THE RAFFLES BULLETIN OF ZOOLOGY 2013 Supplement No. **29**: 155–159
http://zoobank.org/urn:lsid:zoobank.org:pub:7EDF5454-3970-4CF1-AED6-CFC9A4A77052
Date of Publication: 30 Nov.2013

ECOLOGICAL STUDY OF THE MALAYSIAN WATER SHREW *CHIMARROGALE HANTU* (HARRISON, 1958) WITH REMARKS ON "ECOLOGICAL LABELLING" BY PARASITE PATTERNS

Lim Boo Liat
No 12, Jln Koop Cuepacs 3E, Taman Cuepacs, 43200 Cheras, Selangor Darul Ehsan, Malaysia
Email: limbooliat@yahoo.co.uk

Daicus M. Belabut
Institute of Biological Sciences, Faculty of Science, University of Malaya, 50603 Kuala Lumpur, Malaysia
Email: daicus@um.edu.my

Rosli Hashim
Institute of Biological Sciences, Faculty of Science, University of Malaya, 50603 Kuala Lumpur, Malaysia
Email: roslihashim@um.edu.my

ABSTRACT. — Since 1957, 14 specimens of the Malaysian water shrew *Chimarrogale hantu* (nine males and five females) have been obtained from various forest reserves in the western, eastern, central and northern parts of Peninsular Malaysia. Their habitats ranged from lowland and hill forest to montane forest. Though widely distributed, the species is nowhere common. Identifiable stomach contents included a partly decomposed larval caecilian, scales and shells probably representing aquatic crustaceans and molluscs, and abundant insect fragments. Endoparasites identified from the gut included trematodes and cestodes, nematodes and acanthocephalans, while ectoparasites comprised terrestrial ticks and trombiculid mites. The finding of two gravid female shrews, and a captive animal that survived for three weeks in captivity, are significant records.

KEY WORDS. — Malaysian water shrew, *Chimarrogale hantu*, habits, diet, distribution, body measurements, parasites

INTRODUCTION

The Malaysian water shrew *Chimarrogale hantu* of the family Soricidae is nearly as large as the house shrew *Suncus murinus*. Its identity is obvious from its apparent lack of an external ear and the presence of distinctive fringes of stiff hairs on the sides of its partially webbed feet, both adaptations to a life in water. The Malaysian water shrew was first described from Peninsular Malaysia as *Chimarrogale hantu* by Harrison (1958). Specimens have since been recorded under a variety of names by different scientists. It was treated as a subspecies of *C. platycephala* by Medway (1969), as a subspecies of *C. himalayica* by Medway (1978), and as a synonym of *C. phaeura* by Corbet & Hill (1992). Current taxonomic treatment recognises *C. hantu* as a valid species endemic to Peninsular Malaysia (Wilson & Reeder, 2005; Francis, 2008).

In addition to the five specimens reported by Medway (1969, 1978), 14 additional specimens have been collected since 1957. More biological information on this little known animal has thus become available and is presented here.

MATERIAL AND METHODS

Cage traps, hand nets and pitfall traps were deployed along forest streams in the various forest reserves, during extensive mammal surveys throughout Peninsular Malaysia that were intended to investigate the mammalian fauna and associated ecto- and endoparasites. Fourteen water shrews were obtained. Two each were caught by cage traps and pitfalls, and 10 were hand-netted. Only two specimens were brought in apparently healthy; the rest came in dead or died overnight. The two live animals were caught in cage traps at Ulu Langat Forest Reserve, Selangor in Aug.1957 and Feb.1962. The former specimen (female) died a day after capture, and the latter (male) survived for three weeks in captivity.

The male was kept in a fish aquarium measuring 15 × 29 × 29 cm. The floor of the aquarium was layered with sand and medium and small pebbles. A long zinc water tray 15 × 10 ×10 cm was placed at the glass front from end to end. Sand and pebbles covered the inner height of the tray to facilitate the animal climbing for water in the tray. The bottom of the tray was spread with small river pebbles. Various sized stones collected from an old forest stream were used to structure a nest with a small opening for the animal to rest. Dry leaves and small twigs were spread on the sandy and gravel floor. The whole structure of the glass enclosure was intended to simulate a natural water stream environment for the animal.

Body measurements, head and body (HB), tail (T) and hindfoot (HF) in mm were taken using a ruler. Weight in grams was taken using a portable balance TANITA 1476 of 0–100 grams scale. The external body surfaces were examined for ectoparasites following standard procedures. Ticks were preserved in 70% alcohol for visual examination of external characters to determine genus and species under a stereoscope. Chiggers were also preserved in 70% alcohol, and cleared in lactophenol solutions, after which each was mounted in Canada balsam on a glass slide, dried and identified through a high-powered research microscope.

For endoparasites, the viscera were removed and examined immediately. Trematodes were preserved in 70% alcohol, cestodes and acanthocephalans in 5% formalin. Trematodes, cestodes and acanthocephalans were stained with borax carmine or alum carmine, cleared in creosote, and mounted in Canada balsam. Nematodes were cleared in lactophenol and studied as temporary mounts.

RESULTS

Capture. — Nine specimens were captured in forest reserves in Selangor, two in Pahang and one each in Perak, Kedah and Kelantan during the period from 1957 to 2009 (Table 1, Fig. 1). Trapping was carried out at irregular times, thus the collection was opportunistic in nature. Among the three trapping methods used, cage traps were the least efficient. Hand nets, though productive, stressed the animals resulting in death overnight after being transferred into cages. Pitfall traps were most efficient, yielding two individuals in this study during one trapping period.

Description. — The body was covered with velvety water-proof fur. Upper parts were uniform dark grey to black, with silvery guard hairs that were most conspicuous over the hind-quarters. The tail was uniformly greyish brown to dark brown. Underparts were dark brown. Feet were brown and toes partially webbed. Younger animals were uniformly lighter in colour than fully grown adults. All had characteristic fringes of stiff hairs edging the sides of the feet and all lacked an external ear (Fig. 1). The body measurements (14 specimens) of both age-classes are shown in Table 1.

Habits in natural environment. — Animals were observed on four occasions at Ulu Gombak and Ulu Langat Forest Reserve in Selangor, foraging in forest streams. On each occasion the shrew was seen wandering about at the edge of the stream. They were highly sensitive and upon sensing any slight disturbance by intruders (rats or small carnivores, snakes, etc.) nearby, submerged into deeper water and swam away rapidly. According to the Orang Asli, water shrews were also sighted well away from water courses, and occasionally were caught in traps on land. We were shown a few nesting sites of the animal, all of which were among rocks and boulders above the banks of streams. The entrance to the nest was very small with the animal having to squeeze its body into the nest.

Distribution. — During 53 years (1957–2009) only 14 specimens (9 males, 5 females) were obtained. These came from eight forest localities in five states (Table 1, Fig. 2). All except two were caught in hill forest between 600 and 800 m elevation. The exception was one from mountain forest at 1500 m and one from lowland forest below 200 m.

Stomach contents. — Out of seven stomachs examined, three (collected in Nov.1969, Apr.1997, and Oct.1998) had food remains, including both invertebrate and vertebrate taxa (Table 2). These were remnant pieces of shells and scales. Though it was not possible to identify the species from which these particles were derived, based on the semi-aquatic habits of the water shrew, the shell particles were probably those of aquatic and terrestrial molluscs and possibly of crabs. Some of the scales were oblong in shape, indicating that they derived from freshwater prawns. Decomposed earthworms were found in two of the three water shrews examined. Identification of millipedes and centipedes was based on decomposed remnants of the chaetae and claws of these animals. A part of the tibia with three-segmented tarsus of a mole cricket was also found in one of the water shrews.

In the vertebrate group of animals found in the stomach contents were scales of fish. Digits of frogs were also found. An interesting finding was a decomposed part of a larval caecilian.

Reproduction. — Two of the five females (May 1967 and Nov.1969) were found with early pregnancies. The May1967 specimen had two and the Nov.1969 had three embryonic stems.

Fig. 1. Malaysian water shrew, *Chimarrogale hantu.*

Table 1. Body measurements (mm) of Malaysian water shrew. HB = Head & Body, T = Tail, HF = Hind foot, Wt = Weight (g). *Skull was extracted.

Date	Sex	HB	T	HF	Wt	T/HB (%)	Locality
Jan.1955	F	112.8	97.3	22.2	36	86.2	Ulu Langat Forest Reserve (<1000 m a.s.l.), Hulu Langat, Selangor
Aug.1957	M	90.2	87.8	21.9	29.4	97.5	Ulu Langat Forest Reserve (<1000 m a.s.l.), Hulu Langat, Selangor
Dec.1958	M	114.2	90.2	22	34	79	Ulu Gombak Forest Reserve (<1000 m a.s.l.), Ulu Gombak, Selangor
Feb.1962	M	93.1	90.3	21.2	29.4	96.9	Ulu Gombak Forest Reserve (<1000 m a.s.l.), Ulu Gombak, Selangor
Jul.1963	F	115.3	102.3	22.1	33.6	88.9	Ulu Gombak Forest Reserve (<1000 m a.s.l.), Ulu Gombak, Selangor
Jul.1966	M	111.3	95.8	21.4	35.2	86.1	Ulu Gombak Forest Reserve (<1000 m a.s.l.), Ulu Gombak, Selangor
May.1967	F	113.8	98.5	22	34.8	86.6	Kepong Forest Reserve (< 1000 m a.s.l.), Kepong, Selangor
Sep.1968	M	85.1	86.8	20.4	28.8	101.9	Cameron Highlands (1676 m a.s.l), Pahang
Nov.1969	M	117.5	91.6	22	31.8	77	Janda Baik Forest Reserve (<1000 m a.s.l.), Pahang
Mar.1995	M	121.2	94.3	21.9	33.7	77.9	Sungai Singor, Temenggor Forest Reserve (<1000 m a.s.l.), Perak
Apr.1997	F	117.8	98.4	22.2	32.5	83.5	National Park, (<1000 m a.s.l.), Kelantan
Oct.1998	F	112.3	94.8	21.8	35.2	84.4	Ulu Muda Forest Reserve, Baling, Kedah
Feb.2009	M*	97	85	23	26.4	87.6	Ulu Gombak Forest Reserve (<1000 m a.s.l.), Ulu Gombak, Selangor
Feb.2009	M	95	85	23	23.8	89.5	Ulu Gombak Forest Reserve (<1000 m a.s.l.), Ulu Gombak, Selangor
Mean		106.9	95.7	21.9	31.8	87.3	
Range		85.1–121.2	86.8–102.3	20.4–22.2	28.8–36.0	77.1–101.9	

Captive diet. — Based on identified stomach contents, the surviving male water shrew (Nov.1969) was offered several items of animal food: prawns, crabs and snails collected from streams together with terrestrial animals including snails, mole crickets, cockroaches and suckling mice. Out of this list it took aquatic crabs and snails, terrestrial snails and mole crickets, and suckling mice.

Captive behaviour. — It took one day and night for the water shrew to acclimatise to the new enclosure environment. During observer visits in the morning, afternoon and late evening, the animal was moving about the cage, with occasional dipping into the water and resting at the corner of the cage. On the morning of the second day, the water shrew was still actively moving about the cage but had piled debris outside the entrance of the nest, and also carried some into the water tray. On an afternoon visit that day, the entrance of the nest was found to be clear of debris, which appeared to have been carried into the nest. Subsequent observations later found that the animal emerged from its nest at dusk.

Parasites. — Five of the 12 shrews brought in dead were positive for both ecto- and endoparasitic infections. Five species of ectoparasites and six of endoparasites were recovered. The ectoparasites were three species of ticks and two of chiggers (larval trombiculid mites), and the endoparasites were a species of nematode, two species each of trematodes and cestodes and one of an acanthocephalan (Table 3).

Fig. 2. Distribution map of the Malaysian water shrew *Chimarrogale hantu*.

Table 2. Analysis of contents of three stomachs of the Malaysian water shrew.

Date of specimen collected	State of stomach contents	Animal material recovered	
		Invertebrates	Vertebrates
Nov.1969	50% full	earthworms, millipedes, shells, scales-? prawn	fish scales
Apr.1997	25% full	tibia of mole cricket, shells, centipedes	digits of frogs
Oct.1998	75% full	shells, earthworm, mole cricket	caecilian

Table 3. Parasites of the Malaysian water shrew.

Date of specimen collected	Site of Infection**	Eectoparasites		Endoparasites		
		Ticks	Chiggers	Nematode	Trematode	Cestode
Jul.1966	B, Si	1 Dm		3A		2 Hd
May 1967	B, Si		5 Wa		4 Dic	6 Hd
Mar.1995	B	3 Dm				
Apr.1997	B, Si	2 Ix	4 L(L)d	5 Ch	2 Lec	
Oct.1998	B	1 Amb				

** B = Body; Si = small intestine; M = lip muscle
Ticks: Dm = *Dermacentor* sp.; Ix = *Ixodes granulates*; Amb = *Amblyomma* sp.
Chiggers: Wa = *Walchella oudemasi*; L(L)d = *Leptotrombidium* (*L.*) *deliense*
Nematode: A = Acanthocephala = *Moniliformis moniliformis*; Ch = *Capilaria hepatica*
Trematode: Dic = *Dicrocaelid* sp.; Lec = *Lecithodendid* sp.
Cestode: Hd = *Hymenolepis diminata*

DISCUSSION

The low number of the Malaysian water shrews captured at the eight locations and also during previous studies (Medway, 1969, 1978) could have involved three factors: (a) unusual sensitivity to disturbance or trap-shyness, (b) inappropriate types of traps deployed, (c) low trapping effort. Belief that the bite of this animal is poisonous may have made the trappers reluctant to search for it. It may also have accounted for 90% of the catches brought in having been dead specimens. Pitfall traps have been found most efficient in capturing frogs and reptiles, and are most effective for small insectivores such as ground shrews *Crocidura* spp. and *Suncus estrucus* (Muhomad et al., 2007). Our pitfall traps were the least harmful to water shrews. Even so, only one specimen lived for any time; it was found dead in the corner of the cage after 21 days in captivity. Post mortem did not show abnormality in any organs, but there was a weight loss from 35.2 g on arrival to 24.8 g at the time of its death. The cause could possibly have been inappropriate food types or stress in captivity.

The water shrew, though mainly aquatic, is also partially terrestrial in habit. When on the forest floor, like the moonrat *Echinosorex gymnurus*, another semi-aquatic insectivore (Lim, 1967), it is always close to a water environment. Medway (1983) reported that water shrews "are occasionally caught in fish traps set at the edge of large pools or in bends in the river in relatively still water one or two feet deep, flowing over a gravelly bottom in the upper Sungai Nenggiri, Kelantan".

Medway (1969) reported that food items consist of freshwater crabs and a variety of other aquatic animals. Our results showed a considerably broader range, including fish and frogs, and an array of invertebrates. An interesting finding in our study was part of a larval caecilian. The larval caecilian normally dwells embedded in sandy ground at the edge of a river or stream. Thus, the presence of the larval caecilian and also the earthworms in the stomach suggests that the water shrew has a rooting habit similar to that of the moonrat (Lim, 1967). The analysis of stomach contents revealed that, like the moonrat, the water shrew is a generalist feeder.

Life-styles in nature are reflected in parasite loads. Audy (1948, 1958) established that ectoparasites, particularly chiggers, serve as ecological labels related to the pattern of habitat use and behaviour of the hosts. Among endoparasites, helminths such as *Melastrongylus malayensis* occurring in certain rodents have been found to serve as a good indicator of the food habits of these hosts (Lim & Ramachandran, 1979). In water shrews, the dicrocaeliid and leeithodrendriid trematodes and Heanthocephala found are similarly likely to correlate with the host's food preferences as their intermediate hosts are insects and snails that, in turn, are infected when they feed on definitive host faeces. This further indicates that the water shrew eats insects and molluscs in nature as well as under laboratory conditions.

Ectoparasitic ticks and trombiculid mites, particularly the latter group, are distributed throughout a wide range of habitats, from lalang (*Imperata*) grassland, scrub and secondary forest to primary forest at all elevations, although some of them are more habitat-specific than others (Nadchatram, 1970). With the exception of the scrub typhus

vector, *Leptotrombidium (L.) deliense*, found in forest fringe, scrub and secondary forest habitats, the ectoparasites recovered from water shrews occur in general forest type habitats—further evidence of their terrestrial habits.

All the six species of endoparasites are also common intestinal parasites of murids and insectivores (*Suncus murinus*, *Crocidura malayana*), the intermediate hosts of all these endoparasites are insects (Leong et al., 1979; Lim et al., 1983).

The ectoparasites, i.e., the ticks and chiggers with the exception of the cattle tick *Boophilus* sp. which is host specific, are free-living organism opportunistically clinging onto any vertebrate hosts that crosses its path. Of the three species of ticks and two of chiggers identified from the water shrews, the ixoidid tick, *Ixodes granulatus* and the trombiculid mite, *Leptotrombidium* (*L.*) *deliense* are of medical importance. Langat virus has been isolated only from *Ixodes granulatus* from the Ulu Langat Forest Reserve, Hulu Langat District, Malaya (Smith, 1956) and *Leptotrombidium* (*L.*) *deliense* is a vector of scrub typhus (Audy, 1963).

It is obvious from the results that the Malaysian water shrew attracts a fairly wide variety of ecto-and endoparasites despite the small number of specimens examined. Their agility in quest of food in various different niches of the forest could be an important factor in exposure to infection by a diversity of parasites. This could be through direct or indirect contact and through consuming reservoir host species that harbour parasites.

Medway (1983) reported specimens of water shrews from Selangor, Pahang and Kelantan at all altitudes up to 5300 ft (1615 m). Our study increased the known localities and the total geographical and ecological range. Based on our present results, the water shrew is found in localities studied in western, central, eastern and northern parts of Peninsular Malaysia. Failure to obtain the species in the southern part of the country could have been due to less field activities being carried out there. Although the species is widely distributed, field activities in each of the locations investigated confirm that its population density is genuinely low. With the river systems, the primary habitat of this species, being degraded and polluted through deforestation, it is anticipated that the natural population through time would further decline. The species is protected, Appendix II and listed in the Threat status for Mammals in Peninsular Malaysia as VuB2ab (11.111) (DWNP, 2010).

ACKNOWLEDGEMENTS

This paper is a contribution to Supplement No. 29 of the Raffles Bulletin of Zoology, marking the eightieth birthday of the Earl of Cranbrook (V). The authors are grateful to Fred Dunn and the late M. Natchatram at the Institute of Medical Research for the confirmation and identification of the endo- and ectoparasites. Without the assistance of the Orang Asli trappers in the various states, who collected these animals, and without their expert knowledge of the forest and its mammal fauna, this paper would not have been possible.

LITERATURE CITED

Audy, J. R., 1948. Natural history and scrub typhus. *Malayan Nature Journal*, **3**: 114–129.

Audy, J. R., 1958. The role of mite vectors in the natural history of scrub typhus. *Proceedings of 10th International Congress of Entomology*, **3**: 639–649.

Audy, J. R., 1963. The zoogeography of the genus *Leptotrombidium*, trombuculid mite vectors of scrub typus. *Proceedings of 9th Pacific Science Congress, Bangkok*, **9**: 16–18.

Corbet, G. B. & J. E. Hill, 1992. *The Mammals of the Indomalayan Region: A Systematic Review*. Natural History Museum Publications. London and Oxford University Press, Oxford. 488 pp.

DWNP, 2010. *Red List of Mammals for Peninsular Malaysia, 2010*. Department of Wildlife and National Parks, Peninsular Malaysia. 150 pp.

Francis, C. M., 2008. *A Field Guide to the Mammals of Southeast Asia*. New Holland Publishers, London. 392 pp.

Harrison, J. L., 1958. *Chimarrogale hantu*, a new water shrew from the Malay Peninsula, with a note on the genera *Chimarrogale* and *Crossogale* (Insectivora, Soricidae). *Annals and Magazine of Natural History*, Series 13, **1**: 282–290.

Leong, T. S., B. L. Lim, L. F. Yap & M. Krishnansamy, 1979. Parasite fauna of the house rat, *Rattus rattus diardii* in Kuala Lumpur and nearby villages. *Southeast Asian Journal of Tropical Medicine and Public Health*, **10**: 112–126.

Lim, B. L., 1967. Notes on the food habits of *Ptilocerus lowii* Gray (Pentail tree-shrew) and *Echinosorex gymnurus* (Raffles) (Moonrat) in Malaya with remarks on "ecological labeling" by parasite patterns. *Journal of Zoology, London*, **152**: 375–379.

Lim, B. L. & C. P. Ramachandran, 1979. Ecology studies on *Angiostrongylus malaysiensis* (Nematode, Metastrongylidae) in Malaysia. In: Cross, J. H. (ed.), *Studies on* Angiostrongyliasis *in Eastern Asia and Australia*. Special Publication of the U.S. Naval Medical Research Unit No. 2, Taipei, Taiwan. Pp. 25–56.

Lim, B. L., I. N. Ladera & A. Munif, 1983. Parasite fauna of the commensal rats and shrews in Jakarta city, West Java, Indonesia. *Hemera Zoa*, **71**: 213–220.

Medway, Lord, 1969. *The Wild Mammals of Malaya*. Oxford University Press, Kuala Lumpur. 127 pp.

Medway, Lord, 1978. *The Wild Mammals of Malaya and Singapore*. Oxford University Press, Kuala Lumpur. 130 pp.

Medway, Lord, 1983. *The Wild Mammals of Malaya (Peninsular Malaysia) and Singapore. 2nd Edition*. Oxford University Press, Kuala Lumpur. 131 pp.

Muhomad, N. Z., J. Senawi & B. L. Lim, 2007. A note on the arboreal monkey-footed rat in a pit-fall trap. *Journal of Wildlife and Parks*, **24**: 63–65.

Nadchatram, M., 1970. Correlation of habitat, environment and colour of chiggers, and their potential in the epidemiology of scrub typhus in Malaya. (Protosigmata: Trombiculidae) *Journal of Medical Entomology*, **7**: 131–144.

Smith, C. E. G., 1956. A virus resembling Russian spring-summer encephalitis virus from ixodid tick in Malaya. *Nature*, **178**: 581–582.

Wilson, D. E. & D. M. Reeder (eds.), 2005. *Mammal Species of the World: A Taxonomic and Geographic Reference. 3rd Edition.* Johns Hopkins University Press. 2000 pp.