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Mammal survey on Phu Quoc Island, southern Vietnam

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Abstract

An inventory of the mammal fauna of Phu Quoc Island, the largest offshore island of Vietnam lying 20 km off the Cambodian coast, has been conducted for the first time. A total of 17 species of small mammals were recorded: *Cynopterus brachyotis*, *Cynopterus sphinx*, *Hipposideros ater*, *Rhinolophus shameli*, *Rhinolophus lepidus*, *Rhinolophus malayanus*, *Hesperoptenus blanfordi*, *Crocidura* sp., *Menetes berdmorei*, *Hylopetes alboniger*, *Berylmys berdmorei*, *Maxomys surifer*, *Rattus tanezumi*, *Rattus exulans*, *Niviventer fulvescens*, *Tupaia belangeri*, *Paradoxurus hermaphroditus*. In addition, *Pteropus vampirus*, *Callosciurus finlaysonii*, *Trachypithecus germani*, *Macaca fascicularis* and *Muntiacus muntjak* were registered on the basis of field observations. Records for *Sus scrofa* and *Cervus unicolor* are based on interviews conducted. Most of the findings represent new distributional records for Vietnamese mammal fauna.

Keywords: fauna; mammal inventory; Phu Quoc Island; Vietnam.

Introduction

Phu Quoc (ca. 10°01′–10°27′ N, 103°51′–104°50′ E; Kien Giang Province) is the largest offshore island of Vietnam lying in the Gulf of Thailand, 45 km from Ha Tien (Vietnam) and 15 km south of the coast of Cambodia; it is part of an archipelago consisting of 14 islands of various sizes. Phu Quoc Island is 62 km long and 3–28 km wide, and covers ca. 562 km^2. It had a population of approximately 85,000 in 2001. Phu Quoc is called the island of 99 mountains because of its many sandstone ridges gradually descending from the north to the south. The longest is Ham Ninh, stretching along the island's eastern edge for 30 km, with its highest peak called Mount Chua (603 m a.s.l.). Phu Quoc lies in the monsoon sub-equatorial climatic zone, which is characterized by two clearly marked seasons: a short rainy season (October only) and a dry season (November to September). Average annual rainfall is 2879 mm and the average temperature is 27°C.

Phu Quoc Island is well known for its unique, insular primary tropical forests. The Phu Quoc Nature Reserve of approximately 14,957 ha was established in 1986 to protect these forests. Since 2001 this nature reserve has been reorganized as Phu Quoc National Park and now encompasses an area of 31,442 ha. This National Park is situated in the northeast of the island, with its northern and eastern borders formed by coastal lines.

Little information on the flora and fauna of Phu Quoc National Park is available. Although the Nature Reserve was established quite a long time ago, no mammalogical survey has been undertaken to date. A checklist of Vietnamese mammals (Huynh et al. 1994) contains only nine species recorded from Phu Quoc Island: the giant flying fox, *Pteropus vampirus* (Linnaeus 1758); the bicolored roundleaf bat, *Hipposideros bicolor* (Temminck 1834); the fulvus roundleaf bat, *Hipposideros fulvus* Gray 1838; the intermediate roundleaf bat, *Hipposideros larvatus* (Horsfield 1823); the golden jackal, *Canis aureus* Linnaeus 1758; the Indian muntjac, *Muntiacus muntjak* (Zimmermann 1780); Finlayson's squirrel, *Callosciurus finlaysonii* (Horsfield 1824); the red-cheeked flying squirrel, *Hylopetes spadiceus* (Blyth 1847); and the white-handed gibbon, *Hylobates lar* (Linnaeus 1771). Besides, the dugong *Dugong dugon* (Müller 1776), one of the most critically endangered marine mammals of Southeast Asia, is known to inhabit the coastal waters of Phu Quoc Island (Adulyanukosol 2002).

A first biodiversity survey of Phu Quoc Island was carried out in November–December 2003 by the Russian-Vietnamese Tropical Centre. This paper presents a provisional species list of the mammals of Phu Quoc Island. This inventory, though far from complete, covers the main vegetation types and altitudinal zones of the area explored.

Materials and methods

Fieldwork was conducted from 25 November to 20 December, 2003. The expedition base camp was situated in the northern part of Phu Quoc Island, near the Duong Dong-Bai Thom road and close to the northern slope of the main mountain area at 10°22′05″ N, 104°00′19″ E (Figure 1). We surveyed different biotopes at distances of 2–8 km from the base camp.

Two types of trap were used. Large (11 cm× 11 cm×25 cm) cage traps were set up, each with bait consisting of a piece of foam rubber saturated with vegetable oil, which was replaced every third day. Pitfall traps, i.e., plastic buckets 40 cm deep and 30 cm in diameter, were buried flush with the ground surface.

The main forest types occurring in the study site were surveyed, with an altitudinal range of 25–480 m a.s.l. covered. A list of the habitats sampled and details of trapping by cage traps are given in Table 1; in total, there

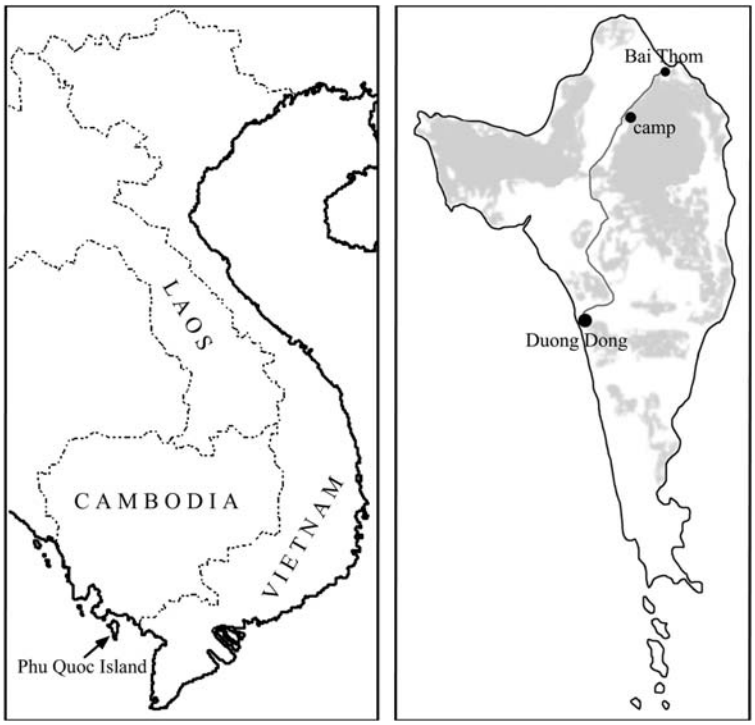

Figure 1 Maps showing the location of Phu Quoc Island (left) and details of the island (right). The location of the field camp is indicated (right figure) and mountainous forested areas are shaded in light gray.

were 1511 trap-nights. Pitfall traps were set up in the dipterocarp forest, near fallen trees at the bottom of the mountain (elevation of 25–40 m a.s.l.) for a total of 105 trap-nights. Except for voucher specimens, all trapped rodents were released at least 1–2 km away from the trap-lines to eliminate repeated captures. Voucher specimens are deposited in the Zoological Museum of Moscow State University (Moscow, Russia) and the Zoological Institute Russian Academy of Sciences (St. Petersburg, Russia).

Bats were trapped using nylon mist nets (10 m×2 m and 12 m×2 m) set up in appropriate locations, i.e., streams, paths and ridge tops, to achieve higher probabilities of catching bats. The borders and sizes of individual sites of *Rhinolophus* spp. were estimated by visual mapping during night excursions, after which the bats were trapped. All netted bats, except for voucher specimens, were released after identification.

Standard external body measurements (head and body length, tail length, hind foot length, ear length) were taken. For bats, forearm length was also measured. Weight was measured in grams.

Additional information was obtained by interviewing the forest protection staff responsible for management of the Nature Reserve, local authorities, house owners and key informants, e.g., local hunters.

Results

Based on 253 trapped specimens, an annotated list of 17 species of small mammals (bats, insectivores and rodents) of Phu Quoc Island is presented here. In addition, seven species are reported based on observations and interview data (Table 2). For each reported species,

Table 1 Details of small mammal trapping on Phu Quoc Island.

Line	Habitat description	Dates	Days	Traps	Trap-nights
1	Open savanna-like habitat, sparse growth of *Meloleuca* trees; grassland with sedges and *Nepentes* sp.	29.11.03–04.12.03	6	40	240
2	Lowland undisturbed dipterocarp forest	14.12.03–17.12.03	4	30	120
3	Lowland dipterocarp forest, sparse scrub; creek near the trap line	26.11.03–18.12.03	23	12	276
4	Evergreen mixed (dipterocarps, podocarps, etc.) forest on the mountain slope; line transects from the foot of the mountain (50 m a.s.l.) to the top (450 m a.s.l)	06.12.03–12.12.03	7	90	630
5	Stony plateau on top of the mountain (485 m a.s.l.); grasses and solitary *Meloleuca* trees	07.12.03–12.12.03	6	10	60
6	Dry light lowland forest with predominance of *Tristaniopsis* trees	28.11.03–04.12.03	7	20	140
7	Northern part of the island, Bai Thom Village, human houses, lodgings and adjacent gardens	14.12.03–16.12.03	3	15	45

Table 2 List of the mammal species recorded from the Phu Quoc Island.

	Species	Observed	Collected	Signs, tracks	Interview data	Literature data
1	*Pteropus vampyrus*	+				Huynh et al. 1994
2	*Hipposideros bicolor*					Huynh et al. 1994
3	*Hipposideros fulvus*					Huynh et al. 1994
4	*Hipposideros larvatus*					Huynh et al. 1994
5	*Cynopterus brachyotis*		+			
6	*Cynopterus sphinx*		+			
7	*Hipposideros ater*		+			
8	*Rhinolophus shameli*		+			
9	*Rhinolophus lepidus*		+			
10	*Rhinolophus malayanus*		+			
11	*Hesperoptenus blanfordi*		+			
12	*Crocidura* sp.		+			
13	*Callosciurus finlaysonii*	+				Huynh et al. 1994
14	*Menetes berdmorei*		+			
15	*Hylopetes alboniger*		+			
16	*Hylopetes spadiceus*					Huynh et al. 1994
17	*Hylopetes lepidus**					Sung 1984
18	*Berylmys berdmorei*		+			
19	*Maxomys surifer*		+			
20	*Rattus tanezumi*		+			
21	*Rattus exulans*		+			
22	*Niviventer fulvescens*		+			
23	*Tupaia belangeri*		+			
24	*Trachypithecus germaini*	+				
25	*Macaca fascicularis*	+				
26	*Hylobates pileatus***					Huynh et al. 1994
27	*Paradoxurus hermaphroditus*		+	+		
28	*Canis aureus*					Huynh et al. 1994
29	*Muntiacus muntjak*			+		Huynh et al. 1994
30	*Sus scrofa*				+	
31	*Cervus unicolor*				+	
32	*Dugong dugon****					Adulyanukosol 2002

*Sung (1984) reported on a single specimen of the red-cheeked gliding squirrel, *Hylopetes lepidus*, from Phu Quoc Island. According to Thorington et al. (1996), the species name *lepidus*, originally described for Java, should be restricted to squirrels from Java and Borneo. These authors recognized flying squirrels from the north of the Isthmus of Kra as the separate, closely related species *H. platyurus*. Without studying the *Hylopetes* specimen from the Museum National d'Histoire Naturelle (Paris) reported by Sung (1984), we are unable to decide if it is a typical *platyurus* or *lepidus*.

**Some authors (Corbet and Hill 1992, Huynh et al. 1994) reported on the occurrence of the pileated gibbon, *Hylobates pileatus* (Gray 1861) (formerly considered a subspecies of the white-handed gibbon *H. lar*) on Phu Quoc Island. Phu Quoc Island is the only place in Vietnam where this gibbon has been recorded. The original source of these reports is Kloss (1929), who speculated that some specimens of the pileated gibbon collected by Mouhot might have originated from Phu Quoc Island. As Mouhot explicitly stated that he did not visit Phu Quoc, however, this speculation is refuted (Fooden 1996). No evidence for the occurrence of this gibbon on Phu Quoc Island was found during our survey. The vocalization, or song, of gibbons is audible for long distances and is the primary method by which scientists locate wild populations. However, we never recorded such vocalization during 25 days of the fieldwork. The interview data also did not confirm the occurrence of gibbons here. It is noteworthy that the pileated gibbon was recorded in all evergreen forest areas in the Central Cardamoms in adjacent Cambodia (Long et al. 2000).

***The population of these large aquatic mammals, also called sea cows (order Sirenia), has declined dramatically in the last 25 years in both Vietnam and Cambodia. Only 10 dugongs remain in the waters of Con Dao Island off the coast of southern Ba Ria-Vung Tau Province, and about 100 others occur near Phu Quoc Island (Adulyanukosol 2002). According to Vietnamese official media reports, at least six dugongs were killed by fishermen near Phu Quoc Island over the autumn of 2002.

we provide relevant taxonomic notes, as well as distributional and habitat data.

Order Chiroptera, family Pteropodidae

***Pteropus vampyrus* (Linnaeus, 1758)** In Vietnam, this species has hitherto been recorded from Hue (Thua Thien Hue Province) and offshore islands of southern Vietnam, including Phu Quoc and Con Dao (Van Peenen et al. 1970, Huynh et al. 1994).

We found a permanent colony of this species on Phu Quoc Island. The estimated number of flying foxes there was approximately 100 animals. According to interview data (local forest guards), roosts are situated in the mangrove forest in the northern part of the island. Giant flying foxes left their roosts at sunset and appeared near trees bearing ripe fruit at 18:00 h (shortly before sunset). These are rather timid and careful animals, flying above the tree crowns. Some of the animals flew directly to trees with ripe fruit, while others scattered around, flying in different directions throughout the night.

***Cynopterus brachyotis* (Müller, 1838)** This species is widely distributed throughout Vietnam and is common on Phu Quoc. We caught six specimens.

***Cynopterus sphinx* (Vahl, 1797)** This species is widespread in Vietnam and common on Phu Quoc. We caught four specimens.

Both species of short-nosed fruit bats are quite abundant on Phu Quoc. They inhabit the lowlands in the northern part of island, at altitudes below 200 m a.s.l. We did not observe species specificity with regard to feeding objects or methods for these bats. Both species feed together on the same trees. The lesser short-nosed fruit bats, *C. brachyotis*, were more abundant than *C. sphinx*, with a ratio of 4:1. Animals of different sexes and ages (from juveniles to adults) were caught simultaneously, but pregnant females were not recorded.

Order Chiroptera, family Hipposideridae

***Hipposideros ater* Templeton, 1848** In Vietnam, this species has hitherto only been reported for Thanh Hoa Province (Huynh et al. 1994).

We collected three adult females, which were captured on a slope near a creek. They were flying in a shrubby layer, 2–3 m above the ground.

Order Chiroptera, family Rhinolophidae

***Rhinolophus shameli* Tate, 1943** Shamel's horseshoe bat displays a disjunction in its range: it is known from Myanmar and northern Thailand, and from southeastern Thailand and Cambodia. It was reported from Pu Mat Nature Reserve in central Vietnam by Hayes and Howard (1998), as noted by Borissenko and Kruskop (2003). On Phu Quoc, it is a common and numerous bat, occurring in different types of plain forests. It has been recorded in many habitats, except for slopes above 230 m a.s.l. We collected two animals.

The feeding territory of this horseshoe bat lies in the lowest forest level and in bushes and grass, and the bat does not leave this area during feeding. Hunting in the second (scrub) level was not recorded. The height of hunting flights was less than 1 m (usually 10–70 cm). Flight was flitting, with sharp changes in height and direction. In open areas, it inhabits islands of dense bush with sparse high trees. The bat hunts in the shrub layer, flying through glades and the paths of large animals, occasionally flying out from undergrowth to a height of several meters, but almost immediately turning back to the shrub layer. Feeding territoriality seems to be very rigid, as all recorded animals were permanently confined to the same site. Distances between individual sites are large (approx. 100–300 m). The cross-sectional diameter of individual sites was approximately 50–100 m.

***Rhinolophus lepidus* Blyth, 1844** This widespread Indomalayan species was questionably reported from Vietnam by Sokolov et al. (1986) and Huynh et al. (1994). Borissenko and Kruskop (2003) mentioned this species only from Con Dao Island. These small horseshoe bats (forearm ca. 36–37 mm) are quite similar to *R. pusillus*, but are larger on average and differ in more massive dentition and generally less acute and more broadly based connecting process (Borissenko and Kruskop 2003).

We collected three animals during our survey. All specimens were caught and recorded in lowland forest. Feeding was observed in bushes of the second forest level, while flying was at 1–2 m above the ground. Hunting took place above the grass level, predominantly in the lower part of bushes, under the main crowns. The flight pattern is typical of pipistrelles: fast and maneuverable. Permanent individual sites were located 500–1500 m apart. The cross-sectional diameter of individual sites was approximately 100–200 m.

***Rhinolophus malayanus* (Bonhote, 1903)** In Vietnam, this species has been reported only from the north of the country in Lai Chau (Huynh et al. 1994) and Quang Binh provinces (Kruskop 2000).

We collected four animals. The species was recorded only for lowland forest. The foraging territory is bush at the secondary forest level. The main foraging habitat was bush tops and immediately beneath them. The height of hunting flight was 1.5–2 m. Flight was smooth and flitting, moving predominantly horizontally. Individual sites were indistinctly bordered. Boundaries of individual foraging sites were sometimes shifted by hundreds of meters and our observations were restricted to a single animal.

Order Chiroptera, family Vespertilionidae

***Hesperoptenus blanfordi* (Dobson, 1877)** This species was only recently reported from Vietnam (Dong Nai Province) by Borissenko and Kruskop (2003), and has also been found in Cambodia (Hendrichsen et al. 2001, Matveev 2005).

We collected a single specimen. Blanford's bat starts hunting at sunset, first flying together with birds for some time. It feeds over roads, sometimes flying through open spaces along roads. It is possible that it does not penetrate into the forest. The species density seemed to be low, as we encountered only four animals, all of them near the Duong Dong-Bai Thom road.

Order Soricomorpha, family Soricidae

***Crocidura* sp.** Five adult specimens of *Crocidura* sp. were collected in pitfall traps set up on a lower mountain slope. This is a medium-sized shrew, with a body length of 68–72 mm and a tail length of 49–59 mm. The fur is dark gray, with ventrum and dorsum of the same color. The ears look grayish and are covered with short grayish hairs. The tail is vaguely bicolored, with the ventral side slightly lighter in color.

The taxonomy of white-toothed shrews of Southeast Asia and particularly of Vietnam is poorly understood (Jenkins 1982, Heaney and Timm 1983, Jenkins and Smith 1995). There are still more species of *Crocidura* and other shrews remaining to be discovered in the region (Lunde et al. 2003, 2004). A revision of the Phu Quoc specimens is currently being prepared by Alexei Abramov and Paula Jenkins of the Natural History Museum, London.

Order Rodentia, family Sciuridae

***Callosciurus finlaysonii* (Horsfield, 1823)** We did not collect specimens of Finlayson's squirrel, but the species was quite common during our survey. It was found mainly in lowland mixed forests. On some large fruit trees we recorded up to 12–15 individuals simultaneously. This is an extremely variable species, which may be of different coloration (Lekagul and McNeely 1988). Finlayson's

squirrel on Phu Quoc has a dark reddish brown dorsum and an orange-red ventrum. The tail is fluffy and light gray, with lengthy white under-hairs.

***Menetes berdmorei* (Blyth, 1849)** This species is mainly distributed in central Vietnam (Lunde and Son 2001). During our survey on Phu Quoc, *Menetes* was frequently observed in different habitats: in bushes near the Duong Dong-Bai Thom road, and in dipterocarp forest at elevations between base camp (25 m a.s.l.) and 200 m a.s.l.

Three specimens were collected by cage traps set up on the ground. All squirrels have a red-brownish dorsum, with black lateral stripes edged by pale stripes above and below on each side of the body; the ventrum is yellowish. A mid-dorsal black stripe is absent. The entire body coloration of *Menetes* from central Vietnam is more grayish, with light under-hairs in the dorsal fur; the tail is also lighter, with well-marked light transversal stripes. The ventrum is white or grayish white. Lateral pale stripes are wider (4–5 mm), while a mid-dorsal black stripe is present and well-marked. Compared to specimens of *M. berdmorei* from continental Vietnam, those from Phu Quoc Island are larger. The body length of an adult female was 222 mm, while subadult males (n=2) had a body length of 178–180 mm and a tail length of 119–122 mm. *M. berdmorei* from central provinces of Vietnam have a body length of 153–184 mm and tail length of 135–165 mm (Lunde and Son 2001). In the collection of the Zoological Museum of Moscow State University, specimens of *M. berdmorei* from Thom Island (a small island situated south of Phu Quoc) are similar to our specimens in size and coloration.

***Hylopetes alboniger* (Hodgson, 1836)** This Indochinese species is mainly distributed in mountainous areas of north and central Vietnam. Our specimens represent the southernmost records in Vietnam.

A family group (four animals) of this distinctive gliding squirrel was found in the hollow of a large *Syzygium* sp. in the sparse dipterocarp forest near the base camp at an elevation of 30 m a.s.l. The hollow, with entrance of 3 cm×10 cm, was situated at 150 cm above the ground. The diameter of the *Syzygium* trunk was 40 cm, and the tree was ca. 20 m in height. The squirrels were caught using nets, measured and then released near the hollow. This family group consisted of an adult male and female and two youngsters (subadult males with a body length of approx. 90% of that of the parents).

Another species of gliding squirrels, *Hylopetes spadiceus*, also recorded for Phu Quoc Island (Huynh et al. 1994), is easily distinguished from *H. alboniger* by its significantly smaller body size and by the bright orange coloration of the head and base of the tail. The baculum of *H. alboniger* is a curved rod, whereas it is a short straight rod in *H. spadiceus* (Thorington et al. 1996).

Order Rodentia, family Muridae

***Berylmys berdmorei* (Blyth, 1851)** We collected seven specimens of *B. berdmorei*, most of which were caught on the ground in bushes near the Duong Dong-Bai Thom road, in bushes near a creek, and in sloping dipterocarp forest (up to an elevation of 200 m). One specimen was collected in Bai Thom village in a kitchen-garden. This is the first record of *B. berdmorei* for southern Vietnam. According to Lunde and Son (2001), this species is known from the southern parts of central Vietnam.

***Maxomys surifer* (Miller, 1900)** *M. surifer* is one of the commonest and most widespread species of forest rats in Vietnam. It was also the most abundant rodent species (45% of total rat captures) during our fieldwork on Phu Quoc. In total, we collected 95 specimens in all forest types from the bottom to the top of the mountain.

***Rattus tanezumi* (Temminck, 1844)** The taxonomy of the genus *Rattus* remains controversial and questionable. Musser and Carleton (2005) assigned many taxa of the Asian type of the *Rattus rattus* species group to the species *Rattus tanezumi*. We follow this opinion. According to Lunde and Son (2001), this species is widespread in Vietnam.

Rattus tanezumi was the second most abundant rat species (after *Maxomys surifer*) in the biotopes studied (40% of total rat captures). We collected 86 animals. This species was found in all habitats studied: in different types of dipterocarp forest, in open savanna-like habitats with *Meloleuca* sp., on rocky ground on a plateau, and along the mountain slope from 25 to 485 m a.s.l. The dorsum is gray-brown and the belly is gray to grayish white, with the boundary between the dorsum and ventrum poorly marked. Many specimens have a reddish or red-brown spot on the breast and chin. The size of these spots varies greatly. It can be a small dab on the chin, or a narrow stripe running from the lower lip up to the base of the leg, or the chin and throat may be fully pigmented; some specimens have an entire breast colored. This reddish spot is completely absent in many specimens (approx. 40%).

***Rattus exulans* (Peale, 1848)** *R. exulans* is widespread in Southeast Asia and it is thought that the continental part of its range is a result of dispersion with man. During 45 trap-nights we collected three specimens from houses in Bai Thom village.

***Niviventer fulvescens* (Gray, 1847)** We collected 21 specimens. This rat was only caught on the ground in dipterocarp forest from sea level up to the high parts of the slope (20–485 m a.s.l.).

The populations of southern Indochina were referred to by some authors as *Niviventer bukit* (Bonhote 1903). In some characters (size, presence of a dark mark on the chest and the belly) the rats from Phu Quoc are close to *N. bukit*. However, we follow Musser and Carleton (2005) in treating *bukit* as a synonym of *fulvescens*.

Order Scandentia, family Tupaiidae

***Tupaia belangeri* (Wagner, 1841)** We collected five adult specimens of this species. Tree shrews were caught only on the ground in different forest habitats.

Order Primates, family Cercopithecidae

***Trachypithecus germaini* (Milne-Edwards, 1876)** A group of langurs comprising four or five adults and one golden infant was often observed in canopies of large trees on the slope at 200–300 m a.s.l. This species is widely distributed in Indochina from central Thailand to Myanmar. In Vietnam, it occurs in the southern provinces up to 15°N (Fooden 1996). It is a rather common species in south Vietnam. Earlier, this form was considered to be *Trachypithecus cristatus* (Raffles 1821), but here we follow the taxonomy proposed by Groves (2001).

***Macaca fascicularis* (Raffles, 1821)** A small group and solitary specimens were recorded in the lowland forest near Bai Thom village.

Order Carnivora, family Viverridae

***Paradoxurus hermaphroditus* (Pallas, 1777)** A partial skeleton with the skull was collected in a snare line set by local hunters on the mountain slope (at approx. 400 m a.s.l.). Recent footprints of the palm civet were recorded along the Duong Dong-Bai Thom road and in dry sandy savanna-like areas with *Meloleuca* trees.

Order Artiodactyla, family Suidae

***Sus scrofa* Linnaeus, 1758** No direct evidence was found of the occurrence of this species during the survey. According to interview data, wild pigs often occur in the southern part of the Mount Chua plateau and are the object of illegal hunting.

Order Artiodactyla, family Cervidae

***Muntiacus muntjak* (Zimmermann, 1780)** Fresh muntjac footprints were found along the forest edge near the Duong Dong-Bai Thom road (ca. 4 km west of the village) on 26 November and 7 December.

***Cervus unicolor* Kerr, 1792** No direct evidence was found of the occurrence of this species during the survey. According to interview data, sambars often occur in forests of the southern, sparsely populated part of the Mount Chua plateau. Sometimes the sambar is the object of illegal hunting.

Discussion

The species composition and the number of small non-volant mammals differ in the habitats studied (Table 3). The highest variety and highest number of small mammals were registered in different types of the dipterocarp forest. Although the small mammal fauna studied is typical for the forests of southern Vietnam, some common forest species, such as *Leopoldamys edwardsi* and *Leopoldamys sabanus*, were not found. Two species, *Maxomys surifer* and *Rattus tanezumi*, completely dominated the forest habitats, comprising 41% and 37% of the total captures of terrestrial mammals. The high number of *R. tanezumi* attracted our attention. Usually, the density of *Rattus* species is low in the forest habitats of Southeast Asia. These rats are more common in cultivated areas, scrub habitats and around houses (Lunde and Son 2001). *R. tanezumi* was found in all types of forest biotopes studied: from elevations of 10–20 m a.s.l. in open savanna-like areas with *Meloleuca* up to the stone plateau with solitary trees and groups of bushes at 485 m a.s.l. In some forest types, for example, in forest with a predominance of *Tristaniopsis* sp., *R. tanezumi* was the only rat recorded.

The bat fauna of Phu Quoc Island is not species-rich, but demonstrates remarkable specificity (Morozov 2005), consisting of two compact ecological groups: frugivorous bats and insectivorous bats, the latter specializing in hunting at the scrub level of lowland forests. Bats of both groups were recorded only at low elevations and were not found in the forest beyond 250 m a.s.l. It is likely that a limiting factor for their distribution is the meteorological conditions (constantly strong trade wind).

Small horseshoe bats, the rhinolophoids, dominated the forests studied. These bats hunted only in the first scrub level. The coexistence of three close ecological forms, similar in many parameters, in the same territory, seems to indicate high productivity of this habitat. The space used for rhinolophoid hunting was divided into three levels. *Rhinolophus shameli* used the lowest layer, under the grass. The middle level, the proper scrub, was dominated by *Rhinolophus lepidus*. The upper level, the top of bush crowns and above, was inhabited by *Rhinolophus malayanus*.

The moist forests of Phu Quoc Island are included in the Cardamom Mountains Rainforest ecoregion (MacKinnon 1997). This ecoregion represents the original extent of the wet evergreen forests that cover the Cardamom Mountains and the Elephant Range in southwest

Table 3 Occurrence and number of different rat species in the habitats studied.

Line	*Berylmys berdmorei*		*Maxomys surifer*		*Niviventer fulvescens*		*Rattus tanezumi*		*Rattus exulans*		Total	
	n	R	n	R	n	R	n	R	n	R	n	R
1							12	5			12	5
2	2	1.7	18	15	1	0.8	11	9.2			32	26.7
3	1	0.4	18	6.5	3	1.1	14	5.1			36	13
4	3	0.5	59	9.4	17	2.7	28	4.4			107	17
5							8	13.3			8	13.3
6							13	9.3			13	9.3
7	1	2.2							3	6.7	4	8.9

Habitat descriptions for lines 1–7 are listed in Table 1. n, number of individuals trapped; R, number of rats per 100 trap-nights.

Cambodia and extends slightly across the border into southeast Thailand. It is separated from the nearest other rainforest by the vast, dry Khorat Plateau in central Thailand to the north and east and by the Gulf of Thailand to the west. The Cardamom Mountain rainforests are considered by some to be one of the most species-rich and intact natural habitats in the region, but they are also one of the least explored. The first comprehensive mammal survey of this region was conducted in the Cardamom Mountains, Cambodia during the Flora & Fauna International Biodiversity Survey (Hayes 2000, Long et al. 2000, Swan and Kry 2000).

Our survey is a first attempt to study the small mammals of Phu Quoc Island. Most of the rodent and bat species recorded represent new distributional records for the Cardamom Mountains Rainforest ecoregion and for Vietnam. The inventory of mammals of Phu Quoc Island is far from complete. The list of mammals will doubtless be enlarged, for example, after studying carnivores. Some species of viverrids and mustelids that are widespread in Indochina (Kanchanasakha et al. 1998) might be found on Phu Quoc Island. Additional research into bats and insectivores is also required.

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