

# Records of bat flies (Diptera: Hippoboscoidea) collected from Palawan and nearby islands, the Philippines

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## ABSTRACT

The Greater Palawan faunal region is one of the major ecoregions in the Philippines and comprises Palawan, Busuanga, Culion, Balabac, Coron, Dumarán, Cuyo, and smaller adjacent islands. Chiropteran fauna of this ecoregion is represented by more than 30 species, including Philippine endemics such as *Acerodon leucotis* (Sanborn, 1950) (Palawan flying fox) and *Rhinolophus virgo* Andersen, 1905 (Yellow-faced horseshoe bat). This paper presents an account of streblid and nycteribiid bat flies found in the region, including new geographic records from Balabac municipality and mainland Palawan. In addition, this paper provides the first checklist of bat ectoparasites found in the Greater Palawan faunal region of the Philippines.

**Keywords:** Chiroptera, ectoparasites, new records, Palawan

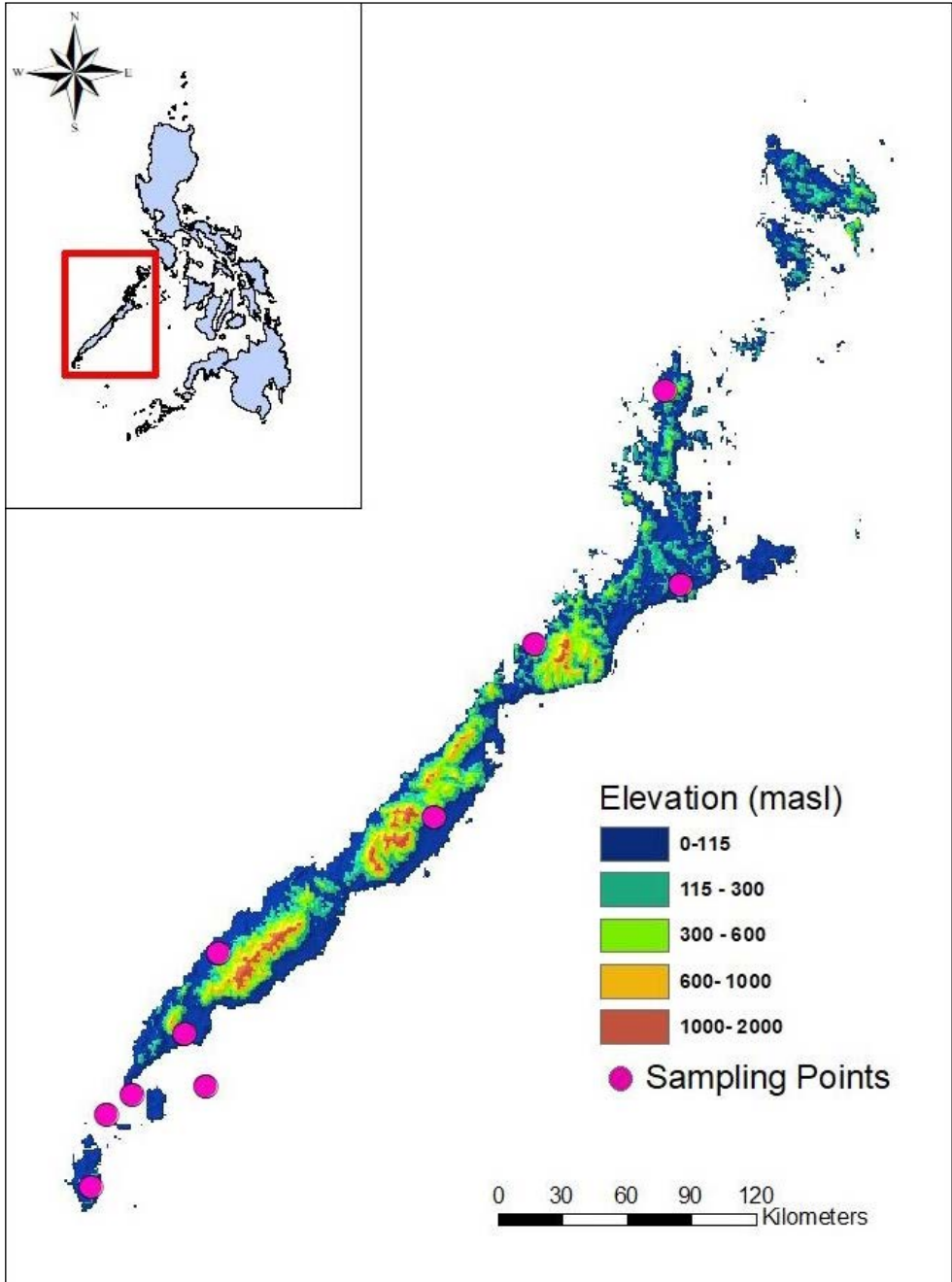
## INTRODUCTION

The Greater Palawan faunal region is one of the major biogeographic divisions of the Philippine archipelago based on the connection of land bridges during the late Pleistocene (Heaney, 1993). This ecoregion comprises mainland Palawan, Busuanga, Culion, Balabac, Coron, Dumarán, Cuyo, and smaller adjacent islands. Due to the presence of a land bridge connecting Borneo to Palawan, mammal assemblage of this faunal region exhibits stronger zoogeographic affinity to the Sunda shelf than other Philippine faunal regions (Everett, 1889; Heaney *et al.*, 1986). The Greater Palawan faunal region is home to more than 30 species of bats belonging to 23 genera representing the families Emballonuridae, Hipposideridae, Megadermatidae, Miniopteridae, Molossidae, Pteropodidae, Rhinolophidae, and Vespertilionidae (Allen, 1922; Esselstyn *et al.*, 2004; Heaney *et al.*, 2010). Of the more than 30 species, only *Acerodon leucotis* (Sanborn, 1950) (Palawan flying fox) is known to be endemic to this faunal region (Mildenstein *et al.*, 2020).

Bat flies (Diptera: Hippoboscoidea) are among the most common ectoparasitic insects associated with bats. These blood-feeding flies have evolved as exclusive parasites of the Order Chiroptera (in addition to fleas of the family Ischnopsyllidae and the bug family Polytectenidae) and are often found foraging on the pelage as well as wing membrane of their hosts (Dittmar *et al.* 2015). Together with the families Glossinidae (tsetse flies) and Hippoboscidae (louse flies and keds), bat flies belong to the superfamily Hippoboscoidea, a group of haematophagous calyptrate flies capable of reproducing via adenotrophic viviparity (Petersen *et al.*, 2007). Records of bat flies in Palawan and its adjacent islands remain sparse, with only a limited number of studies published based on specimens collected from these areas (Jobling, 1951; Theodor, 1963; Cuy, 1980a, b; Amarga and Hastriter, 2023b; Amarga *et al.*, 2023). Our paper presents the bat fly fauna of the Greater Palawan faunal region along with new geographic records from Palawan and Balabac.

## MATERIALS AND METHODS

Bat hosts were captured using mist nets during different fieldworks from 2017–2019 and mist nets were established across different flyways in selected forests and agroforest areas. Upon capture, bats were identified to the species level using published taxonomic keys (Ingle and Heaney, 1992). Ectoparasites were carefully collected with fine-tipped forceps and preserved in 95% ethanol prior to identification. Additional specimens deposited in natural history collections were also examined and included in this study to supplement host and geographic data. Bat flies were examined under Leica S9D microscope (Leica Biosystems, Germany) and identified to species level using published keys (e.g., Jobling, 1951; Theodor, 1963). Map presenting the collection sites was created using ArcGIS version 10 (Figure 1). Acronyms used in this study are as follow: AKSA, First author's private parasite collection (voucher specimens to be deposited in National Taiwan University); BPBM, Bernice P. Bishop Museum, Honolulu, Hawaii (USA); ITL, Insect Taxonomy Laboratory, College of Agriculture and Food Science, University of the Philippines Los Baños; NMNS, National Museum of Natural Science (Taiwan).



**Figure 1.** Field collection sites of bat flies in Palawan and its nearby islands, Philippines.

## RESULTS AND DISCUSSION

The first recorded bat fly species in Greater Palawan faunal region is the flying fox nycteribiid *Cyclopodia horsfieldi* reported by Ferris (1925) from spirit-preserved *Pteropus vampyrus* and unidentified *Pteropus* collected in Palawan. This nycteribiid bat fly is widespread across Southeast Asia and primarily parasitic on flying foxes, particularly the genera *Acerodon* and *Pteropus* (Amarga *et al.*, 2023). Jobling (1951) published the first treatise on Philippine winged streblids based on the materials collected during the 1946–1947 zoological expedition conducted by the Field Museum of Natural History and listed three species from Palawan. Subsequently, Theodor (1963) utilized materials from the same expedition and published a compilation of Philippine nycteribiids wherein he reported four species collected from Palawan, including the first Philippine record of *Basilina majuscula* (Edwards) on *Hypsugo imbricatus* (Horsfield) (reported as *Pipistrellus imbricatus*) from Puerto Princesa. Cuy (1980a, b) listed six nycteribiids and three winged streblids to have occurred in Palawan province and suggested that the Philippine record of *Brachytarsina modesta* (collected in Puerto Princesa) presented in Jobling (1951) is a result of misidentification based on his personal communication with the late Dr. Tsing-chao Maa, a prominent bat fly taxonomist based in Taiwan. Hastriter (2007) reported the endoparasitic streblid fly *Maabella stomalata* Hastriter and Bush from Busuanga Island and this account represents the sole ascodipterine fly in Greater Palawan faunal region known to date. Recently, Amarga and Hastriter (2023b) published a new island record of *C. horsfieldi* in Ursula Island (southern Palawan) and Amarga *et al.* (2023) reported a new host record for *C. horsfieldi* as a parasite of Palawan flying fox (*A. leucotis*).

This paper presents new island records for bat flies in Palawan Province, including the first documentation of *Brachytarsina amboinensis* and *B. werneri* in Greater Palawan faunal region, making the total number of bat flies in the region to 12 species (see Table 1; representative species are presented in Figure 2). Aside from streblids and nycteribiid bat flies, several ectoparasitic arthropods associated with bats have been recorded in Palawan and nearby islands as well. These include accounts of bat fleas from the genus *Thaumapsylla* (Amarga and Hastriter, 2022a), sarcoptid mite (Mitchell and Fain, 1963), and spinturnicid mites (Cuy, 1979; Amarga, 2023a). A summary of bat ectoparasites of Greater Palawan faunal region is presented in Table 1.

Although the list of bat ectoparasites in Greater Palawan faunal region is far from complete, this paper provides a preliminary account of the bat ectoparasite fauna occurring in Palawan and nearby islands. To supplement this faunistic gap, it is also important to explore other sites to further document bat ectoparasites in this region since many areas remain unexplored. For example, cave systems and karst environments especially in Palawan mainland (e.g., Puerto Princesa subterranean system and Tabon Cave Complex) are relatively understudied in terms of chiropteran fauna and its associated ectoparasites. In addition, mountain ecosystems such as Mt. Mantalingajan (southern Palawan) and Mt. Victoria (central Palawan) should also be a subject for future exploration for bats and their ectoparasites. Also, it has been noted that Palawan shared several bat species with the island of Borneo (see Bornean bat list by Struebig *et al.*, 2010). Thus, investigating the extent of shared faunal affinity of two areas in terms of bat ectoparasite assemblage (including fleas and mites) also merits investigation since this comparison has never been done before. Furthermore, screening of associated microbes on bat ectoparasites also merits investigation to further understand the potential role of bat flies on pathogen transmission on bats as well as examine their relationship with the bacterial and viral Bornean strains of bat-associated pathogens.

**Order Diptera Linnaeus, 1758**  
**Suborder Brachycera Macquart, 1834**  
**Parvorder Calypttratae Robineau-Desvoidy, 1830**  
**Superfamily Hippoboscoidea Samouelle, 1819**  
**Family Streblidae Kolenati, 1863**

***Brachytarsina amboinensis* Rondani, 1878**

**Material examined: PHILIPPINES: PALAWAN IS.:** ex *Rhinolophus virgo* Andersen, 1905: 1♀ (AKSA), Barangay Cabigaan, Aborlan municipality (9.465833N, 118.476944E), 21.IV.2017, coll. A.K.S. Amarga. (**new island record**)

**Remarks:** This species is widespread in the Oriental faunal region extending to the Australasian faunal region. In the Philippines, this species was reported on the following island: Batan (Amarga and Amarga, 2023), Bohol (Amarga and Phelps, 2021), Luzon (Cuy, 1980a), Marinduque (Amarga *et al.*, 2017), Mindanao (Jobling, 1951; Cuy, 1980a), Mindoro (Alvarez *et al.*, 2016), Polillo (Cuy, 1980a), Siargao (Amarga and Hastriter, 2022b), and Tablas (Jobling, 1951; Cuy, 1980a). Our account represents the first record of *B. amboinensis* in the Greater Palawan faunal region.

***Brachytarsina proxima* (Jobling, 1951)**

**Material examined: PHILIPPINES: PALAWAN IS.:** ex *Rhinolophus* sp.: 1♂, 1♀ (ITL), Sitio Sabang, Barangay Cabayugan, Puerto Princesa (10.192987N, 118.899916E), 23.IX.1978, coll. P.O. Glass.

**Remarks:** This species is endemic in the Philippines and reported on the following islands: Luzon (Cuy, 1980a), Marinduque (Amarga *et al.*, 2017), Mindanao (Jobling, 1951; Cuy, 1980a), and Palawan (Cuy, 1980a).

***Brachytarsina wernerii* (Jobling, 1951) (Figure 2A)**

**Material examined: PHILIPPINES: DALAHICAN IS.:** ex *Hipposideros diadema* (Geoffroy, 1813): 2♂, 3♀ (AKSA), Barangay Pandanan, Balabac municipality (8.301865N, 117.208012E), 1–3.XI.2019, coll. J. Cantil. (**new island record**)

**Remarks:** This species is known only from the Philippines and was previously recorded in the following islands: Batan (Amarga and Amarga, 2023), Bohol (Amarga and Phelps, 2021), Luzon (Cuy, 1980a), Marinduque (Amarga *et al.*, 2017), Mindanao (Jobling, 1951; Cuy, 1980a), Mindoro (Alvarez *et al.*, 2016), and Samar (Amarga, 2023c). Our account of *B. wernerii* represents the first record for the Greater Palawan faunal region.

***Maabella stomalata* Hastriter and Bush, 2006**

**Material examined: PHILIPPINES: BUSUANGA IS.:** ex “leaf-nosed bat”: 5♀ (BM-1005, BM-1006A-B, BM-1018, BBM-2982), 16 km SE San Nicholas, Busuanga, 22.V.1962, coll. M Thompson (BPBM); ex *Rousettus amplexicaudatus* Geoffroy, 1810: 1♀ (BM-1027A-C), 6 km NE San Nicholas, Busuanga, 24.V.1962, coll. M. Thompson (BPBM).

**Remarks:** This species was first described based on neosomic females collected from China and Vietnam (Hastriter and Bush, 2006). The first account of *M. stomalata* in the Philippines was reported by Hastriter (2007) based on specimens collected in Busuanga Island (Palawan Province), Negros, and Cebu.

***Megastrebla parvior* (Maa, 1965) (Figure 2B)**

**Material examined:** PHILIPPINES: BALABAC IS.: ex *Rousettus amplexicaudatus* Geoffroy, 1810: 3♂, 6♀ (AKSA), Barangay Indalawan, Balabac municipality (7.911886, 117.035129), 25–29.X.2019, coll. J. Cantil. BANCALAN IS.: ex *R. amplexicaudatus*: 2♀ (AKSA), Barangay Bancalaan, Balabac municipality (8.21907N, 117.10364E), 30.X.–01.XI.2019, coll. J. Cantil (**new island record**). PALAWAN IS.: ex *Eonycteris spelaea* (Dobson, 1871): 3♀ (AKSA), Barangay Cabigaan, Aborlan municipality (9.465833, 118.476944), 21.IV.2017, coll. A.K.S. Amarga; ex *E. spelaea*: 2♂, 1♀ (AKSA), Barangay Rio Tuba, Bataraza municipality (8.553901N, 117.430175E), 22–26.VI.2019, coll. R. Giganto; ex *E. spelaea*: 1♀ (AKSA), Barangay Antonino, Roxas municipality (10.439195N, 119.508772E), 25.VII.2019, coll. A.K.S. Amarga and J. Cantil; ex *R. amplexicaudatus*: 2♀ (AKSA), Sitio Malutok, Barangay Ransang, Rizal municipality (8.894204N, 117.573111E), 16–18.XI.2017, coll. H. Centeno.

**Remarks:** This macropterous bat fly is widely distributed in the Oriental region, especially in Southeast Asia and primarily parasitic on pteropodid bats primarily belonging to the genera *Rousettus* and *Eonycteris* (Maa, 1971). In cave environment, fruit bats with co-roosting behavior such as the case of *E. spelaea* and *R. amplexicaudatus* (Corbet and Hill, 1992) are both parasitized by *M. parvior* along with *Eucampsipoda* bat flies and *Thaumapsylla* fleas. In the Philippines, *M. parvior* is the only representative of the genus *Megastrebla* that has been previously reported on the following islands: Balabac (Maa, 1971), Batan (Amarga and Amarga, 2023), Bohol (Amarga and Phelps, 2021), Cebu (Maa, 1971; Amarga and Hastriter, 2023a), Leyte (Maa, 1971), Luzon (Maa, 1971; Cuy, 1980a; Zabat and Eduardo, 2011; Amarga, 2023b), Marinduque (Amarga *et al.*, 2017), Mindanao (Maa, 1971; Cuy, 1980a), Mindoro (Alvarez *et al.*, 2016), Negros (Maa, 1971), Palawan (Maa, 1971; Cuy, 1980a), Samal (Cuy, 1980a), Samar (Amarga, 2023c), and Siargao (Amarga and Hastriter, 2022b).

***Raymondia pseudopagodarum* Jobling, 1951**

**Remarks:** Philippine records of *R. pseudopagodarum* include the following: Bohol (Amarga and Phelps, 2021), Luzon (Cuy, 1980a; Amarga, 2023b), Marinduque (Amarga *et al.*, 2017, Mindanao (Jobling, 1951; Cuy, 1980a), Mindoro (Alvarez *et al.*, 2016), Negros (Cuy, 1980a), and Palawan (Jobling, 1951; Cuy, 1980a).

**Family Nycteribiidae Samouelle, 1819*****Basilina majuscula* (Edwards, 1919)**

**Remarks:** This species is the only representative of the genus *Basilina* Miranda-Ribeiro in the Philippines. To date, the only published record of *B. majuscula* in the Philippines is the account of Theodor (1963) based on specimens collected in Puerto Princesa (Palawan Island) in 1947.

***Cyclopodia horsfieldi* de Meijere, 1899 (Figure 2C)**

**Material examined:** PHILIPPINES: BALABAC IS.: ex *Acerodon leucotis*: 4♂ (NMNS 8722-24, NMNS 8722-25, NMNS 8722-26, NMNS 8722-27), 1♀ (NMNS 8722-23), Barangay Indalawan, Balabac municipality (7.911886, 117.035129), 25–29.X.2019, coll. J. Cantil; URSULA IS.: ex *Pteropus hypomelanus* Temminck, 1853: 1♀, Ursula Island, Bataraza municipality (8.338300, 117.516111), 27.VI.2019, coll. R. Giganto and A. Santillan.

**Remarks:** This large nycteribiid is endemic to the Oriental faunal realm and is primarily parasitic on flying foxes (Amarga *et al.*, 2023). Philippine island records for *C. horsfieldi* are as follow: Balabac (Cuy, 1980b), Busuanga (Cuy, 1980b), Camiguin (Cuy, 1980b), Cebu (Amarga and Hastriter, 2023a; Amarga and Manalo, 2023), Culion (Cuy, 1980b), Guimaras (Cuy, 1980b), Jolo (Cuy, 1980b), Leyte (Cuy, 1980b), Luzon (Cuy, 1980b; Amarga and Manalo, 2023), Mindanao (Cuy, 1980b), Mindoro (Cuy, 1980b; Alvarez *et al.*, 2016), Palawan (Cuy, 1980b), Panay (Cuy, 1980b; Amarga and Manalo, 2023), Tawi-Tawi (Amarga and Manalo, 2023), and Ursula (Amarga and Hastriter, 2023b).

#### ***Eucampsipoda inermis* Theodor, 1955**

**Material examined: PHILIPPINES: BALABAC IS.:** ex *R. amplexicaudatus*: 1♂, 4♀ (AKSA), Barangay Indalawan, Balabac municipality (7.911886, 117.035129), 25–29.X.2019, coll. J. Cantil. **PALAWAN IS.:** ex *Rousettus amplexicaudatus*: 3♂, 5♀ (AKSA), Sitio Malutok, Barangay Ransang, Rizal municipality (8.894204, 117.573111), 16–18.XI.2017, coll. H. Centeno.

**Remarks:** This species is widespread in Southeast Asia. It has been documented in the following islands in the Philippines: Balabac (Cuy, 1980b), Bohol (Amarga and Phelps, 2021), Busuanga (Cuy, 1980b), Cebu (Cuy, 1980b), Catanduanes (Cuy, 1980b), Leyte (Cuy, 1980b), Luzon (Cuy, 1980b), Marinduque (Amarga *et al.*, 2017), Mindoro (Cuy, 1980b; Alvarez *et al.*, 2016), Negros (Cuy, 1980b), Palawan (Cuy, 1980b), Samal (Cuy, 1980b), Samar (Cuy, 1980b), Jolo (Cuy, 1980b).

#### ***Eucampsipoda philippinensis* Ferris, 1924**

**Material examined: PHILIPPINES: PALAWAN IS.:** ex *Eonycteris spelaea*: 2♀ (AKSA), Barangay Cabigaan, Aborlan municipality (9.465833, 118.476944), 23.IV.2017, coll. L.O. Operio.

**Remarks:** Philippine geographic records of *E. philippinensis* are as follows: Leyte (Cuy, 1980b), Luzon (Cuy, 1980b), Negros (Cuy, 1980b), Marinduque (Amarga *et al.*, 2017), Mindanao (Cuy, 1980b), and Mindoro (Alvarez *et al.*, 2016).

#### ***Eucampsipoda sundaica* Theodor, 1955 (Figure 2D)**

**Material examined: PHILIPPINES: BALABAC IS.:** ex *Rousettus amplexicaudatus*: 5♂, 3♀ (AKSA), Barangay Indalawan, Balabac municipality (7.911886, 117.035129), 25–29.X.2019, coll. J. Cantil. **PALAWAN IS.:** ex *Eonycteris spelaea*: 13♂, 7♀ (AKSA), Barangay Rio Tuba, Bataraza municipality (8.553901, 117.430175), 22–26.VI.2019, coll. R. Giganto; ex *R. amplexicaudatus*: 2♂, 6♀ (AKSA), Barangay Pasadena, El Nido municipality (11.253257, 119.445055), 30.VII.2019, coll. A.K.S. Amarga and J. Cantil.

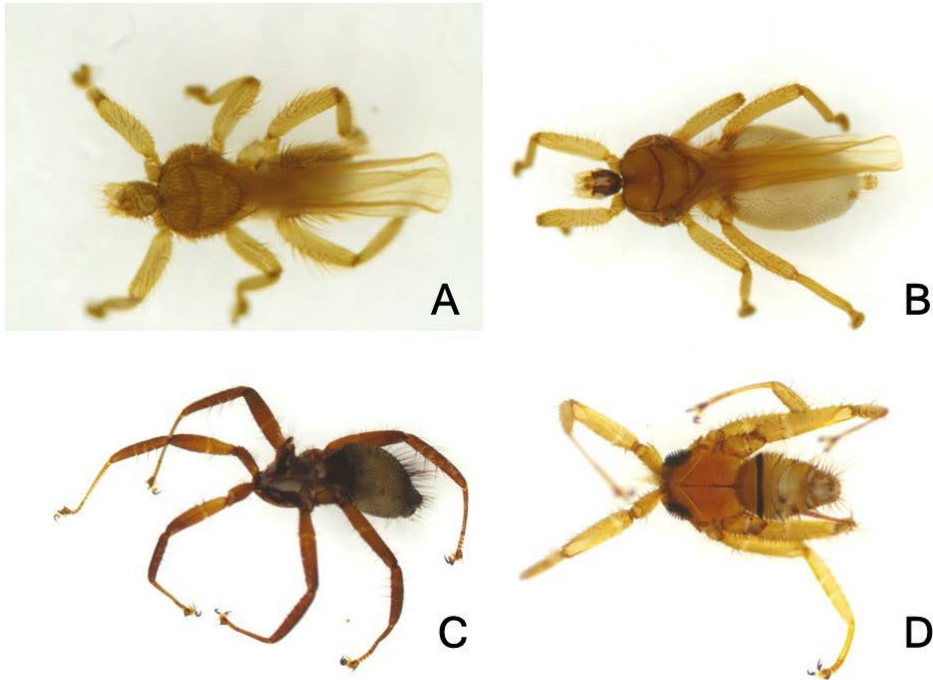
**Remarks:** This species is widespread in Southeast Asia and has been recorded in the Philippines on the following islands: Batan (Amarga and Amarga, 2023), Bohol (Amarga and Phelps, 2021), Leyte (Cuy, 1980b), Luzon (Cuy, 1980b; Zabat and Eduardo, 2011), Negros (Cuy, 1980b), Mindanao (Cuy, 1980b), Mindoro (Cuy, 1980b; Alvarez *et al.*, 2016), Palawan (Cuy, 1980b), and Siargao (Amarga and Hastriter, 2022b).

#### ***Leptocyclopodia palawanensis* (Theodor, 1959)**

**Material examined: PHILIPPINES: BALABAC IS.:** ex *Acerodon leucotis* (Sanborn, 1950): 1♂ (NMNS 8722-30), 2♀ (NMNS 8722-28, NMNS 8722-29), Barangay Indalawan, Balabac municipality (7.911886N, 117.035129E), 25–29.X.2019, coll. J. Cantil. **PALAWAN IS.:** ex *Cynopterus brachyotis* (Müller, 1838): 3♂, 5♀ (AKSA),

Barangay Cabigaan, Aborlan municipality (9.465833N, 118.476944E), 21.IV.2017, coll. A.K.S. Amarga; ex *C. brachyotis*: 2♂, 2♀ (AKSA), Sitio Malutok, Barangay Ransang, Rizal municipality (8.894204N, 117.573111E), 16–18.XI.2017, coll. H. Centeno; ex *C. brachyotis*: 25♂, 20♀ (AKSA), Barangay Rio Tuba, Bataraza municipality (8.553901N, 117.430175E), 22–26.VI.2019, coll. R. Giganto; ex *C. brachyotis*: 2♀ (AKSA), Barangay Antonino, Roxas municipality (10.439195N, 119.508772E), 24.VII.2019, coll. A.K.S. Amarga and J. Cantil; ex *C. brachyotis*: 3♂, 2♀ (AKSA), Barangay Pasadena, El Nido municipality (11.253257N, 119.445055E), 29.VII.2019, coll. A.K.S. Amarga and J. Cantil; ex *C. brachyotis*: 1♂, 1♀ (AKSA), Barangay Pasadena, El Nido municipality (11.253257N, 119.445055E), 30.VII.2019, coll. A.K.S. Amarga and J. Cantil; ex *C. brachyotis*: 4♂, 1♀ (AKSA), Barangay Pasadena, El Nido municipality (11.253257N, 119.445055E), 31.VII.2019, coll. A.K.S. Amarga and J. Cantil; ex *C. brachyotis*: 1♂, 4♀ (AKSA), Barangay Pasadena, El Nido municipality (11.253257N, 119.445055E), 01.VIII.2019, coll. A.K.S. Amarga and J. Cantil.

**Remarks:** This species is endemic to Greater Palawan faunal region and primarily parasitic to *C. brachyotis* (Lesser short-nosed fruit bat) (Theodor, 1959, 1963). The presence of this species on other pteropodids can be designated as a facultative occurrence such as the case in *A. leucotis* (Amarga *et al.*, 2023).



**Figure 2.** Representative species of bat flies of Greater Palawan faunal region. **A**, *Brachytarsina wernerii*; **B**, *Megastrebula parvior*; **C**, *Cyclopodia horsfieldi*; **D**, *Eucampsipoda sundaica*.

**Table 1.** Preliminary checklist of bat ectoparasites reported in Greater Palawan faunal region.

Family	Species	References on Greater Palawan faunal region records
Arixeniidae	<i>Xeniarina truncata</i>	Nakata and Maa, 1974
Argasidae	<i>Argas pusillus</i>	Kohls, 1950
Ischnopsyllidae	<i>Thaumapsylla breviceps</i>	Beaucournu and Kock, 1994; Amarga and Hastriter, 2022a
Nycteribiidae	<i>Basilia majuscula</i>	Theodor, 1963
	<i>Cyclopodia horsfieldi</i>	Ferris, 1925; Theodor, 1963; Cuy, 1980b; Amarga and Hastriter, 2023b; Amarga <i>et al.</i> , 2023; <b>current study</b>
	<i>Eucampsipoda inermis</i>	Cuy, 1980b; <b>current study</b>
	<i>Eucampsipoda philippinensis</i>	Cuy, 1981; <b>current study</b>
	<i>Eucampsipoda sundaica</i>	Theodor, 1963; Cuy, 1980b; <b>current study</b>
	<i>Leptocyclopodia palawanensis</i>	Theodor, 1959, 1963; Cuy, 1980b; <b>current study</b>
Sarcoptidae	<i>Teinoptes asiaticus</i>	Mitchell and Fain, 1963
Spinturnicidae	<i>Ancystropus kanheri</i>	Cuy, 1979
	<i>Ancystropus zeleborii</i>	Cuy, 1979
	<i>Meristaspis calcarata</i>	Cuy, 1979; Amarga, 2023a
	<i>Meristaspis lateralis</i>	Cuy, 1979
Strebliidae	<i>Brachytarsina amboinensis</i>	<b>Current study</b>
	<i>Brachytarsina proxima</i>	Cuy, 1980a; <b>current study</b>
	<i>Brachytarsina werneri</i>	<b>Current study</b>
	<i>Maabella stomalata</i>	Hastriter, 2007; <b>current study</b>
	<i>Megastrebla parvior</i>	Jobling, 1951; Maa, 1971; Cuy, 1980a; <b>Current study</b>
	<i>Raymondia pseudopagodarum</i>	Cuy, 1980a; Jobling, 1951

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