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Breeding pattern, food habits and parasitic infestation of bats in Gunong Brinchang

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INTRODUCTION

West Malaysia is extremely rich in bat fauna. Some 78 species have been listed in a recent review (Medway, 1969). Most of the published information, however, deals with the lowland forms (Bullock, 1963; Dunn, 1965; Medway, 1965, 1972; Medway and Marshall, 1970; Yong, Dhaliwal and Teh, 1971). Bats from hill stations have usually been given only brief mention (Lim, 1966). It is evident that information on the biology of bats from high altitude is lacking.

The present paper deals with bats collected for bio-medical investigations in 1964 in Gunong Brinchang (4°31′ N; 101°23′ E), Cameron Highlands, Pahang, Malaysia.

MATERIALS AND METHODS

All the fruit bats (Megachiroptera) were caught in mist nets set in forest fly-ways at different altitudes of Gunong Brinchang. Most of the insectivorous bats (Microchiroptera) were collected in their roosts in the forest with the help of Orang Asli trappers. Collections were made bimonthly from 5000 ft to 6600 ft elevations.

Ecto- and endo-parasites were collected and blood smears were made from all the bats. Standard measurements were taken of these bats. The stomach contents were analysed and the females were examined for pregnancy. After examination, most of the fruit bats were discarded except for a few representatives of each species which were preserved in 70% alcohol. All the insectivorous bats were preserved. The ecto-parasites were studied by Dr T.C. Maa in Formosa while the helminths and blood parasites were examined locally.

The stomach was removed from each individual bat and its contents were examined under a binocular microscope. The materials in the stomachs of most bats were highly macerated and it was not possible to identify the fragments in some cases.

RESULTS

Table 1 shows the number of bats collected as well as the number that were pregnant during the period from February to December 1964. The collec-

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TABLE 1. Collections of fruit and insect eating bats in Cameron Highlands, Pahang, in 1964.

Species	Numbers of Bats Collected												Total	
	February		April		June		August		October		December			
	M	F	M	F	M	F	M	F	M	F	M	F	M	F
MEGACHIROPTERA														
Rousettus amplexicaudatus (Geoff)	5	8(4)	8	9(2)	7	9(3)	8	4	5	4	5	9(1)	38	45(10)
Cynopterus brachyotis altitudinus (Hill)	3	6(1)	4	9(2)	4	5	5	4	3	4	5	2	24	30(3)
Megaerops ecaudatus (Temminck)	12	10(7)	10	8(3)	6	2(1)	4	5	2	3	8	6	42	34(11)
Balionycteris maculatus (Thomas)	6	5(1)	3	6(1)	4	6	3	7	2	2	6	5	24	31(2)
Aethalops alecto (Thomas)	9	15(4)	6	8(2)	7	9(1)	6	5	7	4	3	5	38	46(7)
Chironax melanocephalus (Temminck)	8	4(1)	7	5(1)	4	3	5	2	6	5	4	3	34	22(2)
Penthetor lucasi (Dobson)	15	3(2)	10	3(1)	9	2(1)	3	3	4	2	2	3	43	16(4)
Eonycteris spelaea (Dobson)	5	7(2)	4	8(3)	8	12	3	10	5	7	3	4	28	48(5)
Macroglossus minimus (Geoff)	4	3(1)	5	6	5	4(1)	3	5	2	4	3	6	22	28(2)
Macroglossus lagochilus. Matschie	2	1	2	3(1)	4	2(1)	1	1	1	0	6	1	16	8(2)
MICROCHIROPTERA														
Emballonura monticola Temminck	1	1	1	2	2	3	1	1	2	3(1)	1	2(1)	8	12(2)
Megaderma spasma (Linn)	1	1	1	1	1	1	2	0	2	1	1	1	8	4(0)
Rhinolophus luctus Temminck	0	0	0	0	0	1	1	0	1	0	0	0	2	1(0)
Rhinolophus trifoliatus Temminck	1	0	2	2(1)	1	0	2	0	1	3(1)	1	0	8	5(2)
Hipposideros armiger (Hodgs)	4	3(1)	3	0	2	2(1)	1	0	2	2	1	0	13	7(2)
Hipposideros diadema (Geoff)	1	0	0	3(2)	3	2	1	0	0	2(1)	0	0	5	7(3)
Myotis mystacinus (Kuhe)	2	4(2)	3	5(2)	5	4(1)	2	2(1)	1	2(1)	2	1	15	18(8)
Kerivoula papillosa (Temm.)	1	0	0	0	0	2	2	0	1	3(1)	1	1(1)	5	6(2)

The figures within brackets refer to the numbers that were pregnant for any of the females collected.

TABLE 2. Stomach contents of Megachiroptera and Microchiroptera

	Hemiptera	Orthopteroidea	Coleoptera	Lepidoptera	Diptera	Hymenoptera	Unidentified insect part	Araneae	Plant materials	Small mammals	Number sampled	Number with food in gut
MEGACHIROPTERA												
Rousettus amplexicaudatus	−	−	−	−	+	−	−	−	+	−	57	15
Cynopterus brachyotis altitudinis	−	−	−	−	−	+	−	−	+	−	50	10
Megaerops ecaudatus	−	−	−	−	−	−	−	−	+	−	70	1
Balionycteris maculatus	−	+	−	−	−	−	−	+	+	−	50	13
Aethalops alecto	−	−	−	+	−	+	−	−	+	−	80	28
Chironax melanocephalus	−	−	−	−	+	−	−	−	+	−	50	7
Penthetor lucasi	−	+	−	−	+	−	−	+	+	−	50	17
Eonycteris spelaea	−	−	−	−	−	−	−	−	+	−	70	9
Macroglossus lagochilus	−	−	−	−	−	−	−	−	+	−	50	14
Macroglossus minimus	−	−	−	−	−	−	−	−	+	−	24	5
MICROCHIROPTERA												
Emballonura monticola	+	+	+	−	−	+	−	−	+	−	20	5
Megaderma spasma	−	+	+	−	−	−	+	−	−	−	12	2
Rhinolophus luctus	−	+	−	−	−	+	+	−	−	−	3	1
Rhinolophus trifoliatus	−	+	+	−	−	+	−	−	+	−	13	6
Hipposideros armiger	−	+	−	−	−	+	−	−	+	−	20	3
Hipposideros diadema	−	+	+	−	−	+	−	−	+	−	12	4
Myotis mystacinus	−	−	+	−	−	+	+	−	−	−	3	8
Kerivoula papillosa	+	+	+	−	−	+	−	−	−	−	11	2

+, present; −, absent

TABLE 3. Percentage of parasitic infections observed in Megachiroptera and Microchiroptera

Species	Blood Parasite	Ecto-parasite				Endo-parasite	
	Hepatocystis	Nycteribiidae	Streblidae	Ticks	Fleas	Nematodes	Trematodes
MEGACHIROPTERA							
Rousettus amplexicaudatus	3.3 (60)	21.7 (83)	16.9 (83)	—	9.6 (83)	40 (40)	—
Cynopterus brachyotis altitudinis	40 (45)	20.4 (54)	3.7 (54)	—	—	4 (50)	—
Megaerops ecaudatus	1.5 (65)	12.8 (70)	5.7 (70)	—	—	16.6 (30)	—
Balionycteris maculatus	40 (40)	28 (50)	16 (50)	—	—	10 (50)	—
Aethalops alecto	8.6 (58)	5.9 (84)	19 (84)	—	—	5 (40)	—
Chironax melanocephalus	2 (50)	30 (55)	25.4 (55)	—	—	26 (50)	—
Penthetor lucasi	27.3 (55)	32.3 (59)	13.5 (59)	—	—	15 (40)	—
Eonycteris spelaea	25.7 (70)	15.8 (76)	13.2 (76)	92.1 (76)	—	20 (45)	—
Macroglossus minimus	0 (50)	16 (50)	22 (50)	—	—	0 (50)	—
Macroglossus lagochilus	0 (24)	12.5 (24)	0 (24)	—	—	0 (24)	—
MICROCHIROPTERA							
Emballonura monticola	0 (20)	0 (20)	20 (20)	0 (20)	0 (20)	15 (20)	55 (20)
Megaderma spasma	33.3 (12)	0 (12)	25 (12)	0 (12)	0 (12)	0 (12)	0 (12)
Rhinolophus luctus	0 (3)	0 (3)	0 (3)	0 (3)	0 (3)	33.3 (3)	66.6 (3)
Rhinolophus trifoliatus	15.4 (13)	15.4 (13)	61.5 (13)	0 (13)	0 (13)	38.5 (13)	64.2 (13)
Hipposideros armiger	30 (20)	20 (20)	25 (20)	0 (20)	0 (20)	35 (20)	40 (20)
Hipposideros diadema	25 (12)	50 (12)	33.3 (12)	25 (12)	0 (12)	25 (12)	41.6 (12)
Myotis mystacinus	0 (23)	9.1 (33)	12.1 (33)	0 (33)	0 (33)	51.5 (33)	27.3 (33)
Kerivoula papillosa	0 (11)	0 (11)	54.5 (11)	0 (11)	0 (11)	63.6 (11)	27.3 (11)

Figures within brackets indicate the number of bats examined.

tion comprised 10 species of fruit bats and 8 species of insectivorous bats. The fruit bats totalled 617 specimens (309 males and 308 females) whilst the insectivorous bats totalled 124 specimens (64 males and 60 females). Pregnant females occurred only from February to June in most of the fruit bats except *Rousettus amplexicaudatus* in which a pregnant female was recorded in December as well. Among the insectivorous bats there was no distinct or uniform breeding pattern although pregnant females of *Myotis mystacinus* were recorded throughout the trapping periods except December.

The stomach contents of the bats examined are given in table 2. Plant materials in the form of yellowish pulpy matter (probably digested fruits and flowers) were found in the gut of all species of fruit bats. Some pollen grains were found in *Eonycteris spelaea* but in *Macroglossus lagochilus* and *Macroglossus minimus* abundant pollen grains were found. Arthropod fragments were occasionally found among the stomach contents of 6 species of fruit bats. Among the insectivorous bats the food items consisted of mainly Orthoptera, Coleoptera, Hymenoptera and some Hemiptera. In a few instances, plant materials were also found among the gut contents. One specimen of *Megaderma spasma* had bits of brown hairs, claws and pieces of bones belonging to bats among the insect fragments in the gut.

Table 3 shows the number of bats that were sampled and the number that had the blood parasite *Hepatocystis* and various other ecto- and endoparasites. Blood parasite infestations occurred in most of the bat species except *M. lagochilus* and *M. minimus* among the Megachiroptera and *Emballonura monticola*, *Rhinolophus luctus*, *Myotis mystacinus* and *Kerivoula papillosa* among the Microchiroptera. The percentage infestation was generally quite low except in *Cynopterus brachyotis altitudinis* and *Balionycteris maculatus* where it was 40%.

Nearly all the bat species, except *R. luctus*, had ectoparasitic infestations. The percentage infestation of individual species was generally low. The commonest ectoparasites were the bat flies, Nycteribiidae and Streblidae. The latter family appeared to be commoner among insectivorous bats. Fleas were found only on *R. amplexicaudatus* whereas ticks (*Ornithodorus batuensis*) occurred on *E. spelaea* and *Hipposideros diadema*.

Most of the bat species, except *M. lagochilus*, *M. minimus* and *M. spasma* had intestinal nematodes. Trematodes were absent in the fruit bats but were found in most species of insectivorous bats except *M. spasma*. The trematodes were either members of the Dicrocoelidae or Lecithodendridae or both.

DISCUSSION

The results of the present study show that Gunong Brinchang is rich in bat fauna, particularly the fruit bats. Of the 14 species of fruit bats recorded in

West Malaysia, 10 have been collected in this study area. With the exception of *Aethalops alecto* and *C. brachyotis altitudinis* which are exclusively highland forms, the rest of the fruit bats can also be found in the lowlands. *Penthetor lucasi* and *M. minimus* although common in Gunong Brinchang, are more numerous in the lowlands whereas *R. amplexicaudatus* and *Megaerops ecaudatus* are less common in the lowlands but very abundant in the highlands (Hill, 1961; Lim, 1966).

Of the insectivorous bats, *H. armiger* and *H. diadema* were obtained only through netting whereas the others were collected mainly from their roosting sites in tree holes and in crevices on rocky banks. In the lowlands, the roosting sites of *H. armiger* and *H. diadema* are large openings of boulders in the forests and these bats are also very common in limestone caves (Lim, 1966; Medway, 1965). It is therefore quite possible that the roosting sites of these two species in Cameron Highlands may be in similar habitats as in the lowlands.

Although the fruit bats feed mainly on fruits and flowers, pollen also constituted an important part of the diet of *M. lagochilus* and *M. minimus*. The occasional presence of arthropod fragments in some of the fruit bats was probably accidental, these being taken in together with the fruits and flowers. In Borneo, *Eonycteris major* and *M. lagochilus* have been found with pollen grains in their stomach contents while insect remains were found in *P. lucasi* (Tan 1965; Lim 1965).

Insectivorous bats feed predominantly on insects. The plant materials found in some of the bats probably originated from the stomachs of the orthopteran prey. The recovery of bat remains in the stomach of *M. spasma* substantiated the observation of Beck (pers. comm.) that this species is cannibalistic. Another species of *Megaderma*, *M. lyra* Geoffroy has also been recorded to feed on other bats (Medway, 1967).

It is interesting to note that pregnancy in most of the fruit bats occurred only from February to June, with February to April appearing to be the peak period. There seems to be a synchronisation of the breeding period with the period of greater flowering and fruiting of forests trees during February to May in Gunong Brinchang. In the lowlands the peak pregnancy period of *Cynopterus brachyotis* is from April to June (Lim, 1970).

Of the insectivorous bats, *M. mystacinus* appears to breed throughout the year and the result concurs with the observations of Medway (1969). The apparent absence of any uniform or distinct breeeding pattern in the other species of insectivorous bats may be due to the small size of the samples.

Hepatocystis, a blood protozoan, has been commonly found infesting bats (Eyles *et al.*, 1964). Although the parasite was found in most of the species of bats examined, the percentage of infestation was generally low so that the absence of the parasite in some of the species could be due to the low sampling number of the bats.

Ectoparasites among the bats are common and information pertaining to West Malaysia is abundant (Maa, 1971; Leong and Marshall, 1968; Beck, 1971). Among the ectoparasites, the batflies, Nycteribiidae and Streblidae are the most common. In the insectivorous bats there seems to be a higher frequency of occurrence of Streblidae than Nycteribiidae. Ticks and fleas were comparatively rare, the former being recorded only in *E. spelaea* and *H. diadema* and the latter only on *R. amplexicaudatus*. In the lowlands, fleas have also been recorded from a species of insectivorous bat, *Tadarida mops* (Lim, unpublished).

Helminth infestations among Malaysian bats are common (Rhode, 1963; Heynemann & Lim, 1965; Ramachandran *et al.*, 1966) Nematodes appear to be common among both the fruit and insectivorous bats. Trematodes, however, have only been found in the insectivorous bats. Most of the dicrocoelid and lecithodendrid trematodes and some of the nematodes are transmitted through insect hosts in at least one stage of their life cycles. Thus there seems to be a good correlation between infestation by helminths and the diet of these bats.

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