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Report on three ectoparasites of the Greater Short-nosed Fruit Bat *Cynopterus sphinx* Vahl, 1797 (Mammalia: Chiroptera: Pteropodidae) in Cachar District of Assam, India

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Abstract: Ectoparasites of bats (Chiroptera: Pteropodidae), with a description of three species of of which two belong to order Mesostigmata (family: Ameroseiidae and Macronyssidae) and one belong to order Ixodida (family: Ixodidae), from northeastern India are discussed. The present study was carried out for six months (January–June 2014) to identify the various ectoparasites of the Short-nosed Fruit Bat *Cynopterus sphinx* in Cachar District of Assam, northeastern India. A total of 12 individuals of *C. sphinx* was captured using mist nets from eight different localities of the study area. During the study, a total of 125 parasites was collected from *C. sphinx*. The identified parasites were *Dermacentor* sp. Indet., *Ameroseius* sp. Indet., and *Steatonyssus* sp. Indet. and falls under the class Arachnida.

Keywords: Ameroseiidae, *Ameroseius*, *Dermacentor*, Ixodidae, Macronyssidae, Megachiroptera, Mesostigmata, *Steatonyssus*.

Bengali সংক্ষিপ্তসার : উত্তর পূর্ব ভারতের আসামে বাদুড়ের উপর থাকা তিন প্রজাতির পরজীবীকে নিয়ে এই গবেষণা পত্র। ছোট নাক বিশিষ্ট ফলাহারী বাদুড় (ইংরাজি নাম, *Cynopterus sphinx*) এর উপর দীর্ঘ ছয় মাস (২০১৪ সালের জানুয়ারী থেকে জুন) অধ্যয়ন করে এই প্রজাতির ১২টা বাদুড়ের শরীর থেকে ১২৫টি পরজীবী সংগ্রহ করা হয়েছিল। গবেষণা করে দেখা গেছে যে মেসো স্টিগ্মাটা পরিবারের এমেরোসিডি ও মেক্রনাইসিডি এবং ইক্সডিডা পরিবারের ইক্সডিডি এই বর্গের প্রাণীগুলো পরজীবী রূপে বাদুড়ের ত্বকের বাইরে বাস করে। শনাক্ত করা পরজীবী গুলোর বৈজ্ঞানিক নাম গুলো হল, ডারমাসেন্টর ও এমেরওসিয়াস প্রজাতি এবং স্টিটোনাইসাস প্রজাতি। বাদুড়ের দেহে এদের উপস্থিতি খুবই উদ্বেগের, এবং এদের দমন করা বাদুড়দের সংরক্ষণের জন্য আসু প্রয়োজন।

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Author contribution: AR contributed to the sample collection, identification, data analysis and wrote the manuscript. PC participated in designing and editing the manuscript.

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INTRODUCTION

Ectoparasites are organisms that infest the external body surface of host animals (Hopla et al. 1994; Hunter et al. 2001) during various stages of their life cycles (nymph, pupa, or adult) and consume blood as well as epithelial cell contents directly from the hosts (Desch et al. 1972; Mullen & Durden 2002). Ectoparasites may be obligate or facultative. An obligate parasite cannot complete its life cycle without exploiting a suitable host. It is considered to be host-specific and completes its entire life cycle on the host (Marshall 1982; Durden et al. 1992). A facultative parasite, on the other hand, can parasitize but does not rely on the host to continue its life cycle. It may change its host during the different life stages. Some facultative ectoparasites may live in the same nests or share the same environment with the host and visit the host periodically (Galloway & Danks 1990).

With more than 1,250 globally known species, the order Chiroptera holds the second largest position in the entire mammalian fauna (Helms 2010; Ghassemi et al. 2012). Chiroptera is subdivided into two suborders, i.e., Megachiroptera (Old World fruit bats) and Microchiroptera (echolocating bats), which represent herbivorous and insectivorous bats, respectively (Bates & Harrison 1997; Sophia 2010). As many as six different bat species were recorded from the Cachar District of southern Assam in India. Three of them are megachiropterans while the other three are microchiropterans. The megachiropteran species recorded from the study area are *Pteropus giganteus*, (Brünnich, 1782), *Cynopterus sphinx* (Vahl, 1797), and *Eonycteris spelaea* (Dobson, 1871) while the microchiropteran species from the area are *Megaderma lyra* (É. Geoffroy, 1810), *Pipistrellus coromandra* (Gray, 1838), and *Scotophilus kuhlii* (Leach, 1821).

Short-nosed Fruit Bat *Cynopterus sphinx* (Image 1) is frugivorous and is placed under the order Megachiroptera (Bates & Harrison 1997). It is a widespread and very common species. IUCN has categorized it as Least Concern. In southern Asia, it is considered to be more adaptable than *C. brachyotis* (Müller, 1838), and the population of *C. sphinx* seems to be stable (Molur *et al.* 2002).

Cynopterus sphinx is widely distributed along the southern Asian range, through southern China and most of mainland and insular southeastern Asia. In southern Asia, this species is presently known from Bangladesh (Dhaka, Khulna, and Rajshahi divisions), Bhutan (Phuntsholing), India (Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Goa, Gujarat, Jammu & Kashmir, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Meghalaya, Nagaland, Nicobar Islands, Odisha, Rajasthan, Tamil Nadu, Tripura, Uttarakhand, Uttar Pradesh, and West Bengal), Nepal (central, eastern, far western, and western Nepal), Pakistan (Sind), and Sri Lanka (Central, Eastern, North Central, Sabaragamuwa, Southern, Uva, and Western provinces) (Molur et al. 2002). In southern China, it is found from Tibet to Fujian (Smith & Xie 2008). Although the species was reported from almost all major areas of southern Asia, comparatively limited information is available from these areas on the organisms that parasitize on them.

Bat parasites are highly diversified groups of organisms and were reported from all over the world (Jaunbauere et al. 2008; Dahal & Thapa 2010; Orlova 2011); however, ectoparasites of bats from some regions of the world remain understudied. As the present study site represents one such area, an attempt was made to document this much-ignored segment of bat ecology, i.e., the ectoparasites associated with the bat *Cynopterus sphinx*.

Study area

The area is located in the Cachar District of Assam in India and lies in the southern part of Assam having tropical evergreen vegetation which is characteristics feature of Barak Basin of northeastern India (Fig. 1). The district is located within 24.367-25.133 in the north and 92.417-93.250 in the east, covering an area of 3,786km^2. The area has an altitude of about 39–40 m. It is characterized by undulated topography, wide plain lands, and low lying waterlogged areas. The climatic condition of the area is subtropical, warm, and humid. Most of the precipitation occurs during May–August/September, which is mainly controlled by the southwestern monsoon. The average rainfall of this area is about 2600–2700 mm. The temperature ranges between 10°C and 38°C while the humidity ranges between 65% and 100% round the year.

MATERIALS AND METHODS

The study was carried out for six months (January–June 2014). For investigating ectoparasites, individuals of *Cynopterus sphinx* were captured using mist net (Kunz & Kurta 1988; Barlow 1999) from various locations of Cachar. Mist nets were placed slightly away from the roosting locations so that minimum disturbance was caused to the bat species. The captured bats were

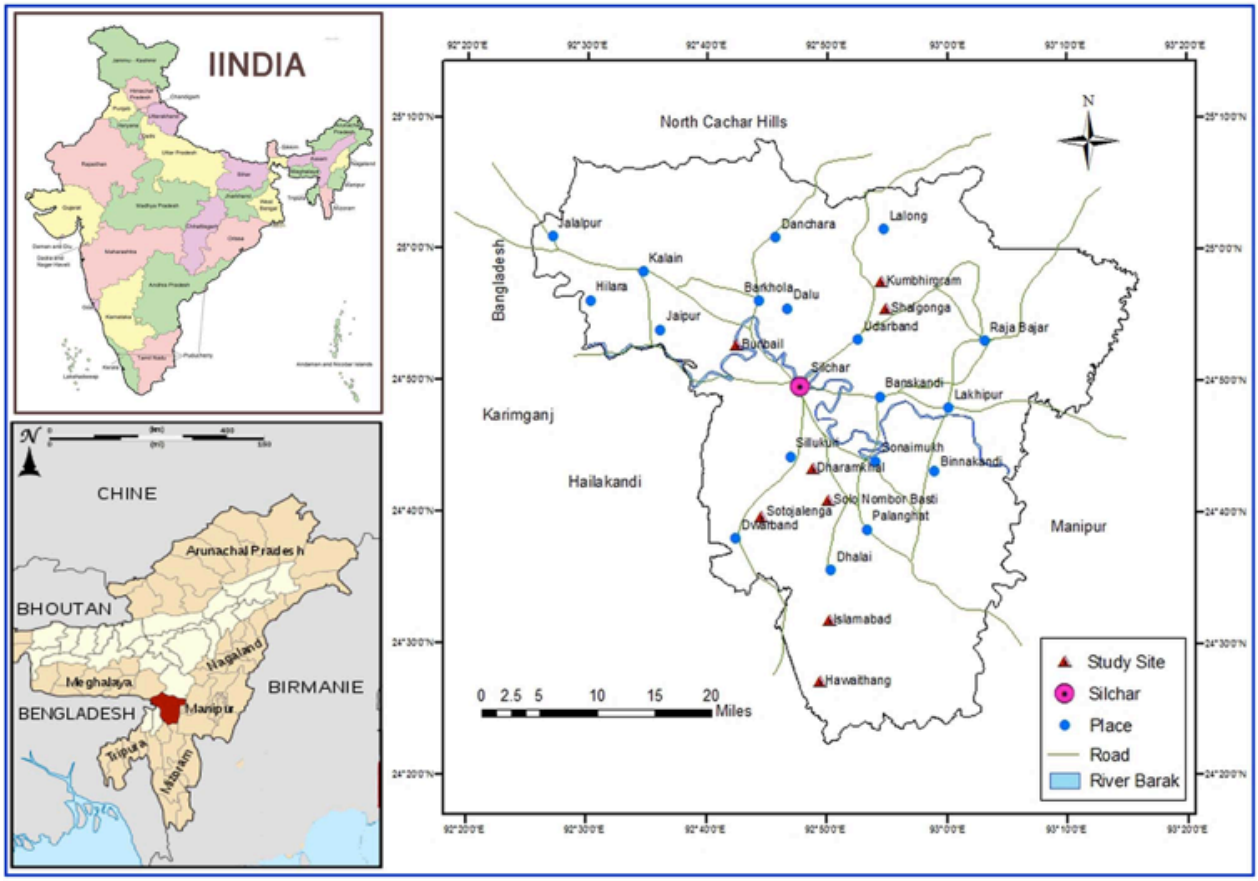

Figure 1. Cachar District in Assam, India, showing the study sites.

Image 1. Greater Short-nosed Fruit Bat *Cynopterus sphinx* in Cachar District of Assam, India.

segregated into two groups (i.e., adult and juvenile) based on the ossification of the phalangeal epiphyses (Burnett & Kunz 1982; Anthony 1988) and then according to sex (male/ female) based on external genitalia. To minimize the capture of pregnant bats, sampling was avoided during parturition period, which typically occurs in February–March and again in June–July each year. Their body mass was measured using analytical balance (Adair Dutt make; Model No:XB-220A). Body condition index (BCI) was calculated as the body weight/forearm length (Speakman & Racey 1996). Body mass, accurate to 0.1g, was measured. Data was converted to a body condition index by dividing the mass by the individual's forearm length in milimetres (as per Speakman & Racey 1996) and then multiplying by mean forearm length of all the bats (Ransome 1995). All the body parts, i.e., wing, ear and tail membrane pelage were visually inspected for ectoparasites (as per Gannon & Willing 1995). Special care was taken to minimise stress during the inspection and all the bats were released within 20min of capture. Ectoparasites were removed using forceps and preserved in vials containing 70% ethyl alcohol (Marshall

1982; Ritzi & Clark 2001). During the process, separate vials were used for the collection of ectoparasites from different individuals. The collected ectoparasites were sent to the Department of Entomology, IARI, New Delhi, for proper identification. Images of ectoparasites were taken using LEICA DFC 425C attached to a LEICA M205 FA stereo zoom microscope with auto montage. Locations of sites from where the bats were collected were noted using GPS (GARMIN E trex 20) and the map of the study site was prepared with Arc View 3.3 ESRI. Inc. 2001.

Image 2. A group of Greater Short-nosed Fruit Bats in Cachar District of Assam, India.

RESULTS

Cynopterus sphinx is a foliage-living species and is found in groups of 3–8 individuals (Image 2). The distribution and abundance of its ectoparasites are elaborately discussed here. During the field survey, a total of 11 roosting locations was documented which harbours 231 individuals of *C. sphinx* (Table 1). The maximum number of individuals was recorded from Urunabandh Tea Estate (39) while the minimum was recorded from Gumra Khelma IV (8). In the course of the study, ectoparasites of *C. sphinx* were collected from eight different study sites (Table 2) as hitherto no information was available on the ectoparasites of any available bat species of Cachar and the adjoining areas of Barak Valley in Assam, India.

During the course of the study, 125 ectoparasites (95 mites, 23 ticks, and 07 unidentified) from 12 individuals of *C. sphinx* (four males, eight females) were collected from different locations as mentioned in Table 2. Dermal ectoparasites were of three different types. The identified species are *Ameroseius* sp. Indet., *Dermacentor* sp. Indet., and *Steatonyssus* sp. Indet. Class/ family-wise distribution of the ectoparasites of *C. sphinx* are furnished in Table 3.

***Dermacentor* sp. Indet**: It is a thallus-bodied tick with legs radiating out from the central lobe. The body is 0.489mm long and 0.331mm wide. The legs are approximately 0.280–0.3 mm long. Gnathosoma, chelicera, and the legs bear numerous sensilla (Image 3A/I,A/II). The present study documented 23 individuals on seven bats from four (out of eight) locations (Table 4).

***Ameroseius* sp. Indet**: The main body is oval-shaped. The length is 0.248mm and the width is 0.161mm. The

Table 1. Population status and distribution of *Cynopterus sphinx* in Cachar District of Assam, India.

	Roosting site	Geographical coordinates	Type of roosting	No. of individuals
				Year: 2014
1	Muniarkhal Tea Estate	24.576°N & 92.950°E	Perennial	17
2	Shalgonga	24.917°N & 92.953°E	Perennial	18
3	Kumbhirgam	24.913°N & 92.974°E	Perennial	36
4	Arunabandh Tea Estate	24.900°N & 92.919°E	Perennial	39
5	Rukni Part II	24.643°N & 24.643°E	Perennial	13
6	Islamabad	24.555°N & 92.842°E	Perennial	35
7	Gumra Khelma VI	24.979°N & 92.520°E	Seasonal	8
8	Simultola	24.908°N & 92.673°E	Perennial	23
9	Kajalbasti	24.825°N & 93.116°E	Seasonal	14
10	Dharamkhal	24.577°N & 92.949°E	Seasonal	16
11	Solo Numbor Basti	24.650°N & 92.841°E	Seasonal	12
			Total	231
		Mean roosting size per tree (mean±SE)		21.00±0.98

Table 2. Summary of mist net locations and number of captured bats and ectoparasite species observed at each site including the total number of parasites and ectoparasite abundance in Cachar District of Assam, India.

Site(s)	Mist-netted locations	Geographical coordinates	No. of bat capture sites	*Ameroseius* sp. Indet	*Dermacentor* sp. Indet	*Steatonyssus* sp. Indet	Unidentified nymph	Total	Abundance
I	Hawaithang	24.519°N & 92.816°E	1	4	0	7	0	11	8.8%
II	Shalgonga	24.923°N & 24.923°E	2	3+5=8	1+2=3	4+3=7	0	18	14.4%
III	Kimbhirgram	24.928°N & 92.960°E	1	0	5	9	0	14	11.2%
IV	Islamabad	24.555°N & 92.844°E	2	4+3=7	0	5+6=11	2+1=3	21	16.8%
V	Solo Nomborbasti	24.649°N & 92.842°E	1	2	6	6	0	14	11.2%
VI	Buribail	24.883°N & 92.699°E	1	0	0	2	0	2	1.6%
VII	Dharamkhal	24.654°N & 92.725°E	3	4+4+3=11	3+4+2=9	6+6+5=17	0	37	29.6%
VIII	Sotojalengah	24.577°N & 92.949°E	1	0	0	4	4	8	6.4%
	Total		**12**	**32**	**23**	**63**	**7**	**125**	

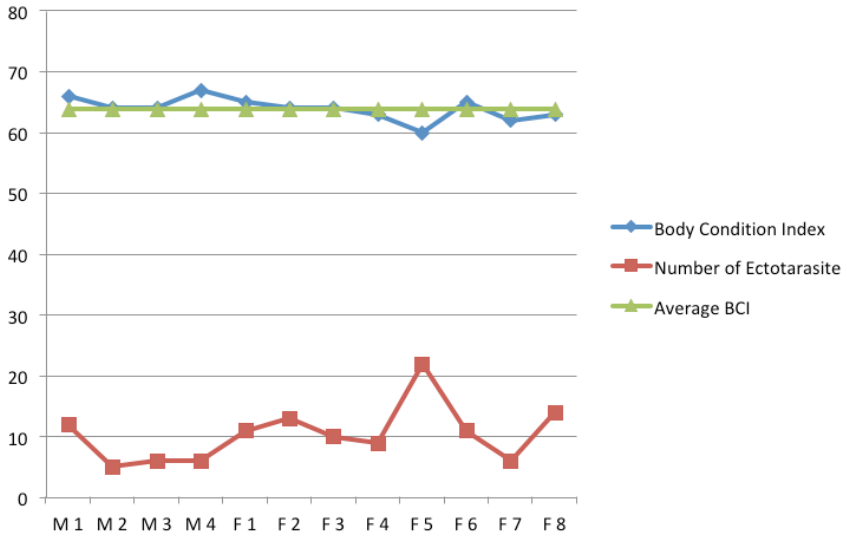

Figure 2. Body condition index and the number of ectoparasites of *Cynopterus sphinx*.

legs are slender and 0.12–0.18 mm long. Oral segment and the chelicera are thickly covered with sensilla (Image 3B/I,B/II). The present study documented 32 individuals on nine bats from five (out of eight) locations (Table 4).

***Steatonyssus* sp. Indet**: It is a slim-bodied parasite having a length of 1.085mm and width of 0.446mm. The long, radiating legs are 0.448–0.452 mm and thinly covered with sensilla (Image 3C/I,C/II). The present study documented 63 individuals on 12 bats from all eight locations (Table 4).

In the present study, individual body condition index (BCI) for males (M_1–M_4), females (F_1–F_8), average BCI of all the 12 bats, and the number of ectoparasites of each of them are given in Fig. 2. Some differences in ectoparasite abundance were observed between males (5–12) and females (7–22). In the case of one female bat (F_5), lower BCI was seen to be associated with a higher occurrence of ectoparasites (22). In other bats, this was not pronounced and may be due to the fact that in general *C. sphinx* have large body mass and thus greater accumulation of adipose tissue.

DISCUSSION

The extensive field survey carried out in the eight different locations of Cachar District revealed the presence of 125 ectoparasites on 12 individuals of *C. sphinx*. Bertola et al. (2005) studied 22 species of bat (sample size of 591) belonging to the families

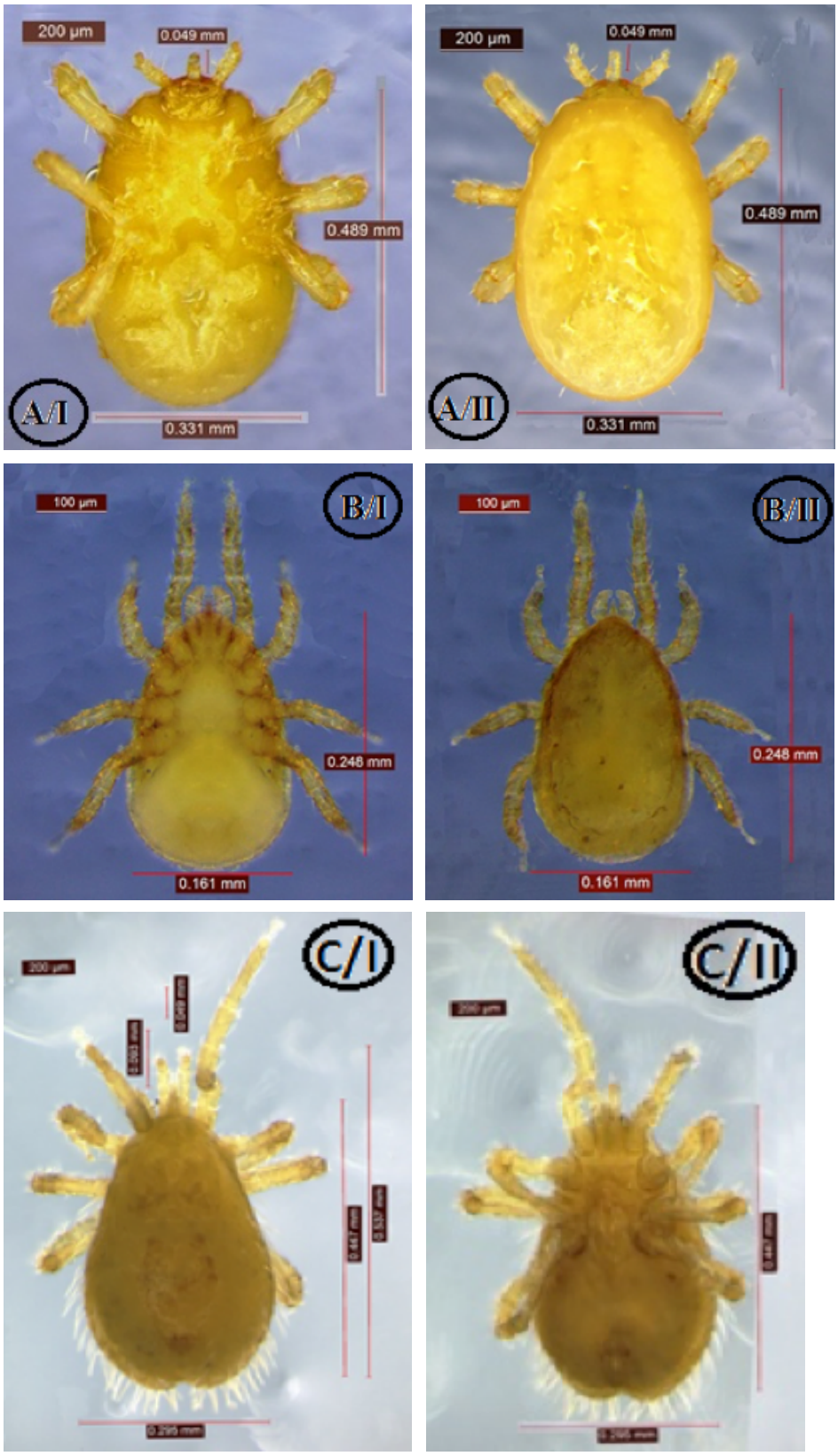

Image 3. Ectoparasites of Greater Short-nosed Fruit Bat *Cynopterus sphinx*: A/I & A/II - Dorsal and ventral view of *Dermacentor* sp. Indet | B/I & B/II - Dorsal and ventral view of *Ameroseius* sp. Indet | C/I & C/II - Dorsal and ventral view of *Steatonyssus* sp. Indet.

Table 3. Class/ family-wise distribution of ectoparasites of *Cynopterus sphinx* in Cachar District of Assam, India.

	Ectoparasite	Order	Family
1	*Ameroseius* sp. Indet	Mesostigmata	Ameroseiidae
2	*Dermacentor* sp. Indet	Ixodida	Ixodidae
3	*Steatonyssus* sp. Indet	Mesostigmata	Macronyssidae
4	Unidentified nymph		

Table 4. Site-wise distribution of ectoparasites of *Cynopterus sphinx* in Cachar District of Assam, India.

	Ectoparasite	Number	Number of bats	No. of recorded locations (out of eight locations)
1	*Ameroseius* sp. Indet	32	9	5
2	*Dermacentor* sp. Indet	23	7	4
3	*Steatonyssus* sp. Indet	63	12	8
4	Unidentified nymph	07	-	-

Molossidae, Vespertilionidae, and Phyllostomidae. Alvarez et al. (2015) studied ectoparasite diversity and host-parasite association of bats and found an ectoparasitic infestation in 46.42% of the bats (65 out of 140). In comparison to those studies, the present study reveals 100% infestation (125 parasite in 12 bats) in the bats. *Dermacentor* sp. Indet was found in 50% (four out of eight) of the locations, *Ameroseius* sp. Indet in 62.5% (five out of eight) of the locations, and *Steatonyssus* sp. Indet in 100% (eight out of eight) of the locations of the area studied.

Studies on ectoparasites of Kathmandu Valley by Dahal & Thapa (2010) recorded 33 ectoparasites belonging to five families (Cimicidae, Ischnopsyllidae, Nycteribidae, Spinturnicidae, and Streblidae) that were associated with five species of bats. On the other hand, the present study reports three ectoparasite species belonging to three families (Ameroseiidae, Macronyssidae, and Ixodidae) on a single bat species (*C. sphinx*).

Esbérard et al. (2005) and ter Hofstede & Fenton (2005) reported higher rate of ectoparasite infestation in enclosed-roosting species than in foliage-roosting bats. Since the present study deals with foliage-roosting bats only, such comparative studies could not be made. As already mentioned, however, variations were observed from 50% to 100% with respect to ectoparasite abundance in all the eight different areas studied.

Variations in ectoparasite abundance (1.6–29.6 %) among different sites were observed (Table 2). Out of the eight sites, the maximum abundance was found at Dharamkhal (Site VII), followed by Islamabad (Site IV) and Salganga (Site II). Due to the limitation of the bat species not being widespread in the area, extensive surveys considering more number of sites was beyond the scope of this study. Generally, it has been observed that bats cannot stay for long in areas with medium to high anthropogenic disturbances. Site VII (Dharamkhal) is a relatively undisturbed area. Since anthropogenic issues are absent in this area, bats stay here longer and so do their ectoparasites.

There are many taboos about bats such as i) seeing bats is inauspicious, ii) their nests in residential areas bring doomsday for families, and iii) the species is sent from hell. Hence, most people dislike them. Therefore, there is little resistance in cutting down their roosting trees and damaging their nesting sites. Semi-structured questionnaire surveys among indigenous communities residing in the area (n=1350) revealed that 4.12% of the people think that bats spread lice and house bugs. The present study found no basis for this and boldly advocates that bats are not responsible for spreading such infestations. These fallacies are responsible for unwanted killings of bats in roosting as well as foraging sites. Awareness among the masses will help in saving bat species from killing due to misconceptions.

CONCLUSION

During the present study, we encountered three individuals of *C. sphinx* that fell down from the roosting location, possibly due to excessive infestation caused by the ectoparasites. The new reporting of three ectoparasites (*Ameroseius* sp. Indet, *Dermacentor* sp. Indet, and *Steatonyssus* sp. Indet) on *C. sphinx* in the biodiversity-rich areas of Assam is remarkably important, especially since it is already mentioned that altogether six different bat species occur in the area. Studies on the ectoparasites of the other five species of bats (two megachiropterans and three microchiropterans) is the future component of our study. Once this is done, bat-ectoparasite relationships would be understood in a better way that would help in formulating conservation strategies for all the chiropterans in a holistic way.

REFERENCES

Alvarez J. D.V., Ireneo L. Lit, Jr. & P.A. Alviola (2015). Bat flies (Diptera: Nycteribiidae) from Mount Makiling, Luzon Island: New host and distribution records, with a checklist of species found in the Philippines. Check List 11(1): 1–4; https://doi.org/10.15560/15.1.1509

Anthony, E.L.P. (1988). Age determination in bats, pp47–58, In: Kunz, T.H. (ed.). *Ecological and Behavioral Methods for the Study of Bats*. Smithsonian Institution Press, Washington, DC, xxii+533pp.

Barlow, K. (1999). Expedition Field Techniques: Bats. Expedition Advisory Centre, Royal Geographical Society, London, 69pp.

Bates, P.J.J. & D.L. Harrison (1997). *Bats of the Indian Subcontinent*. Harrison Zoological Museum, Sevenoaks, Kent, UK, 258pp.

Bertola, P.B., C.C. Aires, S.E. Favorito, G. Graciolli, M. Amaku & R. Pinto-daRocha (2005). Bat flies (Diptera: Streblidae, Nycteribiidae) parasitic on bats (Mammalia: Chiroptera) at Parque Estadual da Cantareira, Sao Paulo, Brazil: parasitism rates and host-parasite associations. *Memórias do Instituto Oswaldo Cruz* 100(1): 25–32. https://doi.org/10.1590/S0074-02762005000100005

Burnett, C.D. & T.H. Kunz (1982). Growth rates and age estimation in **Eptesicus fuscus** and comparison with *Myotis lucifugus*. *Journal of Mammalogy* 63: 33–41. https://doi.org/10.2307/1380668

Dahal, S. & S. Thapa (2010). A Report on Preliminary Study of Ectoparasites of Bats of Kathmandu Valley. Central Department of Zoology, Tribhuban University, Kirtipur, Small Mammal Conservation and Research Foundation, Kathmandu, Nepal, 19pp.

Desch, C., W.B. Nutting & F.S. Lukoshus (1972). Parisitic mites of Surinam VII. *Demodex longissimus* n. sp., from *Carollia perspicillata*, and *D. molossi* n. sp., from *Molossus molossus* (Demodecidae: Trombidiformes): meibomian complex inhabitants of Neotropical bats (Chiroptera). *Acarologia* 15: 35–53.

Durden, L.A., T.L. Best, N. Wilson & C.D. Hilton (1992). Ectoparasitic mites (Acari) of sympatric Brazilian Free-tailed Bats and Big Brown Bats in Alabama. *Journal of Medical Entomology* 29(3): 507–511.

Esbérard, C.E.L., F. Martins-Hatano, E.B. Bittencourt, D.E.P.Bossi, A. Fontes, M. Lareschi, V. Menezes, H.G. Bergallo & D. Gettinger (2005). A method for testing the host specificity of ectoparasites: give them the opportunity to choose. *Memórias do Instituto Oswaldo Cruz* 100(7): 761–764. https://doi.org/10.1590/S0074-02762005000700015

Galloway, T.D. & H.V. Danks (1991). Arthropod ectoparasites of vertebrates in Canada. *Supplement to the Bulletin of the Entomological Society of Canada* 23(1): 11.

Gannon, M.R. & M.R. Willing (1995). Ecology of ecto-parasite from tropical bats. *Environmental Entomology* 24(6): 1495–1503.

Ghassemi, F., H. Khargar & A. Nemati (2012). The study of bat fauna in the south part of Iran: a case study of Jahrom. *Advances in Environmental Biology* 6(10): 2720–2725.

Helms, J.S. (2010). A Little Bat and a Big City: Nocturnal Behaviour of the Tricolored Bat (*Perimyotissub flavus*) near Indianapolis Airport. MSc Thesis. The College of Graduate and Professional Studies. Department of Biology, Indiana State University, Terre Haute, Indiana & UNT Dissertation Publishing, ProQuest LLC, US.

Hopla, C.E., L.A. Durden & J.E. Keirans (1994). Ectoparasites and classification. *Revue Scientifiqueet Technique (International Office of Epizootics)* 13(4): 985–1017.

Hunter, D., R. Reinhardt, D. Scott & A. Vilaythong (2001). Analysis of Ectoparasites of Dominican Bats. Group Project Report. Texas A & M Study Abroad.

Jaunbauere, G., I. Salmane & V. Spungis (2008). Occurrence of bat ectoparasites in Latvia. *Latvijas Entomologs* 45: 38–42.

Kunz, T.H. & A. Kurta (1988). Capture methods and holding devices. pp1–29. In: Kunz, T.H. (ed.). *Ecological and Behavioral Methods for the Study of Bats*. Smithsonian Institution Press, Washington, D.C., 533pp.

Marshall, A.G. (1982). Ecology of insects ectoparasitic on bats, pp369–401. In: Kunz, T.H. (ed.). *Ecology of Bats*. Plenum Press, New York & London, 401pp.

Molur, S., C. Marimuthu, C. Srinivasulu, S. Mistry, A.M. Hutson, P.J.J. Bates, S. Walker, K.P. Priya & A.R.B. Priya (2002). Status of South Asian Chiroptera: Conservation Assessment and Management Plan (C.A.M.P.) Workshop Report, 2002. Zoo Outreach Organisation, CBSG South Asia and WILD, Coimbatore, India, viii+320pp.

Mullen, G. & L. Durden (2002). *Medical and Veterinary Entomology*. Academic Press, London, 597pp.

Orlova, M.V. (2011). Ectoparasite associations of bats from the Urals (Russia). *Hystrix* 22(1): 105–110.

Ransome, R.D. (1995). Earlier breeding shortens life in female Greater Horseshoe Bats. *Philosophical Transactions of the Royal Society of London B* 350: 153–161. https://doi.org/10.1098/rstb.1995.0149

Ritzi, C.M. & M.K. Clark (2001). New ectoparasite records of bats from North Carolina. *The Journal of the Elisha Mitchell Scientific Society* 117(2): 135–137.

Smith, A.T. & Y. Xie (2008). *A Guide to the Mammals of China*. Princeton University Press, Princeton, 576pp.

Sophia, E. (2010). Foraging behavior of microchiropteran bat, *Hipposideros ater* on chosen insect pests. *Journal of Biopesticides* 3(1): 68–73.

Speakman, J.R. & P.A. Racey (1986). The influence of body condition on sexual development of male Brown Long-eared Bats (*Plecotus auritus*) in the wild. *Journal of Zoology* 210(4): 515–525.

ter Hofstede, H.M. & M.B. Fenton (2005). Relationships between roost preferences, ectoparasite density, and grooming behaviour of Neotropical bats. *Journal of Zoology* 266(4): 333–340. https://doi.org/10.1017/S095283690500693X

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