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The mammal fauna of Cat Ba Island, northern Vietnam

Alexei V. Abramov & Sergei V. Kruskop

ABSTRACT. Cat Ba Island is one of largest islands of Ha Long Bay in northern Vietnam. The island harbors a unique mammal fauna, however, still very few thorough mammal surveys have been conducted in Cat Ba. We provided a checklist of the mammalian fauna of Cat Ba on the base of small mammal survey (October 2011) and a comparative analysis of the available literature. In total, the mammal fauna of Cat Ba Island includes 46 species belonging to six orders, 16 families, and 31 genera. Two species (*Tupaia belangeri* and *Crocidura attenuata*) were documented for the first time on Cat Ba Island. Bat fauna includes up to 29 species, a considerable portion of which are specific inhabitants of karst areas of northern Vietnam and southern China. Confirmed occurrence of *Hipposideros khaokhouaensis* suggests faunal connections even with central Laos. Taxonomic position and relations of some Cat Ba *Rhinolophus* and *Hipposideros* require revision. On the whole, Cat Ba fauna should be treated as relic faunal complex existing due to local peculiarities of the landscape and vegetation.

KEY WORDS: mammals, new findings, Cat Ba National Park, Vietnam.

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Фауна млекопитающих острова Катба, северный Вьетнам

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РЕЗЮМЕ. Остров Катба — один из крупнейших островов залива Халонг в северном Вьетнаме. Фауна млекопитающих Катбы уникальна, но до сих пор остров мало исследован в териологическом отношении. В статье приведен полный аннотированный список млекопитающих Катбы, основанный на результатах полевых работ в октябре 2011 г. и сравнительного анализа существующей литературы. Список млекопитающих острова Катба включает 46 видов, принадлежащих 6 отрядам, 16 семействам и 31 роду. Два вида (*Tupaia belangeri*, *Crocidura attenuata*) впервые отмечены для острова. Фауна летучих мышей включает до 29 видов, большинство из которых тесно связано с карстовыми районами северного Вьетнама и южного Китая. Подтверждено обитание на Катбе листоноса *Hipposideros khaokhouaensis*, что позволяет предположить фаунистические связи с центральным Лаосом. Таксономическое положение некоторых форм *Rhinolophus* и *Hipposideros* с Катбы нуждается в дополнительном исследовании. В целом, фауну Катбы можно рассматривать как реликтовый фаунистический комплекс, возникший благодаря локальным особенностям ландшафта и растительности.

КЛЮЧЕВЫЕ СЛОВА: млекопитающие, новые находки, национальный парк Катба, Вьетнам.

Introduction

Cat Ba Island (ca. 20°42′ – 20°55′N, 106°45′ – 107°10′E; Hai Phong Province) is the largest of several hundreds islands that comprise the Cat Ba Archipelago, which located in the southeastern edge of Ha Long Bay in northern Vietnam (Fig. 1). Cat Ba Island lies approximately 30 km east of Hai Phong city and has a surface area of 285 km^2. Approximately half of island is covered by the Cat Ba National Park (established in 1986). The national park also incorporates some of the small islands and marine waters situated to the east of Cat Ba island. In 2003, Cat Ba Archipelago was declared a UNESCO Man and Biosphere Reserve Area in order to protect the multiple terrestrial and aquatic ecosystems as well the diverse plant and animal life that is found on the island.

The landscape of Cat Ba is dominated by limestone karst alternating narrow valleys running along the northeast-southwest. The topography is rugged mountains with elevation 50–200 m and marked by steep outcrops and areas of bare rock. As is typical in well developed karst landscapes, drainage patterns are complicated by subterranean passages, which probably account for most of the drainage of the island. Cat Ba National Park supports a diversity of natural habitats, including for-

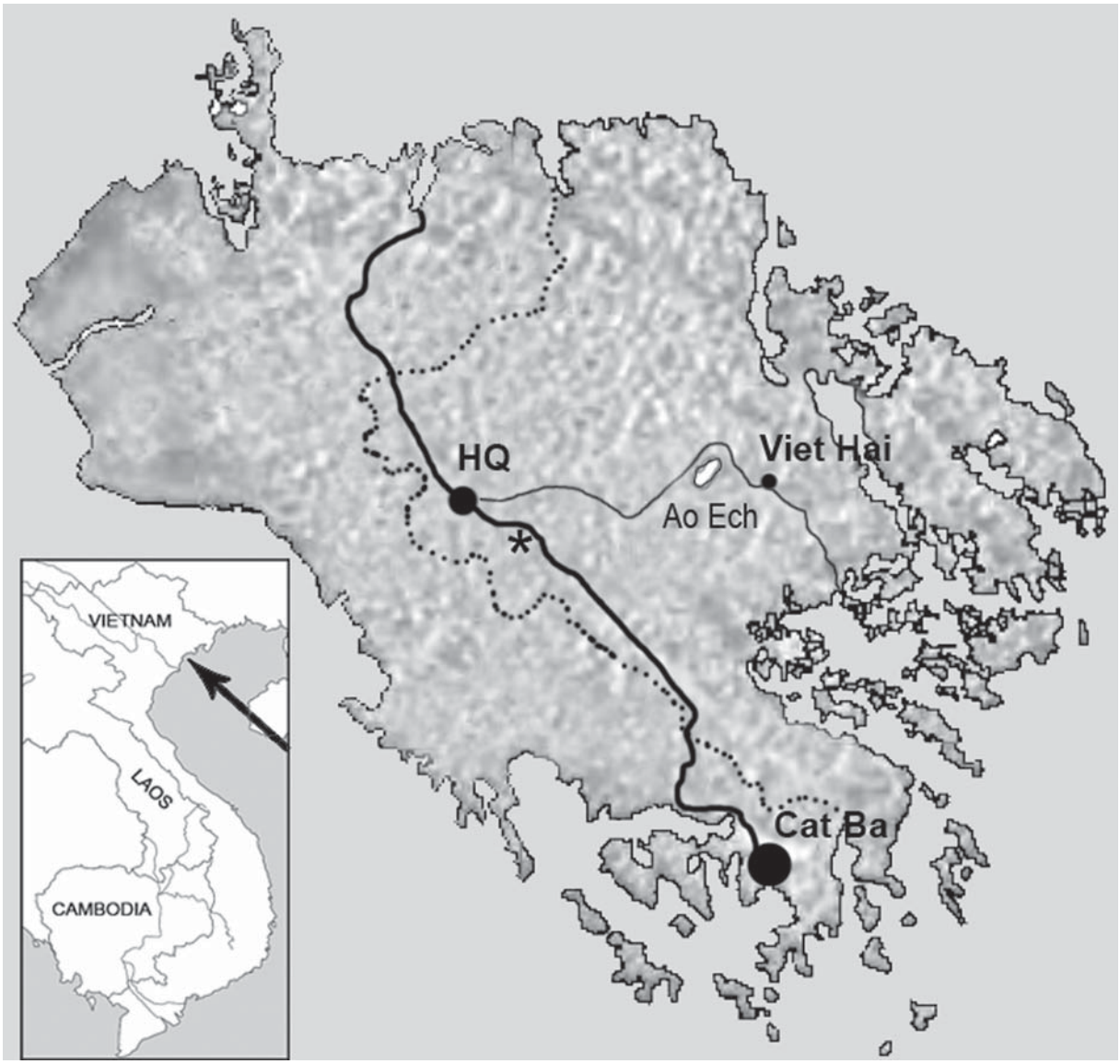

Figure 1. Map of Cat Ba Island. The border of the Cat Ba National Park shown in dots. The solid bold line is the vehicle road, the solid thin line is the main tourist trail from the National Park Headquarters (HQ) to Viet Hai Village. The location of the Trung Trang cave indicated by asterisk.

ested hills, small freshwater lakes, freshwater swamp forest, mangroves, sandy beaches and coral reefs. The main natural vegetation type on Cat Ba Island is tropical moist forest on limestone karst, however, large areas replaced now by limestone scrub or bare rocks.

Several zoological surveys were conducted in the Cat Ba National Park by Vietnamese and overseas scientists during the past two decades. Mammal surveys were mainly focused on the critically endangered Cat Ba langur *Trachypithecus poliocephalus poliocephalus* which is endemic to the island (Ratajszczak *et al*., 1990; Le Xuan Canh & Campbell, 1994; Duckworth & Walston, 1998; Nadler & Ha Thang Long, 2000; Nadler *et al*., 2003). Another mammalian target group of most field surveys in Cat Ba is bats (Duckworth & Walston, 1998; Furey *et al*., 2002; Vu Dinh Thong, 2008; Vu Dinh Thong & Furey, 2008). Despite several previous surveys concerning the fauna of Cat Ba National Park, a comprehensive investigation of mammal species extant on the island has yet to be conducted.

A short biodiversity survey in Cat Ba National Park was carried out in October 2011 by the Joint Vietnam-Russian Tropical Research and Technological Centre. This paper presents a result of our mammalian survey including an annotated list of species extant on Cat Ba Island.

Material and methods

Fieldworks were conducted in the central part of Cat Ba Island from 10 to 25 October, 2011. The base camp was located near the National Park Headquarters (20°48′N, 106°59′E). Different biotopes occurring in the radius of one to five km of the base camp were surveyed. Most of trapping lines and excursions were along the main tourist trail to the Viet Hai Village from the National Park Headquarters (Fig. 1).

The mammal fauna of the National Park was assessed by a combination of field observations, indirect observations (tracks, feces, vocalizations), camera trapping, and bat and non-volant small mammals trapping.

Different types of traps were used as follows: (1) large (11×11×25 cm) cage live-traps, each with a bait of a foam-rubber piece saturated with vegetable oil to be replaced every 2–3 days; (2) pitfall traps, i.e. plastic glasses (13×9 cm), buried flush with the ground surface. In total of 370 trap-nights were conducted for the live-traps and 650 trap-nights for the pitfall traps.

Bat observations were conducted visually with the help of electric lanterns, and acoustically by the use of narrow-band heterodyne ultrasound detector with frequency deviation function D230 (Pettersson Elektronik AB, Sweden). Most observations were held in the thirst half of night time, from the sunset till the 22^{00}–23^{30} PM. For capturing alive bats standard technique of crossing bat flying paths by the nylon mist-nets (size 10×4 m) was used (Kunz *et al*., 1996; Borissenko & Kruskop, 2003) together with the hand net or flap-trap (Borissenko, 1999).

The digital scouting camera (Bushnell® Trophy Cam™) with passive infra-red (PIR) motion sensor was used. The total camera trapping effort was 15 camera-trapping nights.

Night and morning-time excursions, covering the vicinity of the National Park Headquarters and eastern part of the main tourist trail, were conducted mainly for bat studies, but during them wild carnivores were also observed. Some records of nocturnal wild mammals were made during the similar excursions by other members of the research team, first of all by herpetologists, Dr. N.A. Poyarkov and Dr. E.A. Galoyan.

The standard external body measurements (head and body length, tail length, hind foot length, ear length) were taken. For bats, the forearm and tibia lengths were also measured. Weight was taken in grams. Voucher specimens of each species (except squirrel) were taken for confirmation of the record and further comparison with museum collections because of impossibility of clear identification of most species in the field. Most specimens were preserved in 75% ethanol. Tissue samples for genetic studies were taken from fresh specimens or from wing membranes of alive bats and stored in 96% ethanol. Except for voucher specimens, all trapped mammals were released. Voucher specimens were cataloged and studied at the Zoological Institute Russian Academy of Sciences (Saint-Petersburg, Russia) and Zoological Museum, Moscow State University (Moscow, Russia).

Results

We confirmed present occurrence of at least 25 mammal species on the Cat Ba Island, representing six mammalian orders, based on visual and acoustic records, and 84 specimens were captured and studied in hands. Two species were recorded on Cat Ba Island for the first time. We discuss also published records of some other species. The annotated list of mammals of Cat Ba Island is provided in Table 1. The following accounts provide morphological characteristics of species and relevant taxonomic notes along with natural history information for each species collected. The nomenclature of mammals used here follows Wilson & Reeder (2005) unless otherwise stated.

Table 1. List of the mammal species recorded from the Cat Ba Island.

No.	Species	This survey		Literature sources	Comments
		Observations	Captured specimens		
1	*Tupaia belangeri*		+		First record for Cat Ba
2	*Crocidura attenuata*		+		First record for Cat Ba
3	*Mus* cf. *caroli*		+	Kuznetsov & Pham Trong Anh, 1992; Kuznetzov, 2000	
4	*Rattus tanezumi*		+	Furey *et al*., 2002	
5	*Leopoldamys edwardsi*		+	Furey *et al*., 2002	
6	*Tamiops maritimus*	+		Duckworth & Walston, 1998; Nadler & Ha Thang Long, 2000; Furey *et al*., 2002	
7	*Callosciurus erythraeus*		+	Duckworth & Walston, 1998; Nadler & Ha Thang Long, 2000; Furey *et al*., 2002	

Table 1 (continued).

No.	Species	This survey		Literature sources	Comments
		Observations	Captured specimens		
8	*Ratufa bicolor*	+		Duckworth & Walston, 1998; Nadler & Ha Thang Long, 2000	
9	*Hystrix brachyura*			Nadler & Ha Thang Long, 2000	Not seen
10	*Paradoxurus hermaphroditus*	+		Nadler & Ha Thang Long, 2000	
11	*Melogale moschata*	+		Nadler & Ha Thang Long, 2000	
12	*Prionailurus bengalensis*	+		Nadler & Ha Thang Long, 2000	
13	*Sus scrofa*			Nadler & Ha Thang Long, 2000	Not seen
14	*Muntiacus muntjak*	+		Nadler & Ha Thang Long, 2000	
15	*Capricornis milneedwardsii*			Ratajszczak *et al*., 1990; Duckworth & Walston, 1998; Nadler & Ha Thang Long, 2000	Not seen
16	*Macaca mulatta*			Ratajszczak *et al*., 1990; Duckworth & Walston, 1998; Nadler & Ha Thang Long, 2000; Furey *et al*.,2002	Not seen
17	*Trachypithecus poliocephalus*			Duckworth & Walston, 1998; Nadler & Ha Thang Long, 2000	Not seen
18	*Cynopterus sphinx*	+		Vu Dinh Thong, 2008; Vu Dinh Thong & Furey, 2008	
19	*Rousettus amplexicaudatus*	+		Vu Dinh Thong, 2008	
20	*Rhinolophus marshalli*		+	Vu Dinh Thong, 2008; Vu Dinh Thong & Furey, 2008	
21	*Rhinolophus macrotis*			Vu Dinh Thong, 2008	Not seen, possibly misidentification
22	*Rhinolophus pearsonii*		+	Vu Dinh Thong, 2008; Vu Dinh Thong & Furey, 2008	
23	*Rhinolophus* cf. *pusillus*		+	Vu Dinh Thong, 2008; Vu Dinh Thong & Furey, 2008	Taxonomic status needs further studies
24	*Rhinolophus* cf. *subbadius*		+		Identification needs confirmation
25	*Rhinolophus affinis*			Vu Dinh Thong, 2008; Vu Dinh Thong & Furey, 2008	Not seen
26	*Hipposideros larvatus*		+	Vu Dinh Thong, 2008; Vu Dinh Thong & Furey, 2008	
27	*Hipposideros armiger*	+		Vu Dinh Thong, 2008; Vu Dinh Thong *et al*., 2012	
28	*Hipposideros griffini*			Vu Dinh Thong *et al*., 2012	Not seen
29	*Hipposideros turpis alongensis*		+	Vu Dinh Thong & Furey, 2008	
30	*Hipposideros pomona*		+	Vu Dinh Thong & Furey, 2008	
31	*Hipposideros khaokhouayensis*		+	Vu Dinh Thong *et al.*, 2008; Vu Dinh Thong & Furey, 2008	

Table 1 (continued).

No.	Species	This survey		Literature sources	Comments
		Observations	Captured specimens		
32	*Aselliscus stoliczkanus*		+	Vu Dinh Thong, 2008; Vu Dinh Thong & Furey, 2008	
33	*Coelops frithii*			Vu Dinh Thong, 2008; Vu Dinh Thong & Furey, 2008	Not seen
34	*Taphozous melanopogon*			Dang Ngoc Can *et al*., 2008	Not seen
35	*Myotis siligorensis*		+	Vu Dinh Thong, 2008; Vu Dinh Thong & Furey, 2008	
36	*Myotis muricola*			Vu Dinh Thong, 2008; Vu Dinh Thong & Furey, 2008	Not seen
37	*Murina cyclotis*			Vu Dinh Thong, 2008; Vu Dinh Thong & Furey, 2008	Not seen
38	*Murina tiensa*			Vu Dinh Thong, 2008;Vu Dinh Thong *et al.*, 2011;	Not seen
39	*Harpiocephalus harpia*			Vu Dinh Thong, 2008; Vu Dinh Thong & Furey, 2008	Not seen
40	*Scotophilus heathi*			Vu Dinh Thong, 2008; Vu Dinh Thong & Furey, 2008	Not seen
41	*Scotophilus kuhli*			Vu Dinh Thong, 2008; Vu Dinh Thong & Furey, 2008	Not seen
42	*Pipistrellus abramus*			Vu Dinh Thong, 2008; Vu Dinh Thong & Furey, 2008	Not seen
43	*Pipistrellus javanicus*			Vu Dinh Thong, 2008; Vu Dinh Thong & Furey, 2008	Not seen
44	*Pipistrellus tenuis*			Vu Dinh Thong, 2008; Vu Dinh Thong & Furey, 2008	Not seen
45	*Hypsugo pulveratus*			Vu Dinh Thong, 2008; Vu Dinh Thong & Furey, 2008	Not seen
46	*Miniopterus* cf. *fuliginosus*			Vu Dinh Thong, 2008; Vu Dinh Thong & Furey, 2008	Not seen

ORDER SCANDENTIA

Family TUPAIIDAE

Tupaia belangeri (Wagner, 1841)

The northern tree-shrew is common species distributed throughout of Vietnam (Dang Ngoc Can *et al*., 2008). We collected four animals during our survey (Fig. 2). This species was not recorded during the previous mammal surveys on Cat Ba Island (Nadler & Ha Thang Long, 2000; Furey *et al*., 2002).

Figure 2. *Tupaia belangeri*. Photographed by Alexei V. Abramov.

ORDER SORICOMORPHA

Family SORICIDAE

Crocidura attenuata Milne-Edwards, 1872

Gray shrew *Crocidura attenuata* is a widespread and common Southeast Asian species of white-toothed shrews. Most of authors (Hutterer, 2005; Kuznetsov, 2006; Dang Ngoc Can *et al*., 2008; Jenkins *et al*., 2009) suggest a wide geographic distribution of this species in Vietnam. However recent study of mitochondrial DNA (Bannikova *et al*., 2011) restricted the distribution of *C. attenuata* proper to northernmost part of Vietnam (to the north and east of the Red River). It is replaced by *C. tanakae* elsewhere in mainland Vietnam. We collected seven specimens of middle-sized *Crocidura* (Fig. 3) during our survey. Preliminary data of mitochondrial DNA analysis have confirmed they belong to *C. attenuata* proper (unpublished data of Abramov, Bannikova and Rozhnov). This species was not found in Cat Ba Island previously.

All specimens of *C. attenuata* were caught in pitfall line in mixed forest near limestone bare rocks.

ORDER CHIROPTERA

This order on Cat Ba seem to be most well-studied amongst all mammalian orders because of study efforts of the Institute of Ecology and Biological Resources,

Figure 3. *Crocidura attenuata*. Photographed by Alexei V. Abramov.

Vietnamese Academy of Sciences (with the help of some other institutions) held in 2006–2007. Unpublished scientific report (Vu Dinh Thong, 2008) listed up to 27 bat species in the insular fauna, though records of only 25 were later published (Vu Dinh Thong & Furey, 2008; Vu Dinh Thong *et al*., 2011; Vu Dinh Thong *et al*., 2012). One additional species, *Taphosous melanopogon*, was listed on uncertain grounds by Dang Ngoc Can *et al.* (2008). However neither this species nor any other Emballonuridae were reported from Cat Ba Island by other authors.

Family PTEROPODIDAE

Cynopterus sphinx (Vahl, 1797) and *Rousettus amplexicaudatus* (E. Geoffroy, 1810)

No fruit bats were studied in hands. However, since there are only two pteropodids were reported to Cat Ba Island (Vu Dinh Thong, 2008), it was easy to distinguish them in the wild by color of eyes (orange or yellow in *Cynopterus* and cold blue or bluish-green in *Rousettus*, as they seen in the torch light) and by audible clicking calls emitted by *Rousettus*.

Cynopterus was only once seen over the road in the late evening nearby the National Park Headquarters. *Rousettus* bats were several times observed over the forest road. Animals were flying and probably foraging on the level of canopies, at about 10 to 15 m above the ground. At least twice several bats were observed simultaneously, probably concentrating on their feeding territory. The same species was once recorded in the secondary growth nearby the National Park Headquarters and once in the vicinity of Trung Trang cave. It looks like that the *R. amplexicaudatus* is more common fruit bat species on the island than *Cynopterus sphinx*. This contradicts to the situation on the mainland where *Cynopterus sphinx* is usually the most common fruit bat species.

Family HIPPOSIDERIDAE

Hipposideros armiger (Hodgson, 1835)

This bat species, one of the largest Asian members of *Hipposideros*, is widely distributed throughout southern Asia and Vietnam (Borissenko & Kruskop, 2003; Dang Ngoc Can *et al*., 2008; Francis, 2008), inhabiting wide variety of biotopes, though probably preferring rocky landscapes with variable caverns.

No animals were studied in hands. One individual was observed drinking from the artificial pool in the early dusk, when the animal was well-seen in details. Echolocation signal loud, CF ca. 62 kHz. One to three individuals were for several evening observed foraging nearby two streetlamps in front of the National Park Headquarters. Animals flew at about 1.5 to 7 m above the ground, sometimes sliding on spread wings. Being frightened they moved to the office building and sometimes entered to its second flour, suggesting that they use this building as a roost. This species was not observed during our survey either visually or acoustically in any of natural habitats.

There is another closely related form, *H. griffini*, occurring on Cat Ba sympatrically with *H. armiger* (Vu Ding Thong *et al*., 2012). According to frequencies of echolocation calls, we did not observe the newly described species but "typical" *H. armiger*.

Hipposideros turpis alongensis Bourett, 1942

This bat was originally described and for a long time treated as a subspecies of *H. larvatus* s. lato (Corbet & Hill, 1992; Koopman, 1994; Kruskop, 2003). Than they were separated because of coexistence of both forms in Ha Long Bay and the form *alongensis* was transferred to *H. turpis* on the grounds of larger size (Topal, 1993). However, Cat Ba Island specimens are somewhat distinct from typical *H. turpis* inhabiting Ryukyu Island in pelage coloration (golden-brown in *alongensis*, and more dark in *turpis* s. str.) and shape of posterior leaf, which is slightly wider than the intermediate one in *alongensis* and narrower in *turpis* s. str. (Yoshiyuki, 1989). Thus there is a great possibility that the Ha Long form does not belong to *H. turpis* but to Thai species *H. pendleburyi* (Borissenko & Kruskop, 2003) or represents distinct species.

Three males and one female were studied in hands and measured. All three were mist-netted nearby the northern entrance of the Trung Trang cave (Fig. 4). Colony of that species counting about 130–150 individuals was found inside this cave. Most of animals use doom-shaped cavern on the grotto ceiling, at about 10-12 m from the floor, though some individuals probably roost in other parts of the grotto. Animals emerge from the roost just after sunset but later part of them return and after ca. 20^{00} PM 15–20 bats were seen in the roost simultaneously. Detected echolocation call is loud, CF about 78 kHz.

Hipposideros larvatus (Horsfield, 1823)

This bat is thought to be one of the most widespread in Southeast Asia (Corbet & Hill, 1992). However there

Figure 4. Entrance grotto of the Trung Trang cave, which houses colony of *Hipposideros turpis* and small groups of *Myotis siligorensis* and *Hipposideros pomona*.

are strong evidences that actually it represents more than one species (Thabah *et al*., 2006). Number of these species and their interrelations are uncertain (Francis *et al*., 2010). Specimens from the north of Vietnam may be provisionally assigned with the Chinese subspecies *H. l. poutensis* Allen, 1906 though this needs further investigation.

Three males were studied in hands. One was captured on the edge of the vehicle road nearby the secondary arboreal growth. Second was hand-netted while foraging around the streetlamps near the National Park Headquarters. And the third one was captured over the main tourist trail on the edge between forest and flooded open place. All observed animals demonstrate powerful, swift and meantime relatively maneuverable flight. Probably on Cat Ba Island they mainly forage in disturbed and secondary formations with medium-cluttered space. Echolocation signals are loud, CF detectible at 93–103 kHz. Main echolocation frequency is probably 98–99 kHz, which is similar to *H. grandis* from southern Vietnam. However, specimens from Cat Ba Island obviously differ from *H. grandis* in size and pelage coloration and in that features better correspond to "typical" *H. larvatus*.

Hipposideros pomona Andersen, 1918

This bat is widespread in Vietnam, inhabiting variety of forest biotopes (Borissenko & Kruskop, 2003; Dang Ngoc Can *et al*., 2008). However, according to available genetic data, it possibly represents a complex of related species which not oblige to be identical in their ecological preferences (Francis *et al*., 2010).

Three males and one female were studied in hands. One was captured inside the entrance grotto of the Trung Trang Cave where a small colony of this species probably occurs. Another one was netted in the forest nearby that cave, and two other were captured over the road surrounded by secondary growth in vicinity of the National Park Headquarters. Detected echolocations calls, CF ca. 118–119 kHz.

Hipposideros khaokhouayensis Guillen-Servent et Francis, 2006

This bat was only few years ago described from central Laos and Cat Ba Island is still the only known place where this species occurs outside its terra typica (Guillen-Servent & Francis, 2006; Vu Dinh Thong *et al*., 2008).

We few times recorded this bat by its echolocation call (CF 94.3 kHz) but we were not sure in the correct identification. The single individual was captured on Cat Ba Island previously and the published data contains some controversies on exact locality and biotope. However, eventually one adult female was captured near the streetlamp in the Headquarters (Fig. 5). Flight

Figure 5. *Hipposideros khaokhouaensis*. Photographed by Sergei V. Kruskop.

Figure 6. Two morphotypes of pygmy horseshoe bats: *Rhinolophus* cf. *pusillus* (A) and *R*. cf. *subbadius* (B). Photographed by Sergei V. Kruskop.

of this bat is not fast but very maneuverable. Mentioned individual was seen collecting insects directly from the lamp cover, moving extremely close to the lamp and neighboring vegetation. According to calls and observations, solitary animals of this species visited Trung Trang Cave but probably not roosted in that.

Aselliscus stoliczkanus (Dobson, 1871)

This bat has sporadic distribution in northern and central Vietnam and in general seems to be uncommon species (Borissenko & Kruskop, 2003; Dang Ngoc Can *et al*., 2008).

Four males and four females were studied in hands and measured. Most of them were captured over the road on the edge of agricultural landscape and secondary growth. Only one individual was netted over the road inside forest. These data suggest that this relatively fast-flying bat prefers semi-open areas but can forage also along the forest roads.

Family RHINOLOPHIDAE

Rhinolophus pearsonii Horsfield, 1851

This bat has sporadic distribution in northern and central Vietnam and thought to be affiliated with primary forests on limestone outcrops (Dang Ngoc Can *et al*., 2008; Borissenko & Kruskop, 2003).

On Cat Ba Island during the survey this bat was the most common and abundant. Ten adult individuals were studied in hands (equal number of males and females). Besides that, Pearson's horseshoe bats were regularly seen foraging over roads and trails, surrounded by arboreal growth (primary or secondary) or perching on dry tree brunches (usually at about two m over the ground). Presence of individual territories can be expected from our observations and their size is estimated as 50–60 m in diameter, though few times two individuals were observed foraging in the same place. This species was also observed foraging near the streetlamps in front of the National Park Headquarters, obviously demonstrating ability to catch insects in flight and without using perch. Detected echolocation signals loud, CF at ca. 58 kHz, but also audible at 52 kHz (additional harmonics?).

Rhinolophus marshalli Thonglongya, 1973

This bat has a sporadic distribution in Southeast Asia, including northern Vietnam (Corbet & Hill, 1992; Dang Ngoc Can *et al*., 2008). Although this species is likely common on Cat Ba Island, little information is available about its natural history.

Two adult males and one female were studied in hands. Two males were captured over the road surrounded by secondary growth nearby the National Park Headquarters. Animals foraged over the grass aside road and in the plantations between the tree trunks. Flight is not fast, maneuverable, somewhat flattering. Echolocation signal CF at about 45 kHz. Female was captured over the road inside the forest. All observations and captures of this species were made deep in the night, three or four hours after sunset.

Rhinolophus cf. *pusillus* Temminck, 1834 and *R.* cf. *subbadius* Blyth, 1844

Taxonomy of pygmy horseshoe bats from the "*pusillus*" species complex is problematic. Number of valid forms and their accurate distribution limits are uncertain and genetic data and identification keys are somewhat controversial (Borissenko & Kruskop, 2003; Csorba *et al*., 2003; Wilson, 2008; Francis *et al*., 2010). Pygmy horseshoe bat is currently known for Cat Ba Island as *R. pusillus* (Vu Dinh Thong & Furey, 2008). During our study we found that there are two morpho-

logical types of these bats on Cat Ba Island, differ primarily in the shape of connecting process. Two studied specimens (adult males) resemble *R. pusillus* in possessing a triangular upright connecting process, and three others have very narrow and somewhat bent forward connecting processes (Fig. 6). The latter morphology is treated as a diagnostic feature for *R. subbadius* and two Japanese species: *R. cornutus* and *R. imaizumii* (Csorba *et al*., 2003; Wilson, 2008). Position of the lower small (anterior) premolar in all five specimens resembles that of *R. pusillus*: it is definitely in the toothrow, and the canine is well divided from the posterior premolar. The size of the four specimens fit both *R. pusillus* and *R. subbadius* (as stated by Csorba *et al*., 2003), while the fifth one is smaller than it was reported for both species. Also, specimens of the "*pusillus*" morphotype are somewhat different from available *R. pusillus* individuals from southern Vietnam in fur and mask coloration and in slightly longer ears. Until the molecular studies and more deep comparison with the collection material, we supposed the mention both forms of the pygmy horseshoe bats from Cat Ba with the open nomenclature.

Two bats of the "*pusillus*" morphotype were hand-netted in the late evening in light forest south from the National Park Headquarters. Animals flew maneuverable over the grass, mainly very close to ground, at about 0.3–1.5 m from it. Two males of the "*subbadius*" morphotype were hand-netted in front of the Trung Trang Cave and the third one — on the main tourist trail, on the edge between forest and partly flooded open area. Probably this species is a cave-dweller. Flight manner of the latter mentioned individual differs from that of *R. pusillus*; animal foraged over the tall grass and trail at about 2–3 m above the ground.

Family VESPERTILIONIDAE

Myotis siligorensis (Horsfield, 1855)

This bat with wide but sporadic distribution is insufficiently studied in Vietnam. On Cat Ba Island during the period of our survey it was surprisingly the most common vespertilionid species.

Seven males and two females were studied in hands. *M. siligorensis* was detected in almost all observed biotopes, including primary forest, secondary growth and open areas. These bats were seen foraging over trails surrounded by different arboreal vegetation as well as over the main vehicle road nearby the Park Headquarters. Flight pattern is typical to most of "small-footed" *Myotis*. Echolocations call steep FM, detectable in wide range of frequencies, from ca. 35 to 95 kHz. We also found *M. siligorensis* in the entrance grotto of the Trung Trang cave, where small group of these bats roosted in a wall cavern at about 6 m above the flour.

ORDER RODENTIA

Family MURIDAE

Mus cf. *caroli* Bonhote, 1902

The species widely distributed in southern Asia. It occurs in many regions of Vietnam and inhabits fields and other agricultural areas (Lunde & Nguyen Truong Son, 2001; Dang Ngoc Can *et al*., 2008).

Figure 7. *Rattus tanezumi.* Photographed by Alexei V. Abramov.

One specimen was caught in pitfall trap located in the mixed forest. This species listed previously for Cat Ba Island without detailed information (Kuznetsov & Pham Trong Anh, 1992; Kuznetzov, 2000).

Rattus tanezumi Temminck, 1844

Taxonomy of the genus *Rattus* remains controversial and questionable. Musser & Carleton (1993, 2005) assign many taxa of the so-called "Asian type" of the "*Rattus rattus*" group to the species *Rattus tanezumi*. We follow this opinion here. According to the recent data *Rattus tanezumi* is widespread in Vietnam (Lunde & Nguyen Truong Son, 2001; Dang Ngoc Can *et al*., 2008).

Furey *et al*. (2002) reported one specimen of *Rattus sladeni* collected during their survey in 1999 near the National Park Headquarters in *Podocarpus fleuryi* forest. Musser & Carleton (1993, 2005) consider *sladeni* as synonym of *Rattus tanezumi*.

We caught one specimen (Fig. 7) in forest habitat near the small stream. Skull of another specimen was collected by A. Shchinov in December 2011 in open grassy area near western end of the main tourist trail. Three young specimens were collected around houses near the base camp.

Leopoldamys edwardsi (Thomas, 1882)

Rats of the genus *Leopoldamys* are widely distributed in Vietnam; they are common terrestrial rats of lowland and montane forests (Dang Huy Huynh *et al*., 1994; Lunde & Nguyen Truong Son, 2001; Dang Ngoc Can *et al*., 2008). This group requires taxonomic revision (Lunde & Nguyen Truong Son, 2001; Musser & Carleton, 2005). Some authors (Lunde & Nguyen Truong Son, 2001) believed that two species (*L. sa-*

Figure 8. *Leopoldamys edwardsi.* Photographed by Alexei V. Abramov.

banus and *L. edwardsi*) occur in Vietnam whereas other researchers include up to four species (*L. sabanus*, *L. edwardsi*, *L. neilli*, *L. milleti*) in Vietnam fauna (Musser & Carleton, 2005; Dang Ngoc Can *et al*., 2008).

This rat is common in the studied area. We collect 22 specimens in different sites. Also it was most abundant rodent species during the Frontier-Vietnam field survey in 1999 when 13 specimens were caught over the course of 200 trap-nights (Furey *et al*., 2002).

Cat Ba specimens (Fig. 8) differ from *L. edwardsi* occurring in mainland Vietnam being smaller with relatively long tails.

Family SCIURIDAE

Tamiops maritimus (Bonhote, 1900)

The maritime striped squirrel occurs at many provinces of Vietnam (Dang Ngoc Can *et al*., 2008). We did not collect this species but the striped squirrels were commonly observed in all studied areas in the central part of island. This species was also mentioned in previous reports (Duckworth & Walston, 1998; Nadler & Ha Thang Long, 2000; Furey *et al*., 2002).

Figure 9. *Callosciurus erythraeus.* Photographed by Alexei V. Abramov.

Callosciurus erythraeus (Pallas, 1779)

The Pallas's squirrel is widely distributed in Vietnam (Dang Huy Huynh *et al*., 1994; Dang Ngoc Can *et al*., 2008). This is a common squirrel species in Cat Ba National Park. We caught one specimen in cage live-trap set on the tree branch in mixed forest. Cat Ba Island squirrels have olivaceous-gray dorsum and deep reddish-brown ventrum (Fig. 9). Tail grizzled olivaceous-brown with silver guard hairs toward the tip. This species was also recorded during previous surveys (Duckworth & Walston, 1998; Nadler & Ha Thang Long, 2000; Furey *et al*., 2002).

Ratufa bicolor (Sparrman, 1778)

This widespread Asian species is distributed throughout Vietnam (Lunde & Nguyen Truong Son, 2001; Dang Ngoc Can *et al*., 2008). Some authors reported the black giant squirrel is abundant and occurs widely across Cat Ba Island, in pockets of forest on steep karst and in heavily degraded forest on flatter areas (Duckworth & Walston, 1998; Nadler & Ha Thang Long, 2000).

We observed and heard vocalization of this species just few times during our survey. Furey *et al*. (2002) did not mention the *Ratufa* in their report at all. It seems that the population of this species is declining steeply on Cat Ba Island during last decade. This species is especially vulnerable to hunting pressure and habitat disruption, in many areas of Indochina its status is closely similar to that of diurnal primates (Duckworth & Walston, 1998; Walston *et al*., 2008).

Family HISTRICIDAE

Hystrix brachyura Linnaeus, 1758

Baker (1999; cited after Nadler & Ha Thang Long, 2000) mentioned decayed specimen of short-tailed, or Malayan, porcupine *Hystrix brachiura* and found quills of this species. The same species was seen at a restaurant in November 1999, and quills were also collected at another site in December 1999 (Nadler & Ha Thang Long, 2000). Timko (2001) mentioned *Hystrix brachiura* as hunting object for local people on Cat Ba Island.

Figure 10. Small perennial Ao Ech Lake in central part of Cat Ba. Photographed by Sergei V. Kruskop.

We did not record any signs of this species during our survey.

ORDER CARNIVORA
Family VIVERRIDAE
Paradoxurus hermaphroditus (Pallas, 1777)

A single specimen of common palm civet was observed by E. Galoyan during night survey near Ao Ech Lake at 17 October 2011. The footprints and feces which probably belong to palm civet were found a few times near western and central part of the main tourist trail.

Nadler & Ha Thang Long (2000) supposed the occurrence of this species on Cat Ba Island based on the information from local hunters.

Viverricula indica Geoffroy Saint-Hilaire, 1803

The occurrence of this species on Cat Ba Island is questionable. G. Kuznetsov listed this species for Cat Ba Island, however does not provide any details of this record (Kuznetsov & Pham Trong Anh, 1992; Kuznetsov, 2000). Nadler & Ha Thang Long (2000) saw one skin of this species during their survey in 1999–2000, but origin of this skin is unknown.

Family MUSTELIDAE
Melogale moschata (Gray, 1831)

The ferret-badger was twice observed during night excursions in the western part of the main tourist trail at 13 and 18 October 2011. Another animal was twice recorded by camera trap in limestone bare rocks. The camera trap photographs were took at 19 and 20 October 2011 in 10^{35} PM and 02^{35} AM accordingly. Nadler & Ha Thang Long (2000) saw one stuffed specimen in a house on Cat Ba Island in 1999.

Two species of ferret-badgers known in Southeast Asia and also in Vietnam: *Melogale moschata* and *M. personata* (Wozencraft, 2005; Dang Huy Huynh *et al*., 1994; Dang Ngoc Can *et al*., 2008). Due to the external morphological similarity between all *Melogale* species, the field observations or records from camera trap photographs cannot be correctly identified to species. Analysis of available museum specimens (Abramov, in prep.) allowed to specify the distribution of *M. moschata* and *M. personata* in Vietnam. We preliminary attribute the Cat Ba Island records to the Chinese, or small-toothed, ferret-badger *M. moschata* due the close geographic distribution of the latter.

There are no any documented records for other mustelid species in the Cat Ba National Park. As an only exception, Duckworth & Walston (1998) mentioned a specimen of otter collected at Ao Ech Lake in 1979 and is now held in the Hai Phong Museum (it based on information from Nguyen Cu, verbally 1998). There are no other records of otter species. It is difficult to imagine that small and shallow Ao Ech Lake (Fig. 10) can provide enough resources to support permanent occurrence of otter population.

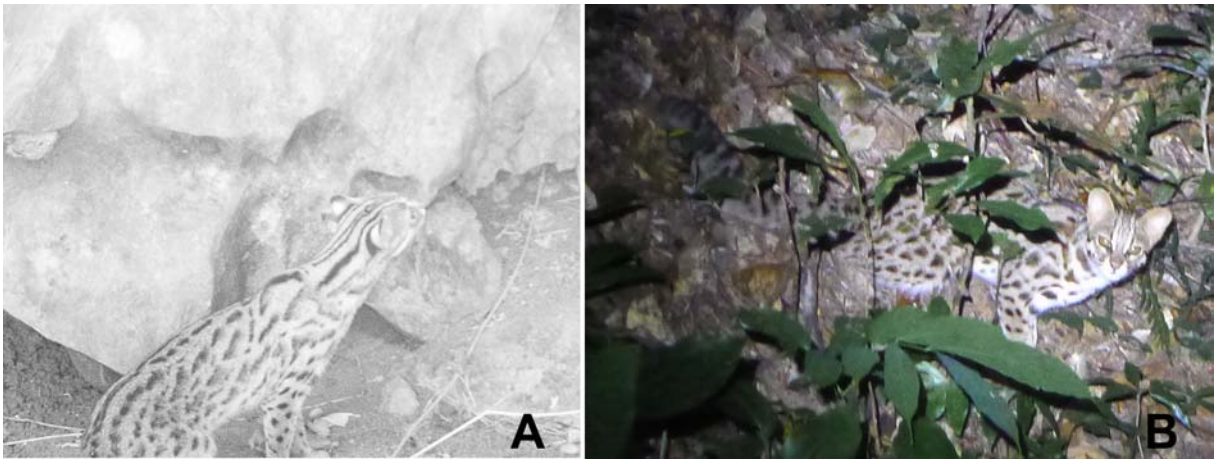

Figure 11. *Prionailurus bengalensis*. A — photo from camera-trap, B — photo taken during night excursion (photographed by Alexei V. Abramov).

Family FELIDAE

Prionailurus bengalensis (Kerr, 1792)

This species is common in the National Park. According to Nadler & Ha Thang Long (2000) this species is regularly trapped on Cat Ba by hunters, and authors saw stuffed specimens and skin in villages. We often observed the leopard cats (Fig. 11A) during night excursions along the main tourist trail from western part of trail to Ao Ech Lake. One specimen was recorded by camera trap (Fig. 11B) in limestone bare rocks in western part of the trail at 13^{08} PM, 23 October 2011.

Duckworth & Walston (1998) preliminary identified a large scat found in an open grassy area near Ao Ech Lake in April 1998 as Asian golden cat *Catopuma temminckii* or fishing cat *Prionailurus viverrinus*. Timko (2001) mentioned the local people including park rangers know two wildcats known locally as "meo rung" (*Prionailurus bengalensis*) and "beo lua" (*Catopuma temminckii*). However there are no any reliable evidences for recent occurrence of second wildcat species on the island.

ORDER ARTIODACTYLA

Family SUIDAE

Sus scrofa Linnaeus, 1758

Nadler & Ha Thang Long (2000) found signs in valleys and around Ao Ech Lake. Authors also mentioned occasional sightings and signs of wild pigs were recorded on island during other biodiversity surveys and visits before (Nadler & Ha Thang Long, 2000: 43).

We did not record any signs of this species during our survey.

Family CERVIDAE

Muntiacus muntjak (Zimmermann, 1780)

The typical barking of this deer was recorded at 11 October 2011 in forest westward of Ao Ech Lake. No signs or feces were found.

Nadler & Ha Thang Long (2000: 43) mentioned the information on the barking deer received during their survey (1999–2000) was scanty and not reliable, and this species is possible extinct. However our acoustical record contradicts the last assertion. Most of karst valleys on Cat Ba Island are very difficult to access for people and significant area of the island can not be studied during brief fieldwork. Nevertheless, in any case insular population of the barking deer can not be large.

Family BOVIDAE

Capricornis milneedwardsii David, 1869

The Chinese serow known from Indochina (including Vietnam) was formerly considered as *Capricornis sumatraensis* (Dang Huy Huynh *et al*., 1994; Corbet & Hill, 1992; Kuznetsov, 2006). Recently, Grubb (2005) raised *milneedwardsii* to the status of full species.

The Chinese serow (under the names *Naemorhedus sumatraensis* or *Capricornis sumatraensis*) was recorded for the Cat Ba Island (Ratajszczak *et al*., 1990; Duckworth & Walston, 1998). Nadler & Ha Thang Long (2000) mentioned that this species is abundant on the island.

We did not saw any spoor of serow in studied area and no recent detailed first hand sighting was traced. According to the information from locals and park rangers this species is quite rare and mainly restricted to karst rocks and coastal cliff in northern part of the island.

ORDER PRIMATES

Family CERCOPITHECIDAE

Macaca mulatta (Zimmermann, 1780)

The occurrence of Rhesus macaque in Cat Ba Island was reported by many researchers (Ratajszczak *et al*., 1990; Duckworth & Walston, 1998; Nadler & Ha Thang Long, 2000). Nguyen Phien Ngung (1998; cited after Nadler & Ha Thang Long, 2000) notes a population of 372 *M. mulatta* on the island. Furey *et al*. (2002) reported a single individual of Rhesus macaque observed in the region of Ao Ech Lake. No macaques were seen during our survey in this part of the park.

Duckworth & Walston (1998) point out stump-tailed macaque *Macaca arctoides* occurred on Cat Ba Island previously in the early 1960s. There are no other records of this species, and even if it occurred in the past, it is now locally extinct (Nadler & Ha Thang Long, 2000).

Trachypithecus poliocephalus Pousargues, 1898

This rare species is known only from Cat Ba Island in Vietnam and Guangxi Province in southern China (Groves, 2005). There are two subspecies, the golden-headed langur, or Cat Ba langur, *T. p. poliocephalus* and the white-headed langur *T. p. leucocephalus*. The Cat Ba langur is currently listed by the IUCN as one of the world's most endangered primate species. This is arguably considered the most outstanding conservation priority for the Cat Ba Island (Duckworth & Walston, 1998; Nadler & Ha Thang Long, 2000). Nowadays the population of this subspecies consists near 50 individuals in several isolated sub-populations on the island. Towards the end of 2000, the Zoological Society for the Conservation of Species and Populations and Münster Zoo (Germany) formed a cooperative partnership with Vietnamese conservation agencies, and the special "Cat Ba Langur Conservation Project" was initiated.

No langurs were seen during our survey.

Discussion

Trang Ngoc But (1995) listed only 20 mammal species for the Cat Ba National Park. Cao Vang Sung (1998) mentioned 28 species, and this list mainly based on published data of distribution ranges of species in Indochina. Some species mentioned there (*Macaca nemestrina*, *Panthera pardus*) certainly do not occur on Cat Ba Island. It is likely that some other published lists also based primarily upon the review of the previous literature (Kuznetsov & Pham Trong Anh, 1992; Le Xuan Canh *et al*., 1997). The first inventory mammal survey indicates that the National Park hosts at least 22 species of mammal, including the langur, 15 of which are bat species (Furey *et al*., 2002). The special bat surveys during the last decade reveal a species-rich bat community. This community counts 23 species according to Vu Dinh Thong & Furey (2008) and even more, up to 27 species, according to unpublished report by Vu Dinh Thong (2008).

Time of our study was obviously too short to uncover all the local bat community. However even in that short period we have revealed about half of the local bat fauna content, including one species previously not known on the island. This confirms a relatively high density and abundance of bats on Cat Ba Island. This result is concordant with the observation that limestone karst has high importance for tropical bat diversity (Furey *et al*., 2010).

Though there are forest bat species known in Cat Ba Island fauna (Vu Dinh Thong & Furey, 2008; Vu Dinh Thong *et al*., 2011), our survey demonstrate that the key feature for the core of local bat fauna is limestone karst. Only five species were observed directly inside the caves. However, most of species recorded during the study are known to be more or less connected with karst areas in their distribution (Bates & Harrison, 1997; Kruskop, 2000; Furey *et al*., 2010; Nguyen Truong Son *et al*., 2010). Noticeable that species which we previously tended to treat as "forest species", such as *Rhinolophus pearsonii*, occurs on Cat Ba Island not only in forest biotopes probably because of high abundance. This demonstrates that karst landscape itself is more important than the type of foraging biotope.

Results from small mammal trapping suggest that the non-volant species composition is poor. Totally we found only eight non-volant small mammals in the studied area. Two species (*Tupaia belangeri*, *Crocidura attenuata*) were confirmed for Cat Ba Island for the first time. Furthermore, given the brevity of the present survey, there is no doubt that further surveys can yield as yet unrecorded small mammal species for the island, particularly in terms of the bat and rodent fauna. Based on our survey and a comparative analysis of the available literature at least 46 mammal species recorded on Cat Ba Island (see Tab. 1). We are not listed here "questionable" species counted for Cat Ba Island in many checklists (Kuznetsov & Pham Trong Anh, 1992; Le Xuan Canh *et al*., 1997; Kuznetsov, 2000). Further evidence (i.e., photographs or specimens with locality data) is still needed for confirmation of their occurrence.

Cat Ba Island is a part of an extended region of Viet Bac Karst zone that stretches from southeastern China to northeastern Vietnam (Do Tuyet, 1998). Vietnam's northeastern karsts harbor high mammal diversity, including a number of endemic and rare species (Lunde *et al*., 2003; 2007; Musser *et al*., 2006; Dang Ngoc Can *et al*., 2008). In the Late Pleistocene – Holocene Cat Ba Island as well as other coastal islands of Vietnam was connected to the mainland during sea regressions (Korotky *et al*., 1995) that provide the routs for faunal dispersal. Cat Ba Island lies close to the mainland and its mammal fauna is similar to that of northeastern Vietnam, but has some peculiarities. Number of species of non-volant mammals on Cat Ba Island is less than that of the mainland supporting the historical-legacy hypothesis for terrestrial mammal distribution on coastal islands (Lawlor, 1986; Patterson & Atmar, 1986).

Coastal provinces of the North Vietnam are obviously insufficiently studied in connection to bats (Dang Ngoc Can *et al*., 2008), so it is hard to include them into faunal comparison. It is very possible that the same species resistant to human occurrence and especially synanthropic species, reported for Cat Ba Island (Vu Ding Thong & Furey, 2008), tentatively inhabit populated places in the coastal part of mainland. Some of them, capable to fly onto long distance, such as *Scotophilus* species and *Taphozous melanopogon* (the latter one is reported for Cat Ba Island by Dang Ngoc Can *et al*., 2008), may occur on the island as seasonal or occasional vagrants. However core of the local insular bat fauna is represented by species common for karst

areas of the northern Vietnam and southern China. These species include *Rhinolophus pearsoni*, *R. marshalli*, *Aselliscus stoliczkanus*, *Myotis siligorensis* and some other, whose populations were formed in the Late Pleistocene or Early Holocene and then divided from the main distribution ranges. *Hipposideros khaookhouaensis* and *Murina tiensa* with their sparse distribution (Vu Dinh Thong *et al*., 2008, 2011) tentatively represent cases of more ancient population splits, demonstrating faunal connections with the Central Indochinese mountainous areas. On the whole, Cat Ba Island bat fauna should be treated as relict faunal complex existing just because local peculiarities of the landscape and vegetation.

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References

Bannikova A.A., Abramov A.V., Borisenko A.V., Lebedev V.S., Rozhnov V.V. 2011. Mitochondrial diversity of the white-toothed shrews (Mammalia, Eulipotyphla, *Crocidura*) in Vietnam // Zootaxa. No.2812. P.1–20.

Borissenko A.V. 1999. [A mobile trap for capturing bats in flight] // Plecotus et al. Vol.2. P.10–19 [in Russian with English summary].

Borissenko A.V., Kruskop S.V. 2003. Bats of Vietnam and adjacent territories. An identification manual. Moscow: Geos. 203 p.

Cao Vang Sung (ed.). 1998. Environment and Bioresources of Vietnam – Present Situation and Solutions. Hanoi: The Gioi Publishers. 235 p.

Corbet G.B. & Hill J.E. 1992. The Mammals of the Indomalayan Region: A Systematic Review. Oxford: Oxford University Press. 488 p.

Csorba G., Ujhelyi P. & Thomas N. 2003. Horseshoe Bats of the World (Chiroptera: Rhinolophidae). Shropshire: Alana Books. 160 p.

Dang Huy Huynh, Dao Van Tien, Cao Van Sung, Pham Trong Anh & Hoang Minh Khien. 1994. Checklist of Mammals in Vietnam. Hanoi: Publishing House "Science & Technics". 168 p. [in Vietnamese].

Dang Ngoc Can, Endo H., Nguyen Truong Son, Oshida T., Le Xuan Canh, Dang Huy Phuong, Lunde D.P., Kawada S.-I., Hayashida A., Sasaki M. 2008. [Checklist of Wild Mammal Species of Vietnam]. Hanoi: Institute of Ecology and Biological Resources. 400 p. [in Vietnamese].

Do Tuyet. 1998. Overview on karst of Vietnam // Yuan Daoxian & Liu Zaihua (eds.). Global Karst Correlation. Beijing: Science Press. P.179–191.

Duckworth J.W. & Walston J.L. 1998. Reconnaissance Bird and Mammal Survey of Hai Phong - Ha Long - Cat Ba - Cam Pha - Ba Mun Area, Hai Phong and Quang Ninh Provinces, Vietnam, With an Emphasis On the Endemic Langur. Hanoi. Unpublished report to the World Bank.

Francis C.M. 2008. A Field Guide to the Mammals of South-East Asia. London: New Holland. 392 p.

Francis C.M., Borisenko A.V., Ivanova N.V., Eger J.L., Lim B.K., Guillen-Servent A., Kruskop S.V., Mackie I. & Hebert P.D. 2010. The role of DNA barcodes in understanding and conservation of mammal diversity in Southeast Asia // PLoS ONE. Vol.5. No.9. P.1–12.

Furey N., Le Xuan Canh & Fanning E. (eds.). 2002. Cat Ba National Park: Biodiversity Survey 1999. Frontier Vietnam Environmental Research, Report 20. Hanoi: Society for Environmental Exploration, UK and Institute of Ecology and Biological Resources. 51 p.

Grubb P. 2005. Order Artiodactyla // Wilson D.E. & Reeder D.M. (eds.). Mammals Species of the World. A Taxonomic and Geographic Reference. Third edition. Baltimore: Johns Hopkins University Press. Vol.1. P.637–722.

Guillen-Servent A. & Francis C.M. 2006. A new species of bat of the *Hipposideros bicolor* group (Chiroptera: Hipposideridae) from central Laos, with evidence of convergent evolution with Sundaic taxa // Acta Chiropterologica. Vol.8. No.1. P.39–61.

Hutterer R. 2005. Order Soricomorpha // Wilson D.E. & Reeder D.M. (eds.). Mammals Species of the World. A Taxonomic and Geographic Reference. Third edition. Baltimore: Johns Hopkins University Press. Vol.1. P.220–311.

Jenkins P.D., Lunde D.P. & Moncrieff C.B. 2009. Chapter 10. Descriptions of new species of *Crocidura* (Soricomorpha: Soricidae) from mainland Southeast Asia, with synopses of previously described species and remarks on biogeography // Voss R.S. & Carleton M.C. (eds.). Systematic mammalogy: contributions in honour of Guy G. Musser. Bulletin of the American Museum of Natural History. No.331. P.356–405.

Koopman K.F. 1994. Chiroptera: Systematics. // Neithammer J., Schliemann H. & Starck D. (eds.) Handbook of Zoology. Mammalia. Berlin & New York: Walter de Gruyter. Vol.8. Part 60. 217 p.

Korotky A.M., Razjigaeva N.G., Ganzey L.A., Volkov V.G., Grebennikova T.A., Bazarova V.B., Kovalukh N.N. 1995. Late Pleistocene-Holocene coastal development of islands off Vietnam // Journal of Southeast Asian Earth Sciences. Vol.11. No.4. P.301–308.

Kruskop S.V. 2000. [The bats in caves of Ke Bang limestone area (central Vietnam)] // Plecotus et al. Vol.3. P.114–120 [in Russian with English summary].

Kunz T.H., Thomas D.W., Richards G.C., Tidemann C.R., Pierson E.D. & Racey P.A. 1996. Observational techniques for bats // Wilson D.E., Cole F.R., Nichols J.D., Rasanayagam R. & Foster M.S. (eds.). Measuring and Monitoring Biological Diversity. Standard Methods for Mammals. Washington & London: Smithsonian Institution Press. P.105–155.

Kuznetzov G.V. 2000. Mammals of coastal islands of Vietnam: zoogeographical and ecological aspects // Bonner Zoologische Monographien. No.4. P.357–366.

Kuznetsov G.V. 2006. [Mammals of Vietnam]. Moskva: KMK Scientific Press. 428 p. [in Russian].

Kuznetsov G.V. & Pham Trong Anh. 1992. [Mammals of coastal islands of Vietnam (biogeographical and ecological aspects)] // Sokolov V.E. (ed.). [Zoological Studies in Vietnam]. Moskva: Nauka. P.182–197 [in Russian].

Le Xuan Canh & Campbell B. 1994. Population status of *Trachypithecus francoisi poliocephalus* in Cat Ba National Park // Asian Primates. Vol.3. No.3–4. P.16–19.

Le Xuan Canh, Cao Van Sung & Sang Don Lee. 1997. Mammal resources of Cat Ba and surrounding areas in Vietnam. Ecosystem and Biodiversity of Cat Ba National Park and Halong Bay, Vietnam // Annals of Nature Conservation, The Korean National Council for Conservation of Nature (KNCCN). Vol.12. P.149–157.

Lunde D. & Nguyen Truong Son. 2001. An Identification Guide to the Rodents of Vietnam. New York: Center for Biodiversity and Conservation, American Museum of Natural History. 80 p.

Lawlor T.E. 1986. Comparative biogeography of mammals on islands // Biological Journal of the Linnean Society. Vol.28. P.99–125.

Lunde D.P., Musser G.G. & Nguyen Truong Son. 2003. A survey of the small mammals from Mt. Tay Con Linh II, Vietnam, with the description of a new species of *Chodsigoa* (Insectivora: Soricidae) // Mammal Study. Vol.28. P.31–46.

Lunde D.P., Nguyen Truong Son & Musser G.G. 2007. A survey of small mammals from Huu Lien Nature Reserve, Lang Son Province, Vietnam // Mammal Study. Vol.32. P.155–168.

Musser G.G. & Carlton M.D. 1993. Family Muridae // Wilson D.E. & Reeder D.M. (eds.). Mammal Species of the World. A Taxonomic and Geographic Reference. Second edition. Washington: Smithsonian Institution Press. P.501–755.

Musser G.G. & Carleton M.D. 2005. Superfamily Muroidea // Wilson D.E. & Reeder D.M. (eds.). Mammal Species of the World. A Taxonomic and Geographic Reference. Third edition. Vol.2. Baltimore: Johns Hopkins University Press. P.894–1531.

Musser G.G., Lunde D.P. & Nguyen Truong Son. 2006. Description of a new genus and species of rodent (Murinae, Muridae, Rodentia) from the Tower Karst Region of Northeastern Vietnam // American Museum Novitates. No.3517. P.1–41.

Nadler T. & Ha Thang Long. 2000. The Cat Ba Langur: Past, Present and Future – the Definitive Report on *Trachypithecus poliocephalus*, the Worlds Rarest Primate. Report for the Frankfurt Zoological Society, Germany. Hanoi: Forestry Inventory and Planning Institute. 104 p.

Nadler T., Momberg F., Nguyen Xuan Dang & Lormee N. 2003. Vietnam Primate Conservation Status Review 2002. Part 2: Leaf Monkeys. Hanoi: Fauna & Flora International and Frankfurt Zoological Society. 226 p.

Nguyen Phien Ngung. 1998. The status of biodiversity and primate conservation in Cat Ba National Park // Proceedings of Workshop on a Conservation Action Plan for the primates. Hanoi.

Nguyen Truong Son, Vu Dinh Thong, Nguyen Xuan Dang & Csorba G. 2010. [Conservation status and distribution ranges of some horseshoe and leaf-nosed bat species in Vietnam] // Vietnamese Journal of Biotechnology. Vol.8. No.3A. P.981–990 [in Vietnamese].

Patterson B.D. & Atmar W. 1986. Nested subsets and the structure of insular mammalian faunas and archipelagos // Biological Journal of the Linnean Society. Vol.28. P.65–82.

Ratajszczak R., Cox R. & Ha Dinh Duc. 1990. A Preliminary Survey of Primates in North Vietnam. Report to World Wide Fund for Nature, Project 3869. Gland: WWF International. Unpublished report.

Thabah A., Rossiter S.J., Kingston T., Zhang S., Parsons S., Mya K.M., Akbar Z., Jones G. 2006. Genetic divergence and echolocation call frequency in cryptic species of *Hipposideros larvatus* s.l. (Chiroptera: Hipposideridae) from the Indo-Malayan region // Biological Journal of the Linnean Society. Vol.88. No.1. P.119–130.

Timko J. 2001. Conservation at what cost? A case study of the social implications of protected areas and the role of local people in Vietnam // MS Thesis. The University of British Columbia, Vancouver, Canada. 185 p.

Topal G. 1993. Taxonomic status of the *Hipposideros larvatus alongensis* Bourret, 1942 and occurrence of *Hipposideros turpis* Bangs, 1904 in Vietnam (Mammalia, Chiroptera) // Acta Zoologica Hungarica. Vol.39. No.1–4. P.267–288.

Trang Ngoc But. 1995. Biological resources of Cat Ba National Park // Proceedings of the National Parks and Protected Areas of Vietnam. Hanoi. P.212–221.

Vu Dinh Thong. 2008. Bat Conservation at Cat Ba Biosphere Reserve, North-east Vietnam. Conservation Leadership Programme. Unpublished report. 18 p.

Vu Dinh Thong, Dietz C., Denzinger A., Bates P., Furey N., Csorba G., Hoye G., Le Dinh Thuy & Schnitzler H.-U. 2011. Further records of *Murina tiensa* from Vietnam with first information on its echolocation calls // Hystrix (n.s.). Vol.22. No.1. P.129–138.

Vu Dinh Thong, Dietz C., Schnitzler H.-U., Denginger A., Furey N.M., Borisenko A.V. & Bates P.J.J. 2008. First record of *Hipposideros khaokhouayensis* (Chiroptera: Hipposideridae) from Vietnam // Journal of Science of HNUS. Vol.53. No.5. P.138–143.

Vu Dinh Thong & Furey N.M. 2008. [The bat fauna of Cat Ba Biosphere Reserve] // Journal of Biology. Vol.30. No.3. P.73–77 [in Vietnamese].

Vu Dinh Thong, Puechmaille S. J., Denzinger A., Dietz C., Csorba G., Bates P., Teeling E.C., & Schnitzler H.-U. 2012. A new species of *Hipposideros* (Chiroptera: Hipposideridae) from Vietnam // Journal of Mammalogy. Vol.93. No.1. P.1–11.

Walston J., Duckworth J.W. & Molur S. 2008. *Ratufa bicolor* // IUCN 2011. IUCN Red List of Threatened Species. Version 2011.2. <www.iucnredlist.org>. Downloaded on 10 January 2012.

Wilson D.E. 2008. Order Chiroptera // Smith A.T. & Xie Y. (eds.). A Guide to the Mammals of China. Princeton and Oxford: Princeton University Press. P.327–387.

Wilson D.E. & Reeder D.M. (eds.). Mammal Species of the World. A Taxonomic and Geographic Reference. Third edition. Baltimore: Johns Hopkins University Press. Vols.1–2. 2142 p.

Yoshiyuki M. 1989. A Systematic Study of the Japanese Chiroptera. Tokyo: National Science Museum. 242 p.