

# DISTRIBUTION OF TERRESTRIAL FAUNA ON SON TRA PENINSULA, DA NANG CITY

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**Abstract** - The terrestrial fauna of Son Tra Peninsula has been studied for a long time, especially when the Son Tra Nature Reserve was established in 1977. Under the pressure of natural and anthropogenic factors biodiversity of the Peninsula is changing. Toward the sustainable development in the future, a re-assessment of the terrestrial animals and their distribution should be conducted to support decisions of conservation and planning. Our study on diversity and abundance of terrestrial animals and their distribution has confirmed the presence of 245 species with 1,695 records. The number of species and records were significantly different among vegetation types and elevational zones. The diversity and abundance of terrestrial taxa in the evergreen broadleaf forest distributed below the 200m above sea level was highest and some threatened species including Red-shanked Douc, Pygmy Slow Loris were also found here. Therefore, any development activities planned for this area should be carefully considered.

**Key words** - terrestrial animals; distribution; vegetation; elevation; Son Tra

## 1. Introduction

Located to the northeast of Da Nang City, Son Tra Peninsula is bordered by the Da Nang Bay to the northwest, by the East Sea to the northeast and southeast, and by the mainland to the southwest. Son Tra Peninsula is an isolated mountain block, with a length of 13 km, and about 5 km at the widest part. Most of the Peninsula was assigned to the Son Tra Nature Reserve (NR), a special use forest established in 1977. According to the Prime Minister's Decision 41-TTg in 1977 the initial area of the nature reserve was ca. 4,000 ha. The coordinates of the reserve are from 16°05'50" to 16°09'06" North latitude and from 108°12'45" to 108°20'48" East longitude (Figure 1).



**Figure 1.** Map of Son Tra Peninsula: Location and land cover and surveyed tracks/sites

The vegetation map of Son Tra Peninsula, based on satellite images in 2016, shows that the total area of forest covered land was 3,317 ha, accounting for 76.21% of the total area. There are two types of forest that occupy the largest area, namely the poor evergreen broadleaf forest, and the medium evergreen broadleaf forest with an area of 1,872 ha and 1,445 ha, respectively. Other types of habitats occupy less than 400 hectares [1].

The Son Tra mountain range has north-south slopes with a steep slope of 25° - 30°, and the northeast slope is steeper than the southwest slope. The topography of Son Tra NR varies drastically from the coast to the top of the mountain and is strongly divided by a system of small streams. The highest peak of Son Tra Peninsula is Oc Cao (696 m), with two other peaks of 647 m and 621 m near the centre of the Peninsula. In general, the whole protected area consists of hilly and mountainous terrain, with many ravines creating a topographic separation, making for a complex and difficult landscape to access.

Studies on terrestrial animals in Son Tra Peninsula have been carried out over many years. However, due to the location of most museum's specimen or observation records mainly using the name Tourane (Da Nang) without further detailed information, it is often difficult to determine the exact location for these specimens. For example, Osgood (1932) recorded a number of mammals in Tourane based on specimens collected during Kelly-Roosevelt's expedition from 1928-1929 including the Asian Mongoose *Herpestes exilis* (*H. javanicus*), Pallas' Squirrel *Callosciurus flavimanus* (*C. erythraeus*), and the Greater Bandicoot Rat *Bandicota gigantea jabouillei* (*Bandicota indica*). Since the reunification of the country, several surveys on biodiversity have been carried out on Son Tra Peninsula. An initial list of plants and animals of Son Tra NR was established through the "technical and economic feasibility study in 1989. In 1997, another list of biodiversity of Son Tra NR was released recognizing 287 species of terrestrial vertebrates, including 36 mammals, 106 birds, 23 reptiles, 9 species of amphibians, and 113 species of invertebrates, mostly insects [2]. Some of thematic studies were then conducted in Son Tra and listed 70 species including 18 amphibian species and 52 reptile species [3], 161 bird species in 2014 [4] and 67 butterfly species. The updated checklist of terrestrial animals of Son Tra includes 41 mammals, 151 birds (after removing synonyms and unconfirmed species), 52 reptiles, 18 amphibians and at least 185 insects (86 butterflies, 20 beetles and 79 other species [2, 3, 4, 5]. However, previous studies provide limited information on coordinates or distribution of animals, information necessary for management plans, leading to difficulty in synthesizing and assessing their distributional characteristics. Therefore, this study re-evaluates the distribution of the terrestrial fauna of Son Tra Peninsula, as well as supplementing and updating information and images for management and other purposes.

## 2. Methods

### 2.1. Time and study area

The study was conducted during 2 years from 2016 and 2017 consisting of 04 field surveys, with each trip lasting 10 days. Field surveys focused on 06 areas including Suoi Om (230 m altitude), Vong Canh Hill (560 m altitude), Ban Co Peak (570 m altitude), Ho Sau area (~150m), Bai Bac area (~ 220m), and the Heritage Figtree (~160m). In addition, the research team utilized the available roads and tracks for survey. Therefore, the scope of the survey is spread evenly across elevation and habitat types.

### 2.2. Data collection

To assess the distribution of animals, the following data collection methods are applied for each specific target group. For mammal and bird groups, opportunistic observation in the main survey areas as well as along the roads were recorded. In addition, 10 box traps with 80 night-traps and four camera traps with 12 night-traps were used to collect small ground mammals and photos of animals. Three 2.6-m x 6-m mist nets were also set at the main survey areas and along the streams for catching bats, and understory birds for accurate identification. For amphibians and reptiles, night surveys were carried out along streams in each surveyed area and along roads of the peninsula area. Specimen were collected by hand, identified and then released. Only unclassified specimens were kept for later identification. For insects (we just focused on beetles and butterflies), hand nets were used to collect butterflies during the day and light traps were used to attract and record beetles and other insects active at night.

During the surveys, images of all species, if possible, were taken with important classification characteristics on the field. Once a species is observed, its coordinates are marked with a GPS locator (Garmin 64 CSX) and the type of habitat was also recorded. All data were aggregated into Excel tables and put into databases.

### 2.3. Sample processing and classification

Most birds and animals were identified directly in the field by using appropriate identification documents such as the *Preliminary Identification Manual for Mammals of South Vietnam* [6]; *A Photographic Guide to Mammals of South-East Asia* [7]; *Bats of Vietnam: Checklist and an identification manual* [8]; *Birds of Vietnam* [9], *A Guide to the Birds of Southeast Asia* [10]. For reptiles and amphibians, after being treated, specimens were identified in the laboratory. Identification of reptile and amphibian specimens follows appropriate determination keys [11, 12, 13] and common names followed *Herpetofauna of Vietnam* [14]. Insect samples were fixed and dried at a temperature of 40°C - 50°C for a period of 2-3 days depending on the size of the specimen. Then, the identification of insect samples was based on the classification documents: *Butterflies of Thailand* [15], *Butterflies of Vietnam: An Illustration checklist* [16], *A Check list of Butterflies in Indochina* [17], *How to know the Beetles* [18], *Beetles of Thailand* [19].

### 2.4. Assessment of distribution

Vegetation and altitudinal factors have great influences on the distribution of animals [20]. In this study, we evaluate the distribution of terrestrial animals in two

criteria: vegetation and elevation zones. For the land covers, 07 main types in the nature reserve are used (Table 1) [1]. For elevation zoning, we divided Son Tra Peninsula into three main zones with a height of less than 200 m asl., from 200 m - 399 m asl., and over 400 m asl. This elevation division not only considers the ecological needs of animals but also involves supporting the decision on land use planning and tourism development of Son Tra Peninsula.

The records of all species have been input in the database with full geographical coordinates, elevation, distribution habitats. This information is statistically analyzed for each vegetation type and elevation zone to assess species distribution, and habitat preferences of animal communities in the Peninsula using Chi-square test.

**Table 1.** Land cover types and their areas on Son Tra Peninsula

No.	Land cover type	Description	Area (ha)
1	Residential land	Houses, infrastructure ...	807
2	Poor evergreen broadleaf forest	Evergreen forest with biomass range between 10 and 100 m <sup>3</sup> /ha	1,872
3	Medium evergreen broadleaf forest	Evergreen forest with biomass range between 101 and 200 m <sup>3</sup> /ha	1,445
4	Planted forest	Planted trees, mainly <i>Acacia</i> , <i>Eucalyptus</i> . Natural reforestation is seen	252
5	Agricultural land/other	Land used for agriculture and other purposes.	188
6	Bare land/ grassland ( <i>Merremia</i> )	Bare land or grassland covered by <i>Merremia</i>	226
7	Bare land/ grassland (other)	Bare land or grassland without <i>Merremia</i>	368

## 3. Results and Discussion

### 3.1. General diversity and abundance

This study has directly recorded 20 mammal species, 82 bird species, 31 species of reptiles, 16 amphibians, and 96 insect species, including 74 butterfly species and 22 species of beetles in Son Tra Peninsula including 3 mammal, 12 bird, 2 reptile, 3 amphibian, 26 butterfly and 14 beetle species new to Son Tra (Appendix 1). There are 16 species listed in IUCN Redlist of Threatened Species and Red Databook of Vietnam (VNRD) including *Pygathrix nemaeus* (VNRD2007: EN, IUCN 2018: EN), *Nycticebus pygmaeus* (VNRD2007: VU, IUCN 2018: VU), *Muntiacus vaginalis* (*M. muntjak annamensis*) (VNRD: VU), *Cynocephalus brachyotis* (VNRD: VU), *Psittacula alexandri* (IUCN 2018: NT); *Pitta nympha* (VNRD2007: VU, IUCN 2017: VU), *Physignathus concincinus* (VNRD2007: VU), *Gecko gecko* (VNRD 2007: VU), *Coelognathus radiata* (VNRD 2007: VU) *Ptyas korros* (VNRD2007: EN), *P. muscosus* (VNRD 2007: EN), *Python reticulatus* (VNRD 2007: CR) *Ohphiophagus hannah* (VNRD2007: CR, IUCN 2018: VU), *Naja atra* (VNRD2007: EN), *Cuora mouhotii* (VNRD: VU, IUCN 2018: VU), and *Troides aeacus* (VNRD 2007: VU). Photos of some threatened species listed in Appendix 2. The updated checklist of terrestrial animals in Son Tra Peninsula include 42 mammals, 162 bird species,

55 species of reptiles, 22 amphibians, and 113 butterfly species and 39 beetle species.

Total records of all species were 1,695, of which 126 records were of mammals, 441 records of birds, 150 records of reptiles, 182 records of amphibian, 715 records of butterflies and 81 records of beetles.

### 3.2. Elevational distribution of terrestrial animals

The number of species and records for each animal group (animal, bird, reptile, amphibian and insect) shows that there are significant difference in elevational distribution of species diversity ( $\chi^2=18.21$   $df=8$ ,  $p=0.02$ ) and relative abundance (number of records) ( $\chi^2=188$ ,  $df=8$ ,  $p<0.0001$ ). Most species and records were found in areas with elevations below 200 m asl. (Table 2). While some species occur in a wide range of elevation, other species were found only in one or two elevation zones.

**Table 2.** Number species and records of terrestrial animals according elevation zones

Elevation	Under 200 m (2,728 ha)		200-399 m (1,392 ha)		Above 400 m (586 ha)	
	# of species	# of records	# of species	# of records	# of species	# of records
Mammals	17	72	14	50	4	4
Aves	75	270	53	90	56	81
Reptiles	24	88	11	39	10	23
Amphibians	13	104	9	72	4	6
Insects	51	274	62	439	27	83
<i>Totals</i>	<i>180</i>	<i>808</i>	<i>149</i>	<i>690</i>	<i>101</i>	<i>197</i>

For the mammals, most of the species were recorded mainly at elevations below 200m asl. and the mammal diversity decreased with elevation, with only a few species occurs in the elevation zone above 400m above sea level (Table 2). The elevational distribution of some mammal groups is different. For instance, more primate records were found in the zone below 200m than higher zones (29 records) compared to 21 record in mid-elevation zone and 02 records in the top zone. Meanwhile, more ungulate mammals were seen in the zone from 200m to 399m (8 records) than in the mid-elevational zone (6 records) and in the top zone (no record). This result indicates that with the current natural conditions of Son Tra, the mammals are mainly distributed in areas below 400m asl., and primarily in the area below 200m. Among mammals, the number records of Red-shanked Douc were highest, 35 records for four surveys.

Similar to the mammals, the bird composition was more diverse at the height below 200 m than higher zones. The abundance of birds expressed by number of records were also highest in the zone below 200 m asl. while it was quite similar between the mid-elevational zone and the top zone (Table 2). However, birds have high ability of dispersal and thus, the data for each elevation zone is only relative. Some species were recorded close to water level and the zone above 400 m but not observed in the middle range (15 species) should be considered distributed at all elevation zones in Son Tra NR.

The species diversity and relative abundance of reptiles and amphibians was also highest in the zone below 200 m asl., however, the species diversity of reptiles in the zones between

200 m - 399 m asl., and over 400 m asl was similar while amphibian diversity and abundance in the zone between 200 m - 399 m asl. Higher than the zone over 400 m asl.

Species diversity and relative abundance of the two target insect's orders of this study, Lepidoptera (butterflies) and Coleoptera (beetles) toward elevation were different to other terrestrial animal classes. Number of species and records was highest in the area between 200 m - 399 m and lowest in the area above 400 m.

Many studies provide evidence for the influence of ecological factors, such as climate, elevation, habitat heterogeneity, on animal diversity. A global analysis of elevational diversity trends for nonvolant small mammals has revealed that the species richness was highest at a mid-elevational zone [21]. Typically, another research on non-volant small mammals on three mountains in southeast China showed significantly positive relationship between mean abundance and elevational range size of those mammals [22]. A study on distribution of birds in the Eastern Himalaya has also indicated that species richness of birds is highest at intermediate elevations [23]. For heperetofauna, relative abundance and species diversity of reptile and amphibians in Matang Range, Borneo decreased with elevation in general and was the highest below 200 m [24].

With the highest peak of 697 m asl., Son Tra is a low mountain. However, the statistics have exhibited a trend of highest diversity shifting toward lower elevations. One of the reasons may be the area of below 200 m is the largest, accounting for 57.96% of Son Tra Peninsula, while the zone above 400 m is the smallest, accounting for 12.46% the Peninsula area. In addition, the zone below 200 m is less steep and has more water sources than the upper elevation zones. Because the amphibians and reptiles are usually distributed along streams, the high diversity of species as well as number of records are found at elevations below 200 m where all permanent streams are found in this area. However, butterflies are more diverse in the middle zone, possibly due to better vegetation compared to area below 200 m and above 400 m.

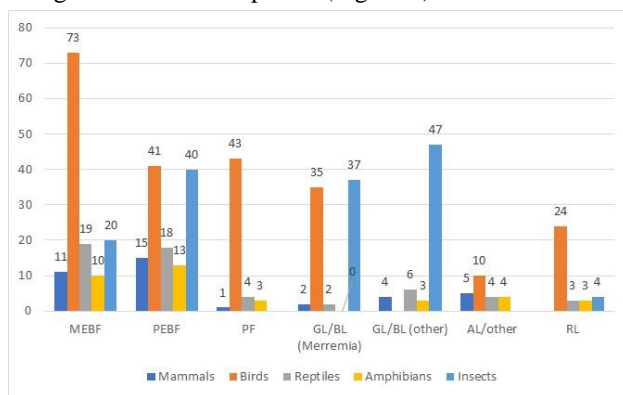
### 3.3. Habitat distribution of terrestrial animals

There are seven land-use covers in the Son Tra Peninsula, among these, poor evergreen broad leaved forests and medium evergreen broadleaf forests have the largest area, about 1,872 ha and 1,445 ha, respectively. Species composition of terrestrial animals in habitats was significantly different ( $\chi^2=200$ ,  $df=24$ ,  $p<0.001$ ) and showed the adaptation of each group of organisms to their environment. Mammals, birds, reptiles and frogs were widely distributed in evergreen medium and poor forests, while insects, and especially butterflies were often distributed in bare lands and grasslands (Figure 2). Agricultural land and residential areas had a low number of species, mainly species with high adaptability to anthropogenic habitats.

As illustrated in Figure 2, there were 11 mammal species recorded in medium evergreen broadleaf forest and 15 species in poor evergreen broadleaf forest. In terms of number of records, these two forest types also support high

abundance of mammals with 29.3% and 54.8% of total mammal records respectively. Some mammal species such as bats and squirrels have been recorded in other vegetation types such as agricultural land or other land that are present in Son Tra Peninsula. For vegetation that is covered by *Merremia*, only two species of mammals, Red-shanked Douc and Rhesus Macaque, were recorded. Interestingly, the Red-shanked Douc is also recorded in the habitat of the plantation (mainly *Eucalyptus*) close to Tien Sa port.

For bird species, the majority of birds (89% species recorded in this study) in the study area live mainly in the medium evergreen broadleaf forest habitats. Meanwhile, the agricultural land and grassland/bare land without *Merremia* were less diverse. According to the number of birds recorded in the poor evergreen broadleaf forest, the plantation and grassland/bare land with *Merremia* were quite similar. Interestingly, residential land also supported a large number of bird species (Figure 2).



Note: MEBF: Medium Evergreen Broadleaf Forest, PEBF: Poor Evergreen Broadleaf Forest, PF: Planted Forest, BL/GL: Bare land/Grassland, AL: Agricultural Land, RL: Residential Land

**Figure 2.** Community species structure of terrestrial fauna in seven habitats of Son Tra Peninsula

For reptiles, more species are distributed in medium evergreen broadleaf forest (61% of total species) and poor-evergreen broadleaf forest (58%). Species distributed in other habitats are less diverse and are highly adaptable species, which are found in many different habitats.

Similar to reptiles, 81% total species of amphibians recorded in this study occurred in poor-evergreen broadleaf forest, and 63% in medium evergreen broadleaf forest. However, we did not record any species in grassland/bare land covered by *Merremia* spp.

Unlike terrestrial vertebrates, most insect species occur in open habitats such as grassland covered by *Merremia* spp. or bare land/grassland (Figure 2).

Habitat preferences are found for most animal groups. The diversity and abundance of terrestrial animals are highest in medium and poor broadleaf evergreen forests except insects. Although some numbers of species observed at each habitat are less than 5; thus, the Central Limit Theorem may not apply and the resultant  $\chi^2$  may be invalid, many species and records in the poor and medium broadleaf evergreen forests were observed. The dominance of species and records in these two forest types would be associated with their size, about 1,872 ha and 1,445 ha, respectively, that took more survey

effort than other habitats. The existence of the Red-shanked Douc and the Rhesus Macaque in the vegetation covered by *Merremia* due to these two species use leaves of *Merremia* spp. as a food source (mainly young leaves). For avifauna, previous studies also have reported that the evergreen forest with the dominance of species belonging to Dipterocarpaceae and Fagaceae has the highest diversity of birds (81 species). Meanwhile, grasslands and shrubs, and bare land, coastal sand dune have poor bird composition, only 28 and 23 species are recorded respectively [5]. Most reptiles and amphibians are distributed in evergreen forest since their life cycle is often associated with permanent streams that frequently exist in the evergreen forest in Son Tra Peninsula, especially lower elevation. Survey in 2013 on herpetofauna also recorded the majority of reptiles and amphibian in primary (13 amphibian and 25 reptile species) and secondary forests (16 amphibians, 33 reptiles) and low diverse in residential land (6 amphibians, 11 reptiles) and grassland/bare land (2 amphibians, 11 reptiles) [3]. In general, insects are most often found in open habitats. In fact, most of the time beetles' larvae and butterflies live on trees in the evergreen forest. However, at the mature stage, they fly into open feeding areas, or are attracted by night light traps in open fields.

#### 4. Conclusion

This study has recorded the distribution of 245 animal species in the terrestrial ecosystem of the Son Tra Peninsula. The numbers of species and records are significantly different among vegetation types and elevational zones. The diversity and abundance of terrestrial taxa in the evergreen broadleaf forest distributed below the 200m asl. shows that this area is very important to many animals in Son Tra Peninsula, including threatened species such as the Red-shanked Douc and Pygmy Slow Loris. Any development activities planned for this area should be considered with great care.

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#### Appendix 1. List of species recorded new to Son Tra Peninsula

Scientific name	Scientific name
<b>Mammalia</b>	<i>Surendra quercetorum</i> (Moore, 1857)
<i>Megaderma spasma</i> (Linnaeus, 1758)	<i>Cirrochroa Tyche</i> Felder & Felder, 1861
<i>Megaerops niphanae</i> Yenbutra & Felten, 1983	<i>Chersonesia risa</i> (Doubleday, [1848])
<i>Myotis hasseltii</i> (Temminck, 1840)	<i>Euripus nyctelius</i> (Doubleday, 1845)
<b>Aves</b>	<i>Euthalia aconthea</i> (Cramer, [1782])
<i>Cypsiurus balasiensis</i> Gray, 1829	<i>Junonia iphita</i> (Cramer, 1779)
<i>Aerodramus brevirostris</i> Horsfield, 1840	<i>Junonia lemonias</i> (Linnaeus, 1758)
<i>Falco amurensis</i> Radde, 1863	<i>Lebadea martha</i> (Fabricius, 1775)
<i>Picus chlorolophus</i> Vieillot, 1818	<i>Moduza Procris</i> (Cramer, 1777)
<i>Calliope calliope</i> (Pallas, 1776)	<i>Neptis columella</i> (Cramer, 1780)
<i>Phoenicurus aureoreu</i> (Pallas, 1776)	<i>Rhinopalpa polynice</i> (Cramer, 1779)
<i>Muscicapa griseisticta</i> (Swinhoe, 1861)	<i>Vargans sinha</i>
<i>Zoothera citrina</i> (Latham, 1790)	<i>Yoma sabina</i> (Cramer, 1780)
<i>Aegithina tiphia</i> (Linnaeus, 1758)	<i>Cepora nadina</i> (Lucas, 1852)
<i>Eudynamys scolopacea</i> (Linnaeus, 1758)	<i>Delias hyparete</i> (Linnaeus, 1758)
<i>Prinia rufescens</i> Blyth, 1847	<i>Pareronia anais</i> (Lesson, 1837)
<i>Mirafra erythrocephala</i> Salvadori and Giglioli, 1885	<i>Coelites nothis</i> (Westwood, [1850])
<b>Reptilia</b>	<i>Elymnias hypermnestra</i> (Linnaeus, 1763)
<i>Calotes emma</i> Gray, 1845	<b>Coleoptera</b>
<i>Ophiophagus hannah</i> (Cantor, 1836)	<i>Dorysthenes walkeri</i> Waterhouse, 1840
<b>Amphibia</b>	<i>Aulacophora</i> cf. <i>dorsalis</i> Boisduval, 1835
<i>Microhyla pulchra</i> (Hallowell, 1861)	<i>Aulacophora</i> cf. <i>lewisii</i> Baly, 1886
<i>Occidozyga martensii</i> (Peter, 1867)	<i>Aulacophora indica</i> (Gmelin, 1790)
<i>Leptolalax rowleyae</i> Nguyen, Poyarkov, Le, Vo, Phan, Duong, Murphy & Nguyen, 2018	<i>Longitarsus</i> sp.
<b>Insecta</b>	<i>Cicindela duponti</i> Dejean, 1826
<b>Lepidoptera</b>	<i>Hemisphaerota</i> cf. <i>cyanea</i> (Say, 1824)
<i>Euploea phaenareta</i> (Schaller, [1785])	<i>Micraspis</i> cf. <i>pusillus</i> Poorani, 2014

<i>Tirumala limniae</i> (Cramer, [1775])	<i>Mimela cf. splendens</i> Gyllenhal, 1817
<i>Castalius rosimon</i> (Fabricius, 1775)	<i>Anomala antiqua</i> Gyllenhal, 1817
<i>Chilades pandava</i> (Horsfield, 1829)	<i>Clinteria atra</i> Wiedemann, 1823
<i>Jamides bochus</i> Stoll, 1782	<i>Oryctes rhinoceros</i> (Linnaeus, 1758)
<i>Jamides celeno</i> (Cramer, 1775)	<i>Lesteva</i> sp.
<i>Loxura atymnus</i> (Cramer, 1782)	<i>Paederus fuscipes</i> Curtis 1826
<i>Megisba Malaya</i> (Horsfield, 1828)	

Note: \* alien species

### Appendix 2. Photos of some threatened species recorded in Son Tra Peninsular



*Pygathrix nemaeus*



*Nycticebus pygmaeus*



*Muntiacus vaginalis*  
(= *M. muntjak annamensis*)



Photo: Nguyễn Lục  
*Pittanympha*



*Physignathus cocincinus*



*Gecko gekko*



*Ptyas korros*



Photo: Dương Thanh Tùng  
*Ohphiophagus hannah*



*Ptyas muscosus*



*Python reticulatus*



*Coura mouhoti*



*Troides aeacus*

(The Board of Editors received the paper on 26/9/2019, its review was completed on 22/11/2019)