Open Access Research Journal of
Multidisciplinary Studies
Journals home page: https://oarjpublication/journals/oarjms/
ISSN: 2783-0268 (Online)

(REVIEW ARTICLE)

Family Nycteribidae (Insecta: Diptera)

Carlos Henrique Marchiori *

Department of Biological Science, Instituto Federal Goiano, Goias, Brazil.

Open Access Research Journal of Multidisciplinary Studies, 2023, 06(01), 017–025

Publication history: Received on 07 July 2023; revised on 27 August 2023; accepted on 30 August 2023

Article DOI: https://doi.org/10.53022/oarjms.2023.6.1.0033

Abstract

Family Nycteribidae bat flies have an interesting reproductive method known as viviparous puparity, in which eggs are fertilized internally and all three larval stages develop within the female. Larvae are nourished by intrauterine glands. Gravid female flies deposit a single, 3rd instar larva on the roosting substrate. The larva then immediately forms a puparium, and following approx. After 3–4 weeks of development, the adult fly emerges to locate and colonize a host. The aim of this article was to investigate the morphological, bioecological, and systematic characteristics of the family Nycteribidae (Insecta: Diptera). For the review, we used indexed articles, scientific book chapters, theses databases, university dissertations, national and international scientific articles, scientific journals, documents, and academic and scientific journals available online ResearchGate, HAL SSRN, Scielo, and Qeios. The present work uses the reference of bibliographical research, understood as the act of inquiring and seeking information on a certain subject, through a survey carried out in national and foreign databases, with the objective of detecting what exists of consensus or controversy.

Keywords: Bats; Dipteran; Ectoparasitic; Larvae; Viviparous

1. Introduction

The superfamily Hippoboscoidea has listed four families of Calyptrate flies, Glossinidae, Hippoboscidae, Nycteribiidae, and Streblidae. Glossinidae comprises hematophagous flies restricted to the Ethiopian Region, while the other three families include hematophagous flies, ectoparasites of birds, and mammals with a cosmopolitan distribution. Hippoboscidae are fly ectoparasites of birds and mammals (artiodactyls, lemurs, and kangaroos). Nycteribiidae and Streblidae are formed by exclusively ectoparasitic species of bats [1-2].

Objective

The aim of this article was to investigate the morphological, bioecological, and systematic characteristics of the family Nycteribidae (Insecta: Diptera).

2. Methods

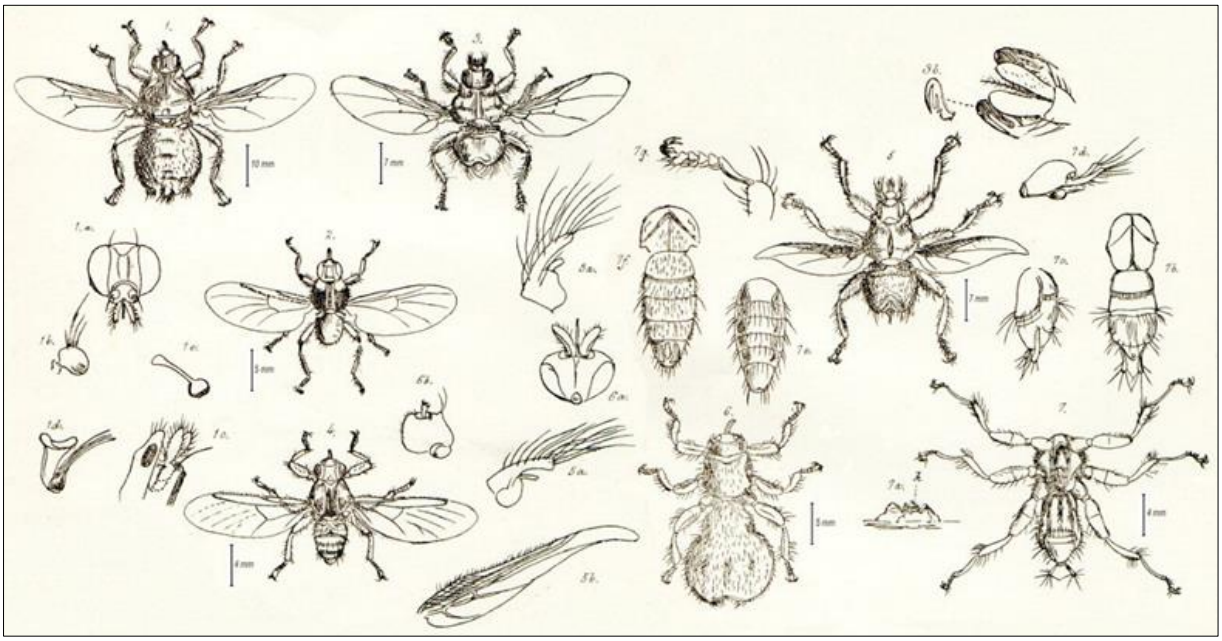
For the review, we used indexed articles, scientific book chapters, theses databases, university dissertations, national and international scientific articles, scientific journals, documents, and academic and scientific journals available online ResearchGate, HAL SSRN, Scielo, and Qeios. The present work uses the reference of bibliographical research, understood as the act of inquiring and seeking information on a certain subject, through a survey carried out in national and foreign databases, with the objective of detecting what exists of consensus or controversy.

* Corresponding author: Carlos Henrique Marchiori

3. Family Nycteribidae

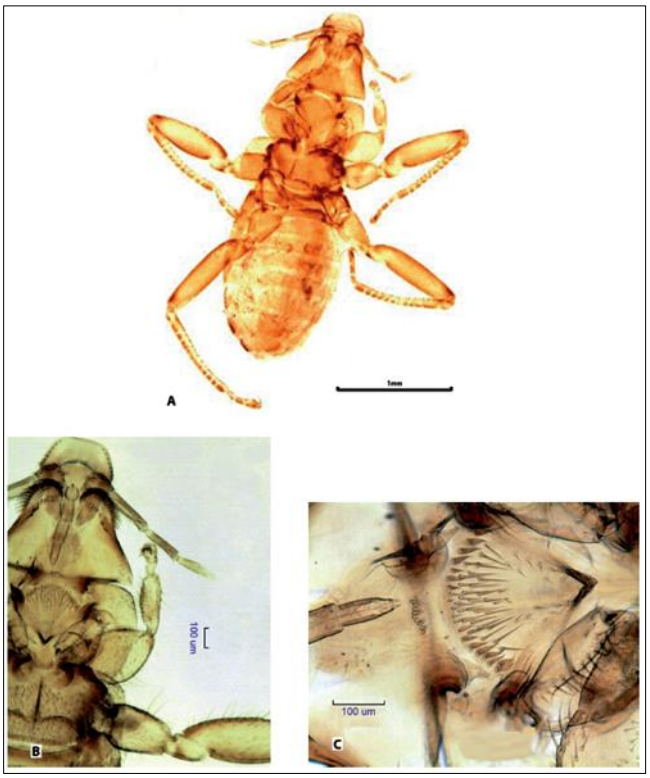
The bat is a mammalian animal of the order Chiroptera distinguished from birds, as these have feathers supported by bones. Bats are the only mammals with true flight. Bats have the most varied diet among mammals, as they can eat fruits, seeds, leaves, nectar, pollen, arthropods, small vertebrates, fish, and blood [1-3].

About 70% of bats are insectivores, feeding on insects, and practically all the rest are frugivorous, that is, they feed on fruits. Only three species feed exclusively on blood: they are the so-called hematophagous or vampire bats, found only in Latin America. In this way, bats contribute substantially to the structure and dynamics of ecosystems, since they act as pollinators, seed dispersers, insect predators (including agricultural pests), nutrient suppliers in caves, and vectors of wild diseases, among other functions. They also have an extraordinary sense of echolocation which they use for orientation, search for food and communication (Figures 1-2) [1-4].



Source: https://www.delta-intkey.com/britin/dip/www/nycterib.htm

Figure 1 *Hippobosca equina* Linnaeus, 1758, with details of head from the front (1a), antenna (1b), front of head from the side (1c), labrum, with lingua and labium and the muscular base by which they are protruded (1d), and one of the halteres (1e). 2 and 4, *Hippobosca cervi* Olivier, 1792. 3, *Ornithomya avicularia*. (Linnaeus, 1758), with details of antenna (3a), and tarsal claws (3b). 5, *Ornithomya pallida* Latreille, 1812. 5a and 5b, *Stenepteryx hirundinis* (Linnaeus, 1758), antenna and wing respectively. 6, *Melophagus ovinus* (Linnaeus, 1758), with details of head from beneath (6a), and antenna (6b). Nycteribidae. 7, *Phthiridium biarticulatum* Hermann, 1804; 7a, the same, with head (h) thrown back in the normal position; 7b, the thorax and abdomen from beneath; 7c and 7d, the same, showing abdomen from the side (7c) and the porrected head from the side (7d). 7e and 7f, *Nycteribia kolenatii* Theodor, 1954: abdomen from above (7e), and thorax and abdomen from below (7e). From Walker (1853), with approximate lengths of insects (front of head to tip of abdomen)

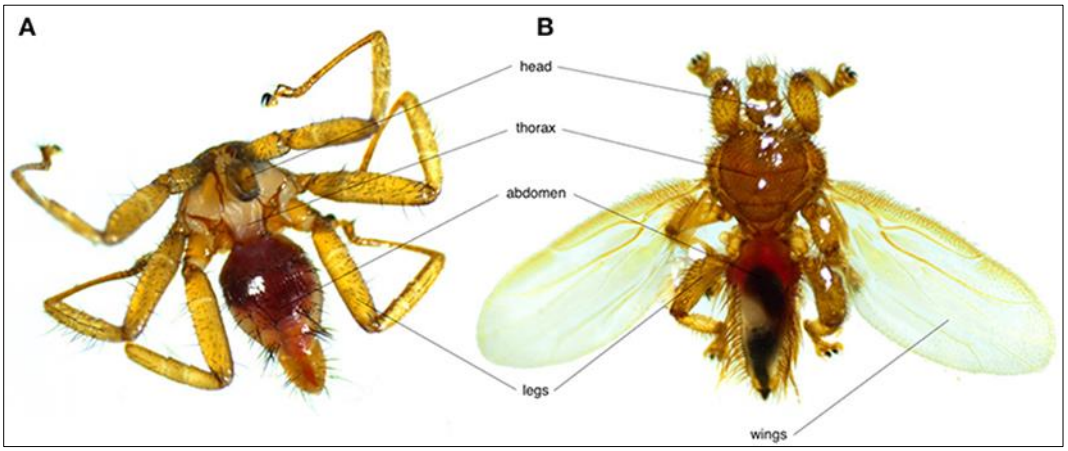


Source: https://www.scielo.br/j/paz/a/spcpTn66ZsVXbmWRdYz7pJC/?lang=en#ModalFigf4

Figure 2 *Hesperoctenes cartus* Jordan, 1922 (CMLA 766 ♀): (A) Ventral view, (B) Antenna and anterior leg, (C) Gular region and Prosternum

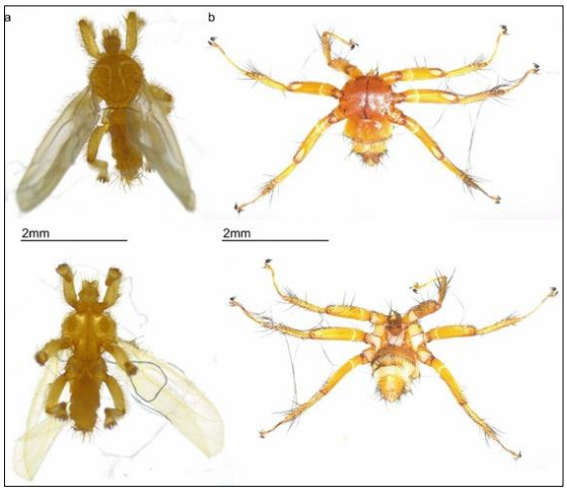
1.1. Description

The species have the mesonotum reduced and depigmented and the pleurae displaced to the dorsal surface due to expansion of the sternum thoracic, making them look acariform. O body length ranges from 1.5 to 5 mm. As in the other families of Hippoboscoidea, the development of the larva takes place in the mother's uterus, where it is fed through glands that produce a nutritive substance. In the third instar, the larva is expelled and deposited in the shelter substrate where it passes to the pupal stage (Figures 3-7) [5-7].



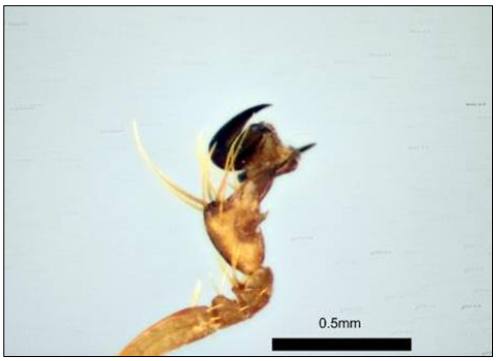
Source: https://www.frontiersin.org/articles/10.3389/fvets.2019.00115/full

Figure 3 Photos showing the morphological differences between (A) a wingless nycteribiid and (B) a streblid bat fly



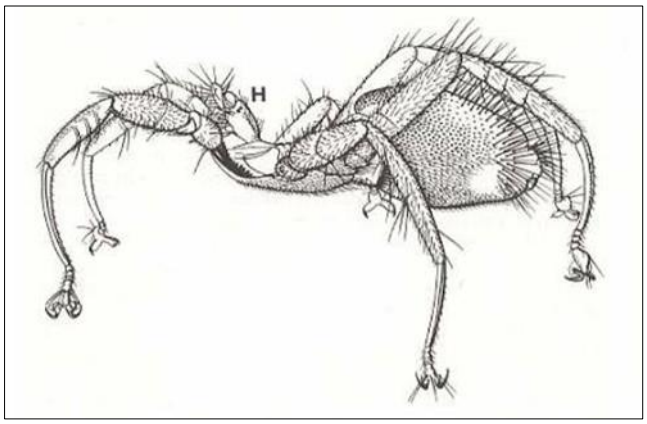
Source: https://www.researchgate.net/figure/Typical-morphology-of-bat-files-belonging-to-the-family-a-Streblidae-and-b-Nycteribiidae_fig2_354875976

Figure 4 The head is the hairy ovoid structure inserted after the 2 front legs and is conspicuously small with either no eyes or very small ones. And just look at their legs – amazingly well adapted for holding onto the fur of bats. Their tarsal segments are completely bendy with huge claws



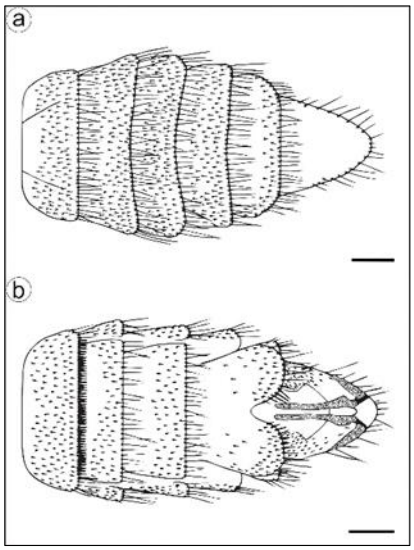
Source: https://www.nhm.ac.uk/natureplus/blogs/diptera-blog/tags/batlice_flies.html

Figure 5 Their legs are amazingly well adapted for holding onto the fur of bats



Source: https://www.nhm.ac.uk/natureplus/blogs/diptera-blog/tags/batlice_flies.html

Figure 6 The batlice fly has an extremely small thorax. So the head and legs are basically dorsal insertions of the thorax – they stick out of the top of the fly rather than at the side which is the more usual way. It is really difficult to work out which way is up as the head does not resemble anything that you are used to

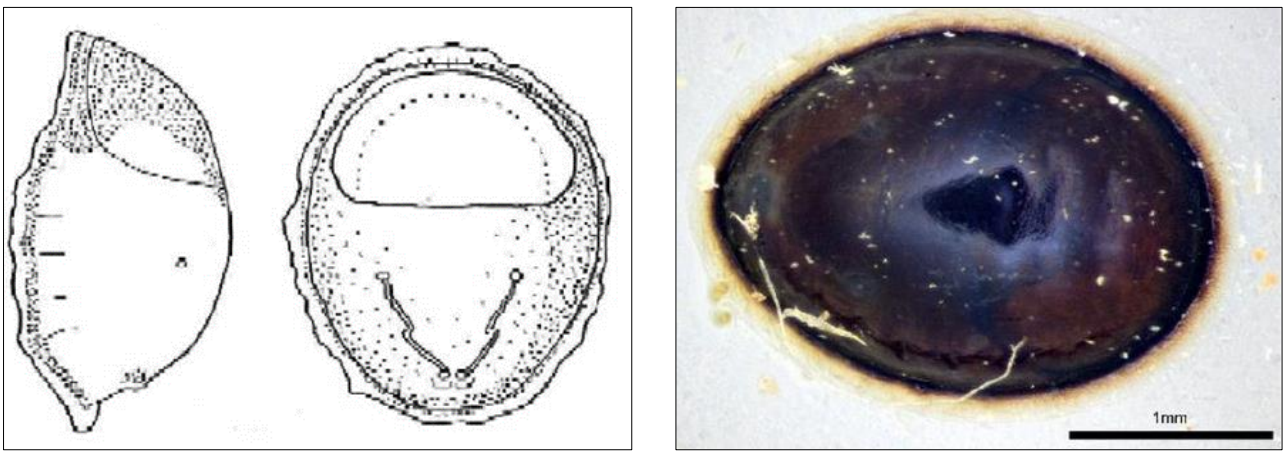


Source: https://www.scielo.br/j/aabc/a/57vTmRfRgWB8f6xJCcXZfZP/

Figure 7 a) Abdomen, female (Holotype), dorsal view, *Hershkovitzia mariae* sp. nov. b) Abdomen, female (Holotype), ventral view, *H. mariae*

1.2. Biology

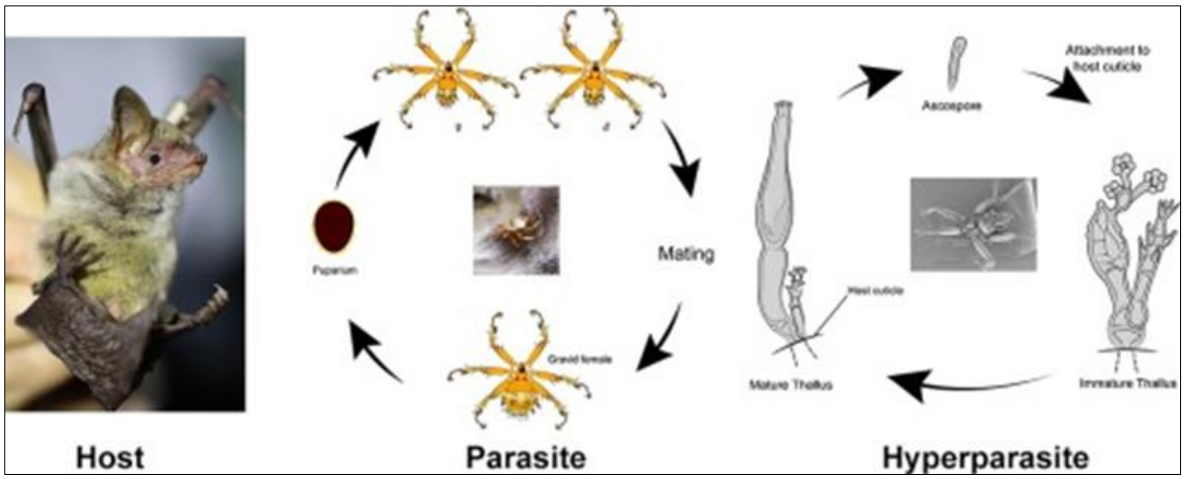
Larvae and pupae. The larvae develop within the mother, being nourished via a greatly developed 'accessory gland', before leaving to pupate (finally pupating on the ground or in the abode of the host); acephalic. The pupae are enclosed within a puparium (Figure 8).



Source: https://www.nhm.ac.uk/natureplus/blogs/diptera-blog/tags/batlice_flies.html

Figure 8 The females leave the bat host when they are about to give birth (as it were). She crawls onto the wall of the cave and the pre-pupal stage emerges. This is an incredibly short stage as the larva pupates within hours. Now there are some great larval body adaptations to help this wee one stick to the cave wall. They are hemi ovoid and have sticky secretions which are also helped by a narrow marginal skirt

Given the dorsal insertion of the legs and general morphology, nycteribiid flies generally move well in any direction, and their movements may be very fast when agitated. This high mobility in the bat's fur may afford them some protection from host grooming, which is understood to be a primary cause of adult fly mortality (Figure 9) [8-10].



Sources: https://doi.org/10.1016/j.jip.2019.107206 https://www.sciencedirect.com/science/article/abs/pii/S0022201119301193

Figure 9 Bat flies (Diptera: Nycteribiinae) are highly specialized bloodsucking bat ectoparasites. Some of the ectoparasitic bat flies are themselves parasitized with an ectoparasitic fungus of the genus *Arthrorhynchus* (Laboulbeniales). Ascospores of the fungus attach to the cuticle of a bat fly and develop a haustorium that penetrates the host cuticle. This interaction defines the fungus as a hyperparasite. Both the fly and the fungus are obligate parasites and this peculiar case of hyperparasitism. *Laboulbeniales*, Engler (1898), genus *Arthrorhynchus* Kolen, in natural populations of bat flies infesting the bat species *Miniopterus schreibersii* (Natterer, 1819), *Myotis bechsteinii*, *Myotis bechsteini* (Kuhl, 1817), *Myotis daubentonii* (Kuhl, 1817), *Myotis escalerae* Cabrera, 1904 and *Myotis* sp. in Portuguese cave

Bat flies have an interesting reproductive method known as viviparous puparity, in which eggs are fertilized internally and all three larval stages develop within the female. Larvae are nourished by intrauterine glands. Gravid female flies deposit a single, 3rd instar larva on the roosting substrate. The larva then immediately forms a puparium, and following approx. 3–4 wk development, the adult fly emerges to locate and colonize a host (Figure 10) [11-13].

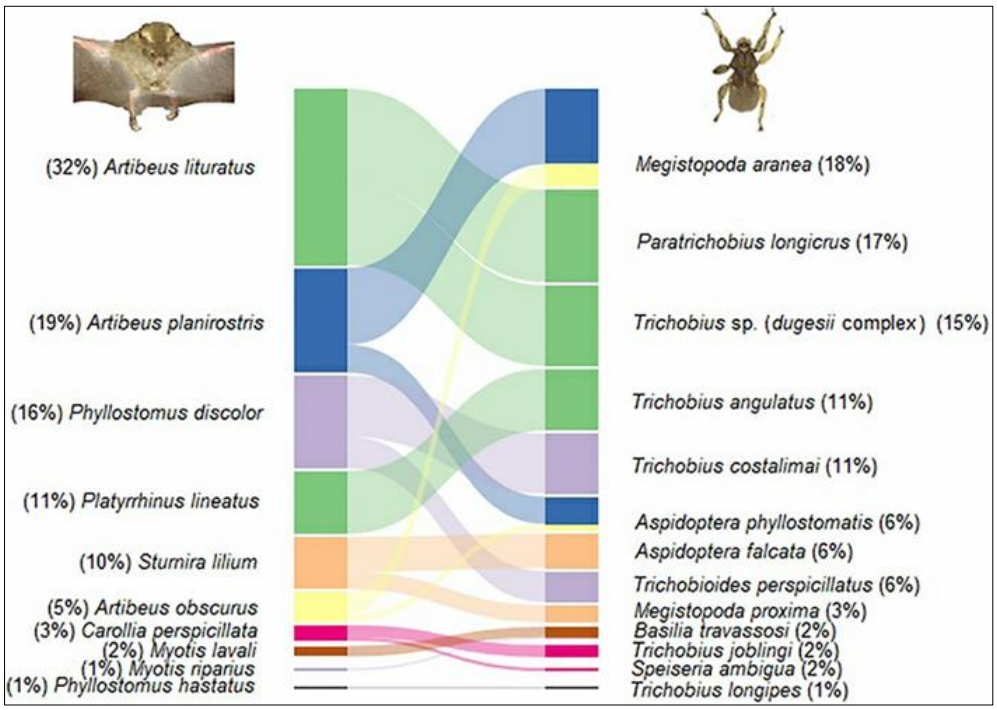


Figure 10 Interaction network between bats and ectoparasites captured in urban green areas of Grande Aracaju, Sergipe, Brazil. The lines and their different colors represent interactions between species, and the width of the line indicates the strength of the interactions. The values in parentheses indicate the frequency of occurrence of the species

1.3. Classification

Currently, the family comprises 260 species, including 13 genera and three subfamilies, Nycteribiinae, Cyclopodiinae, and Archinycteribiinae. On the American continent, two genera are found Nycteribiinae, *Basilia* Miranda-Ribeiro, 1903, *Hershkovitzia* Guimaraes & D'Andretta, 1956, are endemic to the Neotropical Region and are four known species that parasitize bats of the family Thyropteridae. In Brazil, there were two species recorded, *Hershkovitzia cabala* Peterson & Lacey, 1985 and *Hershkovitzia inaequalis* Theodor, 1967, both records in the Amazon region. *Basilia* is the genus with the highest number of species within Nycteribiidae, currently over 100, 47 of which are exclusively American. The species are found on all continents and mainly parasitize bats of the family Vespertilionidae. Some Streblidae and Nycteribiidae (Diptera: Hippoboscoidea) from Maracá Island, Roraima, Brazil [14-17].

4. Selected Manuscripts

4.1. Study 1

Some Streblidae and Nycteribiidae (Diptera: Hippoboscoidea) from Maracá Island, Roraima, Brazil.

4.1.1. Basilia dunni Curran, 1935.

Hosts: *Myotis nigricans* (Schinz, 1821) and *Myotis albescens* Geoffroy (Guimarães 1966).

Distribution: Panamá and Venezuela.

4.1.2. Basilia ferrisi Schuurmans-Stekhoven Jr., 1931.

Hosts: *Basilia ferrisi* Schuurmans-Stekhoven, 1931, occurs on *Myotis albescens* (Geoffroy, 1806), *M. nigricans*, and *Myotis riparius* Handley, 1960.

Distribution: Costa Rica, Colômbia, Guatemala, Guiana, Peru, and Venezuela [18].

4.2. Study 2

- Nycteribiidae Samouelle, 1819.
- *Basilia* Miranda-Ribeiro, 1903.
- *Pseudelytromyia* Miranda-Ribeiro, 1907.
- *Basilia andersoni* Peterson & Maa, 1970.

Hosts*. M. nigricans* (Vespertilionidae), *Eptesicus brasiliensis* (Desmarest, 1819), *Myotis* sp. and *Histiotus velatus* (Geoffroy, 1824) (Vespertilionidae).

Distribution: Brazil (Parana and Rio Grande do Sul) and Uruguay.

4.2.1. Basilia carteri Scott, 1936.

Hosts: *Molossops temminckii* (Burmeister, 1854) (Molossidae), *Eptesicus brasiliensis* (Demarest 1819), *Eptesicus diminutus* Osgood, 1915, *Eptesicus furinalis* (d'Orbigny & Gervais, 1847), *Myotis albescens* (Geoffroy, 1806), *Eptesicus keaysi* Allen, 1914, *M. nigricans*, *Myotis riparius* Handley, 1960, *Myotis ruber* (Geoffroy, 1806), *Myotis* sp., (Vespertilionidae); *Molossus molossus* Pallas, 1766 e *Tadarida brasiliensis* (Geoffroy, 1824) (Molossidae).

Distribution: Brazil (Mato Grosso, São Paulo, Paraná e Santa Catarina), Bolívia, Paraguay and Argentina (Jujuy, Tucumán, Salta and Santiago del Estero).

4.2.2. Basilia currani Guimarães, 1943.

Hosts: *Myotis ruber* (Vespertilionidae), *E. brasiliensis*, *M. albescens*, *Myotis chiloensis* (Waterhouse 1840), *M. levis* (Vespertilionidae) and *T. brasiliensis* (Molossidae).

Distribution: Brazil (São Paulo and Santa Catarina) and Argentina (Catamarca, Tucumán and La Rioja).

Hosts: *Basilia hughscotti* Guimarães, 1946, *Chrotopterus auritus* (Peters, 1856) (Phyllostomidae), *E. furinalis, M. nigricans,* and *M. riparius* (Vespertilionidae).

Distribution: Brazil (Distrito Federal, Minas Gerais and Rio Grande do Sul).

Basilia lindolphoi Graciolli, 2001.

Distribuição geográfica. Brazil (São Paulo, Paraná and Santa Catarina).

4.2.3. Basilia speiseri (Miranda-Ribeiro, 1907).

Hosts: *Lasiurus borealis* (Müller, 1776) (= *Lasiurus blossevillii*) (Vespertilionidae), *Anoura geoffroyi* Gray, 1838, *Carollia perspicillata* (Linnaeus, 1758), *Phyllostoma* sp. (Phyllostomidae); *E. brasiliensis*, *M. albescens*, *M. nigricans* (Vespertilionidae) and *M. obscurus* (Molossidae).

Distribution: Brazil (Mato Grosso, Rio de Janeiro, São Paulo, Paraná and Santa Catarina), Paraguay and Argentina (Santa Fé).

4.2.4. Basilia juquiensis Guimarães, 1946.

Hosts: *M. nigricans*, *M. riparius,* and *Myotis* sp. (Vespertilionidae).

Distribution: Venezuela and Brazil (São Paulo, Paraná and Santa Catarina).

4.2.5. Basilia ferruginea Miranda-Ribeiro, 1903.

Hosts: *Atalapha frantzii* Dobson, 1878 (= *Lasiurus blossevillii*) (Vespertilionidae), *Lasiurus borealis* (Müller, 1776), *Lasiurus cinereus* (Palisot de Beauvois, 1796) and *Lasiurus pfeifferi* (Gundlach, 1861) (Vespertilionidae).

Distribution: Cuba, Panamá, Equador (Galápagos); Brazil (Pará, Minas Gerais, Rio de Janeiro, São Paulo and Santa Catarina) and Paraguai.

4.2.6. Basilia ortizi Machado-Allison, 1963.

Hosts: *Eptesicus melanopterus* (Jentink, 1904) (= *Eptesicus fuscus*) (Vespertilionidae), *Artibeus hartii* Thomas, 1892, *Chrotopterus auritus* (Peters, 1856) (Phyllostomidae); *E. brasiliensis, E. furinalis, Eptesicu*s sp. and *M. riparius*.

Distribution: Belize, Costa Rica, Venezuela and Brazil (Paraná).

4.2.7. Basilia plaumanni Scott, 1940.

Hots: *Histiotus velatus* (Geoffroy, 1824) (Vespertilionidae), *E. brasiliensis, E. fuscus*, *Histiotus macrotus* (Poeppig, 1835), *Histiotus montanus* (Philippi & Landbeck, 1861), *Histiotus* sp. and *M. nigricans*.

Distributiion: Brasil (Minas Gerais, São Paulo, Paraná, Santa Catarina e Rio Grande do Sul), Paraguai, Argentina (Jujuy, Santiago del Estero and Córdoba) and Uruguai.

Hosts: *Myotis albescens* (Vespertilionidae). *M. nigricans* (Vespertilionidae).

Distribution: Brasil (Paraná and Santa Catarina).

4.2.8. Basilia ruiae Graciolli, 2003.

Hosts: *Myotis ruber* (Vespertilionidae).

Distribution: Brazil (São Paulo, Paraná and Rio Grande do Sul) [19].

5. Conclusion

Bat flies (Diptera: Nycteribiinae) are highly specialized bloodsucking bat ectoparasites. Some of the ectoparasitic bat flies are themselves parasitized with an ectoparasitic fungus of the genus *Arthrorhynchus* (Laboulbeniales). Ascospores of the fungus attach to the cuticle of a bat fly and develop a haustorium that penetrates the host cuticle. This interaction defines the fungus as a hyperparasite. Both the fly and the fungus are obligate parasites and this peculiar case of hyperparasitism.

References

[1] Ferreira ABH. New dictionary of the Portuguese language. 2st ed. Rio de Janeiro: New Frontier. 1986.

[2] Kunz TH, Fenton MB. Bat ecology. 1st ed. Chicago: The University of Chicago Press. 2003.

[3] Kunz TH, Torrez EB, Bauer D, Lobova T, Fleming TH. Ecosystem services provided by bats. Annals of the New York Academy of Sciences. 2011; 1223(1): 1-38.

[4] Garrouste ANR, Engel MS. The earliest Pupipara (Diptera: Hippoboscoidea): A new genus and species from the lower Eocene of the Green River Formation. Palaeoentomology. 2023; 6(1): 058–063.

[5] Autino AG, Claps GL, Barquez RM. New records of Diptera (Nycteribiidae) and Siphonaptera (Ischnopsyllidae) from Chiroptera (Vespertilionidae) from Argentina. Bulletin of Venezuelan Entomology, New Series. 2000; 15: 109-112.

[6] Graciolli G. Two new species of *Basilia* Miranda-Ribeiro,1903 (Diptera: Nycteribiidae), members of the ferruginea group, from Southern Brazil. Zootaxa. 2003; 261: 1-7.

[7] Graciolli G, Aguiar LS. Occurrence of ectoparasitic flies (Diptera, Streblidae, and Nycteribiidae) of bats (Mammalia, Chiroptera) in the Cerrado of Brasilia, Federal District, Brazil. Revista Brasileira de Zoologia. 2002a; 19(1): 177-181.

[8] Graciolli G, Bernard E. New records of ectoparasitic flies (Diptera, Streblidae, and Nycteribiidae) on bats (Mammalia, Chiroptera) from Amazonas and Pará, Brazil. Revista Brasileira de Zoologia. 2002b; 19(1): 77-86.

[9] Gregorin R, Taddei VA. Artificial key for the identification of *Brazilian molossids* (Mammalia, Chiroptera). Neotropical Mastozoology. 2002; 9:13-32.

[10] Koopman KF. Order Chiroptera. In: Wilson DL, Reeder DM, eds. Mammals species of the world. A taxonomic and geographic reference. 2st ed. Washington: Smithsonian Institution Press; 1993; p. 137-241.

[11] Graciolli G, Carvalho CJB. Ectoparasitic flies (Diptera, Hippoboscoidea, Nycteribiidae) of bats (Mammalia, Chiroptera) in the State of Paraná. I. *Basilia*, taxonomy, and pictorial key to species. Revista Brasileira de Zoologia. 2001; 18(1): 33-49.

[12] Graciolli GFC, Passos WA, Lim PBK. Records of Streblidae and Nycteribiidae (Diptera) on vespertilionid bats (Chiroptera: Vespertilionidae) from São Paulo State, Brazil. Journal of the New York Entomological Society. 2003; 110: 402-404.

[13] Maa TC. Family Nycteribiidae. In: Evenhuis NL, eds. Catalog of the Australasian and Oceanic Regions. 1st ed. Honolulu: Bishop Museum Press and Brill Bishop EJ; 1989. p. 790-794.

[14] Muñoz LS, González DA, Fernández I. First record of *Basilia silvae* (Diptera: Nycteribiidae) on *Histiotus montanus* (Chiroptera: Vespertilionidae) in Chile. Gayana Concepcion. 2001; 65: 221-222.

[15] Whitaker JRJr, Mumford RE. Records of ectoparasites from Brazilian mammals. Entomological News, 1977; 88: 255-258.

[16] Autino AG, Claps GL, Barquez RM. Ectoparasitic insects of murcielagos from the Yungas of Argentina. Acta Zoologica Mexicana. 1999; 78: 119-169.

[17] Claps GL, Autino AG, Barquez RM. New appointments of ectoparasitic dipterans (Nycteribiidae) for bats from Argentina. Journal of the Argentine Entomological Society. 1992: 50: 88.

[18] Graciolli G, Linardi PM. Some Streblidae and Nycteribiidae (Diptera: Hippoboscoidea) from Maracá Island, Roraima, Brazil. Memórias do Instituto Oswaldo Cruz. 2002c; 97(1): 139-141.

[19] Graciolli G. Nycteribiidae (Diptera, Hippoboscoidea) in southern Brazil. Brazilian Journal of Zoology. 2004; 21(4): 971–985.