ISSN 0121 – 8126
VOL XII – 1992/1993

The Journal of WILDLIFE AND PARKS

TABLE OF CONTENT

VOL. 12 1992/1993

A STUDY ON A COLLECTION OF SNAKES BY THE DEPARTMENT OF WILDLIFE AND NATIONAL PARKS

JASMI BIN ABDUL
LIM BOO LIAT

Abstract

The identification of the snake collections revealed 34 species belonging to 28 genus from 6 families. The recovery of the Leonard's Pipe Snake (*Anomochilus leonardi*) constitutes the fourth specimen and new locality record in addition to two other new locality records of the Blind Snake (*Typhlops diardi muelleri*) and the Mountain Pit Viper (*Trimeresurus monticola*). With a few species which were uncommon, most of the other species examined were common and widely spread.

Abstrak

Daripada satu koleksi pengumpulan ular, telah dikenalpasti 34 spesies yang tergolong di dalam 28 genus dari 6 famili. Dengan terjumpanya Leonard's Pipe Snake (*Anomochilus* leonardi) yang merupakan spesimen keempat pernah dijumpai di kawasan yang baru. Tambahan lagi dua kawasan baru dimana terjumpanya Ular Buta "Blind Snake" (*Typhlops diardi muelleri*) and Ular Kapak Gunung "Mountain Pit Viper" (*Trimeresurus monticola*). Sedikit sahaja spesies yang jarang ditemui manakala spesies yang lain adalah mudah ditemui dan terdapat di merata-rata tempat.

INTRODUCTION

During the years from 1986 to 1993 snake specimens were mostly collected by personnel of the Department of Wildlife and National Parks (DWNP) from the various states of Peninsular Malaysia and were sent to the DWNP Headquarters for identification on curation. Some specimens were collected by outsiders primarily from Kuala Lumpur, and some specimens were obtained from road kills. Within the DWNP HQ surroundings, a number of snake specimens were also collected, amongst them the most significant species was the Malayan Pit Viper (*Calloselasma rhodostoma*) (Jasmi & Lim, 1991)

METHODS

The majority of the snakes were dead specimens either road kills or freshly killed on arrival at the DWNP HQ. Few specimens that were caught alive which were identified as very common species were released. Each specimen was catalogued with a number. All relevant informations such as scalation counts and locality were made. After that, each of the catalogued specimen was preserved in 70% alcohol solution and kept as reference collection.

RESULTS

A total of 81 individual snakes were examined and identified (Table 1). These comprised of six families, 28 genus and 34 species which were as follows:-

Family: Typhlopidae, Aniliidae and Boidae.

A single specimen was obtained from each of these families (Table 1), of these, the Blind Snake (*Typhlops diardi muelleri*) of the family Typhlopidae is not common. This specimen was collected in Pergau, Ulu Kelantan which constitutes a new locality record for this species. The Leonard's Pipe Snake (*Anomochilus leonardi*) of the family Aniliidae was the fourth specimen collected which also constitutes a new locality record in Perak. The first two specimens of this species were collected in Pahang (Tweedie, 1982) and the third was from Selangor (Lim & Mohd. Sharef, 1975). The Short-tailed Python (*Python curtus*) of the family Boidae was a common species and is widespread throughout the Peninsular.

Family Colubridae

In this family, 24 species were identified which comprised of 57 individuals (Table 1). Three amongst the 24 species are freshwater and tidal water snakes (*Enhydris enhydris, Homalopsis buccata* and *Cerberus rhynchops*) which are widespread throughout the Peninsular. The remaining 21 species were all land snakes. Of these, 14 species were found in forest habitats and 7 species were found in more open habitats such suburban areas, plantations, orchards and scrubs (Lim, 1953). Five amongst the 14 forest snake species, the Gimlett's Reed Snake (*Calamaria qimletti*), the Banned Wolf Snake (*Lycodon subcinctus*), the White-spotted Cat Snake (*Boiga drapiezii*) and the Mock Viper (Psammodynastes pulverulentus) are not common while the Malaysian Mountain Reed Snake (*Macrocalamus lateralis*) is restricted to hilly habitats only. The rest of the nine species are common and widely spread throughout the Peninsular.

Family Elapidae

Four species of elapid snakes were identified representing nine individuals (Table 1). The Blue Malaysian Coral Snake (*Maticora bivirgata*) is not common and is found in forest habitat. The King Cobra (*Ophiophagus hannah*) which inhabits both plantations and forests and occasionally found in scruby types of habitat is not common despite its widespread distribution. The remaining two species, the Banded Malaysian Coral Snake (*Maticora intestinalis*) and the Common Spitting Cobra (*Naja sumatrana*) the latter also known as (*Naja naja*) are common inhabitants of human inhabitated areas such as field, scrub and plantations (Lim, 1955). Both these species are widely distributed throughout the Peninsular.

Family Viperidae

Twelve individuals of four species were identified in this family (Table 1). The Wagler's Pit Viper (*Trimeresurus wagleri*) and the Hagen's Pit Viper (*T. hageni*) are both found in forest habitat. The latter is more frequently found than the former. Both the species are widely distributed throughout the lowland forest of the Peninsular. The Mountain Pit Viper (*T. monticola*) is confined to hilly forested areas, and is not common. The Malayan Pit Viper (*Calloselasma rhodostoma*) is restricted to the northern parts of the Peninsular (Lim, 1990). In the present collection, seven of the nine specimens were collected in the vicinity of Cheras, and at the surrounding forest areas of the DWNP HQ. Their presence within a small area in Cheras and at the DWNP HQs was a mystery which was already discussed by Jasmi and Lim (1991).

DISCUSSION

The present collection of snakes by the DWNP represents an opportunistic collection by staff of DWNP, naturalists and interested layman who want to know more about these interesting and facinating creatures. Efforts are now being made to collect snake specimens through personnel of the DWNP by the various State Directors to build up a scientific reference collection for the country.

The identification of the present snake collection revealed one very rare species (*Anomochilus leonardi*) and also established new locality records of some of the other snake species. Since the last two decades, only two new snake species were described by Lim (1963) and by Grandison (1972), and two new records of snakes found in the Peninsular (Li, 1972; Lim & Mohd Sharef, 1975; Grandison, 1972). The Leornad's Pipe Snake (*A. leornadi*), a very rare encounter in the present collection is an example that if collection of this taxa is extended to all state levels by each of the State DWNP Directorate, the chances of obtaining more rare records and probably new species of some of the small snakes that inhabit the forest floors is very possible.

It is interesting to note that only four species of snakes, the Common Spitting Cobra, the King Cobra, the Reticulated Python are protected by the Protection of Wildlife Act 76/72. Steps has to be taken to extend the protection to some of the larger rat-eating snakes, and also other species of economic and medical importance.

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Table 1: A collection of snake species collected by the department of wildlife and national park

R. No.	Taxa: Scientific name	Taxa: Common Name	Date	Locality	Distri-bution	Legal Status
A.	**TYPHLOPIDAE**					
01	*Typhlops diardi muelleri*	Blind Snake	1986	Pergau, Ulu Kelantan/ Collected by Hassan Kassim	NC	o
B	**ANILIIDAE**					
02	*Anomochilus leonardi*	Leonard's Pipe Snake	26.12.91	Bukit Rengit, Lancang/ Collectes by Jasmi Abdul	RA	O
C.	**BOIDAE**					
03	*Python reticulatus*	Reticulated Python	1992	Sungei Terus, Kuala Gahda, Pahang/ Collected by Jasmi Abdul	W	P
D.	**COLUBRIDAE**					
04	*Elaphe flavolineata*	Common Malayan Racer	16.2.92	Hutan Simpan Labis, Segamat Johore	W	O
05	*Elaphe flavolineata*	Common Malayan Racer	15.9.88	Perhilitan HQ, Kuala Lumpur		
06	*Elaphe flavolineata*	Common Malayan Racer	1992	Sungei Dusun, Perak		
07	*Elaphe flavolineata*	Common Malayan Racer	23.1.91	59, Jalan Talala, Kuala Lumpur		
08	*Elaphe flavolineata*	Common Malayan Racer	12.9.92	Sg. Prepe. Ulu Terengganu		
09	*Elaphe flavolineata*	Striped Racer	1.6.92	Ladang Kelapa Sawit, Trong, Perak	W	O
10	*Elaphe flavolineata*	Common Malayan Racer	21.2.91	H.S. Bt. Asahan		
11	*Elaphe flavolineata*	Common Malayan Racer	1992	Sg. Dusun Game Reserve		
12	*Pryas korros*	Indo-chinese Rat Snake	6.1.92	Bt. 4, Songsang, Temerloh	W	O
13	*Pryas korros*	Indo-chinese Rat Snake	27.10.88	Perhilitian HQ, Kuala Lumpur		
14	*Calamaria lowi gimletti*	Gimlett's Reed Snake	24.9.89	H.S. Bt. Sg. Putih, Selangor		
15	*Pseudorhabdion longiceps*	Dwarf Reed Snake	15.3.88	Kuala Perkai/ Collected by Jasmi Abdul	W	O
16	*Pseudorhabdion longiceps*	Dwarf Reed Snake	24.12.91	Kuala Koh, Kelantan		
17	*Pseudorhabdion longiceps*	Dwarf Reed Snake	12.9.89	Kuala Kenyam, Pahang/ Collected by Jasmi Abdul		
18	*Oligodon purpurascens*	Brown Kukri Snake	9.8.91	Kampong Jambu Rias/ Collected by Jasmi Abdul	W	O

R. No.	Taxa		Date	Locality	Distri-bution	Legal Status
	Scientific name	Common Name				
19	*Macrocalanus latgeralis*	Malayan Mountain Reed Snake	23.2.92	Gunung Tahan, Pahang/ Collected by Saharudin	R	O
20	*Dendrelaphis picta*	Painted Bronze Back	3.5.88	Hutan Simpan Bukit Sungai Putih (besides Perhilitan HQ), Kuala Lumpur	W	O
21	*Dendrelaphis picta*	Painted Bronze Back	24.10.88	Hutan Simpan Bukit Sungai Putih (besides Perhilitan HQ), Kuala Lumpur		
22	*Dendrelaphis picta*	Painted Bronze Back	NRA	NRA		
23	*Dendrelaphis formosus*	Elegant Bronze Back	10.3.92	Hutan Simpan Chebar		
24	*Dendrelaphis formosus*	Elegant Bronze Back	24.7.89	Bukit Kemandul, Kuala Langat, Selangor		
25	*Dendrelaphis formosus*	Elegant Bronze Back	30.11.91	Kuala Koh, Kelantan		
26	*Dendrelaphis formosus*	Elegant Bronze Back	26.10.89	H.S. Bt. Sg. Putih, Cheras		
27	*Dendrelaphis formosus*	Elegant Bronze Back	31.1.89	Perhilitan HQ, Kuala Lumpur		
28	*Dendrelaphis formosus*	Elegant Bronze Back	NRA	NRA		
29	*Dendrelaphis formosus*	Elegant Bronze Back	NRA	NRA		
30	*Dendrelaphis caudolineatus*	Striped Bronze Back	26.10.89	Hutan Simpan Bukit Sungei Putih (Bersides Perhilitan HQ), Kuala Lumpur	W	O
31	*Dendrelaphis caudolineatus*	Striped Bronza Back	NRA	NRA		
32	*Chrysopelea paradisi*	Paradise Tree Snake	19.3.92	NRA	W	O
33	*Lycodon subcinctus*	Banded Wolf Snake	30.11.91	Kuala Koh, Ulu Kelantan, Kelantan	NC	O
34	*Boiga dendrophila*	Yellow-ringed Cat Snake	16.1.92	Sungai Dusun, Perak	W	O
35	*Boiga cynodon*	Dog-toothed Cat Snake	20.10.92	Kuala Daing, Raub, Selangor (melanistic)	W	O

R. No.	Taxa: Scientific name	Taxa: Common Name	Date	Locality	Distri-bution	Legal Status
36	*Boiga cynodon*	Dog-toothed Cat Snake	7.4.89	(killed by vehicle)		
37	*Boiga drapiezii*	White-spotted Cat Snake	1993	Kuala Merang, Kedah	NC	O
38	*Psammondynastes pulverulentus*	Mock Viper	20.2.92	Gunung Tahan, Pahang	NC	O
39	*Psammodynastes pulverulentus*	Mock Viper	12.3.92	Felcra Pulau Belantik, Ulu Muda, Perak		
40	*Ahaetulla prasina*	Oriental Whip Snake	1991	Perhilitan HQ, Kuala Lumpur	W	O
41	*Ahaetulla prasina*	Oriental Whip Snake	4.7.88	Perhilitan HQ, Kuala Lumpur	W	O
42	*Ahaetulla prasina*	Oriental Whip Snake	Nra	NRA		
43	*Ahaetulla prasina*	Oriental Whip Snake	1.9.87	Hutan Simpan Bukit Sungei Putih, Kuala Lumpur		
44	*Ahaetulla prasina*	Oriental Whip Snake	5.8.88	Perhilitan HQ, Kuala Lumpur		
45	*Ahaetulla prasina*	Oriental Whip Snake	23.2.92	Gunung Tahan, Pahang		
46	*Ahaetulla prasina*	Oriental Whip Snake	3.3.93	Rubber Estate, Jenderak		
47	*Ahaetulla prasina*	Oriental Whip Snake	16.12.92	Taman Negara, Pahang		
48	*Ahaetulla prasina*	Oriental Whip Snake	12.10.90	Hutan Simpan Bukit Sungei Putih, Kuala Lumpur		
49	*Natrix trianguligera*	Triangle Keelback	17.4.92	Sungai Game Reserve, Perak	W	O
50	*Macropophis maculatus*	Spotted Keelback	9.9.92	Hutan Bukit Belata	W	O
51	*Macropophis maculatus*	Spotted Keelback	9.9.92	Hutan Bukit Belata		
52	*Macropophis maculatus*	Spotted Keelback	14.2.92	NRA		
53	*Macropisthodon rhodomelas*	Blue-necked Keelback	14.2.92	Gunung Tahan, Pahang	NC	O
54	*Enhydris enhydris*	Fresh Water Snake	15.12.89	Kerian, Perak	W	O
55	*Enhydris enhydris*	Fresh Water Snake	30.3.92	Sg. Dusun Game Reserve		
56	*Enhydris enhydris*	Fresh Water Snake	1991	Kuala Gula, Perak		
57	*Homalopsis buccata Selangor*	Puffed-faced Water Snake	20.3.93	Batu 15, Sungai Buloh,	W	O
58	*Homalopsis buccata*	Puffed-faced Water Snake	1991	Kuala Gula, Perak		

R. No.	Taxa: Scientific name	Taxa: Common Name	Date	Locality	Distri-bution	Legal Status
59	*Homalopsis buccata*	Puffed-faced Water Snake	23.11.88	Melaka Air Molek, Melacca		
60	*Cerberus ryhnchops*	Dog-faced Water Snake	1991	Kuala Gula, Perak		
E	**ELAPIDAE**					
61	*Maticora bivirgata*	Blue Malaysian Coral Snake	1989	Hutan Gambang, Pahang	R	P
62	*Mativora bivirgata*	Blue Malaysian Coral Snake	1988	NRA	R	
63	*Maticora intestinalis*	Banded Malayan Coral Snake	19.11.88	Hutan Simpan Bukit Sungei Putih, Kuala Lumpur	W	O
64	*Naja (naja) sumatrana*	Equatorial Spitting Cobra	26.12.92	Perhilitan HQ, Kuala Lumpur	W	P
65	*Naja (naja) sumatrana*	Equatorial Spitting Cobra	10.1.88	Forest Department, Cheras, Selangor		
66	*Naja (naja) sumatrana*	Equatorial Spitting Cobra	1.11.90	Perhilitan HQ, Kuala Lumpur		
67	*Naja (naja) sumatrana*	Equatorial Spitting Cobra	1.12.93	Ampang Utama, Kuala Lumpur		
68	*Ophiaophagus hannah*	Hamadryad or King Cobra	1993	NRA	NC	P
69	*Ophiophagus hannah*	Hamadryad or King Cobra	1992	Bukit Ibam, Pahang		
F.	**VIPERIDAE**					
70.	*Trimeresurus wagleri*	Wagler's Pit Viper	17.4.92	Sungkai Game Reserve, Perak	NC	O
71.	*Trimeresurus hageni*	Hagen's Pit Viper monicola	13.7.86	Upper Sungkai River, Perak	NC	O
72.	*Trimeresurus*	Mountain Pit Viper	1992	Gunung Tahan, Pahang	NC	O
73	*Calloselasma rhodostoma*	Malayan Pit Viper	11.3.92	Hutan Simpan Chebar, Kedah	R	O
74	*Calloselasma rhodostoma*	Malayan Pit Viper	12.3.92	Felcra Pulau Belantik, Ulu Muda, Kedah		
75	*Calloselasma rhodostoma*	Malayan Pit Viper	11.11.92	Hutan Simpan Bukit Sungei		
76	*Calloselasma rhodostoma*	Malayan Pit Viper	30.6.92	Perhilitan HQ, Kuala Lumpur		

R. No.	Taxa		Date	Locality	Distri-bution	Legal Status
	Scientific name	Common Name				
77	*Calloselasma rhodostoma*	Malayan Pit Viper	5.3.88	Hutan Simpan Bukit Sungei Putih, Kuala Lumpur		
78	*Calloselasma rhodostoma*	Malayan Pit Viper	1993	Kuala Nerang, Kedah		
79	*Calloselasma rhodostoma*	Malayan Pit Viper	1993	Kuala Nerang, Kedah		
80	*Calloselasma rhodostoma*	Malayan Pit Viper	2.9.93	Ran over by vehicle Km.10, Jalan Cheras, Kuala Lumpur		
81	*Calloselasma rhodostoma*	Malayan Pit Viper	26.3.92	Perhilitan HQ, Kuala Lumpur		

NRA – No record available
W – Wide distribution
RA – ReccRare
P – Protected

O – Not protected
R – Restricted
NC – not common

VOL. 12 1992/1993

THE BREEDING OF MALAYAN TIGERS (*PANTHERA TIGRIS CORBETTI*) AT ZOO MELAKA, DEPARTMENT OF WILDLIFE AND NATIONAL PARKS, MALAYSIA

ZAINAL-ZAHARI ZAINUDDIN, MOHD NAWAYAI YASAK, MOHD SHARIFF DAIM AND SUBOH HASSAN

Abstract

The breeding behaviour, age at sexual maturity, estrus, mating, birth and maternal care of captive Malayan tigers at Zoo Melaka are described. Currently, the known captive population of Malayan tigers both locally and internationally are below 30 (International Tiger Studbook, 1992). All the initial captive population originated from Zoo Melaka, Department of Wildlife and National Parks (DWNP), Peninsular Malaysia. Partial and complete habitat degradation have contributed to the degeneration of potentially viable population, loss of primary food source, livestock depredation and consequence poaching by man. The age of sexual maturity, duration of estrus and gestation period averaged 1 year 7 months, 4 days and 103 days respectively. The birth weight of male and female averaged 1575 g and 994 g respectively. The problems associated with breeding of the Malayan tigers in captivity include breeding space, inadequate founders, compatibility, mate selectivity and cannibalism. The litter size ranged from 2-4 with a male female ratio of 1:3. Three one month old females were hand reared after their dam died of suspected poisoning. The feed offered include powdered milk with taurine (SNOW, Snow brand milk products Co., Ltd, Tokyo, Japan), taurine supplements (Taurine tablets, Pet-Ag, Inc, USA) and canned cat food (WHISKAS, The East Asiatic Company (M) Bhd, Malaysia). The monthly weight gain until the age of 5 months averaged 2.7 kg.

Abstrak

Perilaku pembiakan, taraf kematangan, estrus, kelahiran dan penjagaan maternal harimau belang adalah dihuraikan. Pada masa ini, populasi harimau belang didalam kurungan didalam dan diluar negara adalah dibawah 30 ekor (International Tiger Studbook, 1992). Kesemua harimau belang didalam kurungan berasal dari stok Zoo Melaka, Jabatan Perlindungan Hidupan Liar dan Taman Negara (PERHILITAN), Semenanjung Malaysia. Pemusnahan habitat telah menyebabkan kemerosotan populasi yang viabel disamping kehilangan sumber makanan utama, pemangsa ternakan dan pemburuan oleh manusia. Purata umur matang ialah 1 tahun 4 bulan, jangkamasa estrus ialah 4 hari dan jangkamasa bunting ialah 103 hari. Purata berat jantan dan betina semasa lahir ialah 1,575 g dan 994 g. Masalah yang berkaitan dengan pembiakan harimau belang di dalam kurungan termasuklah kekurangan kawasan, kekurangan baka, persesuaian betina oleh jantan dan Ranibalisma. Saiz kumpulan adalah diantara 2-4 dengan nisbah jantan:betina sebanyak 1:3. Tiga ekor anak harimau belang berumur 1 bulan terpaksa dipelihara setelah ibunya mati akibat keracunan. Makanan yang diberi termasuk susu tepong dengan kandungan taurine (SNOW, Snow Brand Milk Products Co., Ltd, Tokyo, Japan), tambahan taurine (Taurine tablets, Pet-AG. Inc, USA) dan makanan bertin (WHISKAS, The East Asiatic Company (M) Bhd, Malaysia). Kadar purata tumbesaran bulanan sehingga umur 5 bulan adalah 2.7 kg.

INTRODUCTION

The Malayan tiger as part of the Indo-Chinese sub-species is the second smallest of the sub-species of Panthera and its population extends from Vietnam, Thailand and to the Peninsular Malaysia (Lekagul and McNelly, 1977). In the 1950's the population of the Malayan tiger was estimated at 3000 animals but declined to 300 in 1977. The rapid decline occurred at the time when conservation policy was already implemented. This underlined the intrinsic obstacle in conserving the tiger in areas dominated by man. A survey in 1986 estimated a population of 650 animals (Khan, 1986). Recent estimates indicates the states of Pahang and Perak having big populations (Topani, 1990). The extend of forest degradation and the limited reserves for this species makes it susceptible to extinction as the populations become smaller, fragmented and isolated.

The information on captive breeding of felids have increased significantly in recent years. However, adequate fundamental biological data is not available on the complex problems of providing wild felids with prerequisites that is essential for reproduction in captivity. The availability of these animals from trappings in livestock farms in 1982 triggered the captive breeding efforts and compilation of data which could be shared or compared between facilities with similar species.

METHODS

The initial founders include 2 pairs of subadult from Pahang and Trengganu acquired between 1980-1981. The animals were fed with a mixture of chicken, beef and ribs, Calphos-D, calcium supplement mixed with beef and chickens. A total of 4-6 kg of food were offered daily. The animals were vaccinated with PVR-C-P (MLV) (Feline Calici Virus, Feline Viral Rhinotrachetis and Feline Panleukopenia) as in the domestic cat but twice the dosage. Deworming were carried out 4 times annually. The anthelminthic used is changed every two years. All animals acquired from the wild were treated with praziquantel (Dronsit, Bayer, Leverkusen) orally or parenterally for lung flukes (Paragonimus westermanii).

These animals were housed in a cage 10 m long by 10 m wide by 2.5 m high which is subdivided into 4 compartments interconnected by sliding door. The enclosures were equipped with pools measuring 1.5 m by 2 m. The dens were covered to isolate from public viewing. In 1987, a new exhibit was constructed consisting of a large triangular paddock (35m long) separated from the public by a wide wet moat and a vertical reinforced concrete wall. Trees were planted in the paddock and the soil substrate were planted with carpet grass (*Axonopus compressus*). The paddocks connect two night stalls with a chute inbetween. Sliding doors interconnect these night stalls.

Breeding were carried out with unrelated or distant relatives. All mating were recorded and the females prepared 2 weeks prior to birh. During this time, the females were isolated in a well covered den provided with hay bedding. After birth, the mother was left alone and the cubs were only observed once or twice a day. Birthweights were recorded and morphological parameters noted. This include, the body length, height, heart girth and tail prints. The cubs were weighed regularly until 10 weeks of age when it was almost impossible to handle them.

RESULTS AND DISCUSSION

The Malayan tigers were acquired from the wild through trappings or tranquilization. They were captured due to problems associated with predation on livestock or as a result of being snared by poachers. Their ages ranged from 7 months (Zoo Melaka Accession Number: 76) to more than 6 years (Zoo Melaka Accession Number: 75). One animal had to be amputated at the carpal joint due to a very severe cable snare.

The animals were carefully paired until mating was observed. On the average, the males would start mating within the first 2 weeks after introduction. Matings lasted for 3 to 6 days as compared to an age of 7-1 day for Panthera tigris in general (Fowler, 1986). A total of 40 copulations were observed in a single day. Post partum estrus was observed in the females, 1-2 weeks after the death of their cubs.

Males will be left with the females after mating until 2 weeks prepartum where it would be separated. The gestation period ranged from 100-105 days. The first birth was only observed in 1985. In 2 females late pregnancies were not distinct making mating records very essential for prepartum isolation. However, in some females, trimester pregnancies were very obvious with distension of the abdomen and slight engorgement of the mammary glands. The gestation period in tigers ranged from 98-110 days (Fowler, 1986). At the zoo, parturition occurred throughout the year 7 month to 2 years. This differed considerably with previous reports of 3.5 to 5 years (Fowler, 1986).

The litter size ranged from 2 to 4 within the range reported for Pantera tigris (Fowler, 1986) with male: female ratio of 1:3. The body weight of a day old averaged 1003g. Male cubs averaged 1,575kg and females 994g. The average body weight of cubs from a litter size of 4 and 3 were 963g and 1056g respectively. The cubs were identified based on the tail prints (stripes) which remained unchange throughout life. The cubs were handled in all births, weighed, measured and sexed. A case of abnormally large head (hydrocephalus) was observed in an F1 female.

Selectivity of mate was only observed in one male where mating only occurred after 5 years with the fourth female. This particular male was caught in Selangor while predating on the buffalloes and had to be amputated in the right forelimb at the level of the metacarpus due to gangrene. The animal was kept in an open exhibit and females were introduced for breeding. However the male was not seen mating with females in estrus. Introduction of an experienced female also failed. The fourth female introduced from the first generation was finally impregnated and successfully gave birth to 3 females. However in another incident, a male was observed to mate with two F1 litter mate females within the same enclosure.

Mothering ability varied from individuals. Poor mothering ability was observed in one female where cannibalism occurred in all 5 births. In another female, only the first two litters were neglected with the subsequent litters being reared successfully to weaning age. Cannibalism in a cub was also observed in a male within and adjacent enclosure which was separated by iron bars. Therefore, it is essential to prepare all parturition dens prior to parturition and to remove all males and females from adjacent enclosures.

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VOL. 12 1992/1993

BEHAVIOUR AND FOOD HABITS OF THE GIANT TREE SQUIRRELS (*RATUFA BICOLOR* AND *R. AFFINIS*) IN PENINSULAR MALAYSIA

LIM BOO LIAT [1]

Abstract

Field and laboratory observations were carried out on the behaviour and food habits of the two species of Giant Squirrels. Of the 14 encounters on *Ratufa bicolor* and 9 of *R. affinis*, 85.7% and 88.9% were solitary encounters as compared to 14.3% and 11.1% which were social encounters involving two participants, thus confirming that both these two species were generally solitary in nature. *R. bicolor* was found to be more confined to the upper canopy levels of 25m and above while *R. affinis* frequented the middle storey below 5m with greater frequencies than *R. bicolor*.

Both the Ratufa spp. were observed to feed on ripen and unripen fruits with no specific preference from one to the other. *R. affinis* was observed eating the shoots and leaves of fruit trees with a higher frequency than *R. bicolor*, while the latter's preference was more confined to fruits. At least 15 genus of fruit trees were identified which were frequented by both these animals. Stomach contents of both the Ratufa spp. revealed *R. bicolor* showed a greater preference for fruits than *R. affinis*, but for leaves and shoots, it was the reverse situation. Insect particles were found in stomach contents of relative percentage in both the Ratufa spp. Animal particles were found only in the stomach contents of *R. bicolor* only. Feeding experiments on greens, insects and fruits between both the Ratufa spp. further confirmed the feeding behaviours of both these species in nature.

Parasites pattern were identical in both the Ratufa spp. The findings of the trombiculid mite, *Ascoxchoengastia audyi* and a blood protozoan, Hepatocystis, both of which are associated with arboreal rodents, further confirmed that both the Ratufa spp. are restricted to the canopy levels in the forest.

Most of the seeds of fruits eaten by both the Ratufa spp. were still intact suggesting that they may be potential as seed dispersers.

Abstrak

Pemerhatian di lapangan dan makmal telah dilakukan keatas perilaku dan pemakanan dua spesies tupai kerawak. Daripada 14 kali penemuan dengan *Ratufa bicolor* dan 9 kali dengan *R. affinis*, 85.7% dan 88.9% merupakan penemuan tunggal berbanding dengn 14.3% dan 11.1% yang merupakan penemuan sosial yang melibatkan dua individu dan ini telah mengesahkan bahawa kedua-dua spesies ini mempunyai sifat yang suka menyendiri. *R. bicolor* didapati banyak terdapat di paras 25m keatas manakala *R. affinis* menyukai paras pertengahan dibawah 5m dengan frekuensi yang lebih daripada *R. bicolor*.

1 Currently Research Consultant to the Department of Wildlife and National Parks, Kuala Lumpur

Kedua-dua spesies Ratufa menyukai buah-buahan yang masak dan muda tanpa menunjukkan kegemaran yang khusus kepada keadaan jenis buah. *R. affinis* diperhatikan memakan pucuk dan daun pokok buah-buahan dengan frekuensi yang lebih tinggi berbanding dengan *R. bicolor* yang lebih menyukai kepada buah-buahan. Sekurang-kurangnya 15 jenis pokok buah-buahan telah dikenalpasti sebagai pokok yang sering dilawati oleh kedua spesies ini. Kandungan isi perut daripada kedua spesiees Ratufa menunjukkan *R. bicolor* meminati buah-buahan berbanding *R. affinis* yang meminati pucuk dan daun. Serpihan serangga didapati di dalam kandungan isi perut kedua-dua spesies Ratufa dalam peratus yang kecil. Serpihan haiwan hanya ditemui dalam isi kandungan perut *R. bicolor* sahaja. Eksperimen keatas tumbuhan, serangga dan buah-buahan diantara kedua spesies Ratufa, mengesahkan lagi perilaku pemakanan kedua spesies ini.

Corak parasit adalah sama pada kedua-dua spesies Ratufa. Dengan terjumpanya kutu Trombiculid, Ascoschoengastia audyi dan protozoan darah, Hepatocystis, yang terdapat pada roden arborial yang seterusnya mengesahkan bahawa spesies Ratufa terdapat pada paras kanopi hutan.

Didapati kebanyakan daripada biji buah-buahan yang dimakan oleh kedua spesies Ratufa masih berkeadaan seperti asal dan ini menandakan yang kedua spesies ini berpotensi sebagai penyebar biji buah-buahan.

INTRODUCTION

The tree squirrels, like most of the avi-fauna, amongst the mammalian fauna, are one of the very few groups of mammal species which are diurnal in habits. Like birds, they are out of their dreys at the early break of morning and retreat to their nests at dusk. Their presence in the vicinity are deceived by their loud rattling repeated calls which are habitual behaviours of these animals when alarmed or being approached by intruders. Such behaviours of the two giant squirrel species are more distinct than the smaller squirrel species.

The Black Giant Squirrel (*Ratufa bicolor*) and the Cream Coloured Giant Squirrel (*R. affinis*) are the largest tree squirrels in Peninsular Malaysia. They are very common and occur sympatrically inhabiting the lowland forests to foothills up to montane forests not more than 1500 metres high (Medway, 1983). Despite their common occurence in the forest, very little is known of their ecology. The colouration, their distinctive large sizes and their pronounced rattling calls, once detected, afford better observation opportunity than other smaller diurnal squirrel species in the forest canopy.

Between 1973 to 1975 and as recently as in 1987, while trapping small mammals, primarily rodents, for zoonotic studies in the various forest reserves within a 32km radius of Selangor, both species of giant squirrels were periodically encountered. The nests of these squirrels and their behavioral activities were noted. Though the information on the behaviour pattern of all individuals sighted were less than satisfactory, analysis of stomach contents of some shot specimens in relation to their dietary habits were more conclusive, the results of which are presented herewith.

METHODS

A total of 20 encounters of the two species of Ratufa were made using a pair of binoculars (10 x 40) in the various forest reserves. Observations recorded were as follows:

1. Emergent strata - top of tree canopy estimated at height of 25m and above
2. Middle storey - under canopy at height of less than 5 m
3. Ground - on the forest floor

4. Feeding - feeding on fruits or young leaves

5. Resting - sitting stationary on branches of trees

Fruit and seeds on the forest floor bearing teeth marks presumably that of the giant squirrels were collected and identified. On trees where nests were found, the leaves were gathered and identified by the authorities of the Forest Research Institute (FRIM) at Kepong. In addition, 28 *R. bicolor* and 24 *R. affinis* stomachs were obtained from shot specimens by Orang Asli for the examination of their contents. The content was spread out in a petri-dish and examined under a stereo-microscepope (x 10 power).

Two captive animals, a *Ratufa bicolor* and a *R. affinis* were used for feeding experiments for a 30 day period. Each of these squirrels was kept in indoor cage measuring 2.745 × 2.745 × 2.745m. Tree branches were placed in the cage for the animal to climb and a wooden nest box 0.305 × 0.457 × 0.457m was tied to the side of the cage at 1.83m high next to the tree branch. Mixed fruits (bananas, papayas, guavas), insects (crickets, mealworms and grashoppers) and vegetables (long beans, carrots) were given daily throughout the period. These food items were given at 1000hr. in the morning and removed at 0900hr. the next morning, and fresh food was replaced. Left-over food items were weighed and the amount of each of the food items consumed were recorded.

RESULTS

Observations on field activity

Field observations on *Ratufa bicolor* and *R. affinis* revealed they are generally solitary. Of the 20 encounteers, *R. bicolor* were sighted on 14 occasions and 9 of *R. affinis* on 3 encounters both the species were sighted in the same forest reserves but at different localities. Of the 14 *R. bicolor* sightings, 85.7% were of solitary encounters and 14.3% were of social encounters involving two participants. Encounters of *R. affinis*, 88.9% were of solitary encounters and 11.1% were of social encounters (Table 1).

Ratufa bicolor was shown to be more confined in the upper canopy level. Of the 14 encounters, 85.8% were observed in the emergent strata. Of the remaining two individuals (14.2%), one was in the middle storey and one was seen running on the forest floor. Encounters of 10 solitary animals, 80% were feeding/resting and the remaining two were only resting. Of the two social encounters, one was paired group while the second were both male animals. The paired participants were found sitting on 2 separate branches, one on top of the other and busy feeding on green leaves. After about five minutes the female gave a sort rattling call and the male on the lower branch leaped towards the branch of the female and started chasing each other in the same tree for about two minutes before both leaped to another tree and disappeared into the middle storey. Such intra-activity between male and female suggests they were either in the courting or mating period. In the case of two males observes together, the first male (resident male) while resting on the branch was suddenly approached by another male (intruder) from the adjacent area. The resident male at this moment raised its head, made a loud rattling call and leaped towards the intruder. He chased the intruder up and down the branches of the tall trees for about 3 minutes after which the intruder ran into the thickets of the middle storey. Such inter-activity between them suggests territorial behaviour of the resident male. The solitary animal observed on the forest floor which rushed into the undergrowth gives the impression that this animal was either trying to escape from predatory intruder or was alarmed by our approaches.

Table 1: Field activity observation of *Ratufa bicolor* and *Ratufa affinis*

No of encounters	*Ratufa bicolor*		Remarks	*Ratufa affinis*		Remarks
	Singly	Two		Singly	Two	
1.	+ (ES)		feeding, resting			
2.	+ (ES)		resting only			
3.	+ (ES)		feeding	+(ES)		feeding, resting
4.		+ (ES)	chasing			
5.	+ (ES)		feeding, resting	+ (ES)		feeding, resting
6.	+ (ES)		resting			
7.				+ (MS)		feeding
8.				+ (MS)		feeding
9.	+ (MS)		feeding			
10.					+ (ES)	chasing
11.	+ (ES)		resting			
12.				+ (MS)		feeding
13.	+ (ES)		feeding, resting			
14.		+ (ES)	chasing	+ (MS)		feeding
15.	+ (ES)		resting, resting			
16.				+ (MS)		feeding
17.	+ (ES)		feeding, resting			
18.	+ (G)		running			
19.				+ (ES)		resting
20.	+ (ES)		resting			

ES = emergent strata ranging from 15-20m high
MS = middle storey ranging form 5-10m high
G = ground (undergrowth)
\+ = sightings

Ratufa affinis was also shown to occupy the emergent strata but the frequency of this animal descending to the middle storey was higher than that of *R. bicolor*. Of the 9 encounters, 44.4% were observed in the emergent starata and 55.6% were in the middle storey. Two of the 3 solitary animals observed in the emergent strata were feeding on fruits and leaves and resting intermittently. The third one was resting on the branch all the time. Three of the 5 solitary individuals sighted in the middle storey were actively moving from one tree to another, feeding on the green leaves and flowers of fruits including fruits when encountered. Of the other 2, one was feeding on the stick insect and the other was feeding on the barks of young trees. On each of these separate encounters in the middle storey, the animals rushed into the thickets upon detection of our approaches.

The social encounter was with a paired group in the emergent strata. They were chasing one another up and down the branches with the male continuosly uttering shrill rattling calls.

After about two minutes, the female rested on the branch above the male. Even though the male was resting, he was alertly surveying his surroundings as if in the form of protecting the female's presence. After about four minutes, the female came to the branch where the male was resting while keeping a distance. At that moment, two long-tailed macaques came to the tree and upon their approach the squirrels jumped and disappeared into the middle storey.

A total of 17 dreys of Ratufa spp. were spotted from the various forest reserves. The nest is large and globular in shape. It is built of twigs and leaves and is placed on the slimmer twigs and branches of tall trees of 30 to 40m in height where heavier predators cannot get them. The species of trees where nest were built are *Pterocymbium javanicum, shorea* spp., *Koompassia malaccensis, Tricoma malaccensis* and *Sindora coriacea.*

Observation on feeding behaviour

Both the Ratufa spp. were observed to feed on riped and unripen fruits with no specific preference from one to the other. Based on fallen fruits on the forest floor which were positively identified as eaten by these animals through evidence of tooth marks, seeds of most of the unripen fruits were intact. *R. affinis* showed higher frequencies of eating shoots and leaves of fruit trees than *R. bicolor*. As for insects, only a single sighting was observed of a *R. affinis* eating a stick insect. During the observation period, leaves from fruit trees frequented by these animals and fruits and seeds found on the forest floor bearing any resemblance of being eaten were collected and identified and were presented in Table 2.

Table 2: Types of fruit trees identified through samples of fruits, seeds and leaves.

Fruit tree species	Type of fruit/materials
Austrobuxus nitidus	s., u.
Baccaurea brevipes	s., u.
Buchanchoria sessilifolia	s., u.
Dracpntomelum maqniferum	fl.
Dysoxylum spp.	fl., f.
Ficus spp.	fl., f.
Irvingia malayana s.	
Mangifera spp.	p.
Santiria laevigota	p., s.
Sloetia elongata	fl.,s.
Triomma malaccensis	s., u.,f.
Xanthopyllum affine yl., u.	
Xerosperman intermedium	s., u.
Xylopia malayana	s., u.

fl. = flower
f. = whole fruit
p. = pulp
s. = seed
u. = unripe fruit
yl. = young leaves

Stomach contents

The examination of the stomach contents showed 92.8% and 79.2% of 28 *Ratufa bicolor* and 24 *R. affinis* with contents respectively. Four food types were recognised. They were fruits (including both seeds and pulps), leaves and barks (hard and fibrous material which were unidentifiable), insects (head parts and antennae) and remains of skins and claws, presumably lizards(Tabld 3).

Table 3: Precentage of different food type of stomach contents

Specification (%)	Food Type	Ratufa bicolor	Ratufa affinis
a. Percentage of stomach contents containing some	Fruits Leaves Barks Insects Animals	100 11.5 23.1 11.5 3.8	100 42.1 36.8 21.1 5.3
b. Stomachs which contained predominantly (predominant = > 50% of the volume of the contents)	Fruits Leaves Barks Insects Animals	88.5 7.7 0 3.8 0	63.2 26.3 0 10.5 0

The dietary habits of both the *Ratufa* spp. as revealed by stomach contents concurred with direct observations in that fruits were the main sources of food. *R. affinis* was found to consume more greens than *R. bicolor*. The high percentage of tree barks found in the stomach contents of both the species could be due to the habitual behaviours of most squirrel species gnawing trunks of trees to prevent the incisor teeth from growing longer. Insect remains examined were mostly ants. The finding of these in the stomach contents could be due to (a) that the fruits eaten were infested with ants and (b) it is quite possible that there were individual preferences for ants as a food source. The percentage of animal particles (probably small tree geckos) in the stomach contents of *R.bicolor* was more of an accident rather than part of the food diet of these animals.

Laboratory feeding experiments

Feeding experiments on various food types were carried out on each of the *Ratufa bicolor* and *R. affinis*. Four types of food were introduced and their quantities were monitored. The experiments were carried out for 30 days and the results were presented in Table 4.

Before the feeding experiments, the weight of the *Ratufa bicolor* was 415g and that of the *R. affinis* was 386g respectively. The feeding experiments revealed that each of these *Ratufa* spp. consumed one-third of its body weight in captivity. These experiments also further confirmed that fruits were the predominant diets of both the species and that *R. affinis* consumed higher percentages of greens than that of *R. bicolor*. The small percentage of insects ingested suggests that insects form a small part of the food components in both these squirrels as evidenced in their stomach contents. At the end of the experiment, there was no weight loss, the *R. bicolor* was 408g while the *R. affinis* was 375g.

Parasites

Ten of each of *R. bicolor* and *R. affinis* were examined for parasites. Only 4 of the former and 6 of the latter were found with two types of parasites. A species of trombiculid mite, *Ascoschoengastia audyi* and a species of protozoa parasites in red blood cells, *Hepatocystie* were found. *A. audyi* is known to be a common arboreal species frequently associated with tree squirrels in forests and plantations (Womersley, 1952), and that of *Hepatocystis* are virtually restricted to the canopy and middle zone in undisturbed lowland forests (Dunn et. al. 1968; Lim et. al. 1997). Thus, parasite pattern of small mammals are indicators not only in the understanding of the ecological pattern of the host species, but also the type of habitats and stratification of the forest ecosystem which are associated with the host species.

DISCUSSION

Observations on the behaviour pattern of both the Ratufa spp. revealed that although they occurred sympatically, *R. affinis* was shown to be less restrictive in its niches as it adapted well to life on the lower canopy level than *R. bicolor*. Fruits were found to be the main dietary components in nature and this was further supported by feeding experiments. In addition to fruits, leaves and barks of trees were shown to be components of their food diets, albeit minor, however, there is ample ground for further research as to whether such food items are a normal dietary habit or a supplementary diet on off seasons. Insects and vertebrates animals, based on stomach contents and feeding experiments do not appear to be the normal diet of *Ratufa* spp. However, among the smaller squirrels species, insects in particular, are an important component of their diets (Lim, 1965; Christine & Lim, 1981; Habsah 1990).

Curtin (1976) in his study on Malayan arboreal mammals suggested that those species which are the seeds and pulps of unripen fruits are unreliable seed dispersers. The leaf monkeys (*Presbytis* spp.) and the macaques (*Macaca* spp.), probably the most abundant among the arboreal mammals in the forest are good examples. In fact, they contribute in the net loss of seeds to the plants. In contrast, there are some mammalian species such as the civet cats, elephants and Sumatran rhinoceros that have been shown to be good seed dispersers, where the seeds of plants and fruits passed through these animals have germinated and replenished those plant stocks in nature (Oliver, 19978; Strien, 19974; Alexandre, 1978). In our observation, both the Ratufa spp. were shown to feed on ripen and unripen fruits and those collected on the forest floor, most of the seeds were intact and some were damaged. Such feeding behaviour suggests the possibility of both the *Ratufa* spp. as potentials of seed dispersers should be further investigated.

ACKNOWLEDGEMENTS

The author thanks the Director of Institute for Medical Research, Kuala Lumpur for his support of this piece of work at the time the writer was a member of the scientific staff. He also thanks Dr. Francis Ng of the Forest Research Institute Malaysia for the identification of the plant species.

Day	*Retufa bicolor*			*Ratufa affinis*		
	Mixed fruits 300 gms. daily	**Mixed insects 10 gms daily**	**Mixed vegetables 100 gms. daily**	**Mixed fruits 300 gms. daily**	**Mixed insects 10 gms. daily**	**Mixed vegetables 100 gms daily**
30 days	9,000	300	1,000	9,000	300	1,000
Taken	4,100	9	50	3,485	22	155
Average	136.7	0.3	1.7	116.2	0.7	5.2
Minimum	70	0	0	65	0	0
Maximum	195	3	10	180	3	15
S.D.	33.7	0.7	2.7	32.2	1.0	5.2
Variance	1,136.8	0.63	7.47	1,037.4	1.17	26.69

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VOL. 12 1992/1993

DISTRIBUTION OF LARGE MAMMAL IN TASEK KENYIR TAMAN NEGARA TERENGGANU

HASSAN B. KASSIM

Abstract

A fourteen-day study conducted in Tasek Kenyir Taman Negara Terengganu revealed that the area is rich in wildlife especially in the valley of Sungai Chirchir to Gunong Gagau. Among the large mammals most frequently detected were the elephants followed by the Sumatran rhinoceros and tapir. The distribution of large mammals was the highest between altitude 200m and 600m.

Abstrak

Kajian selama empat belas hari di kawasan Tasek Kenyir Taman Negara Terengganu mendapati yang ianya kaya dengan hiduan liar terutama di lembah Sungai Chichir hingga ke Gunong Gagau. Di antara mamalia besar yang paling kerap dijumpai ialah gagah dan diikuti oleh babak Sumatra dan tapir. Taburan paling tinggi adalah diantara altitud 200m hingga 600m.

INTRODUCTION

Taman Negara Terengganu and the adjacent portion of the Terengganu river basin area are considered rich in wildlife. The distribution of large mammals in the area has been monitored by The Wildlife and National Parks Department since its establishment in 1939.

Several surveys had been conducted in the area by several researchers including Hislop (1961) and Khan (1971) on wildlife in the area. The Department estimated that there were between 20 to 30 tigers around the Kerbat and Besut rivers while Conry (1977) estimated the presence of about 20 seladangs in the area.

The Kenyir Hydroelectric Project which was completed in 1984 has resulted in the impoundment of 36,900 ha in the 260,000 ha watershed area. As a result, 3,500 ha of the Taman Negara was inundated and several islands were also created.

The Department conducted a wildlife rescue operation in the area and managed to rescue about 200 animals consisting of 20 species including elephants (Elephas maximus), bearcat (*Arctictis binturong*), white handed gibbon (*Hylobates lar*), slow loris (*Nycticebus coucang*), long-tailed macaque (*Macca fascicularis*), banded leaf-monkey (*Presbytis melalophos*), dusky leaf-monkey (*Presbytis obscura*), common palm civet (*Paradoxurus hermaphroditus*), black giant squirrel (*Ratufa bicolor*) and common giant squirrel (*R. affinis*) (Misliah, 1984).

A survey to determine the distribution and status of large mammals in Taman Negara Terengganu was conduced by the Department and the result of the survey is presented in this paper. The objectives of this study were to determine the distribution of large mammals in Tasek Kenyir and to estimate their population size.

STUDY AREA

The study was conducted in Taman Negara Terengganu. The total area is approximately 526 km.sq. and consists of small parts of the north east of Taman Negara Pahang, uppper Sungai Terengan and their tributaries, and small portion of Ulu Terengganu forest reserve which is to the north outside of Taman Negara Terengganu (Figures 1 and 2)

METHOD

The study was carried out over a period of 2 weeks from 5 September to 19 September 1992. Seven trails were identified prior to the survey and these tracks were surveyed by a group of four to six personnel. The survey groups were supplied with topo maps (sheets no. 47, 48, 59, and 60), Silva compass, measuring tapes and altimeters.

The surveys along the 7 trails were conducted simultaneously by 7 different groups. The presence of wildlife in the area were based on direct and indirect observations.

The routes taken by the survey groups were as follows.

Trail 1 : The trail starting from Sungai Gagau to Gunong Gagau ridge and down to Sungai Chichir and Sungai Perepek (20 km)

Trail 2 : Starting from Sungai Reh to Bukit Che Hassan before walking down to Sungai Terenggan (28 km.)

Table 3 : Starting from upper Sungai Sepia to Gunong Mandi Angin and down to upper Sungai Terengan before reaching Sungai Perepek (40 km.).

Trail 4 : Starting grom Sungai Petang to Sungai Cacing (20 km.)

Trail 5 : Starting grom Sungai Terengan to upper Sungai Cacing and back (30 km.).

Trail 6 : Kuala Sungai Biwah to upper Sungai Biwah and back via Sungai Chenana (15 km.).

Trail 7 : Starting grom Sungai Kepayang Hampa to the west until meeting upper Sungai Genong and then walking down until meeting Sungai Lawit (14 km.).

All data on wildlife species encountered in the study area were recorded in survey forms distirbuted to the team prior to the survey. These data were also plotted on a map after the survey was completed. The total lenght of the line transects covered during the survey was 167 km.

The distribution of big mammals was plotted in the map based on the information from tracks, dungs or sightings. The population size was estimated from both direct and indirect count. The distribution of big mammals was influenced by the altitude. This parameter was also measured whenever the animals tracks had been located.

RESULTS

A total of eight species of large mammals were recorded with the elephants being the most frequent wildlife species encountered during the survey (Table 1). This was followed by the Sumatran rhinocerous (*Dicerorhinus sumatrensis*) and tapir (*Tapirus indicus*).

The distribution of large mammals in the study area was more concentrated in the areas of Gunong Gagau to the valley of Sungai Chirchir and Perapek (Table 2).

Other mammals recorded in the area included leopard cat (*Felis bengalensis*), small clawed otter (Aonyx cinerea), smooth otter (*Lutra perspicillata*), siamang (*Hylobates syndactylus*), white handed gibbon and lesser mousedeer (*Tragulus javanicus*).

It was estimated that 4 herds of elephant consisting of between 61-69 individuals roamed in the study area (Table 2). However, their distribution covered almost the entire study area except on the eastern part of the Sungai Petang valley (Fingure 3)

A herd of 23 elephants was found at Sungai Chirchir valley until Gunong Gagau. A herd of 10 to 16 elephants was found in the upper Sungai Terengan. The herd also roamed in the upper Sungai Cacing.

Another herd of 10-12 elephants was detected near Sungai Lawit. This herd sometimes moved into the Kelantan side. A herd of about 18 elephants was also located around Sungai Kepayang which was the area where translocated elephants were released.

Rhinoceros tracks were found in five different areas (Table 2 and Figure 4). The tracks were found along Gunong Gagau to Sungai Chichir. The rhinos utilized the path along the mountain ridge to cross into Pahang and vise versa. Several rhinoceros were also recorded by the survey team from Gunong Mandi Angin. About 2 to 4 animals were found roaming in upper Sungai Sepia, Gunong Mandi Angin and upper Sungai Terengan.

Numerous rhinoceros tracks, estimated from about 2-6 animals were found at the upper Sungai Petang dan upper Sungai Genong. Another 1-2 animals were found at Sungai Biwah. The same animals also utilized Sungai Chenana and Sungai Kepayang. Tapir (*Tapirus indicus*), sambar deer (*Cervus unicolor*) and barking deer (*Muntiacus muntjak*) were also found in the study area. Tracks of Malayan tiger (*Panthera tigris corbetti*), serow (*Capricornis sumatrensis*) and Malayan sunbear (*Helarctus malayanus*) were seldom seen.

Table 3 and Figure 7 shows the distribution of large mammals according to altitute. About 50% of the tracks were found between 200m to 60m above sea level. Among the big mammals, the elephants were found up to 1500m above sea level, but were more frequent (20.8%) between 200m and 600m above sea level. Rhinoceros distribution also showed similar trend. About 12% of the tracks were recorded between 200m and 600m above sea level.

Table 1: The list of common large mammals and frequency of observation in the study area

Large Mammals	T1	T2	T3	T4	T5	T6	T7	Total
1. Elephant	31	8	7	–	13	6	29	94
2. Sumatran rhinoceros	27	–	12	14	–	3	1	57
3. Tapir	19	4	3	7	4	1	3	41
4. Sambar deer	3	4	2	3	3	–	1	16
5. Barking deer	9	1	–	1	3	4	4	22
6. Serow	–	–	1	–	–	–	–	1
7. Malayan tiger	4	2	1	–	4	–	1	12
8. Malayan sunbear	1	–	4	–	1	1	–	7
Total	94	19	30	25	28	15	39	250

Table 2: Population estimates of large mammal in study area

Species	Group No.	Location	Total
Elephant	G1	Sungai Chichir	23
(*Elephas mazimus*)		up to Gunong	
	G2	Gagau	10-16
	G3	Sungai Terengan	10-12
	G4	Sungai Kerbat	18
		Sungai Kepayang	61-69
		sub-total	
Sumatran rhinoceros	R1	Gunong Gagau down to	2-6
(*Dicerorhinus*		Sungai Chichir	
sumatrensis)	R2	Sungai Kepayang	1
	R3	Sungai Sepia	2-4
		Gunong Mandi Angin to	
		upper Sungai Trengan	
	R4	Sg. Petang to upper	2-6
		Sg. Genong	
	R5	Sg. Biwah	1
		sub-total	8-17
Malayan tiger	P1	tributary of Sg. Chichir	1-2
(*Panterra tigris corbetti*)			
	P2	Sungai Terengan	1
		and Sungai Pring	
	P3	Sungai Cacing	1-2
	P4	upper Sg. Sepia	1
	P5	Sungai Lawit	1
		Sub-total	5-7

DISTRIBUTION OF LARGE MAMMAL IN TASEK KENYIR
TAMAN NEGARA TERENGGANU

Species	Group No.	Location	Total
Sambar deer (*Cervus unicolor*)	S1	Sungai Chichir	2
	S2	upper Sungai Sat	1
	S3	upper Sungai Terengan	3-5
	S4	upper Sungai Sepia	1
		Sungai Cacing	2-3
		upper -Genong-Petang	2-3
		Sungai Lawit	1
		sub-total	12-16
Barking deer (*Munctiacus muntjak*)	M1	Sungai Chichir	5-9
	M2	upper Sungai Reh	1
	M3	Sungai Cacing	3
	M4	upper Genong-Petang	1
	M5	Sungai Biwah	2-4
	M6	upper Sungai Kepayang	2-4
		sub-total	14-22
Tapir (*Tapirus indicus*)	T1	upper Sungai Sat	1
	T2	Gunong Gagau Ridge	1
	T3	Sungai Chichir	1
	T4	Sungai Biwah	1
	T5	Sungai Kepayang	1
	T6	Sungai Petang	1
	T7	Sungai Genong-Cacing	1-2
	T8	upper Sungai Terengan	2-3
	T9	upper Sungai Sepia	1
		sub-total	10-12
Serow (*Capricornis sumatrensis*)	C1	Gunung Mandi Angin	1
Sunbear (*Helarctos melayanus*)	H1	Gunong Gagau	1
	H2	Sungai Biwah	1
	H3	Sungai Cacing	1
	H4	upper Terengan	1-2
	H5	upper Sepia	1
		Sub-total	5-6

Table 3: Distribution of large mammals by altitude

Altitude (m)	E	R	S	T	M	P	H	C	Total (n=250)
<200m	23	7	7	12	6	4	1	–	60
>200-600	52	30	9	16	10	5	2	–	124
>600-1000	13	12	–	12	6	2	2	–	47
>1000-1400	4	8	–	1	–	1	2	1	17
>1400-1800	2	–	–	–	–	–	–	–	2

E=elephant, R=Sumatran rhino, S=sambar deer, T=tapir, M=barking deer, P=tigeer, H=sunbear, C=serow

DISCUSSION

The distribution of large mammals in Taman Negara had been discussed by Hislop (1961) and Khan (1971 and 1990). Hislop (1961) reported that there was a herd of elephant at Sungai Terengan frequently sighted by fisherman.

Elephant tracks were easily found almost everywhere since the size of the tracks were larger than other mamals such as sambar deer and barking deer where the smaller tracks could be easily hidden by dead leaves on forest floor. As a result, the smaller population sizes of some mammals such as barking deer could be underestimated.

Double counting of elephant and rhinoceros tracks could have happened. The home ranges of both animals were large and it could contribute to double counting. Both animals usually used their same trail while moving from one place to another. From these tracks, it was quite dificult to determine the exact number of individuals and their ages.

It was interesting to note that there were several rhinoceros found in the study area. Although there was a report of rhinoceros presence previously at Sungai Cacing but the population was not known. Gunong Gagau had been known as a rhinoceros habitat. There were about 10 rhinoceros in that area (Khan, personal communication), but during the survey, only between 2 to 6 rhinoceros were found. The existence of rhinoceros at Gunong Mandi Angin was a new record.

During the survey, the presence of seladang herd could not be confirmed evenhough there was a report by Hislop (1961) of a herd of seladang at Pring valley.

ACKNOWLEDGEMENTS

I would like to thank the Director General of DWNP, Mr. Mohd Khan Momin Khan for his support and to Mr. Jasmi Abdul, the Director of Research, Management and Development Division for his guidance. A special thanks to the Director of DWNP Trengganu for the logistic support given.

I am also grateful to Mr. Tajuddin Abdullah, the coordinator of the survey, for the support given. Not forgetting the Superintendent of Taman Negara and his staff and the staff of DWNP who were directly or indirectly involved to make the study possible.

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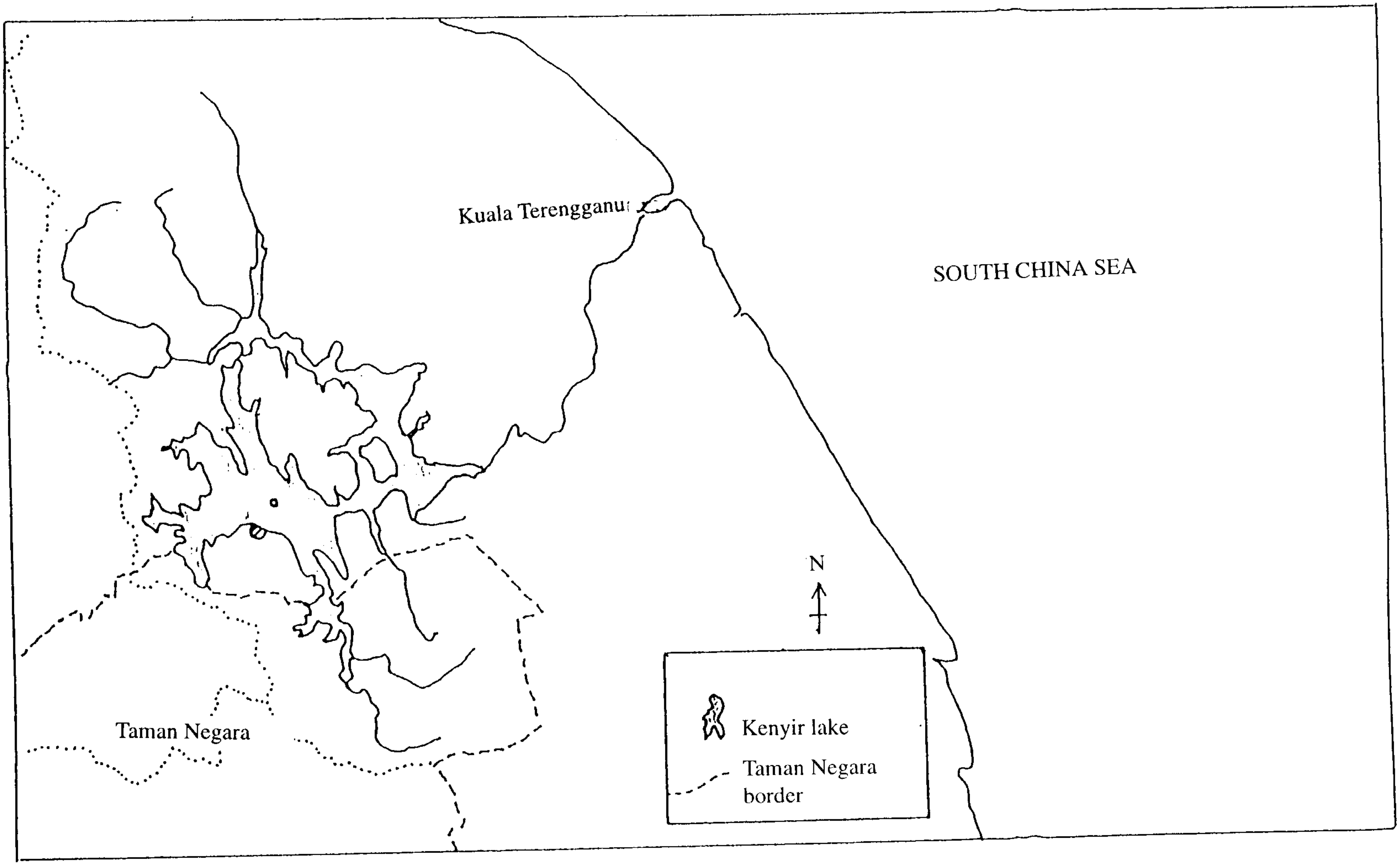
Fingure 1: Location of study area in Taman Negara



Fingure 2: Location of Tasek Kenyir and Taman Negara Terengganu

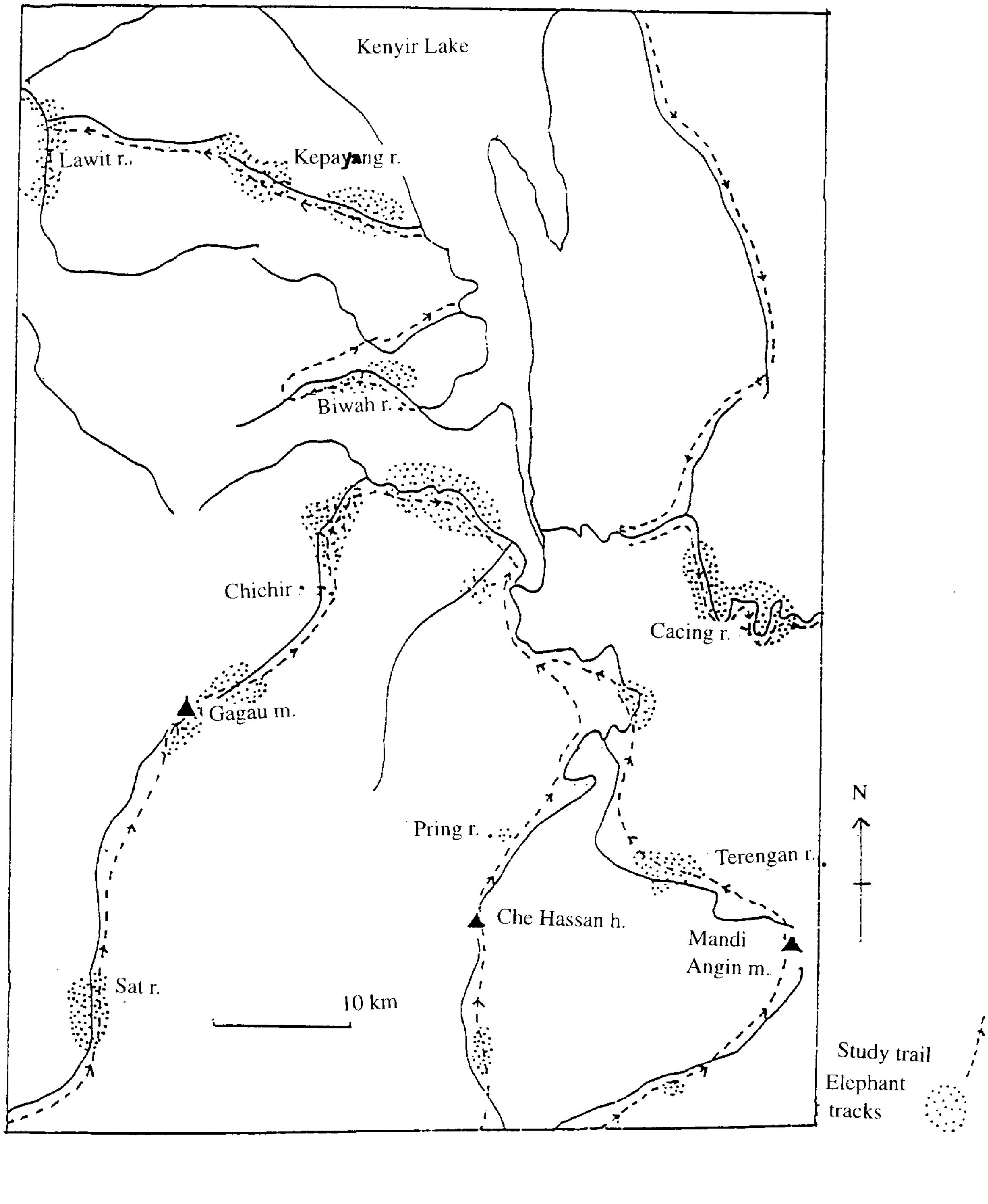
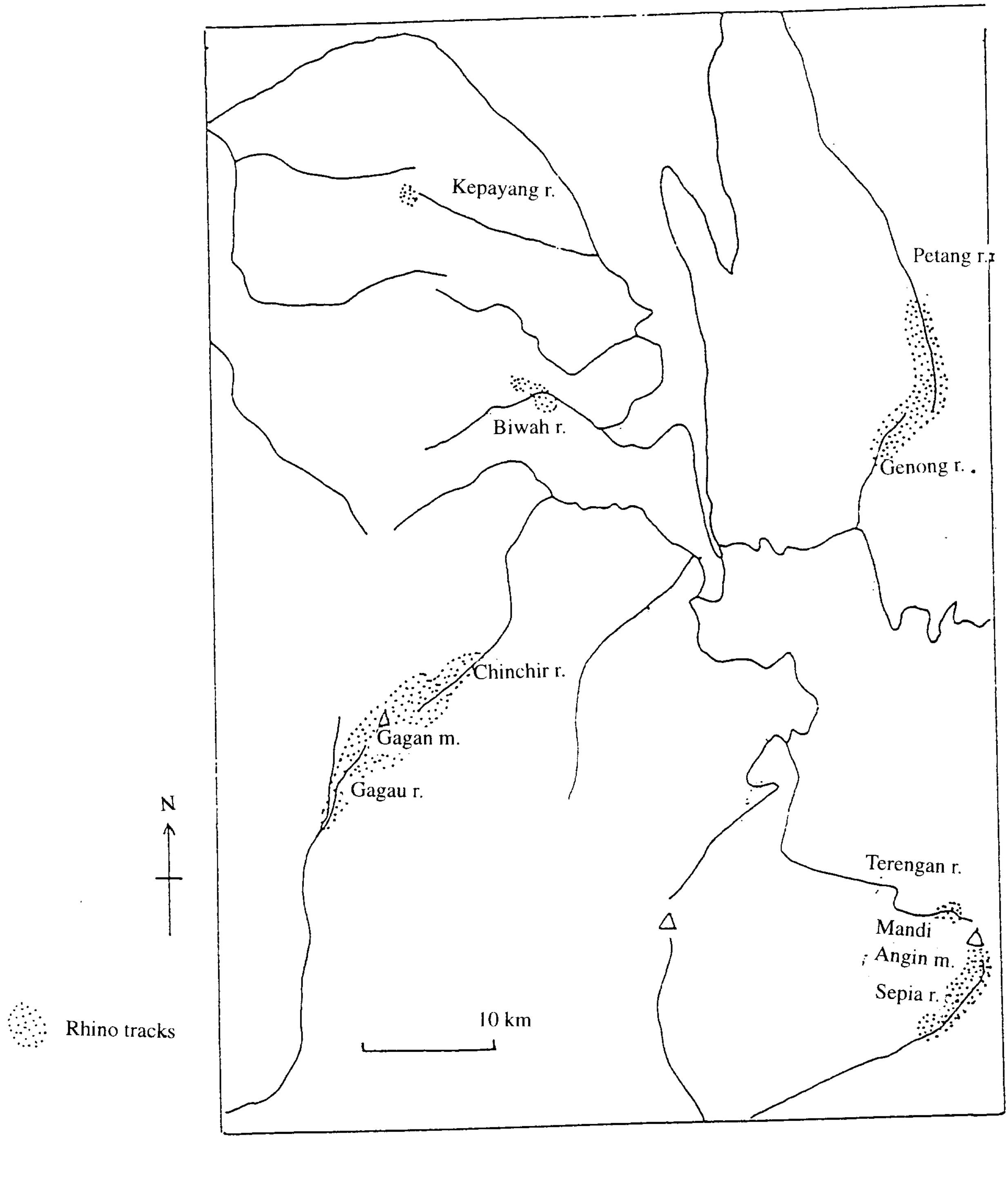
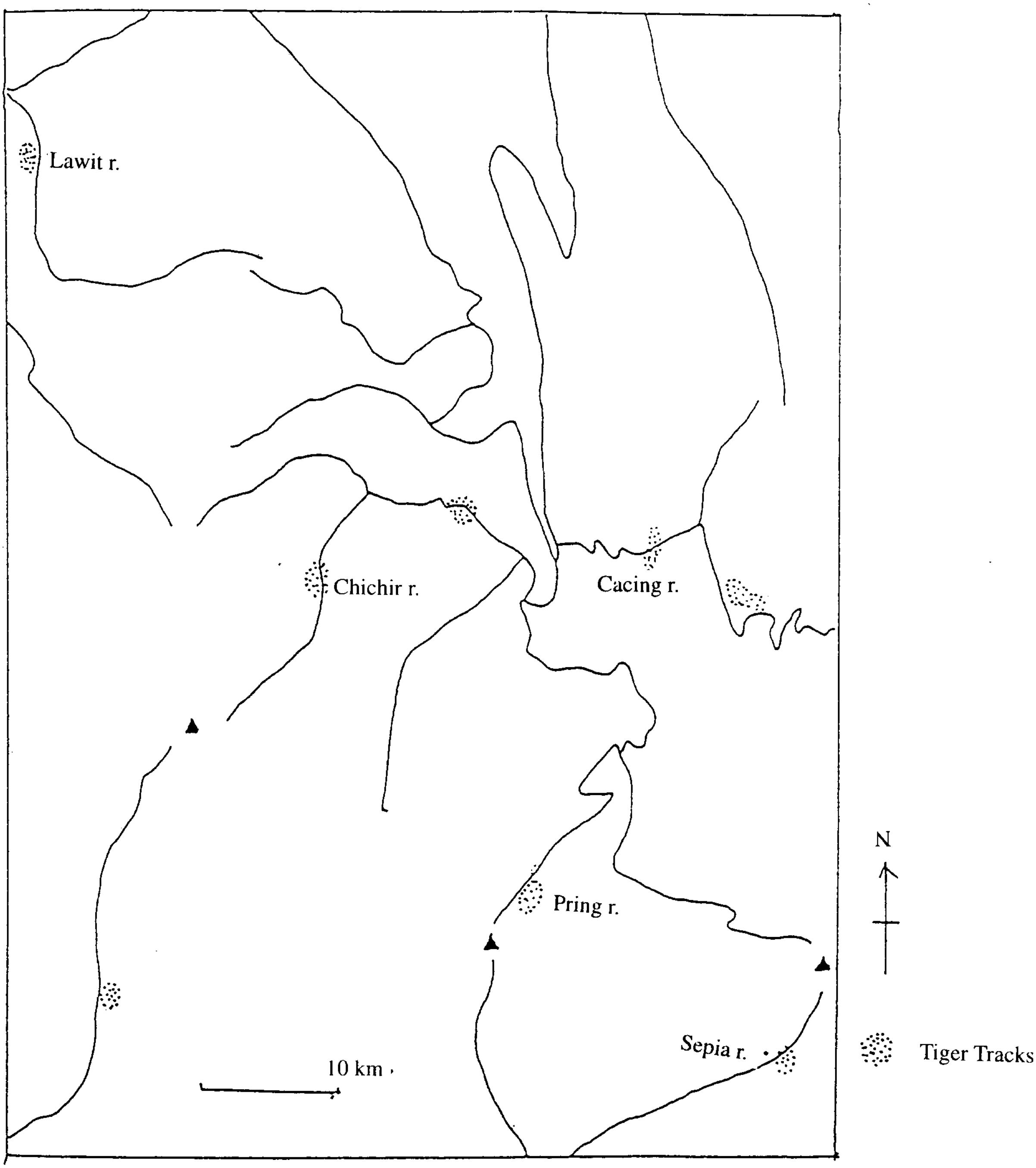


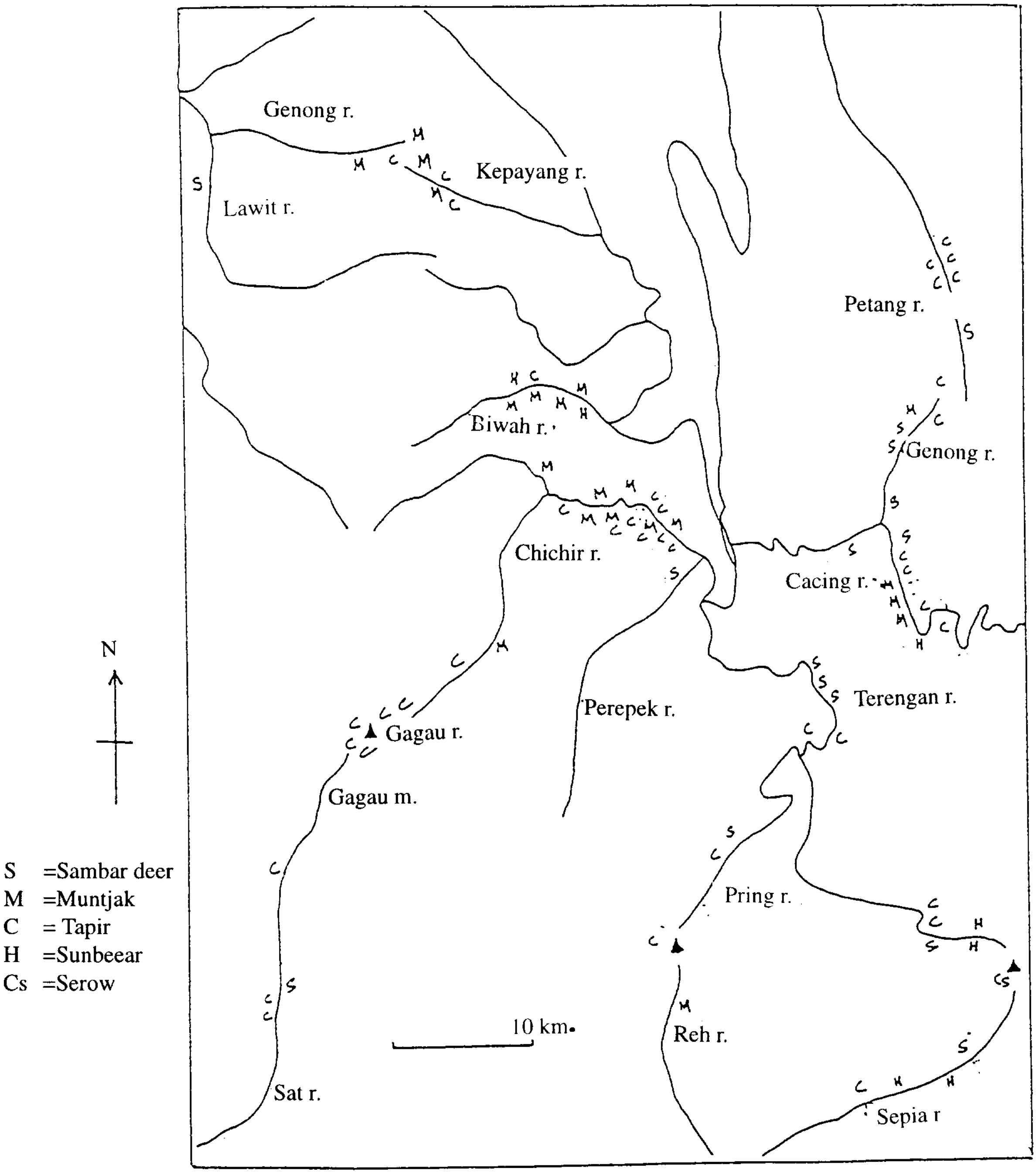
Figure 3: Distribution of elephant tracks in the study area



Fingure 4: Distribution of Sumatran rhinoceros in the study area



Fingure 5: Distribution of Tiger tracks in the study area.



Fingure 6: Distribution of other large mammals in the study area

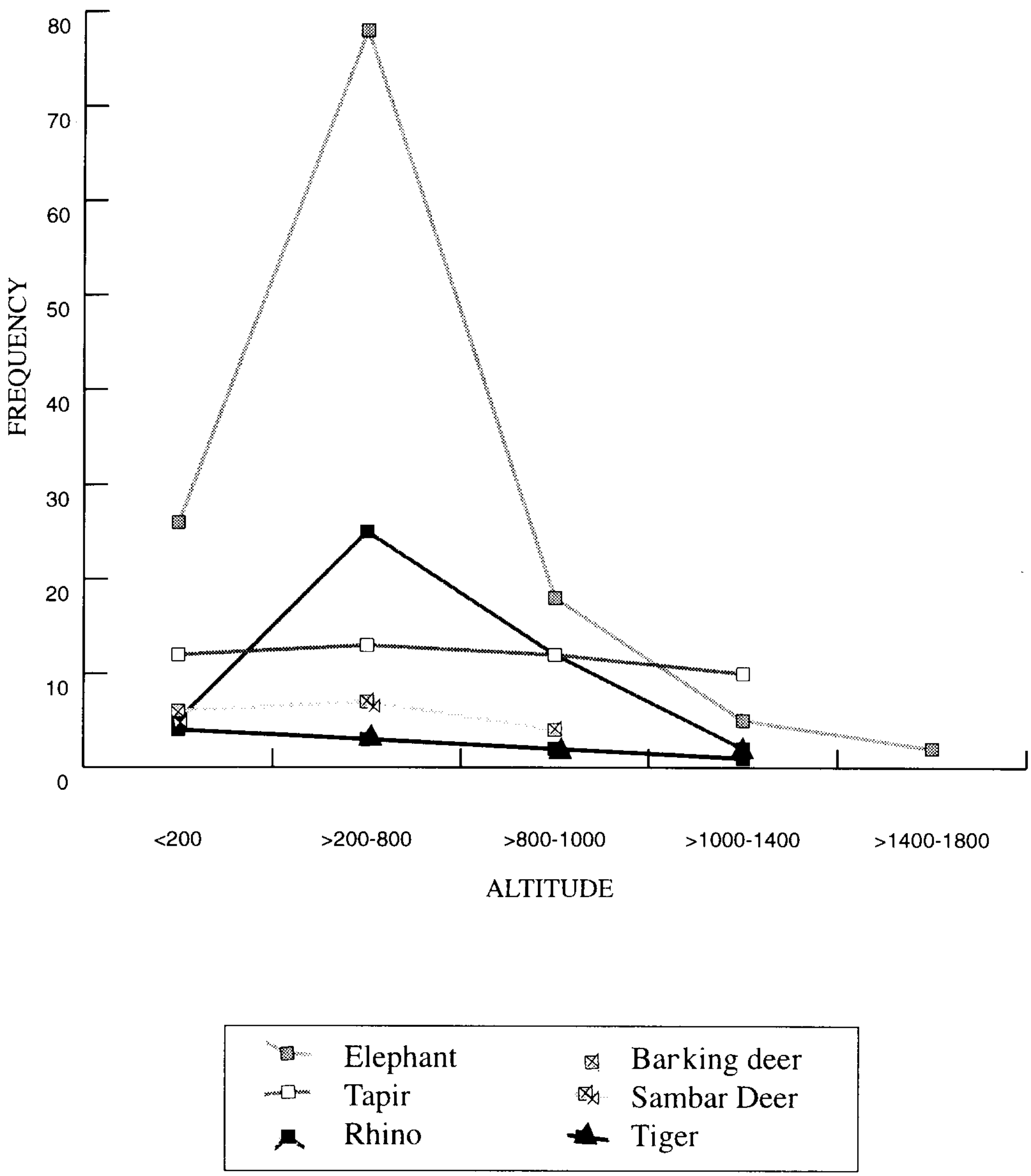


Figure 7: Distribution of large Mammal with altitude (N=255)

THE JOURNAL OF WILDLIFE AND PARKS

VOL. 12 1992/1993

PREDATORS OF SCIURIDS

LIM BOO LIAT [1]

Abstract

The study of predators on sciurids were based on stomach contents examined from 13 species of snakes, 7 species of small carnivores and 5 species of birds of preys. For snakes, 26 out of 81 stomachs examined were positive with animal remains; that of small carnivores and birds of preys, 12 out of 31 and 8 out of 24 stomach examined were positive respectively. Predation on sciurids by snakes is shown to be associated with the different types of predator-prey species living at different levels of the forest. Arboreal snakes tend to feed on sciurids which are mostly arboreal in habit and ground dwelling snakes prey on sciurids which are more terrestrial in their habits. Small carnivore predators of sciurids exhibited similar patterns of predation like the snake predators. Predation by bird of preys is associated with the behaviour pattern of predator-prey activities, nocturnal against nocturnal and diurnal against diurnal. Owls were found to be the main predators of small and medium-sized flying squirrels, the latter appeared to be the first case reported in Peninsular Malaysia.

Abstrak

Kajian pemangsa sciurids telah dijalankan berasaskan kepada isi kandungan perut 13 spesies ular, 7 spesies karnivora kecil dan 5 spesies burung jenis pemangsa. Hasil daripada kajian keatas 81 isi kandungan perut ular, didapati 26 positif iaitu mengandungi sisa makanan haiwan; daripada hasil kajian 31 isi perut karnivora kecil didapati 12 adalah positif dan hasil kajian 24 isi perut burung pemangsa didapati 8 adalah positif. Pemangsaan sciurids oleh ular berhubung kait dengan hubungan spesies pemangsa-mangsa yang hidup pada paras yang berbeza di dalam hutan. Ular jenis arboreal akan memakan sciurids jenis arboreal manakala ular jenis 'ground dwellings' akan memakan sciurids jenis terrestrial. Karnivora kecil juga menunjukkan corak pemangsaan yang sama seperti ular. Pemangsaan oleh burung jenis pemangsa berkaitan dengan corak perilaku aktiviti spesies pemangsa-mangsa, nokturnal dengan nokturnal dan diurnal dengan diurnal. Burung hantu merupakan mangsa utama kepada tupai terbang kecil dan besar dan pemangsaan oleh tupai terbang besar merupakan kes pertama di Semenanjung Malaysia.

INTRODUCTION

Animals that are likely to be attacked by predators have evolved defensive adaptations such as the spines of porcupines, the poisonous spines of various caterpillars, the stinging apparatus of scorpions, bees and wasps, the secretion of repellent fluids by millipedes, termite soldiers, ants and toads, the protective colouration of stick insects, snakes, lizards and some mammal species like moonrat, mousedeer, etc. Animals which have neither the poisonous and spiky weapons nor the repellent and protective colouration depend greatly upon swiftness of escape such as squirrels, weasels, mongooses, etc., each matching the evolution of the predaceous adoptions of their enemies.

1 Currently Research Consultant to the Department of Wildlife and National Parks, Kuala Lumpur

Squirrels which are largely arboreal in habit and agile in nature are animals supposedly with few predatory enemies. But Lim (1956) found that snakes and small carnivores were among some of their predaceous enemies. Follow-up studies on stomach contents of snakes, small carnivores and some predatory birds in later years found that the squirrels have a wider range of predaceous enemies than expected, the results of which are presented herewith.

METHOD

Snakes, small carnivores and few birds of prey were collected by the Orang Asli from Bukit Langong, Bukit Lanjan, Bukit Mandol, Ulu Langat and Ulu Gombak forest reserves in Selangor during the period from 1975 to 1977. Most of the snakes were dead by the time they were brought to the Medical Ecology Laboratory at the Institute for Medical Research, Kuala Lumpur. The small carnivores and the birds examined were shot by the Orang Asli as food.

Most of the animal species examined from the stomach contents of snakes were either wholly or partially intact, although all of them were in the decomposing conditions. This was due to the fact that snakes swallowed their prey whole. For the small carnivores which devoured their preys, only particles of the remains were left, and identification was based on broken skulls, teeth or partially decomposed hind and forefoot. Thus, identification of such characteristics could only be made to the genus of the animals concerned. In the case of the birds of prey, due to the tearing habit of their prey, the skulls were usually swallowed whole, thus leaving it intact and based on these, identifications could be made up to the genus level. but in some cases it could be identified to the specific species.

RESULTS

Snakes

A total of 81 stomach contents of snakes comprising of four species of vipers, two species of pythons and seven species of colubrids were examined. Of these, 26 stomach contents were found with animal remains (Table 1). Among the viper species nine out of 32 stomach contents were found with squirrel and rats remains. Tree-squirrel (*Callosciurus nigrovittatus*, *C. notatus*, *Sundasciurus* sp. and *S. lowii*) were identified in four stomach contents, the remaining five were found with remains of tree mouse (*Chiropodomys gliroides*), spiny-furred rat (*Maxomys* sp), pencil-tailed tree rat (*Niviventer cremoriventer*) and bird feathers.

Table 1: Stomach contents of snakes examined from Selangor, 1975-1977

Type of snakes	No. exam	No. pos.	Type of animals
VIPERS			
Trimeresurus wagleri	14	4	*Cg. S. sp. Cnig.* Nc.
Trimeresurus sumatranus	3	1	SI.
Trimeresurus puniceus	4	1	Cg.
Trimeresurus hangeni	11	3	Cn. M sp., bf
PYTHONS			
Python reticulatus	8	2	Ss. Tj.
Python curtus	6	2	RI. Rs.
COLUBRIDS			
Boiga dendrophila	7	3	Tj. bf. Cc.
Boiga cynodon	3	1	Sl
Boiga drapiezii	4	2	Hsp. Cg.
Zoacys carinatus	2	1	Lins.
Zoacys fuscus	3	1	Rs.
Gonyosoma oxycepalum	10	3	Cn. Ssp. bf.
Elaphe taeniura	6	2	Tg. Rs.

TREE-SQUIRREL
S. Sp. = *Sundasciurus sp.*
Sl . = *Sundasciurus lowii*
Cnig. = *Callosciurus nigrovittatus*
Cn. = *Callosciurus notatus*

GROUND-SQUIRREL
RI. = *Rhinosciurus laticaudatus*
Lins. = *Lariscus insignis*

FLYING-SQUIRREL
H. sp. = *Hylopetes sp.*

LIZARD
Cc. = *Calotes cristellatus*

RAT & MICE
Nc = *Niviventer cremoriventer*
M. sp. = *Maxomys sp.*
Rs. = *Leopoldamys sabanus*
Cg. = *Chiropodomys gliroides*

MOUSEDEER
Tj. = *Tragulus javanicus*

WILDBOARD
Ss. = Sus scrpfa

Four stomach contents out of 14 pythons were positive with animal remains. Remains of a Long-nosed Ground-squirrel (*Rhinosciurus laticaudatus*) and a Long-tailed Giant rat (*Leopoldamys sabanus*) were recorded from the stomachs of the short-tailed python (*Python curtus*). In the stomachs of the Reticulated python (*P. reticulatus*), a young wildboar (*Sus scrofa*) and a mousedeer (*Tragulus javanicus*) were found.

Among the 35 stomach contents from the colubrid snake species, 13 were found with animal remains. Four species of tree and ground squirrels and a species of flying squirrels (*C. notatus, S. lowii, Lariscus insignis* and *Hylopes* sp.) were identified in four stomach contents. Animals identified in the remaining nine stomach contents were mousedeer (*T. javanicus*), tree -shrew (*Tupaia glis*), Long-tailed Giant rat (*L. sabanus*), birds' feathers and Green-crested lizard (*Calotes cristellatus*).

Small Carnivores

The stomach contents of 31 individuals of seven species of small carnivores were examined. Among these, 12 were found with animal particles in them (Table 2). Fruits were found to be the main food in seven positive stomach contents of three species of civets (*Arctogalidia trivirgata, Paradoxurus hermaphroditus* and *Paguma larvata*). Within the seven stomach contents, three were also found with bone particles, mainly the lower and upper jaws, skins and hindfoot of squirrels. Based on the identification of the characteristics of the teeth, all except one belonged to the genus *Callosciurus* sp. The odd one was identified as *Lariscus insignis* which was most pronounced by the remains of part of the skin and a slightly decomposed hindfoot.

Table 2: Stomach contents of Carnivores examined from Selangor, 1975-1977

Type of Carnivores	**No exam**	**No pos.**	**Type of animal contents**
Aretogalidia trivirgata	5	2	Lower and upper jaws of C. sp. + fruits; fruits only
Paradoxurus hermaphroditus	8	3	Fruits only; fruits only; lower jaws + hindfoot of Csp. + fruits
Paguma larvata	5	2	Skin and hindfoot of Csp. + fruits; fruits only
Prionodon linsang	4	1	Lower nad upper jaws of Sund. sp + bf.
Martes flavigula	2	1	Lower and upper jaws of hendfoot of Csp. + bf.
Herpestes brachyura	4	2	Lower jaws of Rl. + fragments of frogs; fragments of frogs only
Felis bengalensis	3	1	Lower and upper jaws of Rs + bf.

TREE-SQUIRREL
Csp. = *Callosciurus* spp.

GROUND SQUIRREL
Sund Sp. = *Sundasciurus sp.*
Rl. = *Rhinosciurus laticaudatus*

RAT
Rs = *Leopoldamys sabanus*

BIRD
bf. = birds' feathers

Small carnivores are the civet (*Prionodon linsang*), the marten (*Martes flavigula*), the mongoose (*Herpestes brachyura*) and a leopard cat (*Felis bengalensis*), and stomach contents of 13 of them were examined. All the five positive stomach contents were present with bone and fragments of vertebrate species. Identification of the teeth characteristics in four of the five stomach contents revealed that two of them were of the genus *Callosciurus* sp., one was positively determined of *Rhinoscirurus laticaudatus* and one was a *Leopoldomys sabanus*. The positive identification of bird's feathers were present in three while fragments of frogs were found in two of the total five positive stomach contents.

Birds of Prey

Among the 24 stomachs of the birds of prey, four of the five species were owls and a single falconet. Eight of the 24 stomachs examined were found present with skulls of vertebrate species (Table 3). The skull recovered from the stomach of the Barn owl (*Tyto alba*) was determined as a *Rattus* sp. probably that of *Rattus tiomanicus* or *Rattus argentiventer* as the Barn owl is the frequenter of oil palm estates. Skulls determined from the stomachs of the other three species of owls (*Phodilus badius*, *Otus scops* and *Strix leptrogrammica*) were that of flying squirrels of the genus *Hylopetes* sp., *Petinomys* sp. and *Iomys horsefieldii*, the latter being represented by a single genera with single species. Two rat skulls were also present in the contents which were positively identified as *Niviventer Cremoriventer* and *Chiropodomys gliroides*. In the case of the black-thighed Falconet (*Microhierax fringillarius*), two skulls were found in its stomach contents which was determined as *Tamiops mcclellandii* and *Sundasciurus* sp. probably *S. lowii*.

Table 3: Stomach contents of birds

Type of birds	No. exam	No. pos.	Type of animal contents
Tyto alba	6	2	skull of R sp.
Phodilus badius	6	1	skull of H sp.
Otus scops	7	2	skull of Nc; skull of P sp.
Strix leptogrammica	4	1	skull of Cg; skull of Ih
Microhierax fringillarius	3	2	skull of Tm; skull of Sund spp.

TREE SQUIRREL
Tm = *Tamiops macclellandii*
Sund sp. = *Sundasciurus* sp.

FLYING SQUIRREL
H sp. = *Hylopetes* sp.
P sp. = *Petinomys sp.*
Ih = *Iomys horsfieldii*

RAT
Nc = *Niviventer cremoriventer*
R sp = *Rattus spp.*
Cg = *Chiropadomys gliroides*

DISCUSSION

Reports on predators of *vertebrate* species such as rats, reptiles, amphibians, birds, wildboars, etc. are common (Lim, 1956, 1965, 1967, 1973, 1973a, 1974). But that of predators of sciurids, with the exception of Lim (1956, 1973) where he found a Red-tailed Racer (*Gonyosoma oxycephalum*) had a Shrew-faced Ground Squirrel (*Rhinosciurus laticaudatus*) in its stomach, and skeletal remains supposedly that of a squirrels in the stomach content of the Banded Musang (*Hemigalus derbyanus*), there is hardly any further information since then. The absence of such information is probably due to the fact that not only are materials not easily available but to the lack of interest. However, the present result revealed that predators of scuirids are more complex in nature than expected when snakes, small carnivores and birds of preys are involved.

Snakes like sciurids inhabit different levels of the forest and predation on sciurids is associated with the different types of predator-prey species. Viperid snakes (*Trimeresurus wagleri, T. sumatranus* and *T. puniceus*) and the colubrid snakes (*Boiga drapiezii* and *Gonyosoma oxycephalum*) which are primarily *arboreal* in habits were found to prey on sciurid and murid species which are arboreal in nature. This consist of the tree squirrels (*Callosciurus nigrovittatus, C. notatus, Sundasciurus* sp. and *Hylopetes* sp.) and the tree murids (*Chiropodomys gliroides* and *Niviventer cremoriventer*).

Snake species which move about the canopy and ground level including *T. hageni, Boiga dendrophila*, and *B. cynodon* were found with arboreal sciurids (*C. notatus, S. lowii*) and ground dwelling mammals (*Maxomys sp., Tragulus javanicus*) and a tree lizard (*Calotes cristellatus*).

Snakes which spent most of the time on the ground such as *Python reticulatus, P. curtus*, rat snake (*Zoacys carinatus and Z. fuscus*) and Racer (*Elaphe taeniurs*) were found to prey on small mammals which are primarily terrestrial in habits. They were the wildboar (*Sus scrofa*), the Giant rat (*Leopoldamys sabanus*), the ground squirrels (*Rhinosciurus laticaudatus, Lariscus* insignis) and the treeshrew (*Tupaia glis*).

Predation of sciurids by small *carnivores* is also associated with their living behaviour patterns. Arboreal civets (*Arctogalidia trivirgata, Paradoxurus hermaphroditus, Paguma larvata and Prionodon linsang*) and the marten (*Martes flavigula*) were found to prey on the tree squirrels of the genus *Callosciurus* and *Sundasciurus* spp. The remaining two small carnivores, the mongoose (*Herpestes brachyurus*) and the leopard cat (*Felis bengalensis*) being terrestrial in habits, were found with terrestrial preys such as the Ground squirrels (*Rhinosciurus laticaudatus*) and the Giant rat (*L. sabanus*).

In the case of the birds of prey, the four species of owls (*Tyto alba, Phodilus badius, Otus scops* and *Strix leptogrammica*) which are strictly nocturnal in habits were found to prey on flying squirrels of the genus *Hylopetes, Petinomys* and *Iomys* spp. and tree rats i.e. *Niviventer cremoriventer, Chiropodomys gliroides* and a species of field rat, *Rattus tiomanicus* all of which are nocturnal in nature. The falconet *Microhierax fringillarius* which is diurnal in habit preyed on diurnal tree-squirrels of the genus *Tamiops* and *Sundasciurus* spp.

The present study revealed that there is a wide range of predators on sciurids in their natural environments. However, from the identification of the remains of tree squirrels, all the species were of the medium and small size which included the nocturnal flying squirrels. It is apparent from the results that snakes play a major role as predators, and small carnivores took more of an opportunistic role as do nocturnal birds of prey. The owl species were the main predators of the nocturnal flying squirrels. The *Ratufa* spp. are the top canopy dwellers, but individuals do descend to the under-canopy levels to feed on fruits. Thus, it is quite possible that they may encounter predators like the civets. Since the Giant Flying Squirrels are nocturnal and confined to the top canopy level, apart from man, their other natural predators, if any are more likely to be large nocturnal birds of preys.

Man, among all the natural predators, is the most destructive predator of mammals in general and sciurids in particular. The Giant tree-squirrels (*Ratufa bicolor* and *R. affinis*) and the medium-sized squirrels (*Callosciurus* sp.) including the Giant flying squirrels (*Petaurista petaurista*, *P. elegans* and *Aeromys tephronmelas*) are the favoured sciurids hunted not only for sports, but more so for their meat. It is a common belief that the consumption of wild animal meat is of medicinal and aphrodisiac value. Obsessed with such superstitious beliefs, man has indiscriminately hunted any wildlife within reach, and sciurids top the list primarily because of their diurnal habits which make them more easily available in their natural habitats than that of the other mammalian species in the forests and cultivated areas.

In conclusion, the present study demonstrated that the predator-prey association of sciurids is not related to competitive interaction such as space and food. The results also revealed that each of those predators examined is free living and catches, kills and devours its sciurids prey for food only, and that the prey species (sciurids) are not predator specific. Conversely, they attract a diverse group of predators and among them, man is the most destructive.

ACKNOWLEDGEMENT

The author thanks the late Simpang anak Ecoin, an Orang Asli at Ulu gombak forest Reserve, Selangor for his assistance in procuring most of the prey animal species. Without his assistance this paper would not have been written.

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VOL. 12 1992/1993

BREEDING PATTERN OF SOME MALAYAN SMALL MAMMALS

SAHARUDIN ANAN

Abstract

Reproductive status of 15 species of small mammals from 16 localities in Melaka, Selangor, Perak, Pahang, Kelantan, Johor, Trengganu and Negeri Sembilan for 1991 and 1992 was reported. Some breeding information was new to the ecological information of the species. Reproductive information from this study was discussed in relation to other studies in other localities.

Abstrak

Taraf pembiakan untuk 15 spesies mamalia kecil dari 16 kawasan kajian di negeri-negeri Melaka, Selangor, Perak, Pahang, Kelantan, Johor, Trengganu and Negeri Sembilan untuk tahun 1991 dan 1992 telah dilapurkan. Sebahagian dari maklumat pembiakan yang dilapurkan adalah yang baru diketahui untuk spesies berkenaan. Maklumat pembiakan dari kajian ini telah dibincangkan dengan membandingkan dengan maklumat dari kajian lain sebelum ini.

INTRODUCTION

Most of the recent studies of small mammals are related to comparative densities and confirmation of species presence in a defined study area (Kemper, 1988; Davidson and Zubaid, 1987). Examples of those studies on reproductive biology were by Lim (1973), Lim (1974), Harrison (1955) and Vanboukar (1958). These reproductive studies reported are mainly on studies in Selangor and Cameron Highlands, Pahang by Beck and Lim (1973), Lim (1970), Lim (1973) and Lim (1974).

Reproduction biology information on the Short-nosed Fruit Bat (*Cynopterus sphinx*) from Malaya was never reported. However, breeding information of this species in India is known. Gopalakrishnan and Moghe (1960) reported that this species had a defined breeding pattern where pregnancy occur once a year from October to December. Vanburker (1958) on the other hand found that this species had two or more pregnancies a year which followed in quick succession.

An extensive study on Malaysian Fruit Bats (*C. brachyotis*) in Sungai Buluh, Selangor was done by Lim (1970). He observed that a three-peak pregnancies in January, May and September where most pregnancies occurred from March to June which coincided with the peak of the fruiting season from April to June.

Another study based on 3,041 specimens of Cave Fruit Bat (*Eonycteris spelaea*) from Batu Caves, Selangor by Beck and Lim (1973) confirmed that the gestation period of this species was slightly more that 6 months (about 200 days). They reported that 50% females examined were pregnant or lactating every month. This Batu Caves colony had a peak pregnancy from May to June in 1966 and April to May and September in 1967.

This paper attempts to add the reproductive information available from study for two years in 1991 and 1992. New locality record for this species was also reported.

METHOD

Studies were carried out in 16 localities in various types of forest reserves, state forest and protected forest in wildlife reserves and national park ranging from lowland dipterocarp to ericaceous forest in highlands. These localities were within the states of Melaka, Selangor, Perak, Pahang, Kelantan, Johor, Terengganu and Negeri Sembilan (Table 1). Breeding information of females were obtained from 110 specimens representing 15 species. These specimens were collected from January 1991 to December 1992. Method of preparation of scientific skins were according to the procedure described in Ratnam et. al (1988).

Reproductive status of the specimens were noted while taking the morphometric information during regular collection of specimens. Reproduction data taken were the confirmation of pregnancy and lactation. State of lactation was confirmed by pressing the nipples and the presence of milk from the nipple was the confirmation for lactation. If milk was not detected earlier and later the presence of milk gland was detected while doing preparation of scientific skin, then it was also recorded as early stage of lactation. The linear crown-rump measurements of the the embryo were taken.

RESULTS

From the records of 110 specimens, pregnancy and lactation were observed for one species of shrew, 10 species of bats, one species of tree shrew and 3 species of squirrels. Sixty six records were from 1991 where else, 46 were from 1992. One female *Crocidura fuliginosa* from Fraser's Hill, Selangor was found pregnant in July.

Breeding information was obtained from 7 fruit bats. Females of *Cynopterus brachyotis* captured in Serting, Negeri Sembilan (N=1) and Sungai Dusun, Selangor (N=34) were found pregnant and lactating in January and those captured in Asahan Forest Catchment Area, Melaka (N-24) were found pregnant and lactating in February. This species captured in Bukit Belata (N=9) and Bintang Hijau Forest Reserve (N=5) were found to be pregnant and lactating in June and April, respectively. However, those captured in Gambang (N=14) and Bukit tinggi (N=14), Pahang were found either pregnant or lactating in August and September.

For *C. horsfieldi* in Labis Forest, Johor (N=1), Bintang Hijau Forest, Perak (N=1) pregnancy was observed for specimens captured in April and in September for individuals from Bukit Tinggi, Pahang (N=3). One female *Balionycteris maculata* from Bukit Belata Forest, Selangor was found pregnant in June. One femala *Chironax melanocephalus* from Fraser's Hill was found pregnant in July.

A Cave Fruit bat (*E. spelaea*) from Serting Forest, Negeri Sembilan was found pregnant in January. This species from Gua Musang was found lactating in July and October. Data were also obtained for the two Malayan species of long-tongued fruit bat. Females of *Macroglossus minimus* from Labis Forest, Johor were found pregnant in January. Females were also found lactating in Krau Wildlife Reserve and Kuala Gula in March, Cameron Highlands in May, Gua Musang in July and Bukit Tinggi, in November. For *M. sobrinus*, it is only found lactating in Gua Musang, Kelantan in October.

Breeding information was obtained from only 3 species of insectivorous bats. *Rhinolophus trifoliatus* female from Bukit Tinggi was found in a lactating stage in September. A rare horseshoe bat, *Hipposideros ridleyi* from Sungai Chaching, Taman Negara, Terengganu was found pregnant in March and was found lactating in August in Krau Willife Reserve in Pahang.

Out of the 3 known species of the tree shrews in Malaya, lactating information was only obtained from *Tupaia glis* collected in Sungai Chaching. The females were found lactating in March.

Breeding data were obtained from only 3 species of squirrels. *Callosciurus notatus* in Kuala Selangor were found in lactating stage in August while *C. previstii* in Bukit Belata, Selangor were found lactating in June. The more common squirrel *C. caniceps* females were found pregnant in February for specimens collected in Asahan Forest, Melaka. Specimens collected in Kg. Leban Seberang, Pahang were found pregnant in August.

DISCUSSION

The result from this study shows that the breeding pattern of most small mammals is similar to Lim (1970), Medway (1983) and Ratnam (1988). Medway (1966) reported that in Pulau Tioman, one female *C. fuliginosa* was found pregnant in April, 1962. This study showed that one female from Fraser's Hill, Selangor was found pregnant in July which was similarly reported by Medway (1983) where there is no specific breeding season in Selangor.

Pregnancy data for *C. horsfieldi* and *C. brachyotis* obtained from this study is similar with those reported before by Lim (1970) and Medway (1983) from information based on studies done in Selangor. This study found that the breeding information of the two species for Johor, Perak and Pahang are the same as those from Selangor. Lim (1970) reported that high frequency of pregnancy occurred in March and June which coincided with the peak fruiting season in April to June in 1970.During the present study, there was no definite pattern pregnancy. This could be due to changes in fruiting season pattern and the erratic weather condition. Studies on related species i.e. C. *spinx* in India showed a pregnancy of once a year in October to December (Gopalakrishnan and Moghe, 1960), and 2 or more pregnancies a year which followed in quick succession (Vanburkar, 1958)

Lim (1973) studied the breeding pattern of fruit bats in Cameron Highlands and found that in most fruit bats, the pregnancies occurred only from February to June except for *Rousettus amplexicaudatus* where one female was found pregnant in December. This study showed that pregnancies also occurred after the month of June for *C. brachyotis*, *C. horsfieldi*, *Chironax melanocephalus*, *E. spelaea*, *M. minimus* and *M. sobrinus*. This is a new breeding record for *M. minimus* and *M. sobrinus*.

The breeding information for *E. spelea* from Negeri Sembilan and Kelantan from this study is similar to Beck and Lim (1973) in Batu Caves, Selangor where pregnancy and lactating females were found throughout the year. Pregnancies detected throughout the year would be accounted for the fact that gestation period was long i.e. 200 days (Beck and Lim, 1973). With these information it could be extrapolated that this species breed twice a year in Selangor, Negeri Sembilan and Kelantan.

ACKNOWLEDGEMENT

I wish to thank the staff of the laboratory unit namely Azmin Rashdi, Rafaee Abd. Hamid, Saari Idris, Abdullah Latiff and Azman Ariff for assistance in field work, gathering of data and preparation of scientific skins. Extra effort by Rafaee Abd. Hamid in retrieving and compilation of the breeding information from the main database is duly acknowledged. Last but not least, to Dr. Lim Boo Liat for reviewing the paper and his constructive comment.

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Table 1: Reproductive status of some mammal species from 16 localities, 1991 and 1992

NO	SPECIES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	*Crocidura fuliginosa*							P (FH)					
2	*Cynopterus brachyotis*	L,P (SF,SD)	L,P. (AF)		L,P(BH)		L,P (BB)		L,P (GP)	L,P(BT)			
3	*Cynopterus horsfieldi*		P(LJ)		P(BH)		P(GM)			P(BT)			
4	*Balionycteris maculata*			P(KW)			P(BB)						
5	*Chironax melanocephalus*							*P(FH)*					
6	*Eonycteris spelaea*	P(SF)						L(GM)			L(GM)		
7	*Macroglossus minimus*	P(LF)		L(KW,KG)		L(CH)		L(GM)				L(BT)	
8	*Macroglossus sobrinus*										L(GM)		
9	*Rhinolophus trifoliatus*									L(BT)			
10	*Hipposideros ridleyi*			P(SC)					L(KW)				
11	*Scotophilus kuhlii*							P(FH)					
12	*Tupaia glis*			L(SC)									
13	*Callosciurus notatus*								L(KS)				
14	*Callosciurus caniceps*		P(AF)						P(KL)				
15	*Callosciurus prevostii*						L(BB)						

LEGEND:

Reproductive status:

L	=	Lactating
P	=	Pregnant

Locality:

AF	=	Asahan Forest, Melaka
BB	=	Bukit Belata Forest, Selangor
BH	=	Bintang Hijau Forest Reserve, Perak
BT	=	Bukit Tinggi, Pahang
CH	=	Cameron Highlands, Pahang
FH	=	Fraser's Hill, Pahang
GM	=	Gua Musiang, Kelantan
GP	=	Gambang, Pahang
KG	=	Kuala Gula, Perak
KW	=	Krau Wildlife Reserve, Pahang
KL	=	Kampung Leban Seberang, Temerloh, Pahang
KS	=	Kuala Selangor, Selangor
LF	=	Labis Forest Reserve, Johor
SC	=	Sungai Chaching, Taman Negara, Terengganu
SD	=	Sungai Dusun Forest, Selangor
SF	=	Serting Forest Reserve, Negeri Sembilan

THE JOURNAL OF WILDLIFE AND PARKS

VOL. 12 1992/1993

ECTOPARASITIC ACARI OF SMALL MAMMALS FROM MONTANE AREA OF CAMERON HIGHLANDS, PAHANG

SHABRINA M. SHARIFF AND RAFAEE AND HAMID

Abstract

Studies on ectoparasitic acari were further continued at various randomly selected habitats. One such locality was situated at the montane forest of Cameron Highlands in Pahang Darul Makmur. Studies were conducted for a ten day period each in the months of January and July 1993. A total of 128 small mammals assemblage inclusive of bats were captured. These trapped fauna comprised primarily of rodents belonging to 5 species of rats, 3 species of squirrels, 2 species of shrews and 1 species of civet. The bats however consisted of 7 species. Only 68.55% of the individuals were infested with ectoparasites. Seven groups of ectoparasites were recovered from these specimens. They encompassed the listrophorids, mesostigmatid/cheyletid/spinturnicid mites, ticks, fleas, lice, larval trombiculid mites or chiggers and bat files. Infestation was pronounced in the rats especially *Niviventer rapit* with listrophorids and the mites dominating as the maximum parasite loads. Fleas were the least prevalent and were encountered in the rats namely *Leopoldamys edwardsi* and *Rattus r. diardii.* The infestation rate in these specimens varied from 2.65% to 37.04%. These harboured ectoparasites fall under the category of 2 Orders namely Acariformes and Parasitiformes.

Abstrak

Kajian ektoparasit akari telah diteruskan dipelbagai habitat yang dipilih secara rambang. Salah satu daripada lokaliti tersebut terletak di kawasan montane di Cameron Highlands, Pahang. Kajian tersebut telah dijalankan setiap 10 hati dalam bulan-bulan Januari hingga Julai 1993. Sejumlah 128 mamalia kecil termasuk kelawar telah ditangkap. Fauna yang ditangkap merangkumi rodentia yang terdiri daripada 5 spesies tikus, 3 spesies tupai, 2 spesies cencurut dan 1 spesies musang. Kelawar pula terdiri daripada 7 spesies. Hanya 68.55% individu telah dijangkiti oleh ektoparasit. Tujuh kumpulan ektoparasit telah diperolehi daripada spesimen tersebut. Ia meliputi 'listrophorids', tungau mesostigmatid/cheyletid/spinturnicid, sengkenit, 'fleas', kutu, tungau trombikulid peringkat larval atau 'chiggers' dan lalat kelawar. Infestasi adalah tertinggi pada golongan tikus terutama *Niviventer rapit* dimana kumpulan 'listrophorid' dan tungau merupakan bebanan parasit yang maksima. Pinjol merupakan parasit yang paling minima bebanan yang ditemui pada golongan tikus juga iaitu *Leopoldamys edwardsi* dan R. r. diardii. Kadar infestasi parasit pada spesimen tersebut adalah daripada 2.65% ke 37.04%. Ektoparasit yang dipungut tergolong dalam 2 Order iaitu Acariformes dan Parasitiformes.

INTRODUCTION

Small mammals inclusive of bats had been extensively trapped and collected for parasites studies at various randomly selected habitats throughout the year 1993. Several localities were covered whereby one or two localities were repeatedly studied. The habitats at these study areas comprised mainly of either montane oak forest/dwarf vegetation or disturbed primary forest and in addition either disturbed, old or logged-over secondary forest.

The ectoparasites recovered from these specimens were preserved for further analysis. Detailed studies on bats at Gunung Brinchang and the land use and ecology of small mammals at Cameron Highlands were conducted by Lim (1973 and 1974). This paper however documented the parasitofauna of small mammals including bats at Cameron Highlands during the months of January and July 1993. The predominant groups of ectoparasites, the rate of infestation and the taxonomic ranking of these ectoparasites to the species level and failing which to the generic level were described.

STUDY AREA

Cameron Highlands which sprawled an area of 1524 m of gentle slopes and lush mountains nestled in the northwestern section of Pahang, the largest state in Peninsular Malaysia.

The highlands are divided into 3 main sub-districts namely Ringlet, Tanah Rata and Brinchang. Ringlet formed the lowest point of the highlands about 45 km away from Tapah, the nearest town which is located in Perak. It is one of the main agricultural areas with numerous terraced vegetable farms and fruit orchards. Further up the hill about 305 m and 13 km from Ringlet, lies Tanah Rata, the principal township. This is a self-contained little town with the charm of old amidst rapid modernization. Brinchang, the highest peak in Cameron Highlands lies another 3 km. northwards. Here, there are numerous jungle tracks leading to hill tops like Gunung Beremban (1,841m), Gunung Jasar (1,696m) and Gunung Brinchang (2,032m).

A research station for the trapping of small mammals was established within the vicinity of Gunung Brinchang at the elevation of 1,800 m to 2,000 m above sea level. Forest of montane ericaceous dominates most of the study area. The trees are typically stunted/dwarf, crooked and sometimes prostrate with a thick covering of moss and other epiphytes on stems and branches. A thick layer of peat and humus carpetted the ground with the roots of trees being matted with semi-decomposed plant residues. Characteristic trees and shrubs are of the genera Ericaceous, Pieris, Vaccinium and Rhododendron. The other common genera include Leptospermum, Podocarpus, Dacrydium, Weinmannia, Eugenia and Schima. A winding mettalled road about 5 km adjoined the study area to the main road. Along the way to the study area, vast acres of hill slopes are endowed with tea bushes and vegetable farms. Bats on the other hand were netted at another established research station at the altitude of 1350 m to 1610 m above sea level bordering the Ulu Bertam Forest Reserve. The area is replendent in ferns and flora of varied species like epiphytes and palms. The research station is also festooned with bright floral blossoms of wild orchids interspersed with giant roses, carnations, crysanthemums, dahlias, geraniums, fuschcia and gladiolis. Temperate and sub-temperate fruits and vegetables also thrived within the cool surroundings of the research station. A few brooks seemed to dissect the study area too.

The weather is found to be spiffingly cool with the day temperature hovering around 21°C and decreasing to 10°C during the night.

METHODS

Small mammals particularly rodents were obtained for parasites studies by trapping using cage collapsible traps while bats were nettted with mist nets.

Trappings were conducted at varying intervals throughout the months of January and July 1993. A lapse period of 5 months hence existed. A total of 20 trapping nights with 100 baited traps were placed randomly at 5 points with 20 traps at each point. Only bananas were used as baits during the study period. The traps were daily inspected in the late morning. Four mist nets were set up in the late evening, left opened overnight and were checked in the early morning.

Any small mammals trapped and bats netted were individually euthenised with chloroform and examined under Wild M8 stereo microscope for the prevalence of any ectorparasites. The ectoparasites were collected and preserved in 70% absolute alcohol. These preserved ectoparasites will undergo further processes according to the techniques previously described. (Shabrina, 1990).

The prepared slides were then examined taxonomically under the phase-contrast microscope for further subsequent detailed examinations.

RESULTS

High catch of 128 individuals of small mammals encompassing 2 civets, 4 shrews, 7 squirrels, 52 rats and 63 bats were obtained. They were however represented by 5 species of murids, 3 species of sciurids, 2 species of insectivores, 1 species of civet and 7 species of bats (Table 1).

A total of 124 individuals excluding shrews were further examined for ectoparasitic acari. Only 68.55% were found infested. The ectoparasitic acari harbouring these infected specimens constituted of 7 broad groups. They were subsequently identified as bat flies, the larval trombiculid mites or chiggers, fleas, lice, listrophorids, ticks and mesostigmatid/cheyletid/spinturnicid mites. These ectoparasites inevitably were recovered from 2 out of 3 species of squirrels, 5 species of rats and 7 species of bats (Table 2). Among the infected specimens, all the 5 species of rats, 4 out of 7 species of bats and 1 out of 3 species of squirrels were noted to carry more than 1 group of ectoparasites (Table 2).

The number of host animals infested by these groups of ectoparasites were also determined as revealed in Figure 1 and Table 3. The infestation rate calculated varied from 2.65% to 37.04%. The infestation rate was highly pronounced among the mesostigmatid/ cheyletid/ spinturnicid mites. The lowest infestation rate was observed in the fleas (Figure 1 and Table 3).

These ectoparasitic acari fall under the two Orders namely Acariformes and Parasitiformes. As in the previous studies, these acarines were further determined where possible to species level, failing which to generic level.

(a) Larval trombiculid mites or chiggers

The larval trombiculid mites or chiggers were mostly dislodged from the ears of the examined specimens. They accounted 15.34% of the 29 infested host species (Figure 1 and Table 3). These identified chiggers fall broadly under the family Trombiculidae. All the 5 species of rats were noted to be infested, with *Niviventer rapit* housing the abundant parasites loads. Among the squirrels, 2 out of 3 species were infected whilst in the bats, only 1 species were infected. The parasites loads in the remaining 2 species of squirrels and 1 species of bats were found to be considerably low (Table 2).

The chiggers encountered mostly belonged to the species *Gahrliepia walchia* and *Leptotrombidium* spp. and is normally predominant among the rats (Table 4). Between the 2 species obtained, only the *Leptotrombidium* species is of medical importance as it is likely to be the vector of scrub typhus in Peninsular Malaysia (Nadchatram, 1970).

(b) Mesostigmatid/Cheyletid/Spinturnicid mites

Mites contributed 37.04% of the infestation rate in 70 infected animals (Figure 1 and Table 3). Three groups of mites were isolated. They belonged primarily to 3 families namely the Laelapidae, Spinturnicidae and Chyletidae. All the 5 host species of rats were infected, with *Niviventer rapit* possessing maximum parasites loads followed by *Rattus r. diardii, N. inas* and *Leopoldamys edwardsii* simultaneously and lastly by *N. bukit* (Table 2).

The majority of the mites inhabiting these rats consisted of laelapid mites with Laelaps spp. being the most preponderant. The species of *Laelaps echidninus* and *L. aingworthae* were determined in the commensal rat, *R. r. diardii* (Table 4).

In the sciurids, only 2 out of 3 species were infested particularly with Cheyletid mites that is *Cheyletus* spp. and *Chelonotus* spp. though mites of the *Laelaps* were also recovered (Table 4). In the bats, 5 out of 7 host species were harboured with mites deriving from the Spinturnicidae family (Table 4). Spinturnicid mites are known to be exclusively ectoparasites of bats (Domrow and Nadchatram, 1978). Most of these spinturnicid mites were collected from the bats such as *Megaerops ecaudatus* and *Chironax melanocephalus* and are usually found attached to the wings and on the ears. The bats *Rhinolophus affinis* and *Pipistrellus* spp. were free from any infestation by the spinturnicid mites (Tables 2 and 4).

(c) Listrophorids

Listrophorids were responsible for 22.75% of the infestation rate with 43 host infested (Figure 1 and Table 3). Most of these listrophorids occurred in all the 5 species of rats and relatively in very low numbers in the squirrels (Table 2). Among all the infested specimens, the rat *N. rapit* recorded the highest prevalence of this hair mites whislt another species of rat, *R. r. diardii* indicated minimum parasites loads (Table 2). These listrophorids were represented by the Listrophoridae family. The hair mites were further examined to be the *Listrophoroides* spp. (Table 4).

(d) Lice

Lice only amounted 5.82% of the infestation rate with 11 of the host animals being infested (Figure 1 and Table 3). These lice were commonly picked up from 3 out of 5 species of rats and 1 out of 3 species of squirrels (Table 2). They were prevalent in very low numbers. Both adult and nymphal stages were recorded. Only 1 species ascribing to the *Hoplopleura* spp. were determined from these infested specimens (Table 4).

(e) Fleas

Fleas attributed the lowest infestation rate of only 2.65% amongst the 7 broad groups of ectoparasites recovered (Figure 1 and Table 3). Only 5 host animals were infested. All the fleas were concentrated only in the rats which include *L. edwardsii*, *N. rapit* and *R. r. diardii* (Table 2). Fleas of the species *Xenopsylla cheopis* were isolated from the rat *R. r. diardii* (Table 4). This flea is the major vector of *Yersinia pestis*, a pathogen of plague (Bacot and Martin 1914).

(f) Ticks

Ticks also revealed a low infestation rate of 8.47% only with 16 infested host animals (Figure 1 and Table 3). These ticks were dominant in 4 out of 5 species of rats and 1 out of 3 species of squirrels (Table 2). The three stages constituting of larval, nymphal and adult were documented from these specimens. Bats were noticed to be free from any tick infestation. Most of the recovered ticks denoted the Ixodes species, Dermacentor species and the Haemaphysalis species (Table 4).

(g) Bat flies

Bat flies produced 7.94% of the infestation rate with 15 infested host animals (Figure 1 and Table 3). Bat flies were known to be prevalent among the bats (Nadchatram 1970) and in this studies, 6 out of 7 species of bats had ectoparasitic infestation except *Hipposideros armiger* (Table 2). Two groups of bat flies were obtained. They fall under the family Nycteribidae and Streblidae. These Nycteribids occurred among the fruit bats *Chironax melanocephalus*, *Cynopterus brachyotis* and *Macroglossus sobrinus* (Table 4). Streblids were also encounterd in the fruit bat *M. sobrinus* in addition to *Megaerops ecaudatus*, *Pipistrellus* spp. and *Rhinolophus affinis* (Table 4).

Table 1 : Small mammals recorded at Cameron Highlands Pahang, 1993

Host Species	Total of individuals captured	%
Bats		
1. *Chironax melanocephalus*	33	25.78
2. *Cynopterus brachyotis*	13	10.16
3. *Macroglossus sobrinus*	7	5.47
4. *Megaerops ecaudatus*	4	3.13
5. *Hipposideros armiger*	1	0.78
6. *Pipistrellus* spp	3	2.34
7. *Rhinolophus affinis*	2	1.56
Rats		
8. *Leopoldamys edwardsi*	7	5.47
9. *Niviventer bukit*	4	3.13
10. *Niviventeer inas*	9	7.03
11. *Niviventer rapit*	29	22.66
12. *Rattus rattus diardii*	3	2.34
Squirrels		
13. *Callosciurus caniceps*	2	1.56
14. *Callosciurus flavimanus*	2	1.56
15. *Dremomys rufigenis*	3	2.34
Shrews		
16. *Crocidura fuliginosa*	1	0.78
17. *Suncus etruscus*	3	2.34
Civet		
18. *Paradoxurus hermaphroditus*	2	1.56
Total	128	100.00

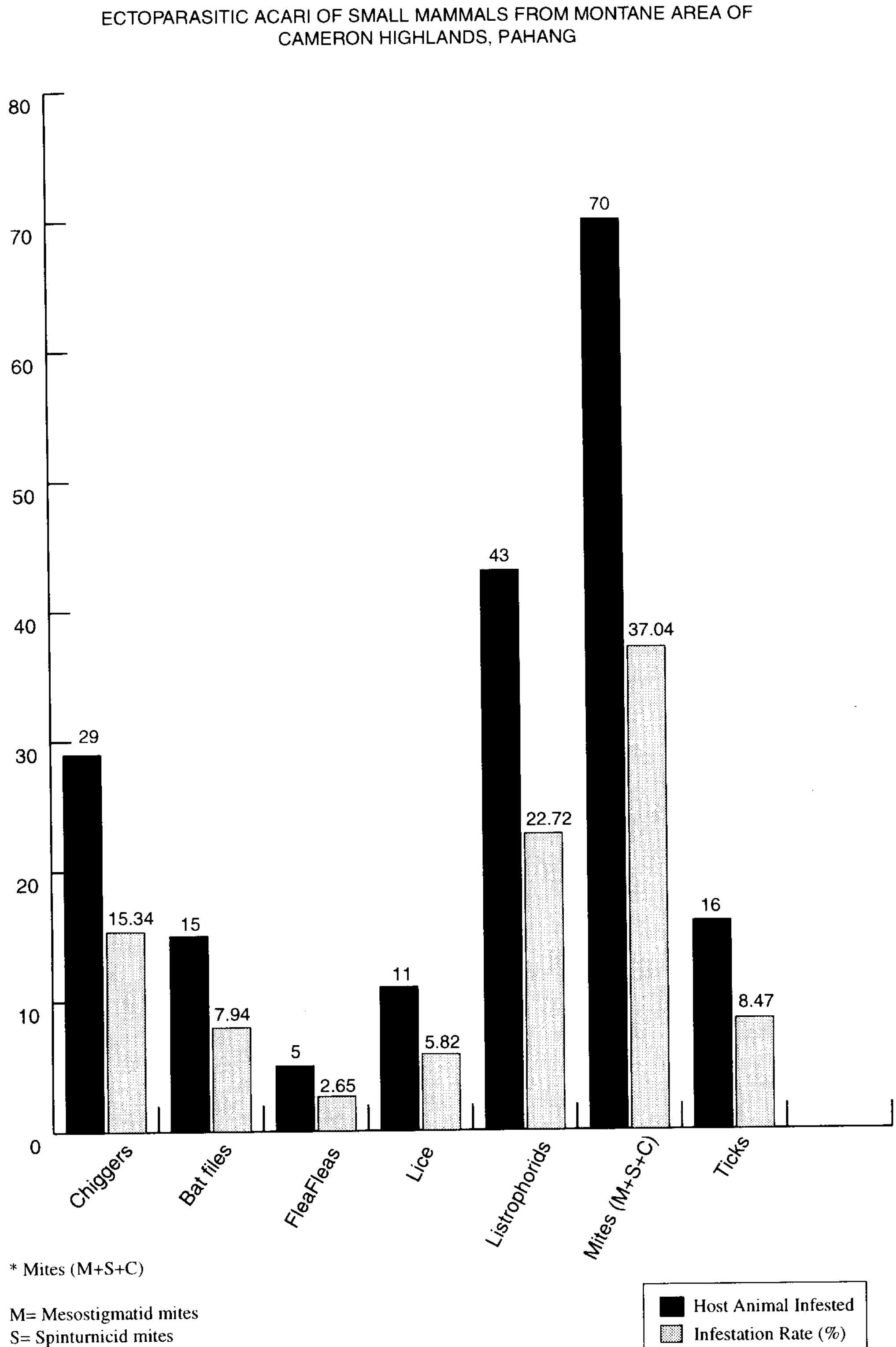

Figure 1: Infestation rate of the ectoparasitic acari of small mammals in Cameron Highlands, Pahang

Table 2: Occurrence of ectoparasites recovered from small mammals collected in Cameron Highlands, Pahang

No.	Taxon/Species	No. examined	No. infestedf	Fleas	Lice	Mesostigmatid/Cheyletid/ Spinturnicid mites	Tick	Chiggers	Bat flies	Lis
	Rats									
1	*Leopoldamys edwardsi*	7	6	1	2	5	10	5	0	4
2	*Niviventer bukit*	4	4	0	1	4	1	1	0	3
3	*Niviventer inas*	6	6	0	0	5	7	3	0	3
4	*Niviventer rapit*	32	32	3	1	31	9	16	0	25
5	*Rattus ratus diardii*	3	2	1	0	1	0	1	0	1
	Squirrels									
6	*Callosciurus caniceps*	2	0	0	0	0	0	0	0	0
7	*Callosciurus flavimanus*	2	2	0	0	2	0	0	0	0
8	*Dremomys rufigenis*	3	3	0	1	1	1	2	0	2
	Shrews									
9	*Crocidura fuliginosa*	(1) 0	0	0	0	0	0	0	0	0
10	*Suncus etruscus*	(3) 0	0	0	0	0	0	0	0	0
	Bats									
11	*Chironax melanocephalus*	33	13	0	0	11	0	0	7	3
12	*Cynopterus brachyotis*	13	7	0	0	4	0	0	7	1
13	*Macroglossus sobrinus*	7	3	0	0	3	0	0	2	0
14	*Megaerops ecaudatus*	4	4	0	0	1	0	0	6	0
15	*Hipposideros armiger*	1	1	0	0	1	0	0	0	0
16	*Pipistrellus* sp.	3	1	0	0	0	0	0	2	0
17	*Rhinolophus affnis*	2	1	0	0	0	0	0	1	0
	Civet									
18	*Paradoxurus hermaphroditus*	2	0	0	0	0	0	0	0	0

* Lis = Listrophorids

Table 3: Infestation rate of the ectoparasitic acari of small mammals in Cameron Highlands, Pahang, 1993

Ectoparasitic acari recovered	**No. of Host Animal Infested**	**Infestation Rate (%)**
Bat flies	15	7.94
Chiggers (Larval trombiculid mites)	29	15.34
Fleas	5	2.65
Lice	11	5.82
Listrophorids	43	22.75
Mesostigmatid/Cheyletid mites/Spinturnicid mites	70	37.04
Ticks	16	8.47

Table 4: Some ectoparasitic acari infesting the small mammals at Cameron Highlands, Pahang

Host species of small mammals	Family/Genus/Species of ectoparasites						
	Mesostigmatid/ Cheyletid/Spinturnicid mites	**Chiggers**	**Listrophorids**	**Ticks (A,L,N)**	**Fleas**	**Lice**	**Bat flies**
Rats							
Leopoldamys edwardsi	*Laelaps* spp			*Haemaphysalis* spp	Xenopsylla spp.	*Hoplopleura* spp (N&A)	
Niviventer bukit	*Laelaps* spp			*Dermacentor* spp		*Hoplopleura* spp (N&A)	
Niviventer inas	*Laelaps* spp			*Haemaphysalis* spp			
Niviventer rapit	*Laelaps* spp	*Leptotrombidium* spp	*Listrophoroides* spp	*Dermacentor* spp			
Rattus ratus diardii	*Laelaps echidninus*	*Gahrliepia walchia*		*Haemaphysalis* spp			
	Laelaps aingworthae			*Ixodes* spp.	*Xenopsylla* spp.	*Hoplopleura* spp. (N&A)	
				Dermacentor spp.	*Xenopsylla cheopis*		
Squirrels							
Callosciurus caniceps	–	–	–	–	–	–	–
Callosciurus flavimanus	*Chylonotus* + Laelap spp	–	–	–	–		
Dremomys rufigenis	*Cheyletus* spp.	*Gahrliepia walchia*	*Listrophoroides* spp	*Dermacentor* spp.		*Hoplopleura* spp.	
Shrews							
Crocidura fuliginosa	–	–	–	–	–	–	–
Syncus etruscus	–	–	–	–	–	–	–
Bats							
Chironax melanocephalus	Spinturnicidae						Nycteribidae
Cynopterus brachyotis	Spinturnicidae	No ID					Nycteribidae
Macroglossus sobrinus	Spinturnicidae						Streblidae
Megaaerops ecaudatus	Spinturnicidae						Nycteribidae
Hipposideros armiger	*Laelaps* spp.						Streblidae
Pipistrellus sp.	–						Streblidae
Rhinolophus affnis	–						Streblidae
Civet							
Paradoxurus hermaphroditus	–	–	–	–	–	–	–

* A = Adult stage L=Larval stoge N= Nymphal stage

DISCUSSION AND CONCLUSION

Studies on parasitofauna at the montane forest of Cameron Highlands, Pahang documented 85 positive specimens from 124 examined individuals. Seven broad groups of ectoparasites were recovered from these specimens and they included the mesostigmatid/ cheyletid/spinturnicid mites, larval trombiculid mites or chiggers, listrophorids, lice, fleas, ticks and bat flies. Majority of these ectoparasites were collected from the murids especially the arboreal mountain rat, *N. rapit*. The other four species of murids and the seven species of bats revealed moderate parasites loads. Sciurids on the other hand produced rather low parasites loads. This may be due to the irregular usage of the nets, the structure of the fur and the nesting behaviour of these species which presumably provide less favourable micro-habitat for these ectoparasites and thus accounted for the lesser parasites loads (Muul and Lim 1974).

In general, a high infestation rate of 68.55% was procured from the current study which could be considered as relatively high. This illustrated that most of the captured specimens harboured ectoparasites on their bodies whereby 1 to 7 groups were normally predominant on these specimens. The infestation rate of the ectoparasites with respect to the host animals infested however was the highest among the mites constituting of the mesostigmatid/cheyletid/ spinturnicids followed by the listrophorids and chiggers respectively. The infestation rate of the other ectoparasites which comprised ticks, bat flies, lice and fleas in these specimens were comparatively low. This pattern of ectoparasites infestation on terrestrial and arboreal small mammals species has already been described by Muul and Lim (1974). It should be noted that the infestation in the field may be built up by the individual hosts, so that coexisting hosts have different infestation and each individual tends to have its own pattern.

In-depth studies should be conducted on these ectoparasites along lines similar to the above whereby Audy (1948,1958) had established that ectoparasites particularly chiggers served as ecological labels. In the prevailing study, the chiggers identified belonged to the family Trombiculidae with the species *Gahrliepia walchia* and *Leptotrombidium* spp. being obtained. It is known that Gahrliepia chiggers are denizens of tropical rainforest where they parasitized a variety of ground rats that nested in burrows. Their nidicolous habitat was discovered in the Malaysian forests recently (Kundin et al., 1966). The occurrence of chiggers in these specimens at the study area is thus not surprising. Furthermore Gahrliepiine chiggers ara known to attain their maximum development in the Oriental Region (Audy 1954, Traub & Morrow 1955) and Southeast Asia is believed to be the centre of evolution for this genus (Nadchatram, 1970). In addition, mites of the family Trombiculidae are of medical importance because the larvae of certain species are well-known vector of *Rickettsia tsutsugamushi*, the disease agent of scrub typhus, and the larvae of several other species are the causative agents of scrub itch (Nadchatram, 1979). Hence, the *Leptotrombidium* spp.isolated from this study is of significant importance as the vector of scrub typhus belonged to this genus. In fact, earlier workers in Southeast Asia had stressed the association of *Rickettsia tsutsugamushi* with rats in the subgenus *Rattus* (*Rattus*), with *Leptotrombidium deliense*-group chiggers and with transitional vegetation (Audy, 1956; Traub & Wisseman, 1974). In the present study, all the 5 species of rats carried chiggers and these results complemented with the above work. In fact, Audy (1954) demonstrated the difference in the assemblage of parasitic trombiculid mite fauna, the rodents in the Malaysian rainforest. The three species of vector chiggers, *L. fletcheri, L. deliense* and *L. arenicola*, of scrub typhus were only found among the ground rodents, whereas chiggers infesting tree-squirrels and tree-rats were not vector species. This difference in the different kinds of chiggers found in the tree-living rodents and the ground rats was due to habitat differences. Even the ground-dwelling forms could support a distinct assemblage of vectors example the house rat, *R. r. diardii* which was trapped during this study too, and is commensal of man, harboured difference assemblage of parasitic mites. This is due to these rats living in different conditions which also reflected the different habitats occupied by individual mites.

Besides chiggers, another group of ectoparasites namely ticks are known to parasitize all ground vetebrates and certain species are strictly host specific. For example, ticks of the Argasidae group mainly infest bats and of the Ixodidae group infest other vertebrate hosts (Audy et al., 1961). The trombiculid vectors of the scrub typhus and most hard ticks are parasites that may serve as excellent ecological labels because thay have specific environmental requirements which also reflect habitat of the host (Lim, 1979) and in view of this, more studies should be undertaken.

The pattern of ectoparasites infestations coupled with the distribution of the host animals contribute paramount importance as information pertaining to the vectors of zoonotic diseases and the species that may be candidates in epidemiologies studies of zoonotic pathogens could be pursued further.

ACKNOWLEDGEMENTS

The authours gratefully acknowledged the field assistance rendered by Mr. Azmin Rashdi, Mr. Saari Idris and Hj. Abdullah Latif.

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THE JOURNAL OF WILDLIFE AND PARKS

VOL.. 12 1992/1993

A METHOD OF COLLECTING SKIN TISSUE FOR POPULATION GENETIC STUDIES OF ASIAN ELEPHANTS USING A CROSSBOW AND BIOPSY-ARROW

E. JEAN BRENNAN[1], GARY BRANSON[1], NASHARUDDIN BIN OTHMAN[2]

[1]University of Tennessee, Knoxville, Tennessee, USA
[2]Department of Wildlife and National Parks, Malaysia

Abstract

This paper reports on a method of collecting skin tissue using a crossbow and arrow fitted with a specially designed biopsy tip. The equipment described was developed for population genetic studies of wild Asian elephants (*Elephas maximus*) in Peninsular Malaysia. The range in weight of the tissue collected using this method was 0.30-0.78 g. The median range of DNA yielded was between 150-300 ug/g of tissue, based on samples collected from 40 animals of varying ages. The criteria used in the design of the biopsy unit and an evaluation of the safety and reliability of this method is also presented.

Abstrak

Kertas ini melaporkan kaedah pengambilan tisu kulit menggunakan busur (crossbow) dan anak panah yang dilengkapkan dengan tip biopsi yang direka khas. Peralatan ini telah dihasilkan khusus untuk kajian populasi genetik bagi gajah Asia (*Elephas maximus*) di Semenanjung Malaysia. Berat tisu yang diperolehi melalui kaedah ini adalah diantara 0.30-0.78 g. Berdasarkan kepada tisu-tisu yang diperolehi dari 40 ekor gajah pelbagai peringkat umur, median range bagi kadar kepekatan DNA adalah diantara 150-300 ug/g tisu. Kriteria yang digunakan didalam merangka unit biopsi ini dan penilaian mengenai langkah keselamatan dan ketepatan kaedah juga dibentangkan.

INTRODUCTION

Recent advances in the area of molecular genetics offer exciting potential in the studies of the population biology of large mammals which, due to their size, longevity and slow-rate of reproduction, have been difficult or impractical using traditional wildlife monitoring techniques. Research on a wide variety of species has demonstrated the utility of molecular studies for obtaining information on breeding systems, relatedness, migration patterns, historical biogeography, changes in population size or structure, and systematic relationships. The application of these molecular tools in the study of wild populations therefore represents a promising field of investigation to scientists attempting to study and conserve populations of large mammals.

The limitation in carrying out genetic-based studies is the ability to obtain the necessary genetic samples from animals in the wild in a safe and reliable manner. This paper describes a method developed to collect the necessary samples for a study on the population genetics and conservation of the Asian elephant (*Elephas maximus*) found in Peninsular Malaysia.

METHOD

The biopsy unit described in this paper is referred to as a modular-biopsy. The design and selection of equipment took advantage of the many commercially available items to reduce the cost of custom-manufactured items. The collecting equipment consisted of two parts: the delivery system, consisting of the crossbow and arrow, and the biopsy unit that was screwed into the front of the arrow. The choice of a crossbow delivery system was made in consideration of the field conditions associated with working in a moist tropical rainforest habitat. The Barnett Wildcat XL (Barnett International, Odessa Florida USA) was chosen because of its ease of operation and maintenance, lightweight and portable design, and its cryptic black colouration. Additional features making this model ideal for use while moving through forest habitat were the retaining device that held the arrow onto the carriage and a locking trigger safety feature. The crossbow was equipped with a 5.7 kg bow or prod. Aluminium arrows, sold at a standard length of 46 cm were cut down to 38 cm, a length sufficient to ensure that the biopsy unit would extend past the end of the crossbow carriage when the bow was cocked. The shaft of the arrow was fitted with a standard size 2216 aluminium thread insert to hold the biopsy unit.

The biopsy unit was the only piece of equipment that actually went in contact with the animal. Parts of the unit were custom-made but other components were commercially available. The design attempts to reduce the cost and reliance on custom-made fittings. The unit consisted of four parts: the biopsy punch, stop-washer with an o-ring, a barbed retaining needle and the adaptor (Fingure 1). The entire biospy unit weighed approximately 10 g. Upon impact, the biopsy punch penetrated and cut the skin, impaling the dermal tissue on the retaining needle that projected through the centre of the punch and was anchored at its base within the adaptor. The needle caught the tissue on its barbs thereby securing the tissue sample within the shaft of the biopsy punch. The biopsy-arrow with the tissue sample fell off upon recoil or when the animal moved.

The biopsy punch was fabricated from stainless steel tubing (9.5 mm OD x 1.25 mm wall thickness) that was cut to a total length of 3.5 cm. A 2.5 cm length of this tubing was turned on a lathe to a wall thickness of 0.65 mm and an inside diameter of 6 mm. The remaining 1 cm length of the punch was 1.25 mm thick with a 8 mm inside diameter. This latter portion of the punch was threaded internally to accept the adaptor. Approximately 3 mm of the leading edge of the biopsy punch was beveled to produce the cutting edge.

The flat stainless steel stop-washer (8 mm ID x 16 mm OD) slipped onto the biopsy punch until it abutted the wider section of tubing that was not turned on the lathe. The washer was then held in place with a rubber o-ring. The stop-washer arrested the punch so that only the 2.5 cm portion penetrated the skin. Both the washer and o-ring were commercially manufactured and readily available from retail hardware stores. The retaining needle was cut to a length of 3.3 cm from a 1.6 mm diameter stainless steel rod. Its point was made using a grinding wheel and the three barbs were cold-chiseled by hand.

The adaptor for attaching the punch to the arrow was 2.8 cm in total length. The front end was threaded (5/16-24) to a length of 4.5 mm, and is 8 mm in diameter. In the centre, a 1.6 mm hole was drilled to a depth of approximately 9.5 mm. That was sufficient to allow the retaining needle to fit into the front portion of the adaptor. On the side, and centred within the threaded area, a 1.778 mm hole was drilled and threaded to fit a 2-56 × 1.6 mm stainless steel set screw that could be tightened using an allen key. The set screw secured the needle in the adaptor. The back portion of the adaptor was threaded (8-32) to a length of 9 mm and was 4 mm in diameter, to fit into a standard 2216 aluminum shaft insert.

All metal parts of the biopsy unit were made of stainless steel to ease in cleaning and sterilization. Immediately after collection, the parts of the biopsy unit were stored in liquid disinfectant. The cutting edge of the punch could be sharpened by hand using both a round and a flat-paddle diamond file. After sharpening all surfaces were scrubbed, washed and disinfected using a cold sterilization soution used in preparing surgical instruments. The diameter of the punch made it convenient to use a cleaning brush or ram generally sold to clean a pistol gun barrel. After cleaning, the unit was reassembled and kept in a sterile plastic bag until it is needed. With the exception of the retaining needle, the entire biopsy unit is reuseable.

After collection, the retaining needle with its impaled plug of dermal tissue was released from the adaptor by loosening the set-screw. The entire plug and needle were placed in a cryotube and immediately frozen in liquid nitrogen. When the tissue was later prepared for genetic studies, the sample was removed from the liquid nitrogen storage and the needle cut away from the tissue. As a further safety measure to guard against the chance that small pieces of tissue might remain on the barbs, the needles were never reused, thus minimizing the chance of DNA contamination among samples.

The tissue collected by this method was sufficient to support several different genetic techniques: allozyme analysis, mitochondrial DNA analysis using restriction fragment length polymorphisms and various techniques using DNA amplified following a polymerase chain reaction. The tissue samples were divided, with half being used for protein studies and the other half for total cellular DNA extraction. In the case of the latter, the tissue was digested with 50 µl of 20% proteinase K at 55°C for 3 hours. The DNA was then extracted using a standard method of phenol and chloroform extraction and ethanol precipitated (Werman, Springer and Britten, 1990). Portable equipment used in the field limited the centrifuge to 8-10,000 rpm. The total purified DNA was stored frozen in a Tris-EDTA buffer pH 8.0. DNA concentrations in each sample were determined by direct staining using ethidum bromide following electrophoresis in a 0.8% agarose gel and 1x Tris-Borate-EDTA buffer. Both the quality and the concentration of the DNA were visually assessed by comparing the sample DNA with DNA standards prepared using phage lambda DNA prepared in a serial dilutions from 0.125-2.0 ug (Bruford, et al., 1992).

RESULTS

Samples were collected from a total of 40 elephants using this biopsy-arrow method. Nine captive animals from local zoos (Taiping, Melaka, Johor Bahru and Singapore) and 31 wild elephants from throughout Peninsular Malaysia were represented. The wild elephants were being translocated as part of the Department of Wildlife and National Parks' programme to control elephants damage and to protect human life. The front foot diameter (FFD) was recorded as a crude measure of age for these animals (see Sukumar 1992:225, Khan, 1992:33 for correlation of age and foot measurements). Table 1 showed that there was little correlation between the age of the animal and the weight of the biopsy sample. The skin biopsy was taken from the animals' flank or hind-quarter. Animal response to this collecting method varied but animals tended to remain motionless even after being shot. It was not uncommon for the arrow to remain projecting out of the elephants skin momentarily before dropping off as the animal moved away or the arrow removed by hand.

The biopsy wounds were monitored continuously for all captive animals and the wounds of the wild elephants were monitored until the animals were released, generally 24-36 hours after collection. The biopsy sites were never cleaned or prepared in any manner prior to collection. In 39 cases, the biopsy wound sealed over with a serous scab within 24 hours, and slight swelling averaging around 3 cm in diameter was not uncommon. The biopsy sites of the captured wild elephants were sprayed with a topical antibiotic after collection. There was never an incident of infection or fly infestation.

In the case of one zoo elephant the staff veterinarian opted to treat the biopsy site after collection by packing the wound with a medicated powder. The following day, the animal developed a swelling of approximately 7 cm in diameter. It was 72 hours after the biopsy was taken before for the wound on this animal completely scabbed over and for the total reduction in swelling.

The weight of each skin sample was recorded to the nearest 0.005 g. The range of tissue weight varied from 0.30-0.78 g. The total cellular DNA yield was quite high. Based on visual assessment using the direct staining method, it was determined that the collecting method and protocol yielded high molecular weight DNA (>30 Kb) and the DNA yields were between 138.8 and 909.1 µg of DNA per g of tissue with a median range of 150 and 300 µg/g.

DISCUSSION

Their size, strength and physiological response to the stress of capture have greatly limited attempts to obtain genetic samples from wild populations of large terrestrial mammals such as th Asian elephant. Generally, it was necessary to chemically immobilize such animals to obtain the needed samples. Chemical immobilization is costly and represents a risk to the human researchers as well as to the animal. Complications such as hyperthermia, aspiration of ingesta, and gastric bloating are potential dangers that can prove fatal if the animal does not receive the chemical reversal agent within a short time after the onset of these conditions. In addition, there is also the risk that the animal may fall in a position that may compromise breathing. It is because of these concerns that this remote method of biopsying large terrestrial mammals was developed.

There were four criteria used in guiding the design of the biopsy unit described: (a) repair and replacement costs, (b) the requirement that there be no tissue carried over on the biopsy equipment to cause contamination between samples, (c) safety and (d) reliability of the method to collect the sample.

(a) Repair and Replacement Costs

Previous studies have reported on various remote methods to collect skin biopsies. The earliest reference used a harpoon gun equipped with a modified harpoon head biopsy unit to collect skin samples for studies on the cytogenetics of various species of cetaceans (Winn et al., 1973). More than a decade later numerous papers began to appear in the literature describing a remote method of tissue sampling using a crossbow (Lambertsen, 1987; Mathews et al., 1988; Amos and Hoelzel, 1990). The basic design of the biopsy unit described in each of those studies is similar, consisting of a single element biopsy punch manufactured on a lathe from a single block of metal. The major difference between the biopsy unit described in this paper and those reported in the earlier literature is in the modular design and in the design of the adaptor.

Because the biopsy unit is custom manufactured, replacement cost is a major factor especially for large-scale field projects such as a field study of elephants. The modular design, incorporating easily replaceable and commercially available parts, was important in this regard. The single unit designed of the earlier punches result in the loss of the entire unit if it suffers any damage, as is frequently the case. The modular design makes it possible to replace the damaged component, rather than replace the entire unit, and is economical both in terms of its manufacturing cost as well as its repair.

(b) No Contamination Between Samples

The adaptors used in the early studies are not specified. Evidently the authors did not consider the adaptor to be part of the biopsy unit as its sole function is to attach the biopsy unit to the shaft of the arrow. In contrast, the adaptor used in the modular-biopsy has been designed as an integral part of the biopsy unit, not only adapting the punch to the arrow but also holding the needle that retains the tissue sample.

The biopsy units described in the earlier studies very primarily in how they retain the tissue. Several units used prongs or barbs soldered inside the collecting-tube part of the biopsy itself to hold the tissue (Mathews et al., 1988; Winn et al., 1973; Amos and Hoelzel, 1990). If the punch is used on more than one animal these designs make it difficult to ensure that the surfaces of these units are adequately cleaned of any fine residual shreds of tissue, an issue critical in studies that rely on DNA amplication. The biopsy punch part of modular-biopsy unit however has completely smooth surfaces. Only the retaining needle is likely to catch and hold tissue but because it is replaced between samples, there is little chance of cross contamination. The biopsy unit described by Karesh et al., 1987 also used a disposable device to hold the tissue by using a dental broach epoxied to the tip of an immobilization dart. However because that biopsy punch is narrow and has an even narrower opening at the base of the punch, it is difficult to clean. In contrast, the unit described here is larger in diameter, and the part of the biopsy punch itself is an open-ended tube when the adaptor is removed. This makes it easier to clean and to inspect the collecting surfaces.

(c) Safety

Given the difficulty of providing follow-up medical treatment for wild animals it was necessary to ensure that this collecting method posed little risk of infection, fly infestation, or trauma. The monitoring of the animals confirmed the safety of this equipment. The fact that there was never an incident of maggots infesting the wound may be because there is very little bleeding associated with this biopsy equipment. The incidence of infection may be low due to the relatively large diameter of the biopsy punch. The rationale for this explanation can be seen if one considers infections that result from the use immobilization darts. Dart abscesses may develop because the hole created by the dart needle closes up almost immediately, trapping any dirt or bacteria that may have been on the instrument within the wound. In contrast, the biopsy hole remains open as a serous fluid exudes for a short time after the tissue is cut. The exudate crystallizes and forms a plug closing the biopsy hole within one day and the wound then heals as the tissue granulates in behind.

(d) Reliablitity

The other biopsy system introduced by Karesh et al. in 1987 looked promising for field application because it was fired from a capture rifle; equipment that is commonly used by many biologist. However the design of the biopsy unit itself proved to be unsatisfactory as the unit often failed to retain the tissue. The modular-biopsy unit introduced here proven superior in not only cutting the sample but in retaining the tissue once the tissue has been cut. The success of this system may be due to the depth of the biopsy. It was carefully researched to ensure that the punch passed from the first layer of dermal tissue into the second underlying layer of muscle. This severs the basement membrane and thereby releases the dermal plug from its attachment at the interface of the two tissue types. The use of the modular-biopsy unit on elephants never failed to obtain the sample either in captivity or in the field.

ACKNOWLEDGEMENTS

This work was supported by the Detroit Zoological Society, Fulbright Research Program, Nixon Griffis Fund, and the Malaysian Department of Wildlife and National Parks. We wish to thank the Goverment of Malaysia, The Prime Minister's Department, The Economic Planning Unit, for permission to conduct this research. This study would not have been possible without the help of Mohd Khan bin Momin Khan, Musa bin Noridn, and most especially Jasmi bin Abdul. Special thanks are given to the members of the Elephant Translocation Unit who helped in so many different ways. We also wish to thank the staff at Taiping, Melaka, Singapore and Johor Bahru Zoos who helped in collecting samples, and to Markbybee and Barnett International for the donation of equipment. All phases of the study received help and encouragement from Gary McCracken, Leslie Johnston, Robyn Barbiers, Steve Graham, Charles Hammond, Carolyn Ewald and the Education and Conservation Committee of the Detroit Zoo.

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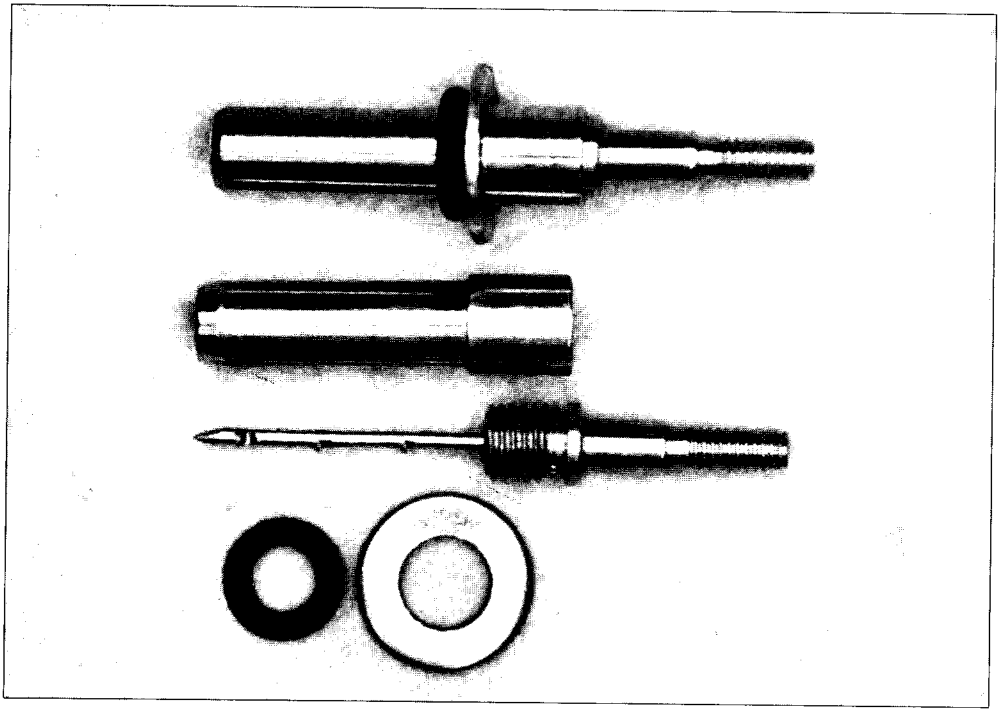

Figure 1. The modular-biopsy unit consists of four parts: the biopsy punch, stop-washer with o-ring, barbed retaining needle, and the adaptor.

Table 1. Weights of tissue samples and DNA concentrations from samples collected from elephants using the modular-biopsy unit. Front foot diameter (FFD) is given as a crude measure of the animal's age. The DNA was degraded in several samples when liquid nitrogen was lost from the storage tank. DNA concentrations of those samples are not presented in the table below and are not included in the summary statistics.

Males				Females			
Sample ID	FFD (cm)	Wt. (g)	DNA Conc (µg/g)	Sample ID	FFD (cm)	Wt. (g)	DNA Conc (µg/g)
18	16.5	0.3	595.0	19	15	0.39	....
11	17.8	0.485	784.3	10	17.8	0.585	251.3
30	20	0.45	416.6	9	19	0.49	909.1
8	21.5	0.56	701.7	17	24	0.52	277.5
37	22	0.51	261.4	1	25	0.75	....
41	23	0.52	731.7	42	26	0.525	444.4
44	24	0.485	200	31	29	0.555	603.4
56	27.5	0.725	270.3	13	30	0..34	....
58	30	0.64	178.5	40	32	0.44	360.0
25	30.5	0.62	188.2	3	33.5	0.63	291.5
39	31	0.69	237.8	48	34	0.645	172.4
33	32	0.68	250.0	26	35.5	0.48	520.8
5	35	0.68	....	35	36	0.38	153.4
23	35.5	0.41	213.4	52	36	0.49	592.6
12	36	0.47	....	28	36.5	0.30	166.3
4	37.1	0.57	333.3	54	37	0.57	294.1
7	unk	0.48	326.1	6	37	0.68	....
47	unk	0.48	357.1	60	38	0.67	380.95
				14	38	0.57	....
				21	39	0.56	133.9
				45	unk	0.51	683.6
				46	unk	0.78	138.8

N = 40
min. DNA conc. = 133.9 µg/g tissue
max. DNA conc. = 909.1 µg/g tissue
median range = 150-300 µ/g tissue

THE JOURNAL OF WILDLIFE AND PARKS

VOL.. 12 1992/1993

HEMORRHAGIC SEPTICAEMIA IN THE INDIAN GAUR (*BOS GAURUS GAURUS*) AT ZOO MELAKA

X.M.RICHARD[1], Z.ZAINAL ZAHARI[2], A. MOHD TAJUDDIN[3]

[1] Faculty of Veterinary Medicine and Animal Science
UniversitiPertanian Malaysia, 43400 UPM Serdang, Selangor, Malaysia.
[2] Zoo Melaka, Department of Wildlife and National Parks, 75450 Air Keroh, Melaka Malaysia.
[3] Department of Wildlife and National Parks, 50664 Kuala Lumpur, Malaysia.

Abstract

Two cases of hemorrhagic septicaemia in the India gaur (Bos gaurus gaurus) at Zoo Melaka are described. The lesions observed included severe pneumonia, marked congestion of the lung, exudative-fibrinous pericarditis, fibrinous pleuritis, laryngitis and hemorrhagic tracheitis. Pure growths of *Pasteurella multocida* Carter's type B were isolated from the heart, lungs, liver and spleen of both animals.

Abstrak

Dua kes penyakit sampar berdarah pada Indian Gaur (*Bos gaurus gaurus*) di Zoo Melaka dibincangkan. Lesi-lesi yang dilihat termasuk radang paru-paru, 'pulmonary congestion', *exudative-fibrinous* pericarditis, fibrinous, pleuritis, laryngitis dan 'hemorrhagic tracheitis'. *Kuman Pasteurella multocida* Carter's type B telah diasingkan daripada jantung, paru-paru, hati dan limpa daripada kedua-dua binatang tersebut.

INTRODUCTION

Hemorrhagic septicaemia (HS) is an acute, often fatal epizootic disease of large ruminants caused by *Pasteurella multocida* Carter's type B and E. This disease has also been reported in a number of wild animals (De Alwis, 1992). It has been reported in North American bison (Blood, et al, 1983) elands, zebra, kangaroos, gnu (Okoh, 1980) red panda (Nayak, 1988) Western European deer and in domestic animals in the Argentinean sheep, horses (Jubb et al, 1985) and camels (Jubb et al, 1985; Momin et al, 1987).

In Malaysia, it is mainly restricted to cattle and the buffalo (Chandrasekaran, 1988; De Alwis, 1992; Joseph, 1979). This paper reports on two cases of hemorrhagic septicaemia in the Indian gaur (*Bos gaurus gaurus*) at Zoo Melaka.

METHOD

History: Three animals, an adult male, an adult female and a subadult female Indian gaur were acquired by Zoo Melaka in January, 1990 from California, USA. The animals were quarantined for a month upon arrival. A week prior to the death of the animals, the weather was cloudy with continuous rain (M.M.S., 1990).

On 15 July 1990, the subadult female was found dead. The next day the adult female showed clinical signs of tachypnoea, hypersalivation, extremely pale mucous membranes, submandibular facial oedema and severe abdominal breathing while the adult male was slightly depressed. Both animals were treated with Septotryl 24% (Sulphadiazine and Trimethroprim) at 1 ml/15 kg BW. The adult female died 12 hours later while the adult male recovered.

RESULTS

Post mortem findings: The prominent lesions in the dead animals were fibrinous pericarditis and pleuritis. The larynx, trachea and lungs were severely edematous and congested. The lungs also had petechial hemorrhages. The prescapular, submandibular, mediastinal and the femoral lymph nodes were moderately enlarged, edematous and haemorrhagic.

The adult female also showed myocardial and endocardial hemorrhages, mild congestion of the semilunar valves, severe enteritis, widespread congestion with petechial hemorrhage on the carcass, marked congestion of the mesenteric lymph nodes, omentum and serosal surface of the rumen.

Bacteriological findings: Bipolar, gram negative coccobacilli to rods were isolated on blood agar culture from the heart, lungs, liver and spleen of both animals. The organism was positive on biochemical test such as oxidase, catalase, glucose, indole, H_2S, mannitol test and did not ferment lactose and arabinose. Based on morphological staining reactions, biochemical tests and Indirect Hemagglutination test, the organism was identified as *Pasteurella multocida* Carter's type B..

DISCUSSION

The clinical signs and necropsy findings of the first case were suggestive of a peracute form of HS while the second case was of an acute form. In the subadult female, the prominent lesions observed were largely confined to the thoracic cavity and the tipper respiratory tract which were similar to that reported in the buffaloes by Siew et.al (1970). However, in the adult female, the lesions were widespread as have been reported in cattle (Kradel et al, 1969 and Zamri-Saad and Saharee, 1990). The adult female did not respond to treatment since the clinical signs were already advanced. According to De Alwis (1992) treatment should be administered before the clinical signs appeared.

It is speculated that the small enclosure, the unfamiliar environment, the wet rainy weather (M.M.S, 1990) and that the animals were not vaccinated against HS had predisposed the animals to the infection.

The mode of introduction of hemorrhagic septicaemia into the animal enclosure remains unestablished since no new ruminants were introduced into the zoo premise immediately prior to the incidence of the disease. There was a possibility of the organism being transmitted by passive carriers (Kradel et al, 1969; Quan, et al, 1986; Siew et al, 1970).

ACKNOWLEDGEMENTS

The authors wish to thank the Director-General of the Department of Wildlife and National Parks, West Malaysia, for support and encouragement. The authors are grateful to the staff of Zoo Melaka, Faculty of Veterinary Medicine and Animal Sciences, Universiti Pertanian Malaysia and Veterinary Research Institute, Ipoh, Perak, for their assistance. Special thanks to Dr. P.G. Joseph, Prof. A.R. Sheikh-Omar, Assoc. Prof. Dr. M.K. Vidyadaran and Dr. A. Majanil of Universiti Pertanian Malaysia, and Dr. S. Chandrasekaran of Veterinary Research Institute, Ipoh, for their invaluable comments.

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