A SURVEY OF ECTOPARASITES IN GUNUNG STONG FOREST RESERVE, KELANTAN, MALAYSIA

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Abstract. A survey of ticks and other ectoparasites was carried out during a national biodiversity scientific expedition at Gunung Stong Forest Reserve, Kelantan, Malaysia from 23-29 May 2003. A total of 272 animals comprised of 12 species of birds, 21 species of bats, 7 species of rodents and 2 species of insects were examined for ticks and other ectoparasites. From these animals, 5 species in 4 genera of ticks; 7 species in 2 families of Mesostigmatid mites and 5 species of chiggers were collected. Among the ectoparasites found were *Ixodes granulatus* and *Leptotrombidium deliense*, which are of known medical importance. A tick island consisting of 10 nymphal stages of *Dermacentor* spp was observed feeding on *Rattus tiomanicus*.

INTRODUCTION

Gunung Stong Forest Reserve (GSFR), which covers an area of approximately 61,128 ha is a permanent hill forest reserve located in Dabong, Kelantan. It is about 103 km from Tanah Merah; 48 km from Jeli and 165 km from Kota Bharu (Fig 1). GSFR is ranked fifth, out of a list of ten destinations for eco-tourism in Malaysia under the National Eco-tourism Plan. It has superb natural assets with seven waterfalls and a great place for jungle trekking and mountain climbing. The forest reserve, which boasts 9 mountains, is popular and well-known to local and foreign mountain climbers. The 3 most commonly climbed mountains in the area are Gunung Ayam (1,504 m), Gunung Stong (1,422 m) and Gunung Baha (1,309 m). Besides mountains, it has the highest waterfall in Southeast Asia with a height of over 200 m. The waterfall, *Air Terjun Jelawang* is the meeting point of two waterfalls, from Gunung Stong and Gunung Ayam. A local study on biodiversity (MOSTE, 1998) has described Gunung Stong as of national importance, viable and requires action to maintain its present level of conservation.

No ectoparasite survey has been conducted in GSFR. The objectives of this study were to obtain data on the distribution and host interactions of ectoparasites from avifauna and non-volant small mammals in Gunung Stong Forest Reserve, Kelantan, Malaysia.

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MATERIALS AND METHODS

Trapping non-volants and avifauna

Trapping of non-volant small mammals and avifauna was conducted in 3 expedition trails on Gunung Stong. The trapping sites were selected from the available trails made by foresters in the expedition. Trapping of non-volant small mammals with wire traps was conducted simultaneously on the 3 trails over 3 consecutive nights using 35 traps (20x20x30 cm) per site. At each trail, traps were laid along a transect line at approximately 10 m intervals. Wire traps were baited randomly with either banana, sweet potatoes, oil palm fruits or roasted coconut flesh. Mist-net and Harp Trap® (Fig 2) were used to capture avifauna and were set along each trail. One Harp Trap and 10 mist-nets were set per

trail for 3 consecutive nights. The traps for non-volant small mammals and avifauna were checked once and twice daily, respectively.

Collection of ticks

Ticks were also collected by flagging or dragging white towels over vegetation and examination of edges and undersides of undergrowth. Where possible, fed immature ticks were reared in the laboratory for confirmation of species.

Processing animals

The animals caught were transported in cloth bags back to a laboratory at base-camp. Those bags were turned inside-out, their contents shaken onto a white enamel tray and examined for ectoparasites. The animals were then identified. Animals that were not protected species were killed using chloroform in a killing jar. For protected species, steps were taken to anesthesize the animal with Zoletil® that ensures a general anesthesia with a short induction time, very few side effects and maximal safety. The dead or anesthesized animal was then removed from the bag, placed on an enamel tray and combed thoroughly with a fine toothed comb such that dislodged materials were collected in the tray. Dislodged materials were examined under a dissecting microscope and ectoparasites seen were picked up with a sharpened applicator stick. Each of the animals was then further examined in detail under a dissecting microscope and any ectoparasite found was picked up with a pair of fine forceps. Nasal passages of rodents were dissected to look for chiggers.

Killing of avifauna was not allowed in the study. Examination was therefore made on live avifauna and only a general screening was possible. For bats, special attention was given to the wing membranes, eye-lids, ear-lobes and nose. The body fur was parted with a forcep and searched for ectoparasites. For birds, a general examination for ticks, mesostigmatid mites and chiggers was made on the skin, primary and secondary feathers. Skin and feathers under both wings and the anal portion of the bird were given priority.

Screening of insects

Two species of insects (Homoptera: Cicadoidea) were given by a participant of the expedition. The insects were caught using light traps from 7:00 PM to 12:00 PM. A millipede, coincidently found by a team member was also screened for ectoparasites. The areas underneath and in between the body segment of the insects and the millipede were examined.

Preservation and mounting of ectoparasites

Most of the ectoparasites found were preserved in 70% ethanol. Where possible, fed immature ticks were reared in the laboratory for confirmation of species. All preserved ectoparasites, excluding ticks, were later mounted for identification. Chiggers were directly mounted. Mesostigmatid mites were first cleared in lactophenol. Astigmatid mites were placed in lactic acid and heated on a hot plate at 200°C for 5 minutes before mounted in Hoyer's medium. Mounted slides were incubated at 40°C for a week and cover-slips ringed with paint.

Identification of ectoparasites

Wherever possible, adult ticks and other ectoparasites were identified to the species level. Identification of sex and life-cycle stages was also made.

RESULTS

A total of 272 animals comprised of 12 species of birds, 21 species of bats, 7 species of non-volant small mammals and 2 species of insects were examined for ectoparasites. The species of avifauna and non-volant small mammals caught as well as the infestation rates are shown in Table 1.

Ticks

Ticks were found only on species of non-volant small mammals, not on bats or birds. All were ixodid ticks belonging to genus *Amblyomma*, *Dermacentor, Haemaphysalis* or *Ixodes.* Most mammals were infested with *Haemaphysalis* (85.7%), followed by *Dermacentor* (57.1%) and *Ixodes* (57.1%) ticks. The only ticks that could be identified to the species level was *Ixodes granulatus*, which was found on *Leopoldamys sabanus*, *Maxomys whiteheadi*, *Rattus tiomanicus* and *Sundamys muelleri*.

Only 4 species of *Dermacentor* ticks were collected from flagging vegetation. The species

Fig 1–Map of the expedition site in the state of Kelantan, Malaysia.

Fig 2–Set-up of a Harp Trap® on one of the trails in Gunung Stong.

Fig 3–A tick island consisted of 10 nymphal stages of *Dermacentor* spp feeding on *R. tiomanicus*.

and their relative percentages were *D. astrosignatus* (30.6%), *D. compactus* (44.4%), *D. steini* (19.4%) and *D. taiwanensis* (5.6%).

A tick "island" consisting of 10 nymphal stages of *Dermacentor* spp of various body sizes was found feeding on one *R. tiomanicus* (Fig 3).

Mesostigmatid mites

Mesostigmatid mites were found on non-volant small mammals and bats but not on birds (Table 2). Infestation rates on the small mammals (55.9%) were higher than on bats (3.3%). Seven species in 2 families of Mesostigmatid mites were recovered from the non-volant small mammals. Laelapid mites were found on all the non-volant small mammals caught. Spinturnicidae was the only family of Mesostigmatids recovered from bats and was mainly found on fruit bats weighing less than 6 grams. The Spinturnicids could not be identified locally and will be sent overseas for further identification. None of the Mesostigmatid mites recovered was of known medical importance.

Chiggers

Chiggers were recovered from 2 species of bats and 6 species of non-volant small mammals, but not from birds. The highest infestation rate (50.0%) was on the mammals. A total of 4 species of chiggers was recovered from eye-lids,

Table 1
Ectoparasitic infestation rates on avifauna and small mammals in Gunung Stong Forest Reserve, Kelantan (23-29 May 2003).

Host species	No. caught	No. of host infested			
		Ticks	Mesostigmatid mites	Chiggers	Others
Birds (Aves)					
Arachnothera longirostra	9	0	0	0	0
Copsychus malabaricus	1	0	0	0	0
Criniger bres	2	0	0	0	0
Cyornis rubeculoides	1	0	0	0	0
Dicaeum trigonostigma	1	0	0	0	0
Enicurus ruficapillus	1	0	0	0	0
Hypsipetes criniger	1	0	0	0	0
Macronous gularis	1	0	0	0	0
Pycnonotus erythropthalmus	1	0	0	0	0
Stachyris nigriceps	1	0	0	0	0
Stachyris policephala	1	0	0	0	0
Trichastoma malaccense	1	0	0	0	0
Total	21	0	0	0	0
Bats					
Balionycteris maculata	3	0	0	0	0
Cynopterus brachyotis	6	0	0	0	0
Hipposideros bicolor	74	0	0	13	0
Hipposideros larvatus	13	0	0	5	0
Kerivoula hardwickii	15	0	2	0	0
Kerivoula minuta	6	0	0	0	0
Kerinoula papillosa	16	0	0	0	0
Kerivoula pellucidae	2	0	1	0	0
Macroglossus minimus	3	0	2	0	0
Macroglossus sobrinus	19	0	1	0	0
Murina cyclotis	3	0	0	0	0
Murina genes	1	0	0	0	0
Murina suilla	4	0	1	0	0
Myotis ater	3	0	0	0	0
Nycteris javanica	1	0	0	0	0
Rhinilopus affinis	29	0	0	0	0
Rhinolopus rifulgens	1	0	0	0	0
Rhinolopus stheno	9	0	0	0	0
Rhinolopus trifoliatus	1	0	0	0	0
Tylonycteris pachypus	2	0	0	0	0
Tylonycteris robustula	4	0	0	0	0
Total	214	0	7 (3.3%)	18 (8.5%)	0
Small mammals					
Leopoldamys sabanus	6	5	4	3	0
Maxomys rajah	1	1	1	0	0
Maxomys surifer	3	2	1	2	0
Maxomys whiteheadi	7	3	5	6	0
Niniventer cremoriventer	6	2	3	1	0
Rattus tiomanicus	8	6	2	2	0
Sundamys muelleri	3	3	3	3	0
Total	34	22 (64.7%)	19 (55.9%)	17 (50.0%)	0
Others					
Narceus spp	1	0	0	0	0
Mogannia spp	1	0	0	0	0
Tanna spp	1	0	0	0	0
Total	3	0	0	0	0
Grand total	272	22 (8.1%)	26 (9.6%)	35 (12.8%)	0

Table 2
Ectoparasites found on bats and small mammals in Gunung Stong Forest Reserve, Kedah (23-29 May 2003).

Species	Bats																					Small mammals					
	Balionycteris maculata	*Cynopterus brachyotis*	*Hipposideros bicolor*	*Hipposideros larvatus*	*Kerivoula hardwickii*	*Kerivoula minuta*	*Kerivoula papillosa*	*Kerivoula pellucidae*	*Macroglossus minimus*	*Macroglossus sobrinus*	*Murina cyclotis*	*Murina genes*	*Murina suilla*	*Myotis ater*	*Nycteris javanica*	*Rhinolopus acuminatus*	*Rhinolopus affinis*	*Rhinolopus rifulgens*	*Rhinolopus stheno*	*Rhinolopus trifoliatus*	*Tylonycteris pachypus*	*Tylonycteris robustula*	*Leopoldamys sabanus*	*Maxomys rajah*	*Maxomys surifer*	*Maxomys whiteheadi*	*Niniventer cremoriventer*	*Rattus tiomanicus*	*Sundamys muelleri*
Ticks																												
Amblyomma spp																						+						
Dermacentor spp																						+	+		+		+	
Haemaphysalis spp																						+	+	+	+		+	+
Ixodes granulatus																						+			+		+	+
Ixodes spp																						+	+					
Mesostigmatids																												
Laelaps aingworthae																						+	+	+	+			+
Laelaps echidninus																						+	+		+	+	+	+
Laelaps insignis																						+		+				
Laelaps nuttali																						+	+			+	+	+
Laelaps scuplturatus																						+			+	+		
Laelaps sedlaceki																							+		+		+	+
Longolaelaps longulus																									+	+		
Spinturnicid mites						+			+	+	+			+														
Chiggers																												
Eutrombicula wichmanni																						+					+	
Gahrliepia (G) fletcheri																						+		+	+	+		+
Gahrliepia (Walchia)naniparma																						+		+				+
Leptotrombidium (L.) deliense																						+					+	+
Leptotrombidium spp				+																								
Whartonia caobangensis				+	+																							

ear-lobes and the bodies of the mammals. The species were *Eutrombicula wichmanni*, *Gahrliepia (Gahrliepia) fletcheri*; *Gahrliepia (Walchia) naniparma*; and *Leptotrombidium deliense* (Table 2). The *Gahrliepia* species was recovered only from forest rodents.

The chiggers on the bats were identified as *L.deliense* and *Whartonia caobangensis*. L. deliense was found on a bat, *Hipposideros bicolor*. *W. caobangensis* was present on 2 species of bats, *H. bicolor* and *H. larvatus*.

Comparison of data with a previous survey

A comparison of species found in GSFR and the only known ectoparasite survey in Kelantan (Shabrina, 1991) is listed in Table 3. Gua Musang, which is in southern Kelantan, is located at 101º55'E latitude and of 4º55' N longitude, whereas GSFR was closer to the center of the state at 101º58'E latitude and 5º24' N longitude.

In GSFR, there were 5 species of ticks that were not found in the Gua Musang survey. One possible reason is that in the Gua Musang sur-

Table 3
A comparison of ectoparasitic species found in Gua Musang (Shabrina, 1991) and Gunung Stong Forest Reserve.

Species of ectoparasites	Presence of ectoparasites in the area	
	Gua Musang 1991	G. Stong Forest Reserve, 2003
Ticks		
Amblyomma spp	+	+
Family Argasidae	+	-
Dermacentor astrosignatus	-	+
Dermacentor compactus	-	+
Dermacentor steini	-	+
Dermacentor taiwanensis	-	+
Dermacentor spp	-	+
Haemaphysalis spp	+	+
Ixodes granulatus	-	+
Mesostigmatid mites		
Chelonotus spp	+	-
Cheyletus fortis	+	-
Cheyletus spp	+	-
Haemolaelaps spp	+	-
Hirstionyssus callosciuri	+	-
Laelaps aingworthae	-	+
Laelaps echidninus	+	+
Laelaps insignis	-	+
Laelaps nuttalli	+	+
Laelaps sanguisugus	+	-
Laelaps sculpturatus	-	+
Laelaps sedlaceki	+	+
Longolaelaps longulus	+	+
Spinturnicid mites	+	+
Chiggers		
Ascoschoengastia audyi	+	-
Ascoschoengastia ctenacarus	+	-
Ascoschoengastia indica	+	-
Diplectria spp	+	-
Gahrliepia (G) fletcheri	+	+
Gahrliepia (Walchia) naniparma	-	+
Leptotrombidium (L.) deliense	+	+
Walchiella oudemansi	+	-
Whartonia caobangensis	-	+
Others		
Hoplopleura dissicula	+	-
Hoplopleura spp	+	-
Listrophoroides borneoensis	+	-
Listrophoroides lativentris	+	-
Listrophoroides pahangi	+	-
Listrophoroides sculpturatus	+	-
Listrophoroides spp	+	-

vey, only immature stages of ticks were recovered and their identification not carried out. Besides that, flagging of vegetation for ticks was not done in the Gua Musang survey. Flagging in GSFR recovered another 4 species of ticks since adult stages are easily found on vegetation. Ticks of the family Argasidae, which was found on bats, *Eonycteris spelaea* in Gua Musang, was not found in GSFR. No *E. spelaea* were trapped in the GSFR survey.

About the same number of Mesostigmatid species were recovered in both surveys. The numbers were similar despite more animals, in terms of numbers and species, were trapped in GSFR, compared to Gua Musang. *L. aingworthae, L. insignis* and *L. sculpturatus* were present in GSFR and not in Gua Musang. Spinturnicid mites were found in both GSFR and Gua Musang.

In the 1991 survey, 7 species of chiggers were recovered, of which only 2 species were found in GSFR. This might be due to the differences in the species of hosts caught and examined for chiggers. Unlike Gua Musang, this survey caught few squirrels. The species of squirrels found in Gua Musang, that were not caught in GSFR, were *Callosciurus nigrovittatus, Callosciurus notatus* and *Rhinosciurus laticaudatus*. The first 2 squirrels species contributed 3 species of *Ascoschoengastia* in the Gua Musang survey.

Gahrliepia (W) naniparma and *Whartonia caobangensis* were present in GSFR and not in Gua Musang. The former was found on animal species that were also caught in Gua Musang. *W. caobangensis* was found on bats, *H. bicolor* and *H. larvatus,* that were not caught in the Gua Musang survey.

DISCUSSION

The identification of *Ixodes granulatus* agrees with reports that the common host for *I. granulatus* is rodents.

It is interesting to note that the tick island consisted of only one genus, although 2 other genera, *Haemaphysalis* and *Ixodes*, were feeding on other parts of the body. Why that was so is not known. There is no published information on whether this feeding behavior is coincidental

or natural where ticks feed in a cluster, consisting only of their "siblings". The ticks on the island were observed to have similar spur shapes of spurs at coxae I, and a similar shape and color of the dorsal scutum. Thus, they were suspected to be of the same species. This is something interesting to study and it is hoped that the feeding behavior can be seen again and recorded in future expeditions.

Among the ticks found, *I. granulatus* is known to transmit pathogens (Marchette, 1966). Lanjan virus (Kaisodi serogroup) in Malaysia was originally described from a *Dermacentor* species (Tan *et al*, 1967). Thus the *Dermacentor* ticks that are predominantly found in this area may be potential vectors too.

L. deliense is of medical importance as vector for scrub typhus in Peninsular Malaysia (Nadchatram, 1970; Nadchatram and De Witt, 1976).

The Rhinolopid bats found in this area are also insectivorous and exposed to the same type of ecology for feeding as *Hipposideros* spp, but none of them was infested by chiggers; these bats have been identified as important hosts of trombiculids (Audy *et al*, 1960).

In conclusion, a total of 5 species in 4 genera of ticks; 7 species in 2 families of Mesostigmatid mites and 5 species of chiggers were identified from 12 species of birds, 21 species of bats, 7 species of rodents and 2 species of insects. This survey produced the first list of ectoparasites in GSFR and the second study of ectoparasites in a locality in Kelantan. Ten species of these ectoparasites are new for Kelantan. The species were *D. astrosignatus, D. compactus, D. steini, D. taiwanensis, I. granulatus, L. aingworthae, L. insignis, L. sculpturatus, Gahrliepia (Walcia) naniparma* and *Whartonia caobangensis*. Further surveys need to be carried out in order to have a more comprehensive directory of ticks and other ectoparasites in Kelantan. For future studies of the hill forest, it would be useful to determine the distribution of ectoparasites at different altitudes.

ACKNOWLEDGEMENTS

The authors wish to thank the Director, Institute for Medical Research (IMR), Kuala Lumpur, Malaysia for permission to publish this paper; the Director, Forestry Department of Peninsular Malaysia; the Director, Forestry Department of Kelantan and the Expedition Leader, Prof Dato' Dr Abd Latiff Mohamad for their assistance and support during the expedition. We are grateful to Mr Siew Sow Chun and Mr Sahudi from IMR; the post-graduate students from the Universiti Sains Malaysia namely Ms Nurul 'Ain Elias, Ms Nor Zalipah Mohamed and Mark Rayan Darmaraj; and Mr Yusoff Ahmad, Mr Awang and Mr Rashid from Universiti Kebangsaan Malaysia for their assistance in the field and Mrs Halimaton Ibrahim from IMR for the processing of the Mesostigmatid samples.

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