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Ectoparasites diversity of bats species collected from Southern Lombok, West Nusa Tenggara, Indonesia

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ABSTRACT

Bats (*Ordo Chiroptera*) are the only animals of the Mammalian that have wings to fly. Ecologically, bats have many roles in both biological and economic terms, but it is also known that bats can transmit disease, including diseases caused by ectoparasites. The ectoparasites that can infect bats are bat flies, lice, mites, fleas and ticks. They are vector of some zoonotic diseases caused by bacterial, protozoa, and viruses. This study is aimed at identifying and determining the diversity of ectoparasite species in bats in the Giant Cave of Tanjung Ringgit. This study was conducted from January to May, 2018 in four locations of cave, these are the Giant Raksasa Cave in Tanjung Ringgit, Gale-gale Bangkang cave in Prabu village, Buwun Cave in Prabu village and Kenculit cave on Semeti Beach. Ectoparasites were collected and identified in Biological Laboratory, FMIPA, University of Mataram. The research found that 14 species are ectoparasites, 7 species are insecta and 7 splecies are arthropods. They are from insect *Cyclopodia horsfieldii, Eucampsipoda sundaica, Leptoyclopodia ferrari, Thaumapsylla breviceps, Megastrebla limbooliati, Raymondia pseudopagadarum* and *Ischnopsyllus hexactenus* and 1 spesies has not been identified. On the other hand, arthropods of arachnida are *Amblyomma* sp, *Ornithodoros sp, Ancystropus aethiopicus, Ancystropus zeleborii, Meristaspis calcaratus, Meristaspis lateralis* and *Meristaspis kenyaensis.*

Key words: Diversity, ectoparasites, bats, Southern Lombok.

INTRODUCTION

Bats are the true-flying mammals (Payne, 2000). They belong to order Chiroptera, which is divided into two sub-genus of Megachiroptera (mostly fruit-eater bats) and Microchiroptera (insect-eater bats) (Suyanto, 2001). Ecologically, bats have many roles on plant pollination (pollinator), dispersal of the plant seeds (seed dispersers), produce the natural fertilizer called guanos (Veevers, 1978), and also as the pest controller (Suyanto, 2001), respectively.

Lombok island have been inhabited by abundance species of bats. Kitchener et al. (1990) recorded thirty-three species of bats in this island. The bat species belong to seven families of Verpertilonidae, Emballonuridae, Molossidae, Megadermatoidae, Rhinolophidae, Pteropodidae, and Hipposideridae, respectively. Fajri et al. (2014a) recorded three new species of bats collected from Lombok Island. They were *Hipposideros bicolor* (Hipposideridae), *Rhinophoma microphyllum* (Rhinopomatidae), and *Phoniscus atrox* (Verpertilonidae), respectively. The new record of bat species increased the number of species and families of bats that were recorded on the island.

The bats were species mostly living in colony. They roost together in a particular place such as trees, building ceilings and caves. Their lifestyle and roles make them interact in various living things, for example, parasites, both endo- and ecto-parasites. Ecto-parasites could infest the bat species which belong to insect and arachnid. The ecto-parasites were identified as being born of dispersion of bacteria, protozoan and virus, which caused diseases

in humans and other animals (Mathishon and Pritt, 2014).

The previous study on several areas in Indonesia identified several species of bat's ectoparasites. Saim and Suyanto (2004) reported that bats of Ballonycteris maculate have been infested by two species of ecto-parasite from the family of Nycteribiidae. In University of Indonesia, Depok, bats from genus Cynopterus and Macroglossus have been reported to be infested by ecto-parasites from the family Nycterbiidae (Putra, 2014). They were *Cyclopodia horsfiledii* and *Leptocyclopodia ferarrii*, respectively. Sari et al. (2015) observed ectoparasites from three species of bats, *Rhinolopus* sp., *Hipposideros larvatus*, and *Hipposideros* sp., from Anjani Cave of Central Java. They found *Ectopocopsis* (Ectopsocidae) infested on bats. On the other hand, the number of studies on the bat's parasite in Lombok island was the lowest number. The study was documented from Astria et al. (2015) and Ulandari (2008). Austria et al. (2015) reported three species of bat's ecto-parasites. They were *Megistopoda aranae*, *Dermacentor* sp., and *Nycteribia kolenati*, respectively. Meanwhile, Ulandari (2008) observed two species of bats in western coastal cave of Lombok, *Macroglossus minimus* and *Eonycteris spealea*. Ulandari (2008) reported the bats have been infested by *Ixodes* sp., *Amblyoma* sp., *Dermacentor* sp., and *Rhipicephalus* sp, respectively.

In this study, we would like to expand number of studies of bat's parasite in Lombok Island, especially from bats collected from southern Lombok. In this study, several bats were collected from four caves of Southern Lombok. They were examined to collect ectoparasites used to describe the diversity of parasites that infested the bats.

MATERIALS AND METHODS

Study area

Bats were collected from Raksasa Cave, located in Tanjung Ringgit, Gale-gale Bangkang cave in Prabu village, Buwun Cave in Prabu village, and Kenculit cave on the Semeti Beach of Southern Coastal of Lombok in October, 2017 to May, 2018. The location of the research is the recommended location to be a conservation area of bats for the benefit of ecotourism in the southern region of Lombok Island.

Procedures

Bat collection and identification

Bats were collected by trapping using mist net. The net was set up at the gate of the cave at 06.00 to 07.00 PM (Fajri et al., 2014b). The bats trapped in the net were removed and collected in plastic bags and then deeply anesthetized using chloroform. The bats were transported to Laboratory of Biology, Faculty of Mathematics and Natural Sciences University of Mataram. The bat specimens were identified by Suyanto (2001) and Kitchener et al. (1990).

Parasite collection and identification

The hairs of anesthetized-bats were swapped using alcohol 70% v/v. The hairs were then combed using tooth comb gently. The parasites collected from bats' hairs were kept in effendorf tube contained alcohol 70%. The parasite specimens were observed under microscope (USB Microscope Digital 1000x). Klimpel and Mehlhorn (2014) identified the ectoparasites identification. Data of ecto-parasites, number and host, collected from the hairs of bat were tabulated. Each species of parasite were separately described.

RESULTS AND DISCUSSION

Bat collection and identification

The bat species were collected from four caves of Southern Coastal of Lombok during field work period of October, 2017 to May, 2018. A total of 201 insect and Arachnida ectoparasites (Table 1), were obtained from 90 individuals of cave bats representing 9 species (Figure 1). We could identify them as ten species infected with ectoparasites of *E. spelaea*, *M. minimus*, *R. ampexicaudataus*, *Rhinolopus simplex, Rhinopoma microphyllum, Rhinolopus acuminatus, Chaerephon plicata, Taphozous melanopogon,* and *Miniopterus pusillus.*

Ectoparasites diversity

In this study period, we could collect ten species of bats. The result showed that 14 species are ectoparasites, 7 species are insecta, while 7 species are arthropods. They are from insect *Cyclopodia horsfieldii, Eucampsipoda sundaica, Leptoyclopodia ferrari, Megastrebla limbooliati, Raymondia pseudopagadarum, Thaumapsylla breviceps,* and *Ischnopsyllus hexactenus*. On the other hand, arthropods of arachnida are *Amblyomma* sp, *Ornithodoros hermsi, Ancystropus aethiopicus, Ancystropus zeleborii, Meristaspis calcaratus, Meristaspis lateralis,* and *Meristaspis kenyaensis.* Table 1 shows the number of individuals of ectoparasites species and their host species.

C. horsfieldii is well known as bat flies (Figure 2). This parasite is a member of class: Insecta, order: Diptera and family: Nyteribiidae. This species has species- specifically host-parasite relationship with bats from genus *Cynopterus* and *Rousetus*. This species was found to infect *R. amplexicaudatus, E. spelaea* in Raksasa Cave and *M. pusillus* in Kenculit Cave. *C. horsfieldii* has a sternal plate

Table 1: Ectoparasites from bats.

Ectoparasite class	Host								
	E. s	**M. m**	**R. a**	**M.p**	**R.m**	**R.s**	**C.p**	**T.m**	**R.ac**
Ordo family									
Insecta									
Diptera									
Nyteribiidae									
Cyclopodia horsfieldii (Meigere, 1899)	10		2	6					
Eucampsipoda sundaica (Theodor, 1955	8								
Leptoyclopodia Ferrari (Rondani, 1878)		4							
Streblidae									
Megastrebla limbooliati (Maa, 1971)						37			10
Hippoboscidae									
Raymondia pseudopagadarum (Jobling, 1951)						23			
Siphonaptera									
Ischnopsyllidae									
Thaumapsylla breviceps (Jordan, 1947)	6								
Ischnopsyllus hexactenus (Kolenati, 1863)					9				
Arachnida									
Ixodida									
Ixodidae									
Amblyomma sp. (Murray, 1844)	20						20	14	
Argasidae									
Ornithodoros sp (Wheeler, 1935)						7			
Mesostigmata									
Spinturnicidae									
Ancystropus aethiopicus (Hirst, 1923)	6								
Ancystropus zeleborii (Kolenati, 1856)	8			10					
Meristaspis calcaratus (Kolenati, 1856)	14								
Meristaspis lateralis (Kolenati, 1856)		10	9						
Meristaspis kenyaensis (Kolenati, 1856)			11						

Note: Es: *Eonycteris spelaea*, Mm: *Macroglossus minimum*, Ra: *Rosettus a amplxicaudatus*, Mp: *Miniopterus pusillus*, Rm: *Rhinopoma microphyllum*, Rs: *Rhinolopus simplex*, Cp: *Chaerephon plicata*, Tm: *Taphozous melanopagon*, Ra: *Rhinolopus acuminatus,* Cyclopodia horsfieldii (Meigere, 1899).

with bent-tip and angles. In the ventral body there is a white suture which lies diagonally in the abdominal part, head is flipped centrally and can be rotated 180°. According to Putra (2014), in the abdominal part, there are several white segments.

Eucampsipoda sundaica (Theodor, 1955)

Eucampsipoda sudoku is a member of the class: Insecta, order: Diptera, and family: Nyteribiidae (Figure 3). Body shape is flat dorsoventrally, wingless with legs and abdomen covered by setae. This species have claws in the tip of the leg. The head is flipped opposite to the thorax. The length of their femur and tibia are equal. According to Maa (1975), their femur and tibia have two white rings. *E. sundaica* have been reported to be found in India, Myanmar, Laos, Cambodia, Thailand, Malaysia, Indonesia and New Guinea. They have species-specifically host-parasite relationship with *E. spaelea* and *R. amplexicaudatus* (Maa, 1971).

Leptocyclopodia ferrarii (Rondani, 1878)

Leptocyclopodia ferrari was formerly a member of the genus *Leptocyclopodia* (Figure 4). Maa (1975) revised the

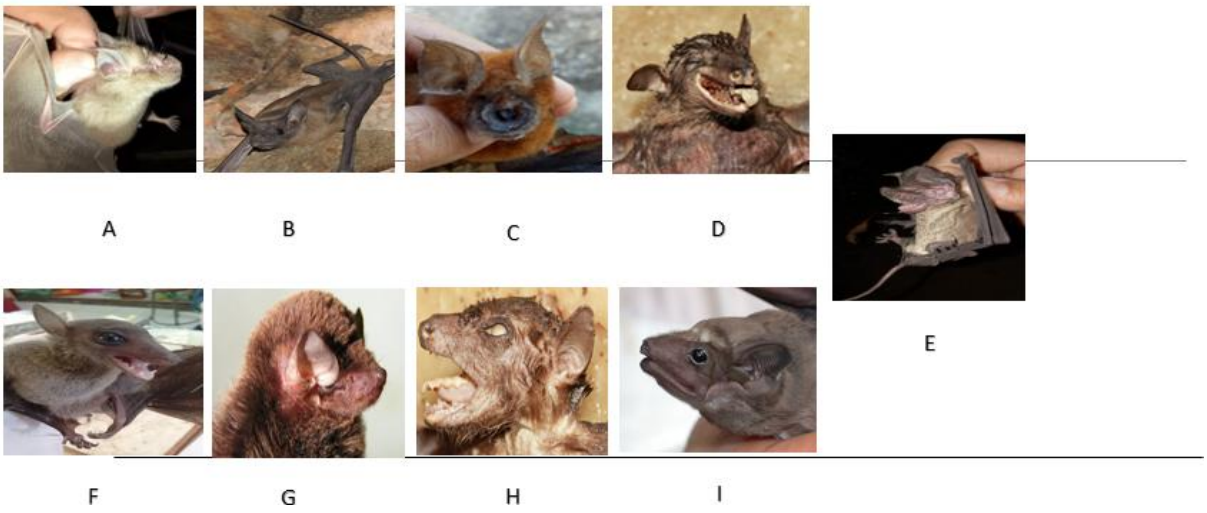

Figure 1: Bat species. A) *Rhinolopus simplex,* B) *Rhinopoma microphyllum,* C) *Rhinolopus acuminatus,* D) *M.minimus*, E) *Chaerephon plicata,* F) *E. spelaea*, G) *Miniopterus pusillus,* H) *R. ampexicaudataus*, and I) *Taphozous melanopogon*.

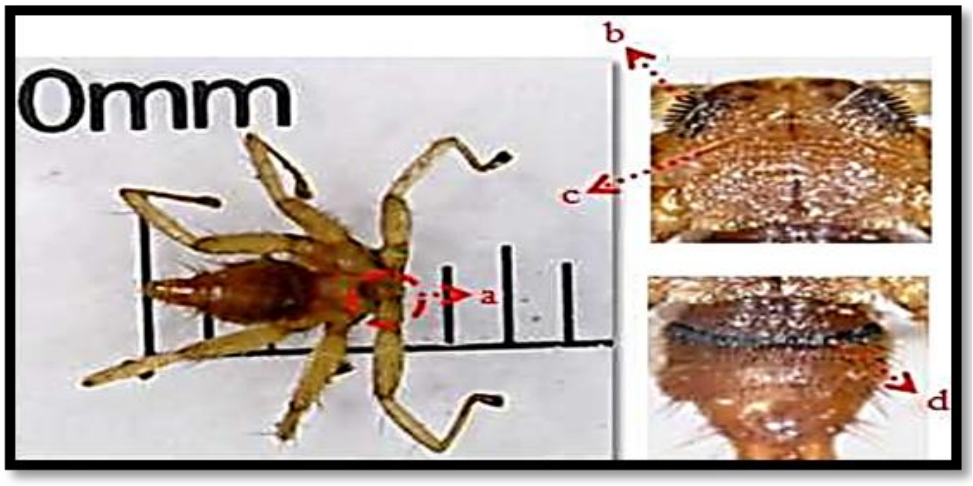

Figure 2: *Cyclopedia horsfieldii.* a) Head, b) Thorax ktenidium, c) Sutura and d) Abdomen ktenidium.

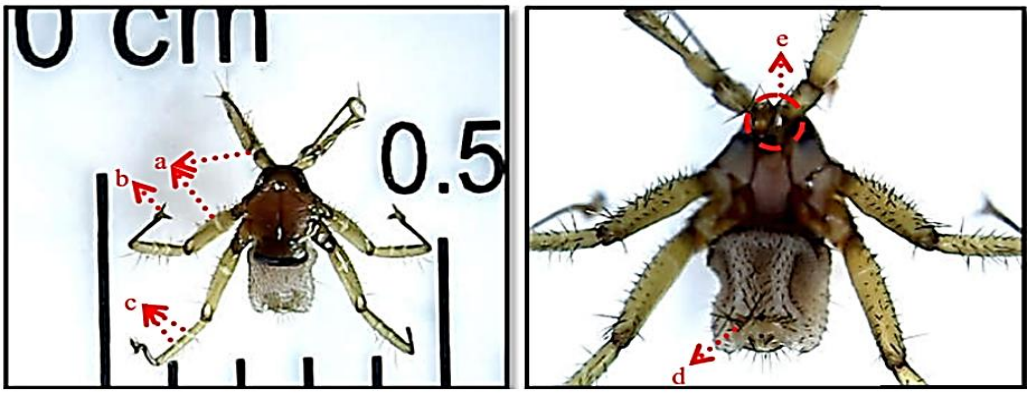

Figure 3: *Eucampsipoda sundaica*. A) Ventral View; a) Femoral ring, b) Claw, c) Tibial ring, B) Dorsal view; d) Setae, e) Flipped head.

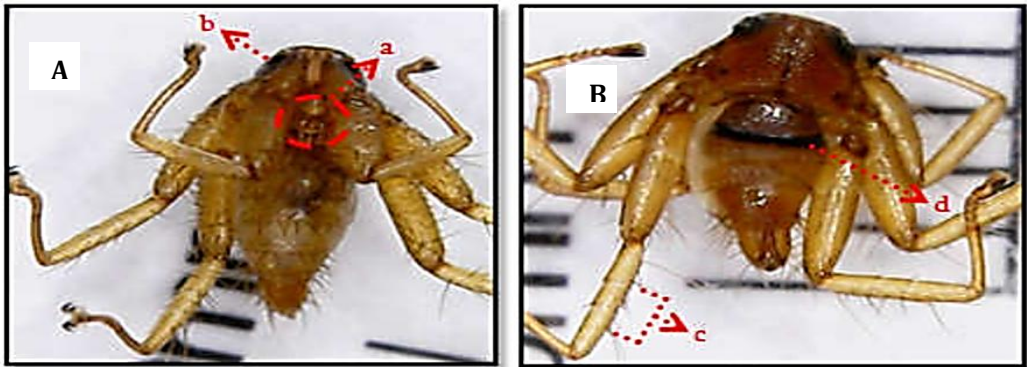

Figure 4: *Leptocyclopodia ferrarii.* A) Dorsal view, B) Ventral view. A) Head, b) Thorax ktenidium, c) Tibial white ring, d) Abdomen ktenidium.

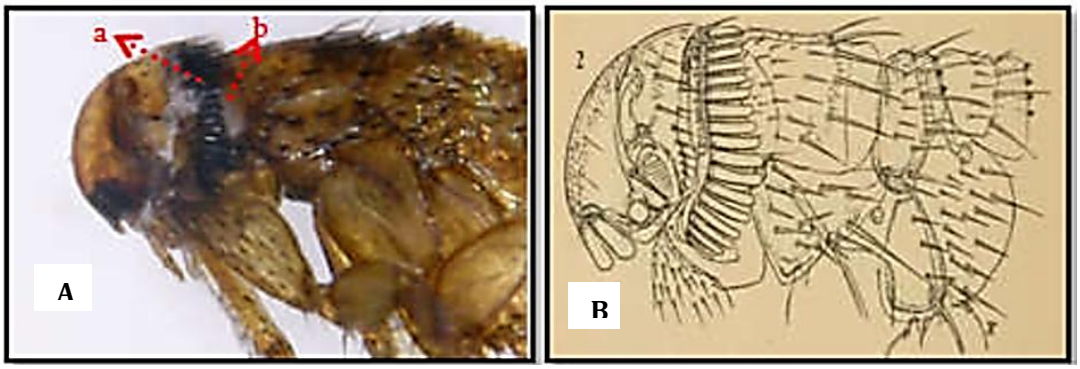

Figure 5: *Thaumapsylla breviceps.* A) Real picture, B) Picture from Pronotal ktinedium (Jordan, 1947) and b) Pronotum.

sub-genus into a distinctive genus of *Leptocyclopodia*. The most main characters are similar with genus Cyclopodia. However, this genus was distinct from Cyclopodia by the presence of three white rings in the tibia (Putra, 2014). *L. ferrari* has been reported to be found in Cambodia, Thailand, Malaya, Borneo and Java. It was collected in *Cynopterus brachyotis* (Maa, 1962).

Thaumapsyla breviceps (Jordan, 1947)

Thaumapsyla breviceps is flea, a member of the order: Siphonaptera and family: Ischnopsyllidae (Figure 5). This species is a new parasite known to infest bats. This parasite has a short head, shorter pronotum separately from ktenida (Jordan, 1974). Amarga et al. (2017) reported the parasite to have been found in bats of genus *Eonycteris* and *Rousettus.* However, in this recent study, the parasite was only found in *E. spaelea.*

Amblyomma sp (Murray, 1844)

Amblyomma sp. is a member of the class: Arachnida, order: Ixodida and family: Ixodidae. *Amblyomma* sp. is known as hard tick (Figure 6). This parasite has special characters of mouth consisting of palpi and celicera which are longer than basal capitulum; length of palpi is twice the width (Noble and Noble, 1989). In this study, we could collect individuals in the larval stage.

Ancystropus

Ancystropus is a tick member of the family: Spinturnicidae (Figures 7 and 8). The 1st leg and 1st claw of this species swells; two to three pairs setae surrounds the edge of the dorsal shield. The epygeal shield is located in the 4th coxa without overseer in the 1st tarsi and 1st coxa (Delfinando and Baker, 1963). *A. aethiopicus* (Hirst, 1923) have 3rd proteronotal setae longer than the 1st and 2nd setae. Tritosternum is a distorted rectangle with irregularly convex anterior. *A. zeleborii* (Kolenati, 1856) have proteronotal 1st setae short, yet relatively well developed, while 2nd and 3rd setae are sub-equal to each other, idosomal setation as in preceding species.

Meristapsis

Meristapsis have characteristics with four pairs of setae surrounding the dorsal shield; the 1st tarsus have a pair of big-plate distal setae. This species also have 1st claw, big-enwidth tritosternum, ephygenials shield in 3rd and 4th

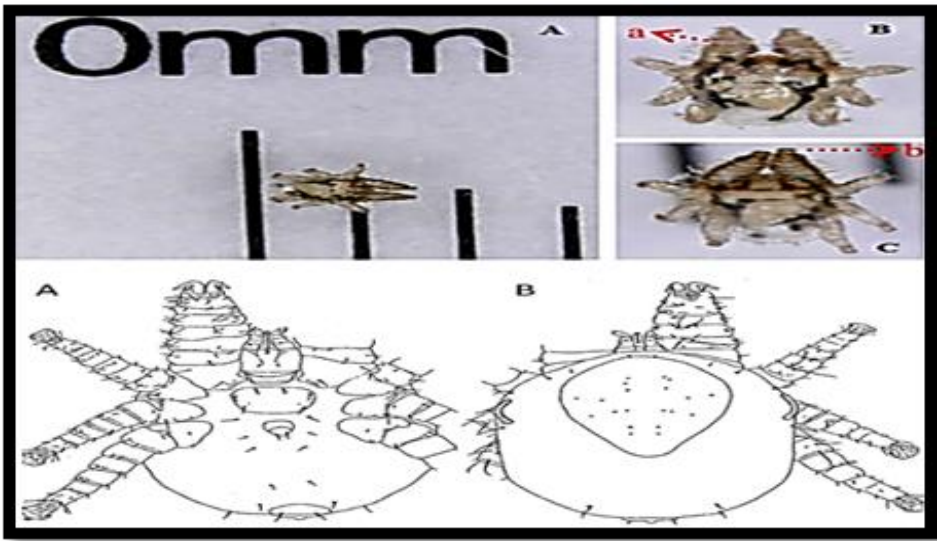

Figure 7: *Ancystropus aethiopicus*. A and C) Ventral view, B) Dorsal view, a) Leg, b) Claws (Hirst, 1923).

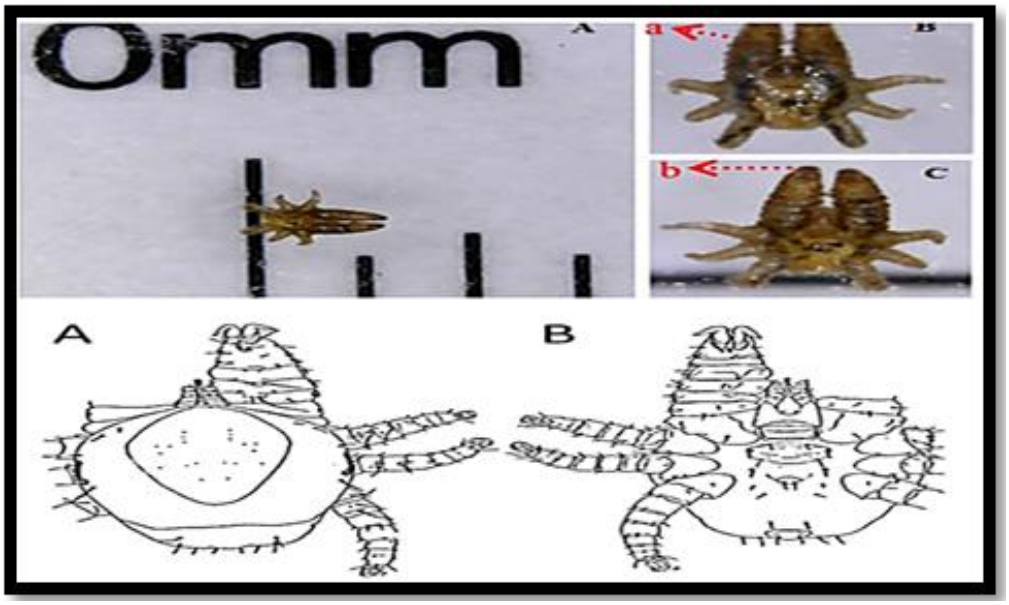

Figure 8: Ancystropus zeleborii. A and B) Dorsal view, B) Ventral view, a) Leg, b) Claws (Kolenati, 1856).

coxa, anal shield with no postanal setae, while the 1st leg swells (Figures 9 and 10). *Meristapsis calcaratus* (Kolenati, 1856) is distinct from *M. lateralis* by idoiosom without transversal line, coxa with strong edge, flattened distal setae in 1st tarsus and rounded tip (Delfianando and Baker, 1963). *M. lateralis* have similar features with *M. calcaratus* (Figure 9). However, this species is distinguished from *Meristapsis kenyaensis* (Figure 11). (Kolenati, 1856) by hipostomal shape like harpoon and a very slim setae in sterna shield (Delfianando and Baker, 1963).

***Megastrebla limbooliati* (Maa, 1971)**

M. limbooliati (Figure 12) have a small head, hardly flattened, anteriorly broad, ventrally without depressions for coxae 1, eye present, 1-facetted, post vertex distinct, arista of antenna flagelliform, palpus longer than wide, apex broadly rounded and not upturned; spherical thorax, complete transverse mesonotal suture, insignificant humeral callus, scutellum rather uniformly setose and mesepisternum not longitudinally depressed. *Megastrebla*

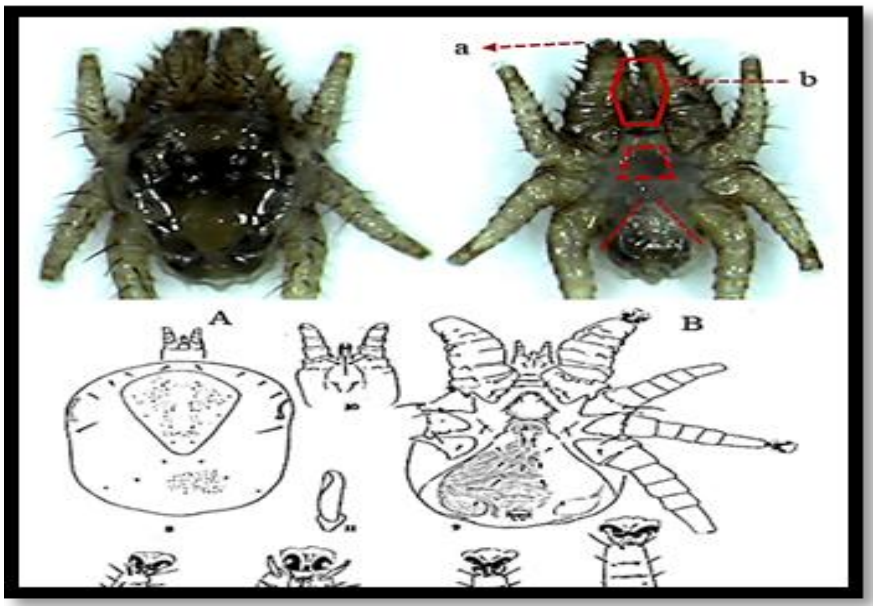

Figure 9: *Meristaspis calcaratus*. A) Dorsal view, B) Ventral view, a) Leg, b) Gnathosoma.

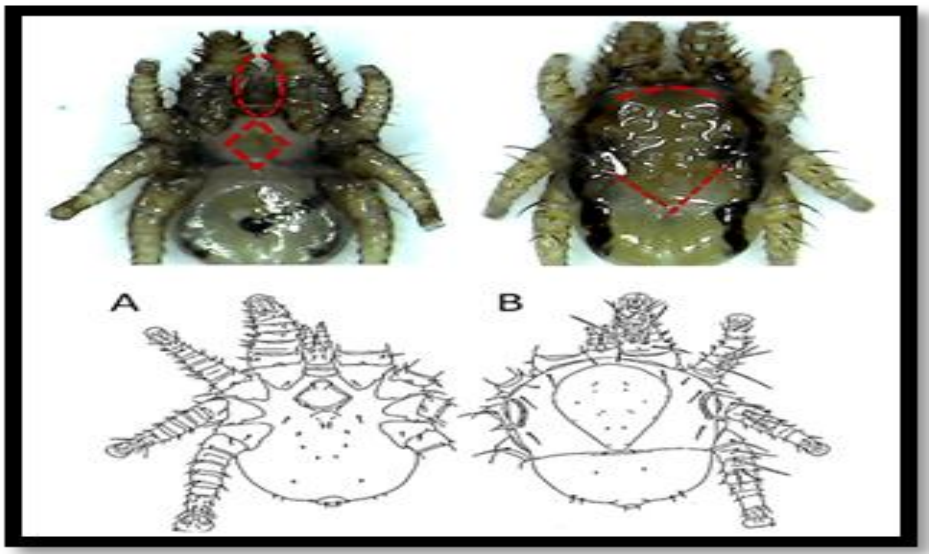

Figure 10: *Meristaspis lateralis.* A) Dorsal view and B) Ventral view.

is the largest in body size of the Macropterous Streblidae and is confined to the megachiropteran bats; hence, it is so named. Distribution is *Megastrebla limbooliati* collected from *Eonycteris major* in Borneo, Serawak, *Cynopterus* sp in Ceylon and *Hipposideros* sp in Malaya (Maa, 1971).

***Raymondia pseudopagadarum* (Jobling, 1951)**

These characters clearly indicate that *Megastrebla* and *Brachytarsina* are more generalized than the remaining genera *(Raymondia, Brachyotheca* and *Raymondioides)* of the sub-family Nycteriboscinae. Head narrower than interdistance between the 2 anterior most major humeral setae; labial theca is round in shape, about as long as broad. Transverse suture of mesonotum is complete. The wings are relatively shorter and broader than in *Brachyotheca.* Chiefly parasitic on Rhinolophidae: *Rhinolophus,* less often on Hipposideridae: *Hipposideros.* Three of the 85 paratypes were originally recorded (Jobl, 1951: 241) from *Rousettus amplexicaudatus* E. Geoffr, or *Eonycteris spelaea glandifera* Lawrence in the Philippines: Mindanao. *R. pseudopagodarum* is collected from *Rhinolophus* sap in Cantor, Sitio Tegato, Davao City, Mindanao, Philippines (Maa, 1962, 1965; Delfinado and Hardy, 1977) (Figure 13). A new report from Amarga et al.

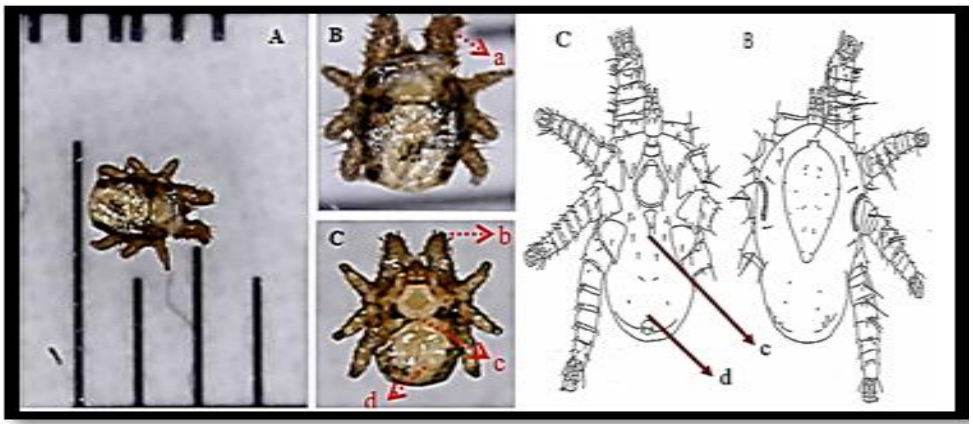

Figure 11: *Meristaspis kenyaensis*. A, B) Dorsal View, C) Ventral view, Leg, b) Claws, c) Epigyneal shield and d) Anal shield.

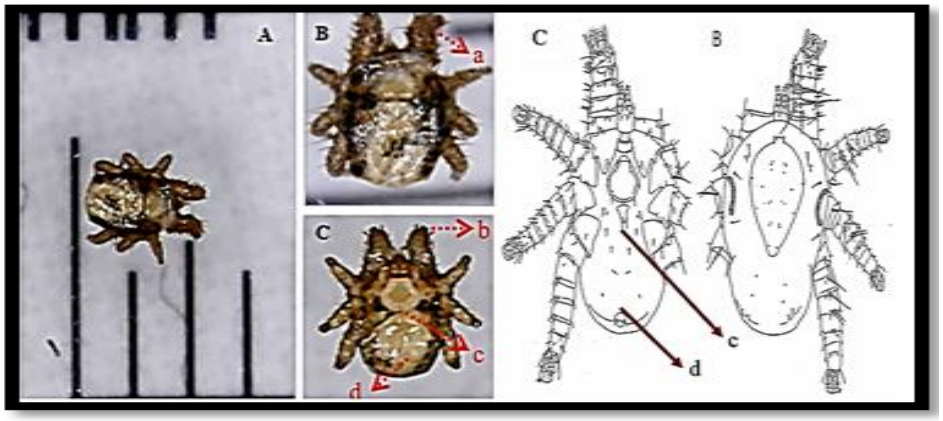

Figure 12: *Megastrebla* limbooliati. A) Ventral view, B) Dorsal view a) Eyes prominent, b) Antenna flagelliform, c) Head small and d) Wing.

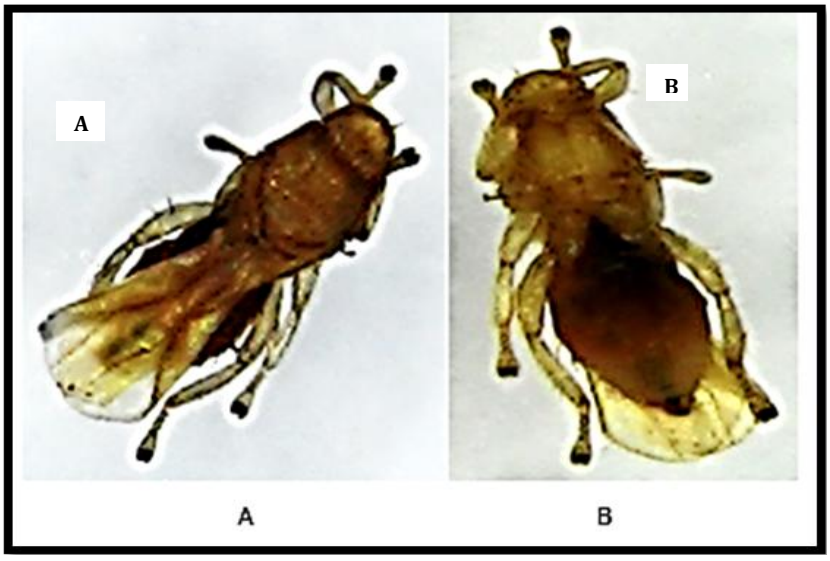

Figure 13: *Raymondia pseudopagodarum*. A) Dorsal view and B) Ventral view.

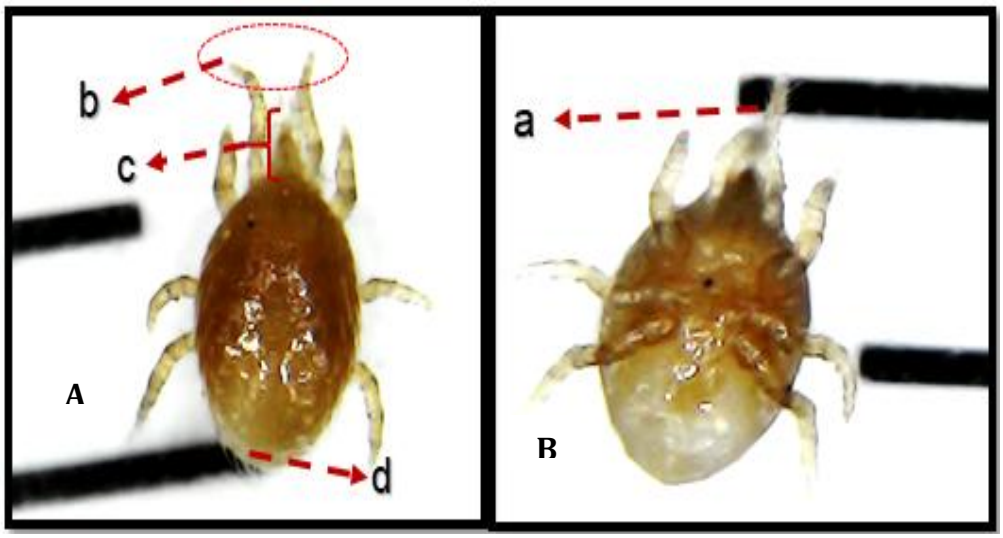

Figure 14: *Ornithodoros* sp. A) Dorsal view, B) Ventral view, a) Leg, b) Claws, c) Cavitulum visible and d) Festoon.

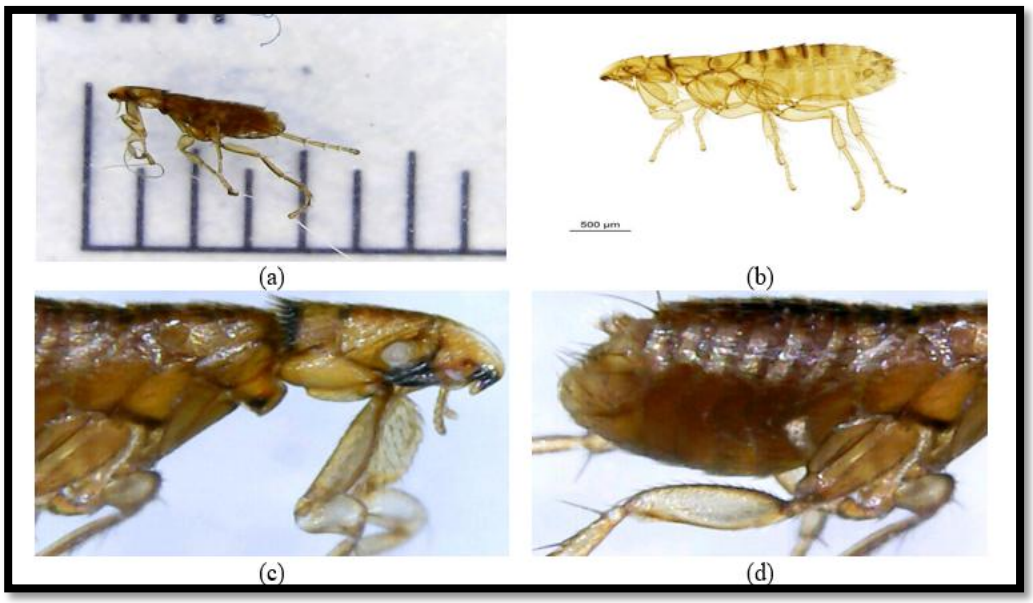

Figure 15: *Ischnopsyllus hexactenus*. a) Full Body, b) Full Body, c) Thorax and d) Abdomen (Kolenati, 1856).

(2017) shows *Raymondia pseudopagodarum* collected from *E. spelaea, Emballanura Alecto* (new host record), *Hipposideros ater* (new host record), *Hipposideros galeratus, Miniopterus Australis, M. schreibersi, Rhinolophus arcuatus, R. philippinensis* (new host record), *R. Rufus* and *R. virgo*.

Ornithodoros sp (Wheeler, 1935)

Ornithodoros sp (Figure 14) is the most diverse of the Agrasidae family, and 118 species have been described around the world. *Ornithodoros* sp was collected from 12 bats, *Noctilio albiventris* in Franch Guian. *Ornithodoros sp* cause infection in bats and their tick with zoonotic bacteria, especially Rickettsia (Tahir and Philippe, 2016).

Ischnopsyllus hexactenus (Kolenati, 1863)

Ischnopsyllus hexactenus (Figure 15) is one of the flea family specifically found in bats and not found in other mammal species. Two bat fly species were collected. *Nycteribia pedicularia* was found on *Myotis daubentoni* and

M. dasycneme. The single specimen of *N. biarticulata* was collected from *M. dasycneme*. Two bat fleas *I. hexactenus* and *M. trisellis* were recorded. *I. hexactenus* was found in five bat species, but *M. trisellis* was found iin two bat species (Jaunbauere et al., 2008). Bats that once hosted *I. hexactenus* were *M. frater* and *Murina hilgendorfi* (Scheffler, 2016) and *Pipistrellus pipistrellus* (Petr et al., 2016). This study also became the first study to report the existence of *I. hexactenus* (The long Eared Bat Flea) in the bat species of *R. microphyllum*.

I. hexactenus is an ectoparasite that can be a vector of some pathogenic bacteria zoonosis including trypanosomes. The abundance of *I. hexactenus* in bats is quite high, even able to make bats its sole host (Fajri et al., 2017).

DISCUSSION

The differentiation of a number of ectoparasite species and those that infested the bat species could be caused by the parasites preference on their host. Several factors that could affect the host were sexual, age, intra and inter species interaction of the host and the host behavior. Ecto-parasite preference on the female bat as the host is the grooming behavior. This behavior could be the defensive mechanism against the parasites (Miller, 2014). However, grooming behavior exhibited by female bats could be exhausted by their calories, unaware to predators, and could lose their hair (Hoftsted and Fenton, 2005). Female bats tend to save their calories for infant nourishing (Piksa et al., 2011). Czenze and Baker (2011) showed those male bats groom more than female bats. They can expedite their extra calories for grooming which may expel more parasites (Christe et al., 2007).

Based on the age, the adult bats are more infested with ectoparasites rather than sub-adult. The parasites could develop the two strategies to infest fit host (adult bats) or vulnerable host (sub-adult bats). However, its infestation on the fit host is more advantageous than those that are vulnerable (Luz et al., 2009). On the other hand, ectoparasite could prefer to infest the adult bats rather than the sub-adult. Contrarily Dick et al. (2003) and Christie et al. (2007) showed that ectoparasite preference to sub-adult bats were high. This strategy is affected by their roosting location shared with an adult female. In addition, the sub-adult bats were also observed not to have exhibited the grooming behavior. These factors could be the advantages for ectoparasites to infest the sub-adult bats.

The foraging behavior of bats could be also one factor in ectoparasites transfer. Bats could share the feeding trees and expel the parasite. When the other individual of bats foraged in the same trees, the parasite could infest the other bats (Olival et al., 2013).

The preference of ectoparasite to infest their host could be caused by their adaptation to host condition. The ectoparasites from family Nycteribiidae is highly dependent on the host that provides the nutrients (Stanko et al., 2002). The location on the body part of the host also affects the preference of parasite. According to Kasso and Balakrisman (2013), body part with dense hair of the host is preferred by parasites. They could hide and when this occurs it becomes difficult to approach the grooming activity (Miller, 2014).

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REFERENCES

Amarga A. Philip KS. Alviola A, Ireneo L, Sheryl AY (2017). Cheklist of Ectoparasitic Arthropods Among Cave-Dwelling Bats From Marinduque Island, Philippines. Check List J. Biodiver. Data. 13 (1):1-10.

Amarga AKS, Alviola PA, Lit IL, Jr. dan Yap SA (2017). Checklist of ectoparasitic arthropods among cave-dwelling bats from Marinduque Isldan, Philippines. *Check List* 13(1): 20-29.

Aroon S, Hill III JG, Artchawakom T, Pinmongkholgul S, Kupittayanant dan S. Thanee N (2015). Ectoparasites Associated With Bats In Tropical Forest of Northeastern Thailand. J. Agric. Technol. 11(8): 1781-1792.

Astria BN, Apriani RM, Firda F, Septhayuda IE, dan Supriadi (2015). Identiflkasi Ektoparasit Pada Populasi Kelelawar Besar (Megachiroptera) di Gill Lawang Lombok Timur. Jurnal Sangkareang Mataram 1(1): 43-47.

Christe P, Glaizot O, Evanno G, Bruyndonckx N, Devievey G, Yannic G, Patthe P, Maeder A, Vogel P, dan Arlettaz R (2007). Host Sex and Ectoparasites Choice: Preference For, and Higher Survival On Female Hosts. J. Anim. Ecol. 76(1): 703-710.

Czenze Z, dan Broders H (2011). Ectoparasite Community Structure Of Two Bats *(Myotis lucifugus* and *M. septenrionalis*) From The Maritimes Of Canada. *Parasitology Research*. Hindawi Publishing. Hindawi.

Delfinado MD, dan Baker EW (1963). Mites Of The Family Spinturnicidae From The Philippines (Acarina). Pacific Insects. 5(4) : 905-920.

Dick CW, Gannon MR, Little WE, dan Patrick MJ (2003). Ectoparasite Associations of bats from Central Peninsylvania. J. Med. Entomol. 40(6): 813--819.

Fajri SR, Idrus AA , Hadiprayitno G (2014b). Kelimpahan Spesies Kelelawar Ordo Chiroptera di Gua Wilayah Selatan Pulau Lombok NTB. Biologi Tropis 14(2): 93-99.

Fajri SR, Idrus AA, Hadiprayitno G (2014a). Kekayaan Spesies Kelelawar Ordo Chiroptera Di Gua Wilayah Selatan Pulau Lombok, Nusa Tenggara Barat. BIOEDUKASI. 7(2): 5-9.

Fajri SR, Primawati SN, Hadi I, Tresnani G (2018). New Record Of *Rhinopoma microphyllum* With The Invested Parasites and Microbes in The Developed Ecotourism Area of South Lombok Island NTB. J. Phys: Conf. Ser. 953. 012011:1-7

Jaunbauere G, Ineta S, Voldemars S (2008). Occurrence of Bat Ectoparasites in Latvia. *Latvijas Entomologs*. 45: 38-42.

Jordan H (1947). On Thaumapsyllinae, A New Subfamily Of Bat Fleas (Suctoria, Ischnopsyllidae). Proceedings of the Entomological Society of Washington. 49 (7) : 182-184

Kasso M, dan M Balakrishman (2013). Ecological and Economic Importance Of Bats (Order Chiroptera). Hindawi Publishing. Hindawi.

Kendall DA (2008). Mites and Ticks In Insects and Other Arthropod. [Serial Online]. www.kendall-bioresearch.co.uk/mite.htm [20 Maret 2017].

Kitchener DJ, Boeadi L, Charlton, dan Maharadatunkamsi (1990). Wild Mammals of Lombok Island: Nusa Tenggara, Indonesia: Systematics and Natural History. Puslitbang Biologi, LIPI. Bogor.

Klimpel S, dan Mehlhorn H (2014). *Bats (Chiroptera) as Vectors of Diseases and Parasites*. Springer. Berlin.

Luz JL. Costa LM, Gomes LAC, dan Eduardo CEL (2009). The Chiggerflea Hectopsylla pulex (Siphonaptera: Tungidae) as An Ectoparasite of Free-Tailed Bats (Chiroptera: Molossidae). *Mem Inst Oswaldo Cruz.* 104(4): 567-569.

Maa TC (1971). An Annotated Bibliography of Batflies. Pasific. Ins. Monogr. 28:119-211.

Maa TC (1971). Review of The Streblidae (Diptera) Parasitic on Megachiropteran Bats. Pasific. Ins. Monogr. 28:213-243.

Maa TC (1975). On new Diptera Pupipara From The Oriental Region. *Pacific Insect* 16(4): 465-486.

MaaTC (1962). Records and Descriptions of Nycteribiidae and Streblidae (Diptera). Pacific Insects. 4(2): 417–436

Mathison BA, dan Pritt BS (2014). Laboratory Identification of Arthropod Ectoparasites. Clin. Microbiol. Rev. 27(1): 48–67.

Miller C (2014). Host Specifity and Ectoparasite Load of Bat Flies in Utila, Honduras. [Undergraduate Thesis]. University of New Orleans. New Orleans.

Noble ER, dan Noble GA (1989). *Parasitologi Biologi Parasit Hewan Diterjemahkan oleh Wardiarto.* UGM Press. Yogyakarta.

Olival K, Dick CW, Simmons N, Morales J, Melnick D, Dittmar K, Perkins S, P. Dazdak P, dan Desalle R (2003). Lack of Population Genetic Structure and Host Specifity in The Bat Fly, *Cyclopodia horsfieldii*, Across Species of Pteropus Bats in Southeast Asia. Parasites Vectors. 6(1): 231-249.

Payne (2000). *Mamalia di Kalimantan, Sabah, Serawak, dan Brunei Darussalam*. UGM Press. Yogyakarta.

Piksa K, Skwarek M, dan Siuda K (2011). Argasid dan Spinturnicid Mite Load On Swarming Bats in The Tatra Mountains, Poldan. Folia Parasitologica. 58(4): 322-325.

Putra MIH (2014). *Hubungan Inang-Ektoparasit Pada Kelelawar Pemakan Buah di Kampus Universitas Indonesia, Depok*. Departemen Biologi Universitas Indonesia. Depok.

Ristiyanto T, Damar B, Farida DH, dan Notosoedarmo S (2004). Keanekaragaman Ektoparasit pada Tikus Rumah *Rattus tanezumi* dan Tikus Polinesia *Rattus exulans* di Daerah Enzootik Pes Lereng Gunung Merapi Jawa Tengah. *Ekologi Kesehatan* 3(2) : 90-97.

Saim A, dan Suyanto A (2014). Keanekaragaman Fauna Parasit Pada Mamalia Kecil di Kawasan Tesso-Nilo, Propinsi Riau. *Ekologi Kesehatan* 3(3): 123-127.

Sari D, Putrisari N, Fajar M, Suwarni S, dan Robiansah D (2015). Identifikasi Ektoparasit pada Kelelawar (Chiroptera) di Gua Anjani, Purworejo, Jawa Tengah. Symposium on Biology Education. ISBN: 978-602-72412-0-6.

Scheffler I, Dolch D, Ariunbold J, Batsaikhan N, Abraham dan A. Thiele K (2010). Ectoparasites of Bats in Mongolia (Ischnopsyllidae, Nycteribiidae, Cimicidae and Spinturnicidae). Erforsch. biol. Ress. Mongolei. 11: 367-381.

Stanko M, Miklisová D, de Bellocq JG dan Mordan S (2002). Mammal Density and Patterns of Ectoparasite Species Richness and Abundance. *Oecologia.* 131(2): 289-295.

Suyanto A (2001). *Kelelawar Indonesia.* Puslitbang Biologi LIPI. Jakarta.

Tahir D, Philippe P (2016). New Rickettsia species in Soft Ticks Ornithodoros hasei Collected from Bats in French Guiana. Sci. Direct J. 7(6): 1089-1096

Tan K (2014). *Eonycteris spelaea (Cave Nectar Bat)*. [Serial Online]. https://taxo4254.wikispaces.com/Eonycteris+spelaea+(Cave+Nectar+Bat)+(Kelly+Tan,+2014) [2 September 2017].

Ulandari NNST (2008). Identifikasi Caplak (Tick) Pada Berbagai Jenis Kelelawar di Gua malimbu Kecematan pemenang Kabupaten Lombok Barat. [Skripsi]. Universitas Mataram. Mataram.

Veevers (1978). *Mamalia Darat Indonesia.* Intermasa. Jakarta.

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