiânia, Goiás, from September to October 2021, through the Portal of Scientific Journals in Health Sciences, Pubmed, Online Scientific Library (Scielo), internet, ResearchGate, Academia.edu, Frontiers, Biological Abstract, Publons, Qeios, Dialnet, World, Wide Science, Springer, RefSeek, Microsoft Academic, Science, ERIC, Science Research.com, SEEK education, Periodicals CAPES, Google Academic, Bioline International and VADLO.

Keywords: Geographical distribution; Species; Life cycle; Damage; Economic; Medicinal importance

1. Introduction

Simuliidae belong to the order Diptera, suborder Nematocera, Infraorder Culicomorpha, Superfamily Chironomoidea, and Family Simuliidae. They are known as "borrachudo" or "pium" in Brazil and as "black flies" in English-speaking countries (Figure 1) [1,2].

1.1. Morphology



Source: http://www.faculty.ucr.edu/~legneref/medical/simuliidaekey.htm

Figure 1 Female and Male Simuliidae

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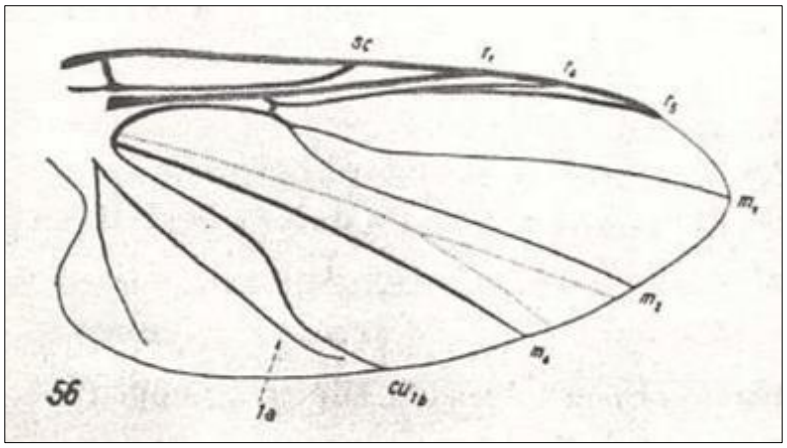
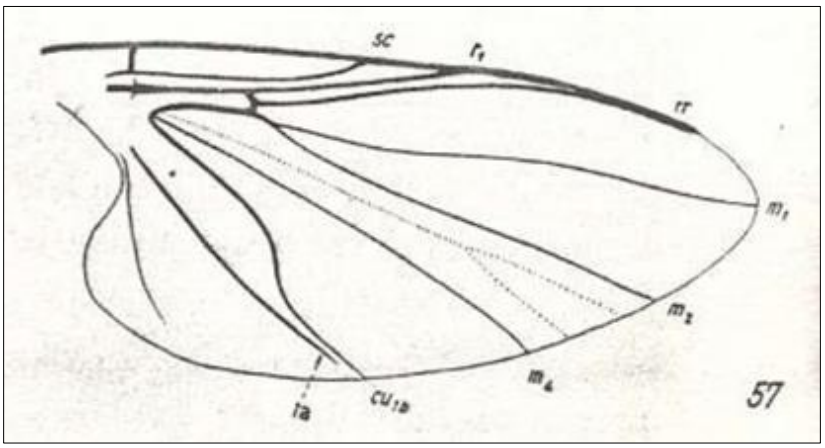
Simuliidae, popularly like black flies, are small black mosquitoes from tropical countries, measuring 1 to 5 mm in length that live near rivers and forests. They have antennas formed by 11 articles, resembling a rattlesnake rattle. Its body is robust, usually dark in color (black, brown, or gray). It has membranous wings, with strong fore ribs. They are cosmopolitan and tiny, measuring from 1 to 5 mm in length (Figures 2, 3, 4 and 5) [3,4].



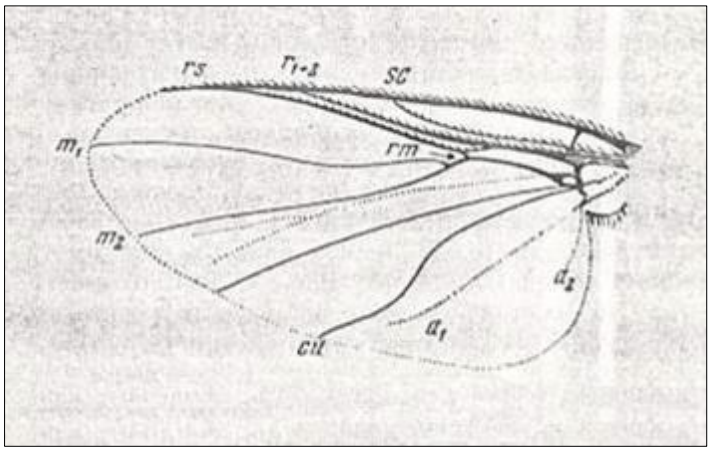
Source: http://www.metafysica.nl/nature/insect/nomos_23.html

Figure 2 Wing-venation of *Prosimulium rufipes* (Meigen, 1830) Order Diptera, Family Simuliidae (= Melusinidae), Superfamily Chironomidea. Basal cell not drawn. Subcosta (Sc) strong, reaching the wing-margin. Therefore, the venation in this form cannot be derived from that in Ceratopogonidae because there, even in their venational ground plan the Subcosta is already in a state of reduction. Radial Sector 2-branched. It is markedly pressed toward the Radius and anterior wing-margin. Apparently the two branches of Rs can be identified as R4 and R5. The Radio-medial cross-vein ta (= r-m) is clearly present, albeit short. The M1-M2 fork (if this identification is correct) is extremely long, that is, its bifurcation-point has been shifted markedly toward the wing-base. The cross-vein tb (= m-cu) is absent. The fork M4-CuA (= M4-Cu1b) is, like the M1-M2 fork, deepened, that is, its bifurcation-point has shifted markedly toward the wing-base. These shifts undoubtedly relate to the secondary broadening of the wings in Simuliidae. Also, the presence of a fork in the area between M2 and M4 relates to this. The presence of this fork should be explained in the same way as we did (following Hennig) with respect to the occurrence of a fork in the region between Rs and M in Ceratopogonidae. The undulation of CuA (= Cu1b) and the strong development of the first and second anal veins are certainly connected with the broadening of the anal area of the wing



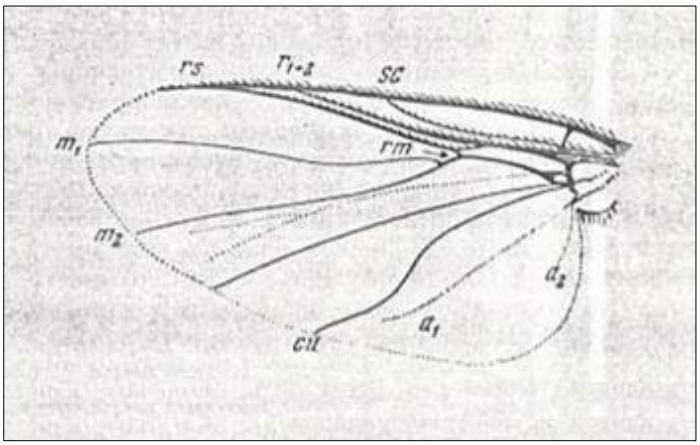
Source: http://www.metafysica.nl/nature/insect/nomos_23.html

Figure 3 The Radial Sector being 2-branched only occurs in *Prosimulium* and *Parasimulium,* while in all other Simuliidae it is just a single vein: Wing-venation of *Melusina reptans* (Linnaeus): sensu Bigot, 1891 Order Diptera, Family Simuliidae (= Melusinidae), Superfamily Chironomidea. Subcoast (Sc) still well developed, reaching the wing-margin. Radial Sector just a single vein. The rest of the venation is identical to that in *Prosimulium*



Source: http://www.metafysica.nl/nature/insect/nomos_23.html

Figure 4 As could be expected, the same venation can be found in species closely related to the one just depicted



Source: http://www.metafysica.nl/nature/insect/nomos_23.html

Figure 5 Wing of *Simulium sericatum* Meigen 1830 Order Diptera, Family Simuliidae = Melusinidae – Superfamily Chironomidea

There are currently about 1,750 species of simulidae distributed all over the world, 300 of which are neotropical and, among these, some have anthropophilic habits and are therefore of medical importance. Simuliids normally occur near rivers with running water and waterfalls, as it is in this type of aquatic environment that their larvae develop. In most species of simulidae, females have a hematophagous habit, needing to feed on blood for egg maturation. Sucking blood mainly in the ankle region of people, and during blood grazing create relatively large wounds, making infection of the region easy [5,6].

1.2. Biological life cycle

They are cosmopolitan insects, except for the Antarctic continent, some archipelagos, and places devoid of running water. Currently, the Simuliidae family represents one of the most studied Diptera families with 2,072 described species, 12 of which are fossils. Simuliids are insects with complete metamorphosis: egg, larva, pupa and adult (Figures 6 and 7) [7,8].

The life cycle comprises two stages: an aquatic (egg-larva-pupa) and an aerial (adults: female and male). The female lays eggs on the surface of running water, in batches ranging from 100 to 600 eggs, with the larvae hatching after several days. It can go through six to nine seedlings depending on the species and characteristics of the breeding site, with up to seven seedlings being the most frequent. The larva builds a cocoon made of silk and passes to the pupal stage, which lasts from four to seven days, without feeding. Simuliids are also important tools for monitoring contamination in freshwater environments because the immature stages (larvae and pupae) are sensitive to organic and inorganic

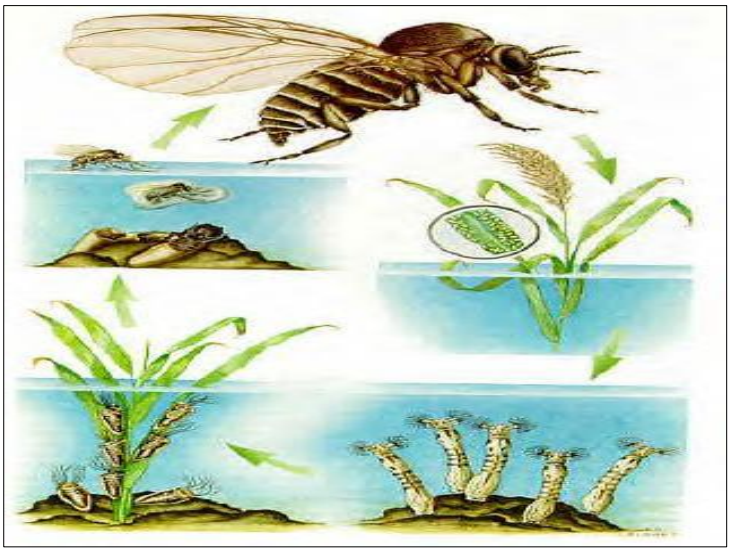
pollutants. The Simuliidae family is of particular evolutionary interest due to its conservative morphology with extensive cryptic specialization and its relinked evolution (Figure 8) [9,10, 11].

Source: Image from URL: http://www.aquatax.ca/insectlifecycle.html

Figure 6 Black fly (Simulidae)

Source: esearchgate.net/figure/batch-of-eggs-of-Simulium-rubrithorax-Diptera-Simuliidae-with-some-first instar-larvae_fig3_10598350

Figure 7 batch of eggs of *Simulium rubrithorax* Lutz, 1909 (Diptera: Simuliidae) with some first-instar larvae (lv) emerging from the eggs (e)



Source: http://www.turtletrack.org/IssueHistory/Issues01/Co04072001/CO_04072001_Fly.htm

Figure 8 The life cycle: Simuliidae

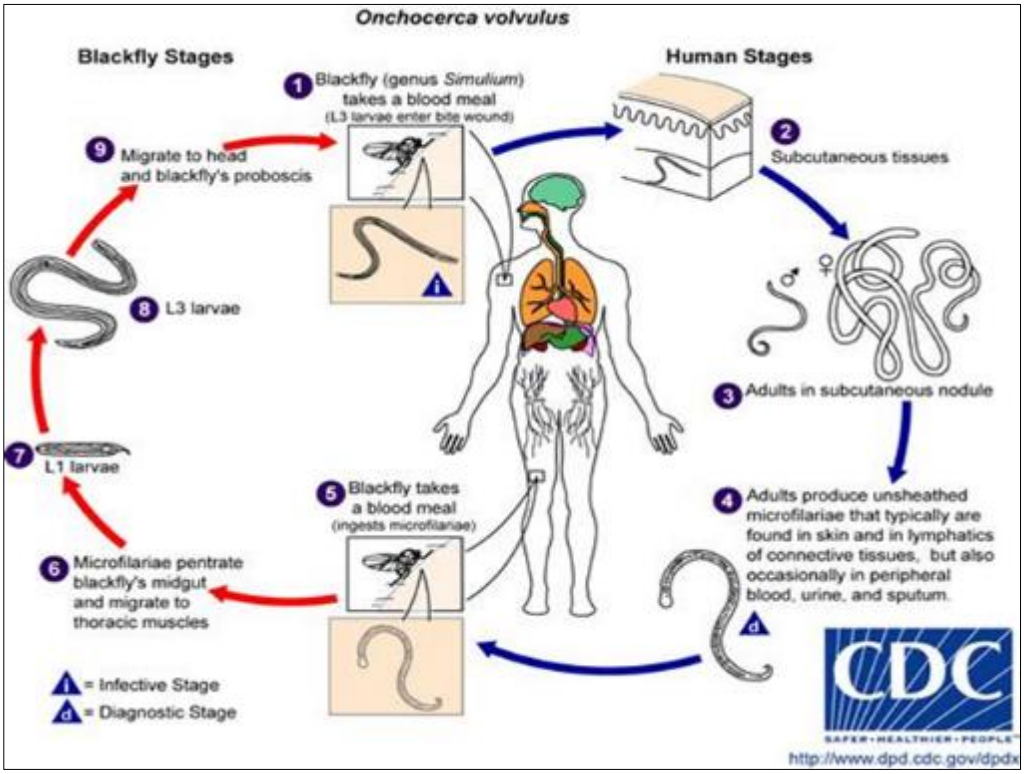
2. Habitat

Found in the Amazon, they serve as food for fish, frogs, dragonflies, and birds. Preserving forests and their natural predators helps control the blackfly. Adult males and females feed on nectar and the female has an additional blood supply for egg maturation the dark colored eggs are coated with a substance that allows them to adhere to rock in flowing streams. Their habitats are usually in rapidly moving streams, but sometimes only slow-moving water can suffice. Female flies lay their eggs over the water, but sometimes dive into it to oviposit. In cold areas the eggs may enter diapause [9,10,11].

Simuliids are also important indicators of contamination in freshwater environments because the immature stages are highly susceptible to organic and inorganic pollution. Furthermore, the immature stages of simuliids are considered key organisms in aquatic ecosystems, being important sources of food for invertebrates and vertebrates. Around 10% of Simuliidae species worldwide bring economic impacts to agriculture, forestry, livestock, and tourism, resulting in losses in the production of milk and beef and a reduction in tourism. In North America, some species proliferate because of rural development, such as the construction of hydroelectric plants [12,13,14].

2.1. Simuliidae as a vector and host of diseases

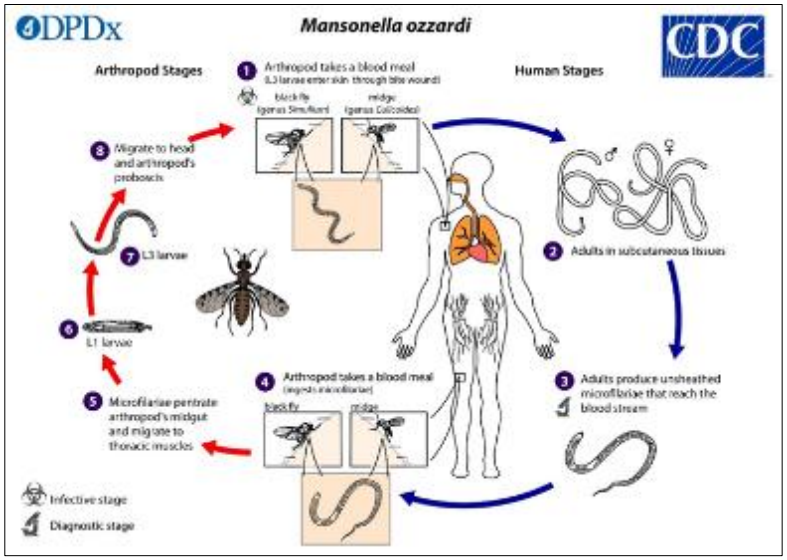
Thus, females are known as biting pests and important transmitters of blood and skin parasites to humans and warm-blooded animals. Simuliids are vectors of several species of parasites, from viruses and protozoa to filariae. These parasites can be transmitted to humans and domestic animals. Among the protozoa we can mention species of the genus *Leucocytozoon* 23 that devastate bird populations and the *Onchocerca volvulus* (Leuckart, 1893) (is a species of parasitic nematode, whose adult form presents a circular section and sexual reproduction and can live up to 14 years in the human host) life cycle, *Mansonella ozzardi* (Manson, 1897) filariae that affect humans. Simuliids are also suspected to be vectors of Venezuelan Equine Encephalitis (Figures 9, 10, 11 and 12) [12,13,14].



Source: https://web.stanford.edu/group/parasites/ParaSites2006/Onchocerciasis/life%20cycle.html

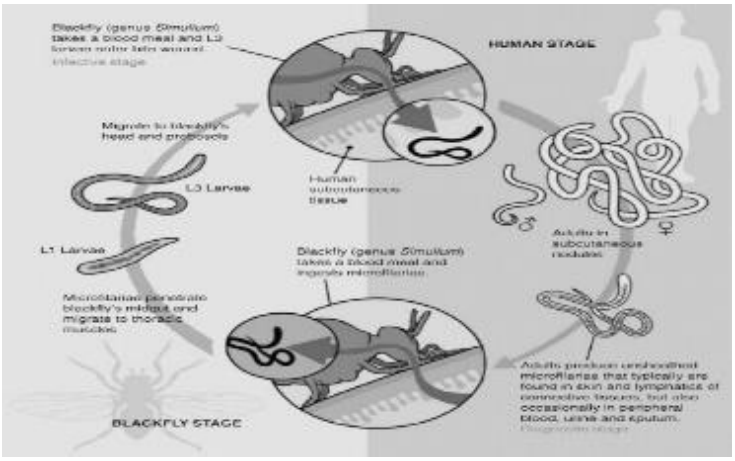
Figure 9 *Onchocerca volvulus* (Leuckart, 1893) life cycle: human phase (6, 7) 1. A female *Simulium* blackfly carrying the parasites takes a blood meal from the human host. The host's skin is punctured by the bite. As the blood is pumped upward, the saliva of the fly carrying the parasite larvae passes into the wound 2.The larvae enter the host's subcutaneous tissue, where they can migrate freely 3.The larvae take up residence in subcutaneous nodules. Here they mature into adults of both sexes. The females dwell in the nodules permanently while the smaller male worms migrate between nodules to mate. The reproductive life of the adult is about 9-11 years4.Within 10-12 months of the initial infection, eggs form inside the female worm and become unsheathed microfilariae (MF). The female worm can produce

up to 1000 microfilariae per day. These thousands of MF migrate in the subcutaneous tissue and are often found in skin and in lymphatics of connective tissue. They can sometimes be observed in peripheral blood, urine, and sputum. Black fly phase (6, 7) 5. Another female blackfly takes a blood meal from an infected host, ingesting MF in the process. 6. Microfilariae penetrate the midgut and migrate to the thoracic muscles. 7. Here they develop into first stage L1 larvae. 8. The L1 larvae molt and become L2 larvae. The L2 larvae then molt and become infective L3 larvae. 9. These infective larvae migrate to the fly's head and subsequently to the blackfly's proboscis. Here, they wait until they can be transferred to the human host when the fly takes a blood meal (step 1)



Source: https://www.cdc.gov/dpdx/mansonellosis/index.html

Figure 10 During a blood meal, an infected arthropod (midges, genus *Culicoides*, or blackflies, genus *Simulium*) introduces third-stage filarial larvae onto the skin of the human host, where they penetrate the bite wound 1. They develop into adults that commonly reside in subcutaneous tissues 2. Adult worms are small and slender, measuring about 49 mm long and 150 µm wide (females) or 26 mm long and 70 µm wide (males). Adults produce unsheathed and non-periodic microfilariae that reach the blood stream 3. The arthropod ingests microfilariae during a blood meal 4. After ingestion, the microfilariae migrate from the arthropod's midgut through the hemocoel to the thoracic muscles 5. There the microfilariae develop into first-stage larvae 6 and subsequently into third-stage infective larvae 7. The third-stage infective larvae migrate to arthropod's proboscis 8 and can infect another human when the arthropod takes a blood meal 9



Life cycle of *O. volvulus*. The illustrator of this figure is Giovanni Maki (Source: Basáñez et al. From: River Blindness: A Success Story under Threat? Basáñez MG MP, et al. PLos Medicine. 2006; 3(9): e371

Figure 11 The lifespan of adult worms is up to 15 years. Developing female adult worms either induce new nodules or enter existing nodules and cluster together with the resident female worms, while the smaller male worms migrate between nodules to mate. Fertilized eggs develop into microfilariae that actively exit from the female worm. The female worm may produce up to 1000 microfilariae per day and the microfilariae lifespan is 1–2 years, which results in millions

of microfilariae residing in the subcutaneous tissues. When the infected host is bitten by female blackfly, microfilariae are transferred from the host to the blackfly where they develop into infective larvae over a period of 6–12 days, which can then be transmitted to a new human host when the blackfly feeds again

MAJOR ZOONOSES OF HORSES

Wearing the recommended personal protective equipment will make the transmission of diseases less likely.

PATHOGEN	TRANSMISSION	ANIMAL DISEASE	HUMAN DISEASE
Leptospirosis	• exposure to the urine of infected animal	• recurrent uveitis(moon blindness), fever, abortions, septicemia	• headache, myalgia, conjunctivitis, hepatomegaly, renal insufficiency, jaundice (*L. icterohemorrhagiae*) • gastrointestinal dyscrasias, diarrhea, nausea, vomiting
Salmonellosis (Salmonella typhimurium)	• fecal/oral	• *Diarrhea, abortion, death*	• Fever, vomiting, diarrhea, dehydration, abdominal cramping
Streptococcosis	• Wound contamination • direct contact (person-to-person, animal-to-person)	• "Strangles" in horses (*S. equi* subsp. Zooepidemicus)	• Severe respiratory infections, meningitis
Rabies	Bite or exposure of saliva from infected animal	Colic, lameness, neurologic signs, depression or aggression	Neurologic signs, coma, death
Anthrax	• Inhalation • Skin puncture • Direct contact with hide, blood or tissues from an infected animal • Biting flies	• High fever, hemorrhages, colic, death in 2-4 days	• Pulmonary form: flu-like symptoms (often fatal) • Gastrointestinal form: bloody vomit and diarrhea (25-50% fatal w/o tx) • Skin form: boil-like lesions
Eastern Equine Encephalitis (EEE-Alphavirus)	• mosquito vector • birds	• biphasic fever, CNS signs, death	• high mortality (30% of clinical cases), diarrhea, fever, CNS signs, delirium, coma, death
Venezuelan Equine Encephalitis (VEE) ***Western Equine Encephalitis (WEE)***	• mosquito vector	• pyrexia, stupor, lethargy • CNS signs	• fever, encephalitis, flu-like symptoms
Equine Encephalitides Family Flaviviridae West Nile Virus	• mosquito vector	• epidemic in horses • asymptomatic or neurologic signs (ataxia), altered behavior, paralysis, convulsions, death	• asymptomatic, or fever, headache, skin rash, disorientation, tremor, convulsions, paralysis

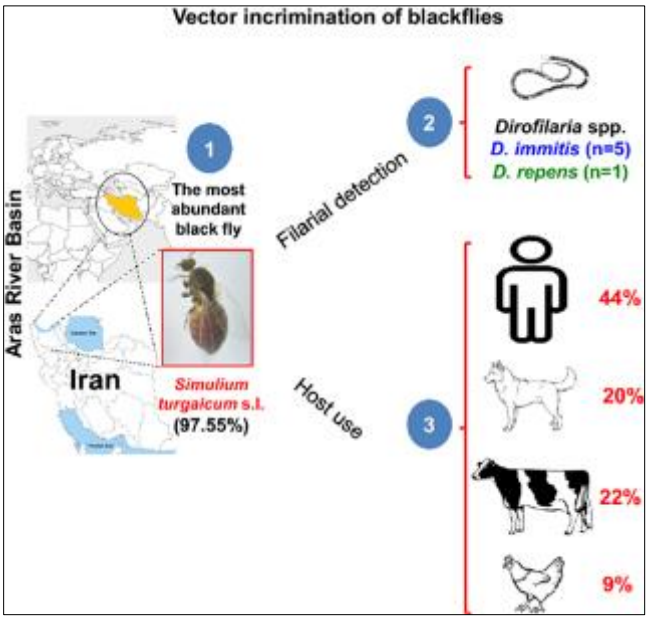
Source: [15] Chomel BB and Jinna Harris. Equine Zoonosis: Fundamentals in Zoonosis. 1st ed. Berkeley: University of California, Davis CA. 2003. [16] Kenneth ML. "Zoonotic diseases: Horses to humans. 1st ed. Cornell: Cornell University. 2009

Figure 12 Venezuelan Equine Encephalitis

In the northern region of Brazil, simuliids have been reported to cause autoimmune reactions in migrants and not in natives who inhabited the transamazon highway. This disease was known as Altamira Hemorrhagic Syndrome with cases of secondary thrombocytopenic purpura. The direct action of the toxin caused localized or disseminated cutaneous hemorrhages (the form of multiple petechiae and ecchymoses) around the site of the bites. Many patients had cases of mucosal bleeding, anemia, and death. The occurrence of this syndrome has been attributed to the saliva of *Simulium amazonicum* Goeldi, 1982. In the Amazon region, simuliids are important in the transmission of *O. volvulus* and *M. ozzardi* to humans (Figures 13A and B) [12,13,14].

Source: State Simulídeo Control Program-RS

Figure 13A Lesions resulting from simuliid bites in a rural resident of RS



Source: https://www.google.com/search?q=The+feeding+mode+occurs+Simuliidae&

Figure 13B Molecular detection of *Dirofilaria* spp. And host blood-meal identification in the *Simulium turgaicum* Rubtsov, 1940 complex (Diptera: Simuliidae)

Female of *Thyrsopelma guianense* (Wise, 1911): (Diptera: Simuliidae) before and after blood meal in humans. Impacts of simulid bites in simuliids only the female is hematophagous, and they are commonly known for the aggressiveness of their bites. The impacts caused by the sting can be grouped into three categories: (1) nuisance, caused by stinging swarms; (2) trauma, caused by the injection of salivary toxins; and (3) disease, caused by the transmission of parasites. Each impact can be caused by species affecting humans, domestic and wild animals. Different species have a persistent habit of flying into the eyes, ears, nose, mouth, hair, and skin causing panic and discomfort from their bites, in addition to causing several symptoms that include fever, swelling, headache and joint pain (Se. In unaccustomed animals and people, the bite of simuliids can cause strong reactions due to the toxic effect of the injection of salivary secretions, known as simuliotoxicosis (simuliid poisoning) [14,15,16].

The large number of bites 25 can also result in deaths in the most diverse animals (cattle, horses, pigs, sheep, and birds) due to excessive blood loss, uncontrolled behavior of the animal (resulting in being run over, footsteps and crushing between them), and suffocation due to clogging of the airways. Some species of simulid cause damage to the economy of different countries such as buffalo pests in the United States and Canada (*Cnephia pecuarum* (Riley, 1887) and *Prosimulium mixtum* Syme and Davies, 1958, respectively) [14,15,16].

Southern Brazil, the species *Chirostilbia pertin* (Kollar, 1832) is the main target species in simuliid control programs. The bite of this species causes intense itching and irritation, which can lead to severe immune reactions. Several control programs have been implemented to reduce the population of these insects and minimize the suffering of rural populations who work in traditional activities, such as grape harvesting and farming. Only in the northern region of Brazil do simuliids have epidemiological importance in the transmission of filaria [14,15,16].

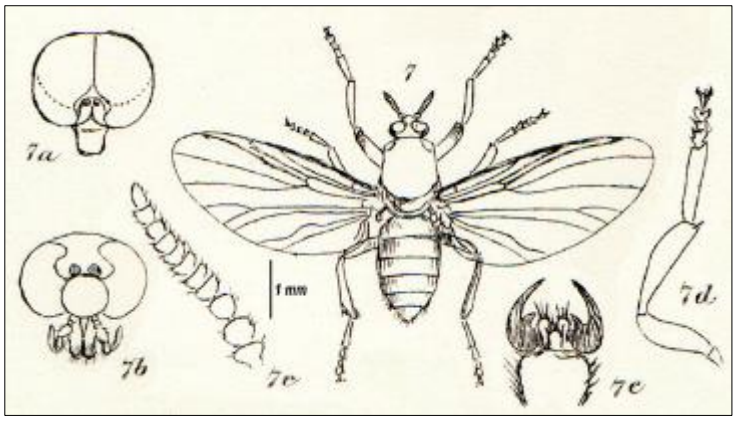
2.2. Geographic distribution

This disease is endemic in Latin America (Argentina, Bolivia, Colombia, El Salvador, Paraguay, Peru, and Venezuela) and in some parts of Brazil (Goiás, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Paraná, São Paulo) having been attributed to the saliva of insects, including simuliids (*Simulium nigrimanum* Macquart, 1838 species) in addition to other environmental factor [15,16].

2.3. Oral apparatus of Simuliidae

In addition to causing great discomfort to the population. In some regions of the Amazon, more than 6,780 fbites/man/day have been recorded. 1.2 Blood feeding of simuliidae female simuliidae carry out a blood feed, in addition to sugars, for the maturation of the eggs. Among the culicomorphs, simuliids are known to tear the host's tissue in the search for blood, being called "pool feeders unlike mosquitoes that have a cannular oral system and can feed directly on

a blood vessel and therefore are called vessel feeders. Twenty four the "pool feeders" feeding mode for simuliids is due to their short mouthparts. The tearing of the host tissue is performed by a structure called syntrophy, consisting of mandibles, maxillary lacinia, hypopharynx and labrum. The other mouthparts such as the lip and lip lobes do not penetrate the skin and are retracted, allowing the sting (Figure 14) [15,16].



Source: Watson L, Dallwitz J. Insects of Britain, and Ireland: the families of Diptera. 27th ed. London: DELTA database. 2019

Figure 14 Oral apparatus of Simuliidae 7, *Simulium variegatum* Walker. 7ª-d, *Simulium reptans* L. 1758: front of head of male (7ª), front of head of female (7b), antenna of female (7c), fore-leg of female (7d), and tip of tarsus showing internally hooked and toothed claws. From Walker (1856, Plate XXIV), with 1mm scale added

The feeding mode occurs in four moments: 1) penetration of the mandibles; 2) syntrophy consolidation in the skin; 3) functioning of two functional pumps (one in the cibarium and the other in the pharynx), both separated from the alimentary canal; and 4) release of mouthparts and syntrophy. The success in obtaining blood food in hematophages, including simuliids, has also been attributed to the production of a magic potion in the saliva of these insects [15,16].

These insects have a wide distribution and can be found in flowing water courses, of different volumes, speeds, temperature, pH, and altitude from sea level.

2.4. Taxonomic

Originally described as subgenera, close to *Psaroniocompsa: Cerqueirellum and Coscaroniellum*. Even without making studies of the phylogenetic relationships, they considered as groups of species within *Psaroniocompsa*, in which, and had defined only 14 species.

There are four genera among over 2000 species that are of primary importance to humans: *Simulium, Rosimulium, Austrosimulium* and *Cnephia*. However, *Simulium* is the most important as many are vectors of disease. Service (2008) reports that in Africa the main concern is with the *Simulium damnosum* L., 1758 complex and the *Simulium neavei* Roubaud, 1915 group. Central and South America have *Simulium ochraceum* Walker, 1861*, Simulium metallicum* Bellardi. 1859 and *Simulium exiguum* Roubaud, 1906 complexes that transmit parasitic nematodes that can cause onchocerciasis. In Brazil *Simulium amazonicum* Lutz, 1917 is a vector of *Mansonella ozzardi* (Manson, 1897) (Nematoda: Onchocercidae), which is a filarial parasite [15,16].

Objective

This study objective to report the characteristics of the Family Simuliidae

3. Methods

The research was carried out in studies related to quantitative aspects of the Family, Subfamily and Species (taxonomic groups) and conceptual aspects such as biology, geographical distribution, species, life cycle, damage, economic importance, medicinal importance, biological aspects, and reproduction. A literature search was carried out containing articles published from 1971 to 2021.

The mini-review was prepared in Goiânia, Goiás, from September to October 2021, through the Online Scientific Library (Scielo), internet, Portal of Scientific Journals in Health Sciences, Pubmed, ResearchGate, Academia.edu, Frontiers, Biological Abstract, Publons, Qeios, Portal of Scientific Journals in Health Sciences, Dialnet, World, Wide Science, Springer, RefSeek, Microsoft Academic, Science, ERIC, Science Research.com, SEEK education, Periodicals CAPES, Google Academic, Bioline International and VADLO.

4. Studies performed

4.1. Study 1

The aim of this study was to verify the community structure, species composition and biodiversity of Simuliidae in using Malaise traps on the Highest Mountain in Thailand.

In total, 9406 adult black flies belonging to 44 species of five subgenera were trapped in six collection sites: *Daviesellum, Takaoka* and Adler (one species, 2%), *Gomphostilbia* Enderlein (10 species, 23%), *Montisimulium* Robtsov (five species, 11%), *Nevermannia* Enderlein (seven species, 16%) and *Simulium* Latreille s. str. (21 species, 48%). Of these, 14 species (32%) were the most abundant, in which more than 100 specimens were found for each one. A range of between 11 and 100 specimens were found for each of 24 species (54%), and six species (14%) were considered as rare, representing ≤ 10 specimens for each one (Figure 15).

Source: http://v3.boldsystems.org/index.php/Taxbrowser_Taxonpage?taxid=24918

Figure 15 *Simulium nigrogilvum* Summer 1911

The most relatively abundant taxon was *Simulium tenebrosum* complex (11.1%), followed by the *Simulium asakoae* species-group (9.6%), the *Simulium striatum* species-group (7.7%), *Simulium inthanonense* complex (6.6%), *Simulium doipuiense* complex (6.4%), *Simulium amazonicum* (3.0%), *Simulium chomthongense* complex (5.3%), *Simulium chumpornense* (5.1%) and *Simulium nigrogilvum* (4.1%). These eight taxa accounted for 57% of all collected specimens. The most frequent taxa at all the sites (100% SO) were the two human-biting species *S. nigrogilvum* and the *S. asakoae* species-group followed by *S. inthanonense complex, S. angkaense, Simulium chamlongi, Simulium fenestratum,* the *S. striatum* species-group and *Simulium tani* complex, representing the same percentage of species occurrence (50% SO) [17].

4.2. Study 2

To verify the environmental variables that best explain the structure of the community of simuliid species.

Thus, the main objective of this work was to know the diversity of Simuliidae, as well as the abiotic variables that affect its distribution, in the Piratinim river basin, considering the seasons (spring and autumn) and two spatial scales: the main regions of the basin (high, medium, and low) and three stretches of tributary streams of the river (springs, medium and mouth) (Figure 16).

Source: http://www.solcomercio.com.br/linha-solvet-vetor.php?id=4

Figure 16 *Simulium pertinax* Kollar, 1832. Blackbird / Simuliids Biological aspects of simuliids Insects of the genus *Simulium* are found in the Brazilian territory in the states of Mato Grosso, Minas Gerais, Bahia, Espírito Santo, Rio de Janeiro, São Paulo, Paraná, Santa Catarina, Rio Grande do Sul, both inland and on the coast. Known as "borrachudos" or "piuns" are holometabolous insects, of relatively small size, usually frizzy in black or yellowish-brown tones. Females differ from males by the type of facets of the eyes: Females are dioptic with a single type of facets (microfacets) and holoptic males with macrofacets and microfacets

S. pertinax, S. orbitale and *S. incrustatum* were the most abundant species, representing 86.4% of the total captured. The remaining six species were collected with proportions below 10%. As for the occurrence in streams (OR), *S. subpallidum* was the only species found in all locations, followed by *S. incrustatum* (94.44%) and *S. pertinax* (88.89%), as can be seen in the. Most species were collected in both seasons, except for *S. lutzianum* and *S. travassosi*, which were found only in autumn and spring, respectively. Simulidae abundance was lower in the autumn period, with only 24.71% of the total specimens [18].

5. Conclusion

Simuliidae is a cosmopolitan family of insects of the order Diptera, with 2,348 officially recognized species. They are holometabolic insects, whose immature (egg, larva and pupa) inhabit running water environments, and adults inhabit the terrestrial environment, because they are winged. They are of great environmental importance, as they are a source of food for numerous animals, such as fish and birds. Females of a large portion of Simuliidae species have a hematophagous habit, making them an object of medical and veterinary interest. They are vectors of several pathogens, such as *O. volvulus*, which causes human onchocerciasis (also known as river blindness).

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