PRELIMINARY INVENTORY OF THE SMALL MAMMAL FAUNA OF THE YOK DON NATIONAL PARK (DAK LAK PROVINCE, VIETNAM)

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1. INTRODUCTION

Yok Don National Park is situated in the north-east part of the Dak Lak Province and represents in general low plateau with common elevations of 150-300 m a.s.l, covered by light dipterocarp forest. It was established in August, 9, 1986 on ca. 400 km^2, and in 1991 its territory was expanded to 582 km^2. Due to efforts of conservative organizations like BirdLife International and WWF Indochina, to the 1998 Park territory covered more than 1155 km^2, including 80 947 ha of highly protected forests, 30 426 ha of rehabilitation forests and 4172 ha used for administrative and managements purposes. Else, 1338.9 km^2 were supposed to form a buffer zone, though no special restrictions of human activity were not provided. Local climate is characterized by presence of definite dry (December to April) and wet (June to October) seasons.

Acquaintance with the reports of above-mentioned organizations showed that the mammalian studies in Yok Don were mainly aimed on investigation of species diversity of larger mammals, first of all - ungulates, estimation of their population conditions and elaboration of conservation recommendations. Representations about small mammal fauna were based on occasional visual records, interrogation of local residents and on some data about traces of life. The only exception is a short bat survey, conducted in 1997. Its results were not ever published, but material stored in Royal Ontario Museum (Toronto) were used later in description of a new species, *Cassistrellus yokdonensis* [1].

In the framework of the Joint Vietnam-Russia Tropical Science and Technology Research Centre activity aimed to the investigation of the Vietnamese biodiversity, short-term studies of Yok Don mammals were held in 2017 and 2011 years. Due to some objectives Park territory was studied unevenly and thus our results cannot be considered final, and the diversity of local small mammals was not revealed entirely. Nonetheless, since there were no other direct studies of small mammals in Yok Don and adjacent territories, publication of our results still seems to be reliable.

2. MATERIALS AND METHODS

Studied area. Our mammalian studies were held in the beginning of wet season (June, 13 to 30, 2007), during the transition between seasons (May, 14 to 25, 2011), and in the beginning of dry season (December, 12 to 24, 2011). In June 2007 atmospheric precipitation took place once per 3 - 4 days and usually lasted for 1-1.5 hours. Rainwater usually quickly passed through the soil not accumulated on the surface. Beds of the seasonal watercourses gradually filled with water and in the last days of June turned into streams. During the trip in May 2011, several small rains and two strong showers with 2 - 3 hours of duration were recorded. Small rains

almost not made influence on soil and growth. After the first shower part of dry watercourses was filled and did not dried up until the end of the expedition; meantime in other parts of the Park water entirely soaked into the soil. During the December trip of 2011 no rainfall was observed.

The park is characterized by annual artificial dry season grass-roots fires, during which leaf litter and above-ground parts of bamboo in a light dipterocarp forest are burn out. These fires imitate the natural grass fires characteristic for this phytocenosis (A.N. Kuznetsov, pers. comm.) and, presumably, do not affect significantly on the natural way of life of animals. The high canopies of dipterocarp trees and the absence of continuous canopy layer make crown fires almost impossible. According to our observations, fires do not penetrate deep into areas with high-polydominant forest growing on the slopes of the mountain ranges and on floodplains of seasonal watercourses.

Bat survey. In May 2011, because of limitation in car use and weather condition, most of bat observations and captures were made in the evening hours. Bats were observed and captured for proper identification in time period between 18^{15} (beginning of activity) to 20^{30}-00^{30}. The observations were held with the help of electric lanterns and narrow-band heterodine ultrasound bat detector [2]; D-230 Pettersson Elektronik AB was used. Nylon monofilament mist nets 11×4.5 meters put across potential flight paths were used for vital captures of animals; we also used Borissenko's flap trap (net of thin fishing line 2.5×2 m, put between two 5-meter fishing rods) [3 - 5]. Those methods were used separately or simultaneously, according to local and momentary conditions. In 2007, ornithological mist nets (10×2 and 12×2 meters) were limitedly used for bat capture.

Captured specimens were weighed and measured, checked for their age, gender and reproductive condition, and photographed. Exoparasites (mainly parasitic flies from Streblidae and Nycterebiidae families) were collected. Part of captured animals (one to four individuals per species) was taken as vouchers for more precise identification and taxonomic studies.

Non-volant small mammals survey. Fieldworks were conducted from 13 to 30 June 2007 and from 12 to 24 December, 2011.

Different types of traps were used as follows: 1) large (12×12×25 cm) cage live-traps and snap-traps each with a bait of raisins and a foam-rubber piece saturated with vegetable oil and honey; 2) pitfall traps, i.e. plastic baskets (40×30 cm), buried flush with the ground surface, with two plastic fences (3-5 m length). Cage live-traps were set on the ground as well as on the tree branches (1-3 m above the ground).

During 18 working days in 2007 we studied 9 transects, located in northern part of the Park. In total of 1048 trap-nights were conducted for all type of traps, including 328 trap-nights for the pitfall traps, 26 specimens of five species were collected. During 13 working days in 2011, 344 trap-nights were conducted for all type of traps, including 302 trap-nights for the pitfall traps, 4 mammal specimens were collected.

Additional information was obtained during night and day-time excursions, covering the dipterocarp forest in left side of Srepok River from Don Village to Yok Don Mt.; in vicinity of forest station 5; in forest around artificial lake located at 6 km from Cambodian border; in the polydominant forest on the left bank of the Srepok River; in northern part of the Park, and around the Park Headquarters in Don Village (N 12º52.348′, E 107º48.452′).

The standard external body measurements (head and body length, tail length, hind foot length, ear length) were taken. Tissue samples for genetic studies were taken from fresh specimens and stored in 96% ethanol. Voucher specimens kept at the Zoological Museum, Moscow State University (Moscow, Russia) and Zoological Institute Russian Academy of Sciences (Saint Petersburg, Russia).

3. SPECIES ACCOUNTS

Order Soricomorpha

Phanluong's shrew - *Crocidura phanluongi* Jenkins, Abramov, Rozhnov et Olsson, 2010

During survey of 2007, four specimens of unidentified shrews were captured in the northern part of the Park. Further studies showed that they could not be assigned to any known species. As result, new species *C. phanluongi* was described on the basis of those specimens [6]. The species rank of that form was confirmed by DNA analysis [7]. Besides Yok Don, Phanluong's shrew is known to occur in neighboring areas of Cambodia [6] and in lowlands of the southern Vietnam, including Ma Da Forest in Dong Nai Province and Bu Gia Map Nature Reserve in Binh Phuoc Province [7, 8].

Order Chiroptera

Previous knowledge about bats from Yok Don National Park is quite limited. Small number of bat specimens, collected in 1997 by B. Lim and M. Theberge, are preserving in the Royal Ontario Museum (Toronto), of which specimens of the fairy tube-nosed bat, *Murina harrisoni*, and Walston's tube-nosed bat, *Murina walstoni*, were studied by us. Also, new serotine species, *Cassistrellus yokdonensis*, was recently described based on two specimens from Yok Don [24]. During our short survey, 27 specimens of eleven species were captured and one species was visually recorded. One more species was found earlier, during survey of 2007.

Indian short-nosed fruit bat - *Cynopterus sphinx* (Vahl, 1797)

Seven specimens of this bat were captured with the mist nets. Indian short-nosed fruit bat is probably a most ecologically flexible pteropodid species in Vietnam, which inhabits wide variety of landscapes and elevations [9]. Four animals were captured in highly disturbed forest on left side of Srepok River, not far from the Park headquarters. Three fruit bats were captured in about 4 km from the headquarters, also on the left side of the river, at the edge of open dipterocarp forest nearby artificial pond. We have not found exact food source of this species and got no information about its food preferences during the season of survey.

Another fruit bat mentioned for Yok Don is *Megaerops niphanae* [24].

Malayan false vampire - *Megaderma spasma* (Linnaeus, 1758)

Two adult females were captured on 19.04.2011 in the northern part of the Park. Animals were netted in the dry growth nearby the seasonal water bed; no any other bat activity was observed in the same place. One of the females carried one newborn. Probably, this female with offspring was seen later close to the capture place in the hollow of broken old *Largerstroemia*, about 4 - 5 m high above the ground surface.

Chasen's horseshoe bat - *Rhinolophus chaseni* Sanborn, 1939

One individual was captured on 25.06.2007 in the northern part of the Park. This species of horseshoe bat is probably characteristic for lowland forests of the Vietnamese south [9]. In the right side of the Park (in relation to Srepok River) it may use crevices in rock outcrops or drainage pipes under the road.

Nepalese whiskered bat - *Myotis muricola* (Gray, 1846)

One individual (adult female) was captured on 18.04.2011 in the northern part of the Park. Thus, Yok Don is one of relatively few places in Vietnam, where *M. muricola* co-occurs with closely related *M. ater* in the same area and landscape.

Moluccan whiskered bat - *Myotis ater* (Peters, 1866)

Two males and a female were captured on 23.04.2011 in the northern part of the Park. Two animals were mist-netted on the edge of the artificial pond nearby the road in the partly disturbed forest. Third one was captured not far from the previous place, on the area with tall *Lagerstroemia* trees. It looks like that this species in Vietnam is more connected with forest habitats than *M. muricola* and avoid open places.

Walston's tube-nosed bat - *Murina walstoni* Furey, Csorba et Son, 2011

Adult female was captured at ca. 4 km from the Park headquarters on the left side of Srepok River on 21.04.2011, on the edge of the light dipterocarp forest nere the shore of artificial pond. This species was rather recently described based on few specimens from Cambodia and one specimen from Yok Don [10]. In hands, this tube-nosed bat can be easily distinguished by the combination of relatively small size (in our specimen forearm is 33.4 mm, and body mass is 5.6 g.) and pure white fur on underparts. This species is probably confined to lowland forests of Southern Vietnam, and Yok Don represents its northmost point of distribution range [11].

Fairy tube-nosed bat - *Murina harrisoni* Csorba, Bates, 2005

Adult female was captured in same place and date, as previous species. This tube-nosed bat widely occurs mainly in the northern part of Indochina [12], and probably inhabits different types of lowland forests. Yok Don record represents the most southern point of its known distribution range; next record in Vietnam is known from Nghe Anh Province [11, 13, 14].

Pied bat - *Kerivoula picta* (Pallas, 1767)

On April 18, 2011, at about 6 AM, in conditions of relatively good light, one individual of this brightly colored bat was observed over the clearing in the low-stemmed polydominant forest. Most probably that was occasionally frightened off the day roost. It is known that the pied bats spend days in the foliage, at least sometimes [16]. It is noteworthy that dry (but not fallen) leaves of *Dipterocarpus* look somewhat alike wings of that bat species in their color and surface texture. If pied bat really roosts in such leafs, they can provide good camouflage. However, in our case direct search for such a shelter did not gave a positive result.

Burmese pipistrelle - *Pipistrellus paterculus* Thomas, 1915

Two adult males were netted on 23.04.2011 in the northern part of the Park. Animals were captured into mist net set nearby small non-drying pool, surrounded by forest. This pipistrelle species was firstly found in Vietnamese fauna only in 1999 [17]; currently no more than ten localities of this bat are known in the country [9]. The one nearest to Yok Don is situated in Kon Chu Rang, Gia Lai Province [14].

Least pipistrelle - *Pipistrellus tenuis* (Temminck, 1840)

Tree males were captured in the northern part of the Park. One animal was mist-netted nearby small non-drying pool, surrounded by forest. Two other individuals were captured into ornithological mist nets in the polydominant low-stemmed forest. This pipistrelle is more commonly reported from the north of Vietnam [14], while in southern part of the country it was found only in Ninh Thuan Province [14] and in Bu Gia Map reserve, Binh Phuoc Province [17]. In Yok Don this bat species seems to be relatively common: it is likely that just those bats were multiply observed while they foraged over roads and semi-open areas.

Javanese pipistrelle - *Pipistrellus javanicus* (Gray, 1838)

Female and two adult males were captured on 23.04.2011 in the northern part of the Park. All individuals were netted nearby small non-drying pool, surrounded by forest. This pipistrelle species is one of the most common in Southern Vietnam [5, 14].

Tickell's bat - *Hesperoptenus tickelli* (Blyth, 1851)

Male and female were netted in the northern part of the Park on 23.04.2011; one more male was captured in the same area, but somewhat southward, in December of the same year. Two animals were captured into mist net set nearby small non-drying artificial pond, surrounded by forest. Tickell's bat has wide but sporadic distribution across tropical Asia [18] but from Vietnam it was reported from only two places [14, 19].

Great house bat - *Scotophilus heathii* Horsfield, 1831

Adult female was captured in the northern part of the Park on 17.04.2011. The animal was netted at the edge of the polydominant low-stemmed forest nearby small pond. Few bats of the same species were observed drinking from the pond and foraging over the canopies of neighboring trees.

Order Scandentia

Northern tree-shrew - *Tupaia belangeri* (Wagner, 1841)

Nineteen individuals were captured in 2007, one specimen was captured in 2011. All tree-shrew specimens were caught on the tree branches or lianas at the height from 0.5 to 3 m above ground.

Sex ratio was near 1:1 (10 males, 9 females). Most of females (five of nine) took part in breeding in June (see Table 1). A pregnant female with 2 fully-developed embryos was caught on June 20. From June 22 only the already given birth females were caught. A similar condition of the uterus in these females may indicate that their birth occurred approximately simultaneously. According to available data, pregnancy in *T. belangeri* lasts 41 - 45 days in captivity [20]. The adult female, caught in December 2011, was a non-breeding.

It can be assumed that the breeding season of *T. belangeri* in Yok Don starts in the first decade of May. It is believed that tree-shrews reproduce one litter per year. Given that *T. belangeri* puberty occurs at the age of 4 months [26], the presence in the population of non-breeding females suggests that not all sexually mature animals give birth every year, or there is another peak of reproduction. In favor of the second assumption, there is also indirect evidence of the presence in the population of subadult animals. However, the presence of several (two) peaks of breeding is a rather unusual feature for mammals of the plain forests of southern Vietnam with strongly pronounced change of seasons.

The diet of tree-shrews (according to the data for *Tupaia glis*) includes various arthropods, as well as fruits, seeds and leaves. Although tree-shrews have an arboreal lifestyle, they feed mainly on the ground. The contents of the stomachs of *T. belangeri* from Yok Don confirm this assumption -in the stomachs were found the remains of various invertebrates (termites, cockroaches, spiders, etc.) from predominantly terrestrial arthropod groups.

Order Rodentia

Indochinese ground squirrel - *Menetes berdmorei* (Blyth, 1849)

Two adult females were captured in northern part of the Park, one specimen was captured on 18.04.2007, another one - on 23.12.2011. Squirrels were captured in cage live-traps set on tree-like lianas, at height of about 1 m from the ground. In 2011 *M. berdmorei* were commonly observed in the northern part of the Park, mainly at the forest edges and in sparse forest areas. The squirrels mostly stayed on the ground, however, once we observed an animal in a tree hollow about 5 m from the ground.

Cambodian striped squirrel - *Tamiops* cf. *rodolphii* (Milne-Edwards, 1867)

Squirrels of genus *Tamiops* were commonly observed in most of studied areas of the Park. Based on the external characters (all four light dorsal stripes of equal intensity, pale stripe under eye faintly continuous with lateral light stripe - [22] we preliminary identified these animals as *Tamiops rodolphii*. However, other species of *Tamiops* also can be found in the Park.

Black giant squirrel - *Ratufa bicolor* (Sparrman, 1778)

The species was recorded in December 2011 in the polydominant forest at the Yok Don Mountain.

Indian giant flying squirrel - *Petaurista philippensis* (Elliot, 1839)

The species was observed in June 2007 in the polydominant forest at left bank of Srepok River.

Asian flying squirrel - *Hylopetes* sp.

In 2007 we observed the stuffed specimen of *Hylopetes* sp. at the market of Don Village. This specimen was collected at the region near of the Park territory.

Indochinese forest rat - *Rattus* cf. *andamanensis* (Blyth, 1860)

Six specimens were captured in 2007, and only one specimen - in 2011. Five specimens were collected in different forest biotopes: in polydominant forest at the top of small hill; in a flood plain polydominant forest alongside of temporary streams; in dipterocarp forest, and in the logging site. One specimen was caught in a house at the Park Headquarters.

Bower's white-toothed rat - *Berylmys bowersi* (Anderson, 1879).

Skull of white-toothed rat was found by A.B. Vassilieva and E.A. Galoyan on the Yok Don Mountain in 2011. Species identification made by A.E. Balakirev (Joint Vietnam-Russia Tropical Science and Technology Research Centre).

Sumatran bamboo rat - *Rhizomys* cf. *sumatrensis* (Raffles, 1821)

Settlement of bamboo rats was found in 2007 at the northern part of the Park in the forest alongside of temporary stream. In 2011 we found a few holes which perhaps belong to the bamboo rats in another area of the northern part of the Park.

4. CONCLUSION

During our studies in the Yok Don National Park, we found at least 23 mammalian species. Together with enigmatic *C. yokdonensis*, to the moment, no less than 16 bat species from four families are known for Yok Don, which is hardly exhausts the real composition of local bat fauna. Herewith, even part of revealed suitable places was not observed because of lack of time; in relation to bats, surroundings of the Yok Don Mountain itself were not investigated. Thus we may suppose much rich local bat fauna, on one hand, and many new faunistic findings on this territory, on another.

Attention of previous researchers was concentrated mainly on larger mammals of the Yok Don National Park [21, 22]. Our studies, even very short-term, showed very poor knowledge about small mammal fauna in the Park, especially in relation to crepuscular and nocturnal species. Few species of land mammals (*Crocidura*

phanluongi, *Berylmys bowersi*, *Rattus* cf. *andamanensis*, *Rhyzomys* cf. *sumatrensis*) and many of Chiropterans (*Rhinolophus chaseni*, *Megaderma spasma*, *Myotis muricola*, *Myotis ater*, *Murina harrisoni*, *Pipistrellus paterculus*, *Pipistrellus tenuis*, *Pipistrellus javanicus*, *Hesperoptenus tickelli*, *Scotophilus heatii*, *Kerivoula picta*) were recorded in the Park for the first time. Amongst the non-volant mammals, tree-shrew *Tupaia belangeri* and Cambodian striped squirrel *Tamiops rodolphii* were most common species in major of studied habitats. The density of rodents and shrews was low both in 2007 and in 2011. *Rattus* cf. *andamanensis* was the most common species among Muridae, it was recorded in most of studied forest biotopes. At the same time, attention is drawn to the fact that we could not find the rats of the genera *Maxomys*, *Niviventer* and *Leopoldamys* which common for the forests of southern Vietnam.

Singularity of the small mammal fauna of Yok Don might be explained by the structure of a dipterocarp forest, annual grassland fires and a network of temporal (seasonal) streams with a polydominant forest in floodplains and on hill slopes. Annual fires in a dipterocarp forest destroy dead wood, fallen tree trunks, plant seeds, insects and other terrestrial invertebrates, thus depriving small mammalian shelters, building material for nests and food resources. In contrary to dipterocarp forest, it is cooler under the canopy of polydominant forest. Available water sources remain in such areas after seasonal watercourses. However, with the beginning of the rain season, a sharp rise in the water level occurs in riverbeds and seasonal streams causing a temporary flooding of floodplains.

In view of these factors, it can be expected that the mammalian distribution will vary significantly depending on the season. Small terrestrial mammals, such as *Rattus* cf. *andamanensis*, *Berylmys bowersi*, *Rhizomys* cf. *sumatrensis*, and *Crocidura phanluongi*, should be strictly sensitive to these factors. When the dry season beginning, both large and small mammals concentrate on polydominant forest areas on the mountain slopes and in the floodplains of seasonal streams. At the beginning of rain season, it can be assumed that animals that live in the plain area can either disperse into the dipterocarp forest or migrate to the slopes of mountains and hills. This explains to some extent why the common small mammals in Yok Don were arboreal species (tree-shrews and squirrels), whereas terrestrial rats and shrews were few in number. Perhaps, for the same reasons, there are no typical forest rats of the genera *Maxomys*, *Niviventer* and *Leopoldamys*, who could not adapt to such unusual conditions.

Bats are able to move easily on distances almost not available to rats and shrews, and thus they are less vulnerable for direct impact from seasonal fires and floods. However, these factors affect inevitably on the richness and composition of their food base, because ground fires could destroy large percent of soil larvae, while insects with water larvae hardly can rich high numbers during wet season. This circumstance explains relatively low bat density in observed parts of the Park.

Meantime, local species diversity of bats is rather high, at least partly because of highly mosaic habitats. However, large part of it is composed by species which are not connected to any specific habitat types (*Cynopterus sphinx*, *Megaderma spasma*, *Rhinolophus chaseni*, *Myotis muricola*) and which therefore can easily change foraging places, or species which can move on relatively large distances in search of food (first of all, *Scotophilus heathii*, but also *Pipistrellus* spp., *Hesperoptenus tickelli*, and probably *Cassistrellus yokdonensis*). Tube-nosed bats, which are not inclined to long-distance movements, were captured only in left-bank part of the Park, were ground fires seem to be less frequent and wide network of water beds can decrease level of seasonal floods. According to this tendency, we may suppose higher density of bats and higher proportion of settled species on the Yok Don Mountain itself and its nearest surroundings.

It is necessary to mention importance of non-drying water sources for bats. Meanwhile most species are avoiding Srepok River (probably for fear of bird of prey) and prefer small artificial ponds. As in better studied Cat Tien, ponds situated on the border of forest and open habitats are using more frequently. The highest bat density was observed nearby water source, which totally surrounded by the forest and from one side was neighbored with area covered by tall *Lagerstroemia*. Meantime, temporal water sources, filled by water during rains, did not attracted bats and did not caused any changes in their spatial activity.

It should be noted, however, that the collected material is insufficient for univocal support of those suggestions. Further ecological and taxonomic studies are need for the argued discussion about the reasons of the originality of the Yok Don micromammalian fauna.

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SUMMARY

Three short surveys of mammals were held in 2007 (June, beginning of rain season) and 2012 (May, low season, and December, beginning of dry season) in Yok Don National Park (Vietnam, Dak Lak Province) under the aegis of Joint Vietnam-Russia Tropical Science and Technology Research Centre. Occurrence of 23 small mammal species was revealed including 13 species new to Dak Lak Province. The latter are represented mainly by bats of which the most important records are *Murina harrisoni*, *Pipistrellus paterculus* and *Hesperoptenus tickelli*, and also by rats (*Rattus* cf. *andamanensis*, *Berylmys bowersi*) and white-toothed shrew *Crocidura phanluongi*. Tree-shrew (*Tupaia belangeri*) was the most abundant non-volant mammal during the survey. On the whole, the micromammalian fauna of Yok Don seems to be strongly underestimated.

Keywords: *Small mammals, York Don National Park, Dak Lak, biodiversity.*

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