

# A contribution to the ectoparasite fauna of bats (Mammalia: Chiroptera) in Mindoro Island, Philippines: I. Blood sucking Diptera (Nycteribiidae, Streblidae) and Siphonaptera (Ischnopsyllidae)

James D. V. Alvarez<sup>1\*</sup>, Ireneo L. Lit, Jr<sup>1,2</sup>, Phillip A. Alviola<sup>1,2</sup>,  
Edison A. Cosico<sup>1</sup> and Eduardo G. Eres<sup>1</sup>

<sup>1</sup>Museum of Natural History, University of the Philippines Los Baños, Laguna 4031, Philippines; <sup>2</sup>Institute of Biological Sciences, University of the Philippines Los Baños, Laguna 4031, Philippines

(Accepted 14 March 2016)

**Abstract.** New data on bat ectoparasites from Mindoro Island, Philippines are reported. Eighty-three individuals of ectoparasitic insects representing seven species of Nycteribiidae and five species of Streblidae (both Diptera), and one species of Ischnopsyllidae (Siphonaptera) were recorded from 11 bat species captured in Naujan Lake National Park, Mindoro Oriental Province, Philippines. *Raymondia pagodarum* is a new record for the country. Eight species are also newly recorded for Mindoro Island, including *Cyclopodia garrula*, *Leptocyclopodia ferrarii mabuhai*, *Megastrebla parvior*, *Brachytarsina amboinensis*, *B. weneri*, *R. pagodarum*, *R. pseudopagodarum* and *Thaumapsylla longiforceps*. Five species are newly documented on various hosts: *C. horsfieldi* on *Pteropus pumilus*, *M. parvior* on *Macroglossus minimus*, *B. amboinensis* on *Hipposideros diadema*, *B. weneri* on *Rhinolophus arcuatus* and *R. pagodarum* on *Hipposideros bicolor*.

**Key words:** Bats, ectoparasites, Ischnopsyllidae, Nycteribiidae, Streblidae, Mindoro Island

## Introduction

Ectoparasites are externally borne organisms that are well-adapted as blood or lymph feeders (Patterson *et al.*, 1998; Patterson *et al.*, 2007). Early studies on bat ectoparasites in the Philippines were on various arthropod groups including bat flies (Ferris, 1924a,b, 1925a,b; Theodor 1955, 1963; Maa, 1962, 1966, 1968, 1971, 1975; Cuy, 1980a,b, 1981), fleas (Hopkins and Rothschild, 1956), chiggers (Womersley, 1957), ticks (Kohls, 1950), laelaptoids (Delfinado, 1960), spinturnicid mites (Delfinado and Baker, 1963; Baker and Delfinado, 1964; Prasad, 1970; Cuy, 1979) and sarcoptid mites (Klompen, 1992). The most recent literature on bat ectoparasites in

the Philippines include those by Zabat and Eduardo (2011) and Alvarez *et al.* (2015).

Although there is an immense diversity of ectoparasites associated with bats, they are often disregarded or neglected in the study of bat ecology (Messenger *et al.*, 2003). For instance, only a few studies have reported on the ectoparasites of bats in Mindoro. In his synopsis of Philippine bat flies, Cuy (1980a,b) reported only four species from Mindoro. In addition, Theodor (1963) described two new species (*Penicillidia oligacantha* and *P. acuminata*) which was erroneously reported by Ferris (1924b) as *Penicillidia jenynsii*. In 1981, Cuy also noted the presence of *Eucampsipoda philippinensis* in the island. Thus, only seven bat fly species are known in Mindoro.

These ectoparasites are of veterinary importance as potential vectors that enable pathogens and

\*E-mail: jdalvarez1@up.edu.ph

**Table 1.** Species of bats inspected for ectoparasites at Naujan Lake National Park, Mindoro Island, Philippines in 2011

Bat species	Number inspected for ectoparasites	Number of infested individuals (%)
Fruit bats		
<i>Cynopterus brachyotis</i>	28	3 (10.71)
<i>Eonycteris spelaea</i>	2	2 (100)
<i>Macroglossus minimus</i>	30	1 (3.33)
<i>Ptenochirus jagori</i>	15	4 (26.67)
<i>Pteropus pumilus</i>	5	2 (40)
<i>Rousettus amplexicaudatus</i>	11	10 (90.91)
Insect bats		
<i>Harpiocephalus harpia</i>	1	0 (0)
<i>Hipposideros bicolor</i>	1	1 (100)
<i>Hipposideros diadema</i>	1	1 (100)
<i>Myotis rufopictus</i>	1	0 (0)
<i>Rhinolophus arcuatus</i>	2	2 (100)

potentially pathogenic microorganisms to bypass barriers such as fur and skin (Messenger *et al.*, 2003; Dick and Patterson, 2006). In the Philippines, bats were recently shown to harbour parasitic protozoans (Murakoshi *et al.*, 2016) and viruses (Watanabe *et al.*, 2010; Taniguchi *et al.*, 2011; Tsuda *et al.*, 2012), although their zoonosis are still indefinite. Bat flies are also reported to harbour fungi belonging to Order Lalouleniales (Blackwell, 1980; Marshall, 1982).

In this paper, we provide an update on the bat fly and flea fauna present in Mindoro Island, particularly in the vicinities of Naujan Lake National Park.

## Materials and methods

### *Field sampling of bats and ectoparasites*

Mist nets were used to capture bats. Upon removal from the nets, captured bats were placed separately in clean cloth bags for further identification and ectoparasite collection. We followed the treatment of Ingle and Heaney (1992) regarding bat nomenclature. Bats were identified to species level (Table 1). Voucher specimens were also collected for each species as stipulated in the Gratuitous Permit No. 2011-0002 issued by the Philippine Department of Environment and Natural Resources (DENR), and were deposited at the University of the Philippines Los Baños Museum of Natural History (UPLB MNH), Philippines. Bats that were not sacrificed and preserved as voucher specimens were released back to the wild. Prior to release, bats were fed with sugar–water solution for energy.

Bats that were sacrificed were euthanized with ethyl acetate. Afterwards, the surface of the bats was inspected closely with particular attention to body parts typically preferred by certain parasites, i.e. head, patagia and axilla. Ectoparasites were

collected with a pair of forceps and placed in vials containing 70% ethanol.

### *Ectoparasite preparation and identification*

Ectoparasites were identified using the identification key of Cuy (1980a,b) and Hopkins and Rothschild (1956). Streblidae, Ischnopsyllidae and representative individuals of Nycteribiidae were cleared in 10% potassium hydroxide (KOH) and mounted in modified Hoyer's medium. Unmounted specimens of nycteribiids were stored in 70% ethanol. Host and distribution records were based on available literature on ectoparasites of bats in the Philippines (Cuy, 1980a,b, 1981; Alvarez *et al.*, 2015). Voucher specimens were deposited at the Entomological Collections, UPLB MNH.

## Results

From the 11 species of bats that were collected, 83 individuals of ectoparasites, including seven species of nycteribiid flies, five species of streblid flies and one species of ischnopsyllid flea were documented (Table 2). This number includes five new host and eight new island records. *Raymondia pagodarum* (Diptera: Streblidae) is a new record to Mindoro and the Philippines. These species are given below.

### *Ectoparasite accounts*

#### Order Diptera

##### Family Nycteribiidae

##### Subfamily Cyclopodiinae

##### Genus *Cyclopodia*

*Cyclopodia garrula* Maa 1968

**Table 2.** Summary of bat ectoparasite species recorded in the Philippines and Mindoro Island, from previous studies and current study

All species recorded in Phillipines	Species recorded in Mindoro Island	
	Previous studies	This study
Diptera: Streblidae		
<i>Megastrebla parvior</i>	–	+
<i>Brachytarsina cucullata</i>	–	–
<i>Brachytarsina macrops</i>	–	–
<i>Brachytarsina hoogstraali</i>	–	–
<i>Brachytarsina amboinensis</i>	–	+
<i>Brachytarsina proxima</i>	–	–
<i>Brachytarsina wernerii</i>	–	+
<i>Raymondia pagodarum*</i>	–	+
<i>Raymondia pseudopagodarum</i>	–	+
Diptera: Nycteribiidae		
<i>Leptocyclopodia pilosiptectus</i>	–	–
<i>Leptocyclopodia simulans</i>	+ (Cuy, 1980b, 1981)	+
<i>Leptocyclopodia ferrarii mabuhai</i>	–	+
<i>Leptocyclopodia ferrarii palawanensis</i>	–	–
<i>Leptocyclopodia brevicula</i>	–	–
<i>Leptocyclopodia haplotes</i>	–	–
<i>Cyclopodia horsfieldi</i>	+ (Cuy, 1980b, 1981)	+
<i>Cyclopodia garrula</i>	–	+
<i>Eucampsipoda inermis</i>	+ (Cuy, 1980b, 1981)	+
<i>Eucampsipoda sundaica</i>	+ (Cuy, 1980b, 1981)	+
<i>Eucampsipoda philippinensis</i>	+ (Cuy, 1980b, 1981)	+
<i>Penicillidia dufourii tainani</i>	–	–
<i>Penicillidia oligacantha</i>	+ (Theodor, 1963; Cuy, 1981)	–
<i>Penicillidia acuminata</i>	+ (Theodor, 1963; Cuy, 1981)	–
<i>Basilia majuscula</i>	–	–
<i>Phthiridium brachyacantha</i>	–	–
<i>Phthiridium mindanaense</i>	–	–
<i>Nycteribia allotopa</i>	–	–
<i>Nycteribia allotopoides</i>	–	–
<i>Nycteribia parvula</i>	–	–
<i>Nycteribia parvuloides</i>	–	–
Siphonaptera: Ischnopsyllidae		
<i>Thaumapsylla longiforceps</i>	–	+
<i>Thaumapsylla breviceps orientalis</i>	–	–

+Species recorded in Mindoro.

–Species not recorded in Mindoro.

\*New species record for the Phillipines.

This species was previously recorded on *Harpyio-nycteris whiteheadi* (Cuy, 1980b) and *Ptenochirus jagori* (Alvarez *et al.*, 2015; present study). It is endemic to the Philippines and previously recorded only from Mindanao (Maa, 1968) and Luzon (Alvarez *et al.*, 2015). The current collection represents a new distribution record for *C. garrula*.

*Specimens examined:* On *P. jagori*, one female (UPLBMNH DIP-1588).

*Cyclopodia horsfieldi* de Meijere 1899

Previously recorded from the pteropodids *Pteropus vampyrus*, *P. hypomelanus*, *P. speciosus*,

*Acerodon jubatus* and *Rousettus amplexicaudatus* (Cuy, 1980b, 1981), this bat fly species is newly recorded on *Pteropus pumilus*, a bat species endemic to the Philippines. *Cyclopodia horsfieldi* is widespread in Thailand, Cambodia and Indonesia. In the Philippines, it is recorded in Luzon, Mindoro, Palawan (Busuanga, Culion, Balabac), Leyte, Panay, Guimaras and Mindanao (Camiguin, Jolo) (Cuy, 1980b).

*Specimens examined:* On *P. pumilus*, four males and eight females (UPLBMNH DIP-1589 to 1600).

#### Genus *Eucampsipoda*

*Eucampsipoda inermis* Theodor 1955

*Eucampsipoda inermis* is a parasite of the pteropodids *Rousettus amplexicaudatus* and *Eonycteris spelaea*. In the Philippines, it is distributed in Luzon, Catanduanes, Mindoro, Palawan (Busuanga, Balabac), Samar, Leyte, Cebu, Negros and Mindanao (Samal, Jolo). It is also widely distributed in Myanmar, Thailand and Indonesia (Cuy, 1980b).

*Specimens examined*: On *R. amplexicaudatus*, 13 males and six females. (UPLBMNH DIP-1601 to 1613, 1615 to 1620); on *E. spelaea*, one male (UPLBMNH DIP-1614).

*Eucampsipoda philippinensis* Ferris 1924

This endemic species was previously recorded from Luzon, Leyte, Mindoro, Negros, Polillo and Marinduque. Host records include *Eonycteris robusta*, *Hipposideros diadema*, *R. amplexicaudatus*, *Miniopterus schreibersii* (Cuy, 1980b, 1981) and *P. jagori* (Alvarez et al., 2015).

*Specimens examined*: On *R. amplexicaudatus*, one male, one female (UPLBMNH DIP-1633, 1634).

*Eucampsipoda sundaica* Theodor 1955

*Eucampsipoda sundaica* is parasitic on *R. amplexicaudatus* and *E. spelaea* (Cuy, 1980b). This species is widely distributed in India, Myanmar, Laos, Cambodia, Thailand, Malaysia, Indonesia and the Philippines (Luzon, Mindoro, Palawan, Leyte, Negros and Mindanao) (Cuy, 1980b, 1981).

*Specimens examined*: On *E. spelaea*, two females (UPLBMNH DIP-1621, 1622).

**Genus Leptocyclopodia**

*Leptocyclopodia ferrarii mabuhai* Maa 1975

This subspecies is recorded on the fruit bats *Cynopterus brachyotis*, *P. jagori*, *Haplonycteris fischeri*, *Macroglossus minimus*, *E. spelaea* and the insectivorous bat *H. diadema*. This endemic subspecies is distributed in Luzon, Leyte, Panay, Guimaras, Negros, Camiguin, Mindanao and recently reported for the first time in Mindoro.

*Specimens examined*: On *C. brachyotis*, one male, two females (UPLBMNH DIP-1623, 1624, 2431).

*Leptocyclopodia simulans* Theodor 1959

This is another endemic species that is parasitic on the fruit bats *P. jagori*, *C. brachyotis*, *R. amplexicaudatus*, *E. robusta* and *M. minimus*. Cuy (1980b) noted that this species is distributed in Luzon, Mindoro, Leyte, Bohol, Cebu, Negros, Camiguin and Mindanao.

*Specimens examined*: On *P. jagori*, two males and one female (UPLBMNH DIP-1625, 1627, 1628); on *C. brachyotis*, one female (UPLBMNH DIP-1626).

**Family Streblidae**

**Subfamily Nycteriboscinae**

**Genus Megastrebla**

*Megastrebla parvior* Maa 1962

In the synopsis of Cuy (1980a), *Megastrebla parvior* is parasitic on the vespertilionids *Miniopterus australis* and *M. schreibersii*, the hipposiderid *H. diadema* and the pteropodids *R. amplexicaudatus*, *E. spelaea* and *E. robusta*. In the current survey, it is newly recorded from the pteropodid *M. minimus*. This species is also newly reported in Mindoro, adding to its distribution in Luzon, Leyte, Negros, Cebu, Palawan, Balabac, Mindanao and Samal (Cuy, 1980a). It is also found in India, Myanmar, Thailand, Malaysia and Indonesia (Cuy, 1981).

*Specimens examined*: On *M. minimus*, one male (UPLBMNH DIP-1630); on *R. amplexicaudatus*, one male and two females (UPLBMNH DIP-1629, 1631, 1632).

**Genus Brachytarsina**

*Brachytarsina amboinensis* Rondani 1878

This species is common in the Oriental and Australian regions. In the Philippines, it is distributed in Luzon, Polillo, Tablas, Mindanao and in this study, it is recorded for the first time in Mindoro. In his account on the bat flies of the Philippines, Cuy (1980a) noted that *B. amboinensis* is parasitic on *M. australis*, *M. schreibersii*, *M. tristis*, *R. amplexicaudatus*, *E. spelaea*, *Rhinolophus* sp. and *Hipposideros coronatus*. This study reports its presence in *H. diadema*.

*Specimens examined*: On *H. diadema*, one female (UPLBMNH-DIP-1575); on *Rhinolophus arcuatus*, four females (UPLBMNH-DIP-1580, 1581, 2437, 2438).

*Brachytarsina werneri* Jobling 1951

This is an endemic species previously recorded only from the hipposiderid *H. diadema* and the pteropodid *E. robusta*. This study reports its presence in *R. arcuatus*. In addition to its record in Luzon and Mindanao (Cuy, 1980a), its distribution extends to Mindoro.

*Specimens examined*: On *R. arcuatus*, one male and two females (UPLBMNH-DIP-2444 to 2446).

**Genus Raymondia**

*Raymondia pagodarum* Speiser

The occurrence of this streblid bat fly in the Philippines is reported for the first time, extending its known geographical distribution. In the Oriental region, this species has overlapping distribution with *R. pseudopagodarum* but extends to tropical South Pacific islands such as the Solomon Islands, Papua (New Guinea) and New Britain (Maa, 1962). In this study, it was recorded only from *Hipposideros bicolor*.

*Specimens examined:* On *H. bicolor*, three females (UPLBMNH-DIP-2403 to 2405).

*Raymondia pseudopagodarum* Jobling 1951

This species is widely distributed in the South-east Asia region, including Borneo, China, Malaya and the Philippines. In the country, it is recorded from Palawan, Negros, Mindanao, Luzon and currently in Mindoro (additional record). In the Philippines, it is known to parasitize *R. arcuatus*, *R. rufus*, *R. virgo*, *Hipposideros galeritus* (= *H. diadema*), *Miniopterus schreibersii*, *M. australis*, *R. amplexicaudatus* and *E. spelaea* (Cuy, 1980a).

*Specimens examined:* On *R. arcuatus*, one male, nine females (UPLBMNH-DIP-2432 to 2436, 2439 to 2443).

**Order Siphonaptera**

**Family Ischnopsyllidae**

**Subfamily Thaumapsyllinae**

**Genus Thaumapsylla**

*Thaumapsylla longiforceps* Traub 1951

This species is similar to *T. breviceps* but can be distinguished by the form of the clasper and crochet in males, and the large sinus and small number of bristles ( $\leq 6$ ) on sternite VII in females. The two species also overlap in their host species.

*Thaumapsylla longiforceps* is distributed in the Oriental and Australian regions. In its Oriental range, it is reported from *Miniopterus tristis* (Philippines), *R. amplexicaudatus* (Java) and *C. brachyotis* (Borneo) (Hopkins and Rothschild, 1956). Its distribution extends to New Guinea where it is a parasite of *H. diadema* (Hopkins and Rothschild, 1956). This is the first record of this species in Mindoro. Previously, it was collected from Montalban, Rizal Province in Luzon Island (Hopkins and Rothschild, 1956).

*Specimens examined:* On *R. amplexicaudatus*, three males, one female (UPLBMNH-SIP-0001 to 0004).

**Discussion**

Prior to this survey, there were only seven species of ectoparasites recorded from bats in Mindoro. For the recent collection, we documented an additional seven species, including *R. pagodarum*, which is a

new record to Mindoro and the Philippines. Thus, 14 species of bat ectoparasites are currently known from the island. This also includes four species and one subspecies endemic to the Philippines. This number, however, is probably an underestimate and subsequent collections of other bat species will likely add to the ectoparasite fauna of Mindoro.

The pteropodid fauna of Mindoro island has amongst the most endemic species compared to any other island in the Philippines, with two endemic species, *Desmalopex microleucopterus* (Esselstyn *et al.*, 2008) and *Styloctenium mindorensis* (Esselstyn, 2007). However, we were only able to capture four pteropodid species. Other pteropodids known from the island include *A. jubatus*, *D. microleucopterus*, *E. robusta*, *H. fischeri*, *H. whiteheadi*, *P. vampyrus* and *S. mindorensis* (Heaney *et al.*, 2010). From these bat species that were not collected in the current study, it is possible to document at least 16 species of bat flies which are not previously reported on the island. Information on the ectoparasites of the recently described species of bats (i.e. *D. microleucopterus* and *S. mindorensis*) from Mindoro is non-existent.

During our survey, we were able to capture only five species of insectivorous bats. However, a further 21 species of bats have been recorded in Mindoro. These insect bats are usually cave dwelling and we failed to document any cave within the vicinities of Naujan Lake. More extensive collections are necessary to document more ectoparasite species that could be new host and locality records or new to science. Large samples are also necessary to determine and establish patterns of host-parasite relationships. During our sampling, we used the typical mist nets, which are less efficient in capturing echolocating bats that easily evade these nets. Thus, use of multiple methods to capture host bats is recommended for future studies.

**Acknowledgements**

We dedicate this study to the memory of Luisito Salandanan Cuy who continues to inspire young wildlife biologists and arthropod systematists in the Philippines, but who unfortunately perished together with six others during a forestry practicum and wildlife fieldwork on Lake Naujan in May 1982. The study was part of the UPLB MNH project 'Naujan Lake National Park Site Assessment and Profile Updating' under the leadership of one of the authors, Dr Ireneo L. Lit, Jr. We acknowledge with sincerest thanks the funding provided by the Mindoro Biodiversity Conservation Foundation, Inc. (MBCFI) through the initiative of Executive Director Grace Diamante. MBCFI also arranged collection permits in the area. We thank colleagues from the UPLB Museum of Natural History. We also thank Mr Jeremy Carlo B. Naredo for assisting

in specimen preparations. Special thanks to the anonymous reviewer for improving the manuscript.

## References

- Alvarez J. D. V, Lit Jr. I. L. and Alviola P. A. (2015) Bat flies (Diptera: Nycteribiidae) from Mt. Makiling, Luzon Island: New host and distribution records, with a checklist of species found in the Philippines. *Check List: The Journal of Biodiversity Data* 11, Article 1509. doi: <http://dx.doi.org/10.15560/11.1.1509>.
- Baker E. W. and Delfinado M. D. (1964) Spinturnicidae of South East Asia and the Pacific Region. *Pacific Insects* 6, 571–591.
- Blackwell M. (1980) Developmental morphology and taxonomic characters of *Arthrorhynchus nycteribiae* and *A. eucampsipodae* (Laboulbeniomyces). *Mycologia* 72, 159–168.
- Cuy L. S. (1979) Synopsis of Philippine Spinturnicidae (Acarina: Mesostigmata). *Kalikasan: The Philippine Journal of Biology* 9, 162–172.
- Cuy L. S. (1980a) Nycteriboscinae (Diptera: Streblidae) of the Philippines. *Kalikasan: The Philippine Journal of Biology* 9, 137–144.
- Cuy L. S. (1980b) Nycteribiidae (Diptera) of the Philippines. *Kalikasan: The Philippine Journal of Biology* 9, 145–168.
- Cuy L. S. (1981) Geographical distribution of Philippine Nycteribiidae and their hosts. *Kalikasan: The Philippine Journal of Biology* 10, 197–213.
- Delfinado M. D. (1960) On some parasitic laelaptoid mites (Acarina) of the Philippines. *Fieldiana Zoology* 42, 93–114.
- Delfinado M. D. and Baker E. W. (1963) Mites of the family Spinturnicidae from the Philippines (Acarina). *Pacific Insects* 5, 905–920.
- Dick C. W. and Patterson B. D. (2006) Bat flies: Obligate ectoparasites of bats, pp. 179–194. In *Micromammals and Macroparasites: From Evolutionary Ecology to Management* (edited by S. Morand, B.R. Krasnov and R. Poulin). Springer, Tokyo.
- Esselstyn J. A. (2007) A new species of stripe-faced fruit bat (Chiroptera: Pteropodidae: *Styloctenium*) from the Philippines. *Journal of Mammalogy* 88, 951–958.
- Esselstyn J. A., Garcia H. J. D., Saulog M. G. and Heaney L. R. (2008) A new species of *Desmalopex* (Pteropodidae) from the Philippines, with a phylogenetic analysis of the Pteropodini. *Journal of Mammalogy* 89, 815–825.
- Ferris G. F. (1924a) Two Diptera Pupipara from Philippine bats. *Philippine Journal of Science* 24, 73–78.
- Ferris G. F. (1924b) Some Diptera Pupipara from the Philippine Islands. *Philippine Journal of Science* 25, 391–403.
- Ferris G. F. (1925a) Third report upon Diptera Pupipara from the Philippine Islands. *Philippine Journal of Science* 27, 413–421.
- Ferris G. F. (1925b) Fourth report upon Diptera Pupipara from the Philippine Islands. *Philippine Journal of Science* 28, 329–339.
- Heaney L. R., Dolar M. L., Balete D. S., Esselstyn J. A., Rickart E. A. and Sedlock J. L. (2010) Synopsis of Philippine Mammals. The Field Museum of Natural History in cooperation with The Philippine Department of Environment and Natural Resources, Protected Areas and Wildlife Bureau. 16 pp. Available at: <https://www.fieldmuseum.org/synopsis-philippine-mammals>.
- Hopkins G. H. E. and Rothschild M. (1956) *An Illustrated Catalogue of the Rothschild Collection of Fleas (Siphonaptera) in the British Museum (Natural History) Vol. II: Coptosyllidaw, Vermipsyllidae; Stephanocircidae; Ischnopsyllidae, Hypsophthalmidae and Xiphopsyllidae*. The British Museum (Natural History), London. 445 pp.
- Ingle N. R. and Heaney L. R. (1992) A key to the bats of the Philippine Islands. *Fieldiana Zoology*, n.s. 69, 1–44.
- Klompen J. S. H. (1992) Phylogenetic relationships in the mite family Sarcoptidae (Acari: Astigmata). *Miscellaneous Publication* 180. Museum of Zoology, University of Michigan, Ann Arbor, USA. 155 pp.
- Kohls G. M. (1950) Ticks (Ixodoidea) of the Philippines. *Bulletin of the National Institutes of Health* 192, 1–28.
- Maa T. C. (1962) Records and descriptions of Nycteribiidae and Streblidae. *Pacific Insects* 4, 417–436.
- Maa T. C. (1966) Partial revision of the Cyclopodinae (Diptera: Nycteribiidae). *Pacific Insects* 8, 648–685.
- Maa T. C. (1968) Additions to the Cyclopodinae. Part I (Diptera Nycteribiidae). *Pacific Insects* 10, 1–23.
- Maa T. C. (1971) Review of the Streblidae (Diptera) parasitic on megachiropteran bats. *Pacific Insects Monograph* 28, 213–243.
- Maa T. C. (1975) On new Diptera Pupipara from the oriental region. *Pacific Insects* 16, 465–486.
- Marshall A. G. (1982) Ecology of insects ectoparasitic on bats, pp. 369–401. In *Ecology of Bats* (edited by T. H. Kunz). Plenum Publishing Corporation, New York.
- Messenger S. L., Rupprecht C. E. and Smith J. S. (2003) Bats, emerging virus infections, and the rabies paradigm, pp. 622–679. In *Bat Ecology* (edited by T. H. Kunz and M. B. Fenton). The University of Chicago Press, Chicago, Illinois.
- Murakoshi F., Recuenco F. C., Omatsu T., Sano K., Taniguchi S., Masangkay J. S., Alviola P., Eres E., Cosico E., Alvarez J., Une Y., Kyuwa S., Sugiura Y. and Kato K. (2016) Detection and molecular characterization of *Cryptosporidium* and *Eimeria* species in Philippine bats. *Parasitology Research* 115, 1863–1869. doi: [10.1007/s00436-016-4926-4](https://doi.org/10.1007/s00436-016-4926-4).
- Patterson B. D., Ballard J. W. O. and Wenzel R. L. (1998) Distributional evidence for cospeciation between Neotropical bats and their bat fly ectoparasites. *Studies on Neotropical Fauna and Environment* 33, 76–84. doi: [10.1076/snfe.33.2.76.2152](https://doi.org/10.1076/snfe.33.2.76.2152).

- Patterson B. D., Dick C. W. and Dittmar K. (2007) Roosting habits of bats affect their parasitism with bat flies (Diptera: Streblidae). *Journal of Tropical Ecology* 23, 177–189. doi:[10.1017/S0266467406003816](https://doi.org/10.1017/S0266467406003816).
- Prasad V. (1970) Bat mites (Acarina: Spinturnicidae) mainly from South-East Asia and the Pacific Region. *Acarologia* 11, 657–677.
- Taniguchi S., Watanabe S., Masangkay J. S., Omatsu T., Ikegami T., Alviola P. A., Ueda N., Iha K., Fujii H., Ishii Y., Mizutani T., Fukushi S., Saijo M., Kurane I., Kyuwa S., Akashi H., Yoshikawa Y. and Morikawa S. (2011) Reston Ebolavirus antibodies in bats, the Philippines. *Emerging Infectious Diseases* 17, 1559–1560.
- Theodor O. (1955) On the genus *Eucampsipoda* Kol. and *Dipseliopoda*, n.g. *Parasitology* 45, 195–229. doi:[10.1017/S0031182000027578](https://doi.org/10.1017/S0031182000027578).
- Theodor O. (1963) Philippine Zoological Expedition 1946–1947. Philippine bat flies of the family Nycteribiidae (Diptera, Pupipara). *Fieldiana Zoology* 42, 151–192.
- Tsuda S., Watanabe S., Masangkay J. S., Mizutani T., Alviola P., Ueda N., Iha K., Taniguchi S., Fujii H., Kato K., Horimoto T., Kyuwa S., Yoshikawa Y. and Akashi H. (2012) Genomic and serological detection of bat coronavirus from bats in the Philippines. *Archives of Virology* 157, 2349–2355. doi: [10.1007/s00705-012-1410-z](https://doi.org/10.1007/s00705-012-1410-z).
- Watanabe S., Masangkay J. S., Nagata N., Morikawa S., Mizutani T., Fukushi S., Alviola P. A., Omatsu T., Ueda N., Iha K., Taniguchi S., Fujii H., Tsuda S., Endoh M., Kato K., Tohya Y., Kyuwa S., Yoshikawa Y. and Akashi H. (2010) Bat coronaviruses and experimental infection of bats, the Philippines. *Emerging Infectious Diseases* 16, 1217–1223. doi: [10.3201/eid1608.100208](https://doi.org/10.3201/eid1608.100208).
- Womersley H. (1957) New genera and species of Acarina from bats from New Guinea, Philippines and Australia. *Transactions of the Royal Society of South Australia* 81, 115–139.
- Zabat A. G. and Eduardo S. L. (2011) Some ectoparasites of the common Rousette bat (*Rousettus amplexicaudatus* Geoffroy, 1810) (Mammalia: Chiroptera: Pteropodidae) from colonies in Batangas and Rizal, Philippines. *Philippine Journal of Veterinary Medicine* 48, 53–56.