

**MINISTRY OF AGRICULTURE AND RURAL
DEVELOPMENT VIETNAM NATIONAL UNIVERSITY OF
FORESTRY**



STUDENT THESIS

**ASSESSMENT OF SPECIES DIVERSITY AND
DISTRIBUTION OF SNAKES (SERPENTES) IN BA VI
NATIONAL PARK, HANOI**

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ABSTRACT

This research was conducted to provide the checklist of snake species in Ba Vi National Park, Ha Noi, Vietnam. Total 20 species were recorded within survey from 24th July - 16th November 2018 and 12th April – 15th July 2019 in Ba Vi National Park. The number of snake species in BV NP has increased to 39. Remarkably, 9 new recorded species was described (*Boiga guangxiensis*, *Gonyosoma prasinum*, *Lycodon futsingensis*, *Lycodon ruhstrati abditus*, *Opisthotropis lateralis*, *Hebius chapaensis*, *Hebius boulengeri*, *Pareas hamptoni* and *Sinonatrix percarinata*) for the first time from Ba Vi National Park. The main threats to the snake fauna is created by tourism activities. Therefore, the research has recommended some solutions for reducing the threats consisting of managing, keeping and protecting snakes in Ba Vi National Park.



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TRƯỜNG ĐẠI HỌC LÂM NGHIỆP

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ABBREVIATIONS

IUCN	International Union for Conservation of Nature
Decree 06	Governmental Decree No 06/2019/ND-CP
RBVN	Vietnam Red Data Book
Et al	And others
a.s.l	Above sea level
VNUF	Vietnam National University of Forestry
BV-NP	Ba Vi National Park



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Chapter I. Introduction

Currently, there are about 3,789 species of snakes belonging to 520 genera and 20 families distributed in every continent on the world except Antarctica, and on most smaller land masses (Uetz et al. 2019). Despite their unwarranted reputation, snakes are critically important animals for our world. Snakes maintain balance in the food web and therefore keep ecosystems healthy. They provide humans an ecological service by controlling pest populations. Snakes are truly interesting and amazing animals, which are celebrated or worshiped in cultures around the globe. Yet, due to increased conflict with humans, many snakes species are under threat of extinction. There are many threats to snakes including habitat loss, road kill, human kill and poachers (Santos et al. 2008; Datta et al. (2018).

With the forest type is tropical forests, Vietnam is home for more than 200 snakes to live, each species has different ecological and color for adapt the condition and habitat (Uetz et al. 2019). In Vietnam, snakes distribute from the north to the south region. The threats of snake in Vietnam same with other country including habitat loss, hunting, poaching, snake wine (Somaweera & Somaweera 2010; Anna et al. 2016).

Ba Vi National Park (BV-NP) is not only known as the lungs of Hanoi, but also the home to hundreds of wildlife species, and many rare and precious species listed in the Red Book of Vietnam. BV-NP was forgotten by scientists until 2009 with the total snake is 30 species of 21 genera based on the record of Nguyen et al. (2009). Currently the information on vertebrates in this NP is very limited or almost unknown, especially snakes are a group of little concern.

Therefore, I conducted research on the topic: "*Assessment of species diversity and distribution of snakes (Serpentes) in Ba Vi National Park, Hanoi*". The main purpose of this study is to explore the diversity of snakes in the area mentioned above.

Chapter II. Literature Review

Snake fauna diversity in Southeast Asia

The number of snake species have slightly increase in some of Southeast Asia countries from 2010 up to now, including: Myanmar and Cambodia increase only 5 species of snake and bring the total is 176 and 102 respectively; Philippine, Malaysia and Laos increase 2, 4 and 6 species, respectively with total is 138 (Philippines), 220 (Malaysia) and 105 (Laos); Thailand has increased 9 species a total of 221 species; Vietnam and Indonesia have the highest increases of snakes in Southeast Asia with 21 species and total 244 for Vietnam, 20 species and total 360 for Indonesia. Three country Singapore, Brunei and Timor - Leste do not change anything (Uetz et al. 2019).

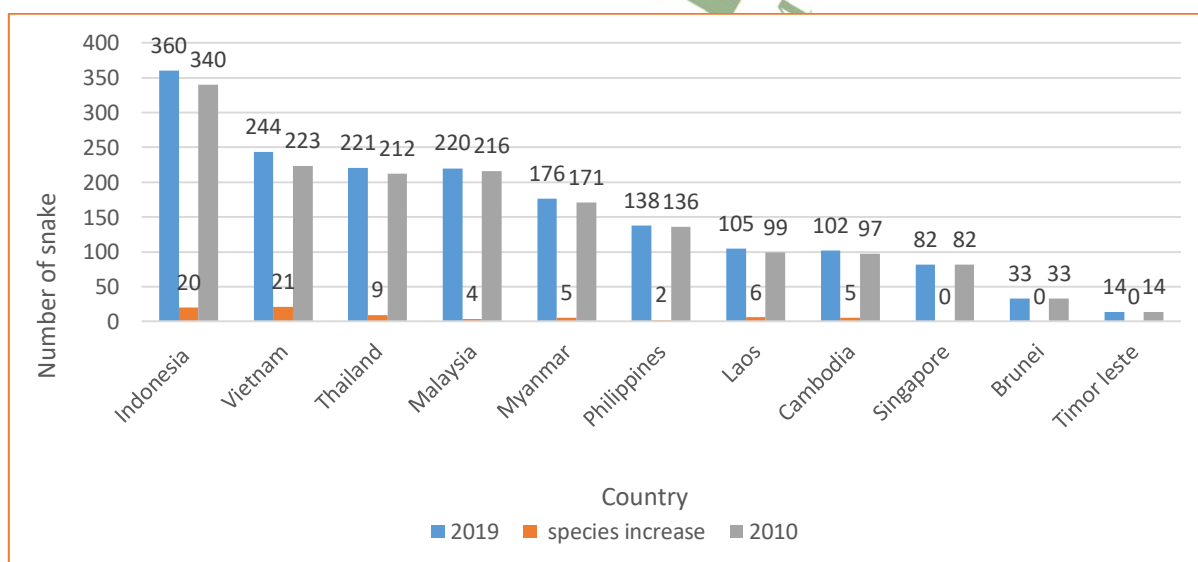


Figure 2.1. Diversity of snakes in Southeast Asia countries during 2010 - 2019

Snake fauna research in Vietnam

In 2019, the total number of snake species in Vietnam is 244 (Uetz et al. 2019). Snakes are widely distributed in many area of Vietnam including plains, midland, mountainous, nature forest, stream and river. The number of snake species has increased rapidly when new species have been described consecutive in recent years. Twenty-one snake species are found for nearly one decade (Table 2.1)

Table 2.1. List of new snake species in Vietnam during 2010-2019

No	Scientific name	Year	Location
1	<i>Calamaria concolor</i>	2010	Thua Thien - Hue
2	<i>Emydocephalus szczerbaki</i>	2011	Ba Ria - Vung Tau
3	<i>Opisthotropis cucae</i>	2011	Kon Tum
4	<i>Trimeresurus rubeus</i>	2011	South of Vietnam
5	<i>Homalopsis mereljcoxi</i>	2012	South of Vietnam
6	<i>Oligodon nagao</i>	2012	Cao Bang
7	<i>Azemiops kharini</i>	2013	Tam Dao
8	<i>Oligodon cattienensis</i>	2013	Dong Nai
9	<i>Cylindrophis jodiae</i>	2015	Central vietnam
10	<i>Oligodon arenarius</i>	2015	Ba Ria - Vung Tau
11	<i>Parafimbrios lao</i>	2015	Son La
12	<i>Oligodon condaoensis</i>	2016	Ba Ria - Vung Tau
13	<i>Oligodon culaochamensis</i>	2017	Quang Nam
14	<i>Opisthotropis voquyi</i>	2018	Bac Giang
15	<i>Parafimbrios vietnamensis</i>	2018	Lai Chau
16	<i>Calamaria dominici</i>	2019	Dak Nong
17	<i>Lycodon namdongensis</i>	2019	Thanh Hoa
18	<i>Achalinus juliani</i>	2019	Cao Bang
19	<i>Achalinus timi</i>	2019	Son La
20	<i>Achalinus emilyae</i>	2019	Quang Ninh
21	<i>Opisthotropis haihaensis</i>	2019	Quang Ninh

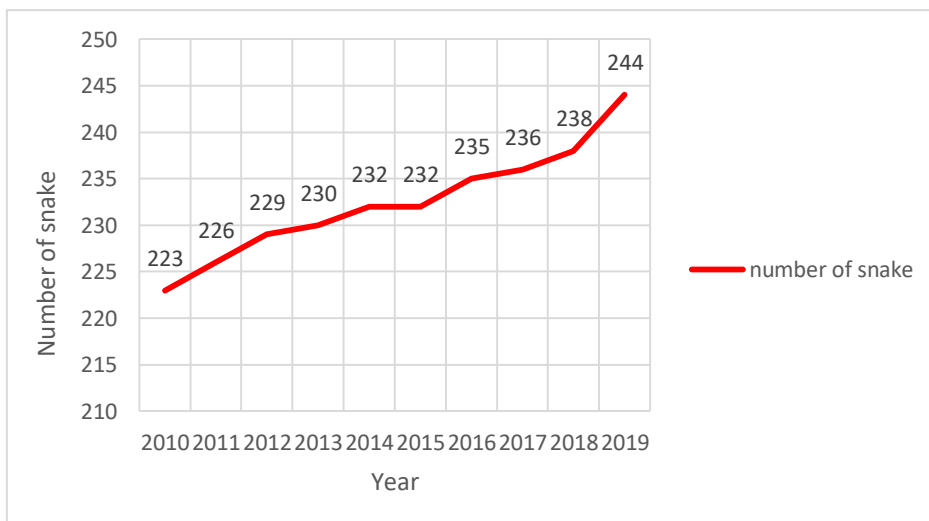


Figure 2.2. Number of snake increase over 9 years in vietnam

In 2005, the total number of snake in Vietnam is 172 species, according to Nguyen et al. (2005). The book Herpetofauna of Vietnam was published by Nguyen et al. (2009) noted that Vietnam has 192 species of snakes. Ziegler and Vu (2009) have published 54 species in Phong Nha - Ke Bang National Park and 4 years later, Luu et al. updated a list of 58 snakes for this National Park. In 2013, Pham et al. have published 44 species in Son La Province. Hoang et al., has published 7 snakes in Van Long wetland Nature Reserve and Nguyen et al., published 38 snake species in Xuan Lien Nature Reserve, Thanh Hoa Province in 2016. In 2017, Tran Thi Hong Ngoc reported 18 species of snakes in Trang An World Heritage - Natural Culture Area. In 2018, there are 2 papers dealing with snake species published including: Le et al. reported with 25 species in Yen Bai Province and Nguyen et al. reported 43 species in Hoa Binh Province. Recently in 2019, 6 new snake species have been published including: *Opisthotrips haihaensis* in Quang Ninh Province, *Calamaria dominici* in Dak Nong, *Achalinus juliani* in Cao Bang Province, *Achalinus timi* in Son La Province, *Achalinus emilyae* in Quang Ninh by Ziegler et al. (2019), and *Lycodon namdongensis* in Thanh Hoa Province by Luu et al. (2019). Also one short note published in the Herpetological Review about the diet of *Lycodon meridionalis* in BV-NP.

Chapter III. Goal, Objectives, and Research Methods

3.1 Goal

- To provide basic information about snake diversity and to recommend solutions for conservation of snake fauna in Ba Vi National Park.

3.2 Objectives

- To investigate the snake species composition in Ba Vi National Park.
- To identify the distribution of snake species across habitat types and elevations in the study site.
- To assess threats to snake fauna in the study site.
- To recommend solutions for conservation and management of snake fauna in the study site.

3.3 Research Methods

3.3.1 Study area

a. Location

Ba Vi National Park is located in Ba Vi district of Hanoi and Luong Son and Ky Son districts of Hoa Binh Province, with a total area of 12,023 ha, about 50 km from the west of Hanoi, Ba Vi is the park closest from Hanoi capital in Viet nam. There are three high peaks in the National Park: the highest is Dinh Vua at 1,296 m, followed by Tan Vien at 1,226 m and Ngoc Hoa at 1,120 m. Habitat of BV-NP is characterized by evergreen forest and mixed forest of coniferous and broadleaf at elevations above 600 m (Tran et al. 2001).

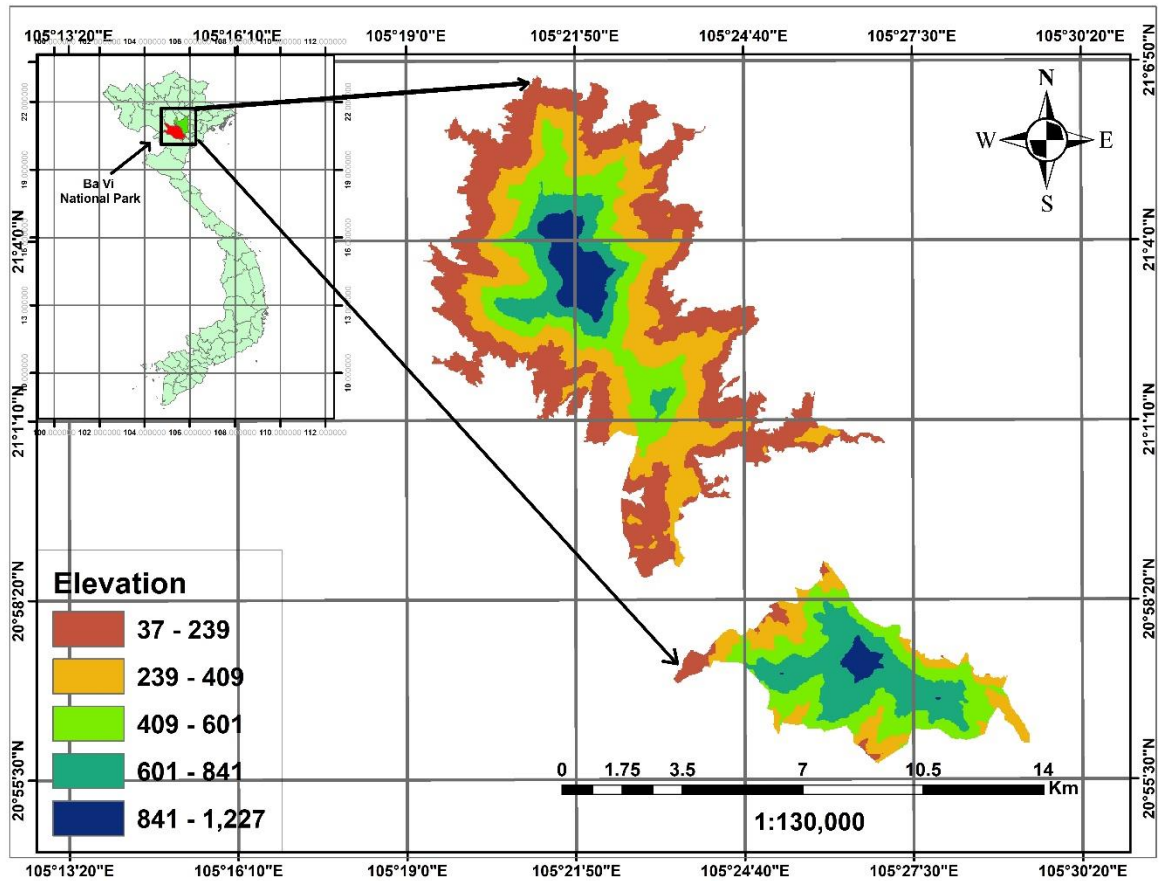


Figure 3. 1. Topography map of Ba Vi National Park



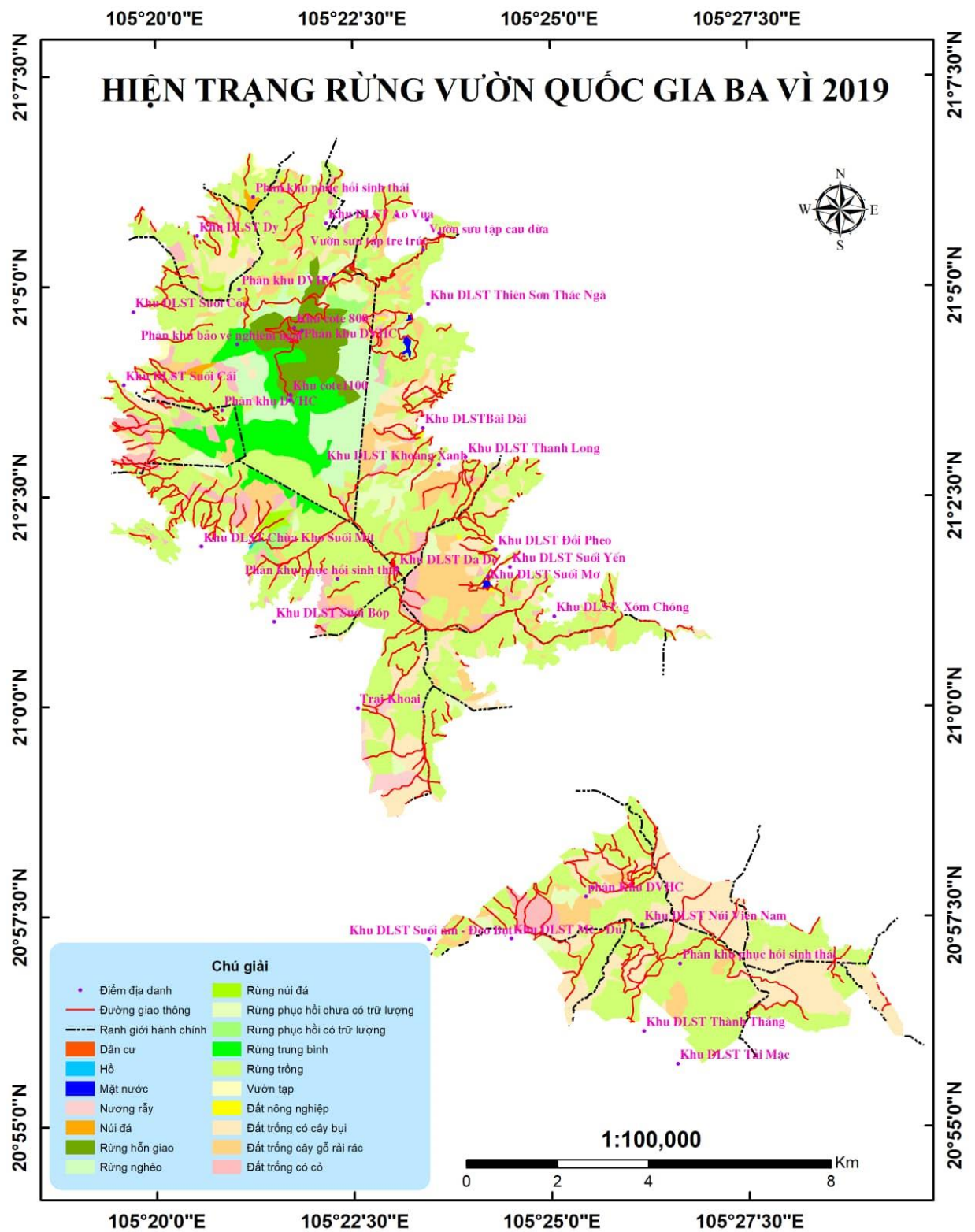


Figure 3. 2. Map of the forest status in Ba Vi National Park (make by Tran Quang Huy)

Coordinates:

Latitude: 20°55' - 21°07' North

Longitude: 105°18' - 105°30' East

The north is Ba Trai, Ba Vi, Tan Linh commune, Ba Vi district, Hanoi city.

The south is Phuc Tien, Dan Hoa of Ky Son district, Lam Son communes of Luong Son district, Hoa Binh Province.

The east is Van Hoa, Yen Bai communes of Ba Vi district, Yen Quang, Yen Trung, Yen Binh commune of Luong Son district, Tien Xuan commune of Thach That District, Dong Xuan Commune of Quoc Oai district, Hanoi city.

The west is Khanh Thuong, Minh Quang communes of Ba Vi district and Phu Minh of Ky Son district, Hoa Binh Province.

b. Topography

Ba Vi has medium and low mountains, there are including some high peak mountains such as: Vua peak (296m), Tan Vien peak (1227m), Ngoc Hoa peak (1131m), Vien Nam peak (1031m) and some lower peaks such as Hum cave peak 776, Gia De peak 714m

Ba Vi mountain range consists of two main ridges. The first ridges, which belong to the east-west from the Oi stream to bridge Dat, through the Vien and Lobster peak is long 9km. The second ridges is belonging to west –north – east – south from Yen Vien Son through the Tan Vien peak to Quyt mountain is 11 km long, and then extend to Vien Nam, Hoa Binh Province.

Ba Vi is the area have big rate of slope, the mean of slope is 25° and with the elevation above 400, the average of slope is 35° .

c. Climate

Ba Vi National Park have been effected by the north latitude factors, monsoon with the combination to make humid tropical climate there are dry and cold in winter. According to date recorded from Ba Vi hydrometeorology station the annual average temperature is 23.4°C , the lowest temperature is 2.7°C and the highest reach to 42°C . The elevation of 400m has an average temperature of 20.6°C , above 1,000 m the average temperature is about 16°C and sometimes in the winter temperature can decrease to 0.2°C . The annual precipitation is about 2,500 mm, mostly in July and August. The air humidity is about 86.1%, from

the 400m high there is no dry season here. With those characteristics of climate, this areas become a good resort and attract tourists from North Vietnam.

d. Fauna

According to the latest additional survey in 2008, the Vertebrate Fauna and Flora Area in BV-NP recorded 342 species. Among them, there are 3 endemic species and 66 rare species. Among 342 species recorded, 23 species have been collected or stored locally, 141 species are observed in the field and 183 species are interviewed by hunters or gathered through existing documents. There are 2 endemic species of BV-NP such as: *Thằn lằn tai Ba Vì* *Tropidophorus baviensis* and *Ếch vạch* *Chaparana delacouri*

Table 3.1: Diversity of wildlife in Ba Vi National Park

Classes	Species	Family	Order
Mammal	63	24	8
Bird	191	48	17
Reptiles	61	15	2
Amphibian	27	4	1
Total	342	91	28

e. Flora

According to the list of plants sampled and additional survey results in 2008, Ba Vi National Park has so far had 1201 plant species belonging to 649 genera and 160 families. Compared to the results of the survey in 1998, the number of family, genus and species in 2008 increase to 61 families, 177 genera and 389 species.

3.3.2 Field surveys and data collection

a. Preperation and Equipment

Before conducting field survey, we have to study, identify snake species, searching information from documents and internet related to investigation and composition of snake in that area. Besides, the map linked to the study area and materials about snake identification were also prepared in advanced. Therefore, there were some special tools and chemicals for survey activities such as:

surgical instruments, bottle for preserving specimens, camera, headlamp, etiket, GPS, ethanol, ethyl acetate, cloth bag, snake tong and snake hook.

b. Field surveys

- Site selection: Survey sites were selected at elevation ranges from 400 to 1200 m above sea level (a.s.l.).

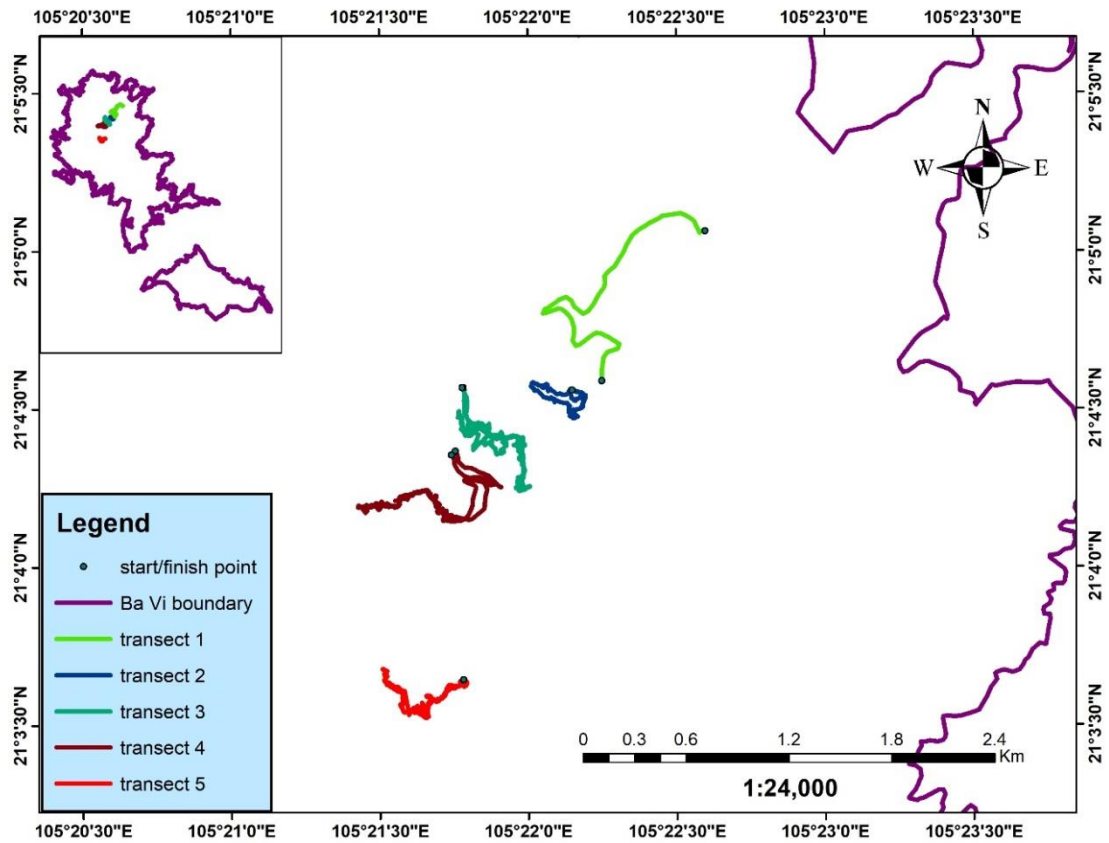


Figure 3. 3. Map of transect surveys in the study site



Table 3.2. Coordinate of survey transects

Transect	Location	Coordinate (start - finish point)
Transect 1	Elevation 400: Ngoc Hoa stream	21.08437 N/ 105.376617 E – 21.076492 N/ 105.370811 E
Transect 2	Elevation 600: French camping area	21.075972 N/ 105.369125 E
Transect 3	Elevation 800: Ruins of Old French Church	21.076126 N/105.363014 E – 21.076126 N/105.362961 E
Transect 4	Elevation 1000:	21.072584 N/ 105. 362335 E – 21.072733 N/ 105.36261 E
Transect 5	Elevation 1200: French Era Political Prison (Ruins)	21.060711 N/ 105. 362999 E– 21.060726 N/ 105.363029 E

c. Data collection

- Main collection time from 19:00 pm to 23:00 pm
- Collecting method: All specimens were caught by hand (if non-venomous) or by snake tong and snake hook (if venomous). After that taking photographs and note information of species in survey note, the common species were released to their environment. Individuals with potential characteristics were collected for taxonomic and identification at the laboratory of VNUF
- Specimen fixing and preserving:
 - Anaesthetization: Within 24 hours after collecting, the selected animals were anaesthetized and euthanized in a closed vessel with a piece of cotton wool containing ethyl acetate (Simmons, 2002).
 - Collection tag: Every collected specimen was labeled directly with a tag providing information about the locality (e.g. BV), field number and the date of collection. Later, it was also labeled with a museum number (VNUF).

- Fixing in 80% ethanol for 4-6 hours, and then transferred to 70% ethanol for permanent storage. Tissue samples were preserved separately in 95% ethanol for further study.

- Specimen management: Collected specimens were deposited in the collection of Vietnam National University of Forestry (VNUF), Hanoi, Vietnam

- The following abiotic data was recorded for every single collected individual.

- Geographic coordinates and elevation will be tracked with GPS Garmin 62st or GPSmap 78s. Air temperature and humidity were measured with a digital compact thermos-hygro-barometer (Atech, model: KW307-CSJ, accuracy 0.1% for temperature, 1% for relative humidity). Additionally, information regarding the habitat as well as the distance to the ground and the presence of a stream or trail will be recorded.

All the data in the survey time was recorded in a survey note and survey sheet (Table 3.3 & 3.4)

Table 3.3: Field survey note

Transect name.....	Day.....	month....	year 2019
Species name.....	name of GPS.....		
Coordinate.....	elevation.....m		
Temperature.....C ⁰ ,	Humidity %.....	Time.....:'
Habitat.....	Specimens metaphor.....		

Table 3.4. Field survey sheet

Name	Field number	Sex	Time	Coordinate	Habitat	Date	Temperature	Humidity	Note

d. Data analysis

- **Morphological analysis**

The morphological examination of the collected specimens from Ba Vi National Park were identified in the laboratory of the VNUF). Morphometric measurements will taken with an Etopoo digital caliper to the nearest 0.1 mm and the number of scale will counted by used the electron microscope (Leica S6E). Terminology of the morphometric characters, followed Manthey & Grossmann (1997).

Table 3.5: Abbreviations of main morphological characteristics

No	Abbreviation	Explanation
1	SVL	Snout-vent length (from tip of snout to anterior margin of cloacal)
2	TaL	Tail length (from posterior margin of cloacal to tip of tail)
3	TL	Total length (from tip of snout to tip of tail)
4	TaL/TL	Ratio of tail length divide total length
5	HL	Head length (from the tip of snout to the back of mandible)
6	HW	Head width (the largest pattern of the head)

Table 3.6: Abbreviations of scales in snake group

No	Abbreviation	Explanation
1	F	Frontal scale
2	In	Internasal scale
3	L	Loreal scales
4	SL	Supralabial scales
5	IL	Infralabial scales
6	M	Mental scale
7	N	Nasal scale
8	P	Parietal scale
9	Pf	Prefrontal scale
10	PostOc	Postocular scales
11	Preoc	Preocular scales
12	R	Rostral scales
13	Atem	Anterior temporal
14	Ptem	Posterior temporal
15	VEN	Ventral scales
16	SC	Subcaudal scales
17	DSR	Dorsal scale rows

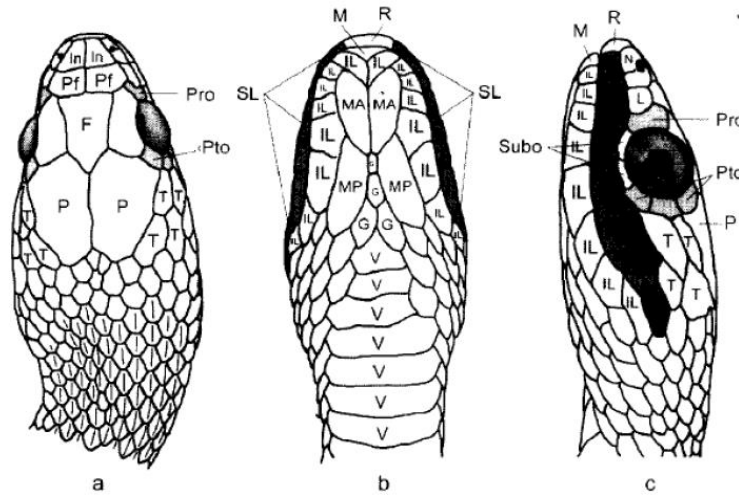


Figure 3. 4: Scale in head pattern of snake (Manthey & Grossmann, 1997)

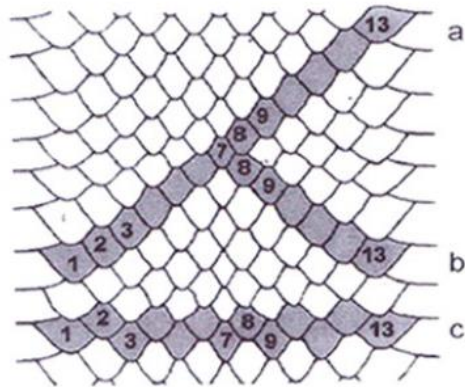


Figure 3. 5: Body scale count (Manthey & Grossmann, 1997)

a) Oblique count, b) V-shape count, c) Alternate count

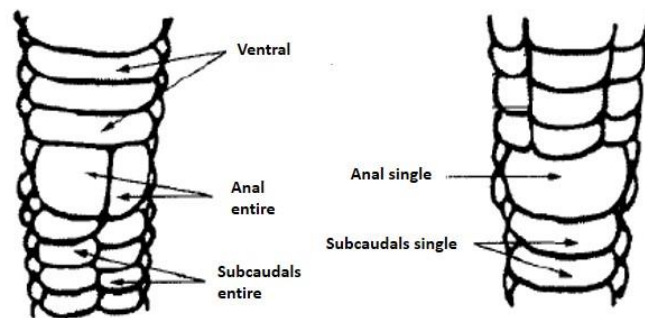


Figure 3.6: Ventral, subcaudal and cloacal scale (Manthey & Grossmann, 1997)

- ***Taxonomical analysis***

Morphological characters of specimens from study sites were also compared with data from the literature, such as species descriptions, identification keys and reviews of Vietnam and neighboring countries: Smith (1943), Ziegler et al. (2008); Vogel et al. (2009); Hecht et al. (2013); Luu et al. (2013); Pham et al. (2013); Le et al. (2014); Ziegler et al. (2014); Le et al. (2015); Do et al. (2016); Gawor et al. (2016); Nguyen et al. (2016); Pham et al. (2016); Neang et al. (2017); Pham et al. (2017); Le et al. (2018); Nguyen et al. (2018); Phan et al. (2018); Luu et al. (2019).

Usings keys to species of snake families: Ziegler et al. (2007); Nguyen Van Sang (2007); Davil et al. (2011); Ziegler et al. (2017); Luu et al. (2019).

3.3.3 Distribution characterisitic of snakes

- ***Distribution by elevation***

According to Bain & Hurley (2011), based on the nature condition including topography and vegetation, they divided the elevation in the area of Indo-Chinese into 2 types of elevation: above 800 m and below 800 m. In this research, base on the topography in the study site, four elevation ranges are divided : from 400-600 m; from 600-800 m; from 800-1000 m; from 1000-1200 m.

Table 3.7. Distribution of snakes along elevation gradients

No	Scientific name	Vietnamese name	Elevation			
			400-600 m	600-800 m	800-1000 m	1000-1200 m
1						
2						

- ***Distribution by habitat***

Based on the UNESCO vegetation classification in 1973 and the extent of human impact on vegetation cover according to the document “Manual notebook for biodiversity survey and monitoring (2003), and based on the current forest status in BV-NP, we divided into 2 types of habitat including: nature forest and stream.

Table 3.8. Macrohabitat selection by snakes in Ba Vi NP

No	Scientific name	Common name	Habitat	
			Nature forest	Stream
1				
2				

• ***Distribution by microhabitat***

Based on the record position of snakes including: on the ground, on the tree, on the wall, road, under the stream for assessments the living area of snakes.

Table 3.9. Microhabitat selection by snakes in Ba Vi NP

No	Scientific name	Vietnamese name	Microhabitat				
			On the ground	On the tree	On the wall	Under the stream	Road
1							
2							

3.3.4. Evaluate species have conservation value

Species have conservation value are those listed in some document such as: Vietnam Red Data Book – RBVN (2007); The IUCN Red List of Threatened Species – IUCN (2019), species are currently recorded only in Vietnam are considered endemic species have name in appendix of Governmental Decree No 06/2019/ND-CP – Degree 06(2019).

Table 3.10. List of threatened species

No	Scientific name	Conservation value		
		IUCN (2019)	Degree 06	RVBN (2007)
1				
2				

3.3.5. Conservation issues

Evaluate factors that directly impact on snakes such as: loss and degradation habitat, overexploitation. The assessment was conducted through on filed observations. Proposing recommendations for conservation of snakes focusing on: Protecting and restoring species habitats, controlling hunting.

Chapter IV: Results and Discussions

4.1. Snake species composition in Ba Vi National Park

4.1.1. List of snakes from Ba Vi National Park

Twenty two specimens were collected during field surveys from July 24th 2018 to July 15th 2019. Based on morphological examination, 20 species of 23 genera and 6 families were identify including: Colubridae, Pseudoxenodontidae, Elapidae, Homalopsidae, Pareidae and Viperidae. This study found 9 new recorded snake species for the first time for BV-NP. Combination with the snake number of Nguyen et al. (2009). This findings bring the total snake number to 39.

Table 4.1. List of snakes record from BV-NP

No	Scientific name	Vietnamese name	Nguyen et al. (2009)	This study	New Record
	Reptilia	Lớp bò sát			
	Squamata	Bộ có vảy			
	Colubridae	Họ Rắn nước			
1	<i>Ahaetulla prasina</i> (Boie, 1827)	Rắn roi thường	+		
2	<i>Boiga quangxiensis</i> Wen, 1998	Rắn rào quang tây		+	+
3	<i>Boiga multomaculata</i> (Boie, 1827)	Rắn rào đốm	+		
4	<i>Calamaria pavimentata</i> Duméril, Bibron & Duméril, 1854	Rắn mai gằm lát	+		
5	<i>Calamaria septentrionalis</i> Boulenger, 1890	Rắn mai gằm bắc	+	+	
6	<i>Coelognathus radiatus</i> (Boie, 1827)	Rắn sọc dưa	+		
7	<i>Gonyosoma boulengeri</i> (Mocquard, 1897)	Rắn vòi	+		
8	<i>Gonyosoma prasinum</i> (Blyth, 1854)	Rắn sọc xanh		+	+
9	<i>Hebius boulengeri</i> (Gressitt, 1937)	Rắn sãi bầu-len-giơ		+	+
10	<i>Hebius chapaensis</i> (Bourret, 1934)	Rắn bình mũi sapa		+	+
11	<i>Hebius khasiensis</i> (Boulenger, 1890)	Rắn sãi kha-si	+		
12	<i>Hebius sauteri</i> (Boulenger, 1909)	Rắn sãi sau-te	+		
13	<i>Lycodon futsingensis</i> (Pope, 1928)	Rắn khuyết futsing		+	+
14	<i>Lycodon meridionalis</i> (Bourret, 1935)	Rắn lệch đầu kinh tuyến	+	+	
15	<i>Lycodon ruhstrati abditus</i> Vogel, David, Pauwels, Sumontha, Norval, Hendrix, Ru & Ziegler, 2009	Rắn khuyết đốm		+	+
16	<i>Lycodon subcinctus</i> Boie, 1827	Rắn khuyết đai	+		
17	<i>Oligodon cinereus</i> (Günther, 1864)	Rắn khiếm xám	+		
18	<i>Oligodon eberhardi</i> Pellegrin, 1910	Rắn khiếm e-be-hác	+		
19	<i>Oligodon fasciolatus</i> (GÜNTHER, 1864)	Rắn khiếm đuôi	+		

		vòng			
20	<i>Opisthotropis lateralis</i> Boulenger, 1903	Rắn trăn bên		+	+
21	<i>Ptyas korros</i> (Schlegel, 1837)	Rắn ráo thường	+		
22	<i>Ptyas major</i> (Günther, 1858)	Rắn đai lớn	+		
23	<i>Ptyas multicinctus</i> (Roux, 1907)	Rắn nhiều đai	+	+	
24	<i>Ptyas nigromarginata</i> (Blyth, 1854)	Rắn ráo xanh	+		
25	<i>Rhabdophis callichroma</i> (Bourret, 1934)	Rắn hoa cỏ ba vì	+		
26	<i>Rhabdophis subminiatus</i> (Schlegel, 1837)	Rắn hoa cỏ nhỏ	+	+	
27	<i>Sinonatrix percarinata</i> (Boulenger, 1899)	Rắn hoa cân vân đen		+	+
28	<i>Xenochrophis flavipunctatus</i> (Hallowell, 1860)	Rắn nước	+		
	Pseudoxenodontidae	Họ rắn hổ núi			
29	<i>Pseudoxenodon bambusicola</i> Vogt, 1922	Rắn hổ xiên tre	+	+	
	Elapidae	Họ rắn hổ			
30	<i>Bungarus fasciatus</i> (Schneider, 1801)	Rắn cạp nong	+		
31	<i>Naja atra</i> Cantor, 1842	Rắn hổ mang trung quốc	+	+	
32	<i>Ophiophagus hannah</i> (Cantor, 1836)	Rắn hổ chúa	+		
33	<i>Sinomicrurus macclellandi</i> (Reinhardt, 1844)	Rắn lá khô thường	+	+	
	Homalopsidae	Họ rắn ri			
34	<i>Hypsiglossus plumbeus</i> (Boie, 1827)	Rắn bông chì	+		
	Pareidae	Họ rắn hổ mây			
35	<i>Pareas hamptoni</i> (Boulenger, 1905)	Rắn hổ mây hampton		+	+
36	<i>Pareas margaritophorus</i> (Jan, 1866)	Rắn hổ mây ngọc	+	+	
	Viperidae	Họ rắn lục			
37	<i>Ovophis monticola</i> (Günther, 1864)	Rắn lục núi	+	+	
38	<i>Protobothrops mucrosquamatus</i> (Cantor, 1839)	Rắn lục cườm	+	+	
39	<i>Trimeresurus albolabris</i> Gray, 1842	Rắn lục mép trắng	+	+	

The most diverse family is Colubridae with 28 species and 13 genera (including: *Ahaetulla*, *Boiga*, *Calamaria*, *Coelognathus*, *Gonyosoma*, *Hebius*, *Lycodon*, *Oligodon*, *Opisthotropis*, *Ptyas*, *Rhabdophis*, *Sinonatrix*, *Xenochrophis*). Next is Elapidae with 4 species and 4 genera (including: *Bungarus*, *Naja*, *Ophiophagus*, *Sinomicrurus*). Viperidae with 3 species and 3 genera (including: *Ovophis*, *Protobothrops*, *Trimeresurus*). Pareidae with 2 species and 1 genus (*Pareas*). Pseudoxenodontidae with 1 species and 1 genus (*Pseudoxenodon*) and Homalopsidae also with 1 species and 1 genus (*Hypsiglossus*).

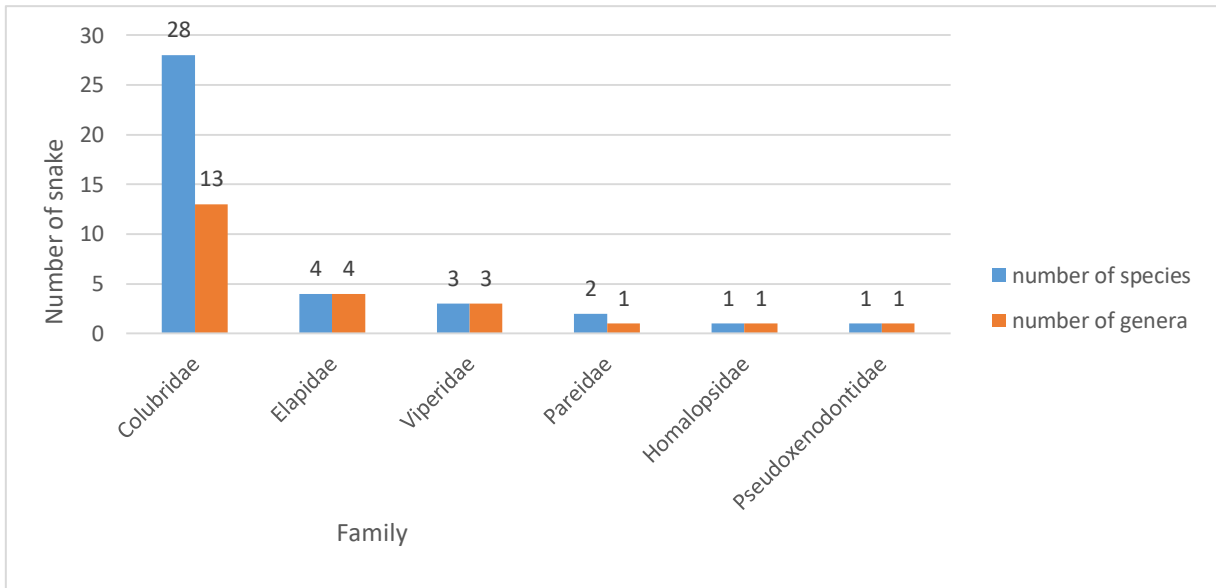


Figure 4.1. Snake diversity in BV-NP by family and genus

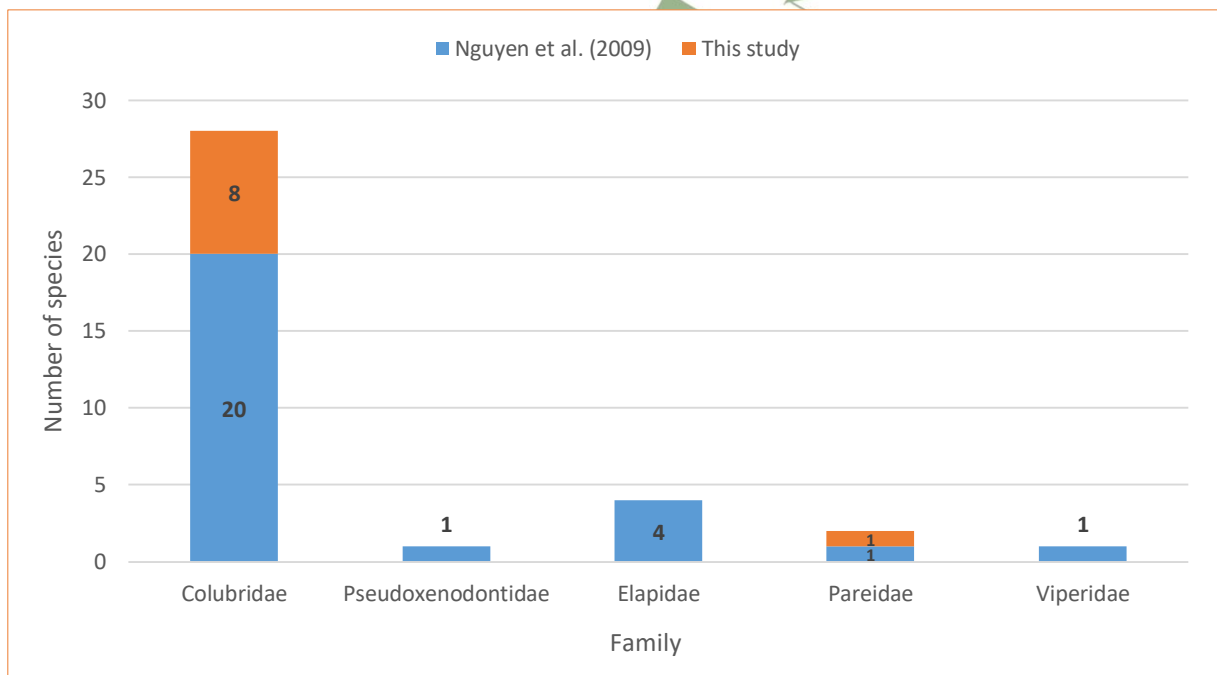


Figure 4.2. New recorded snake species in comparison with previous document

Compare with the previous document from Nguyen et al. 2009. This study has recorded eight new species distribution of family Colubridae and bring the total into 28 species for BV-NP including: Guangxi Cat Snake *Boiga guangxiensis*; Green bush ratsnake *Gonyosoma prasinum*; Boulenger's Keelback *Hebius boulengeri*; Sapa Flat-nosed Snake *Hebius chapaensis*; Futsing Wolf Snake *Lycodon futsingensis*; Mountain Wolf Snake *Lycodon ruhstrati abditus*; Tonkin Mountain Keelback *Opisthotropis lateralis*; Eastern Water Snake *Sinonatrix percarinata*. Not only family Colubridae but also family Pareidae has

recorded one new species distribution (Hampton's Slug Snake *Pareas hamptoni*) in BV-NP.

4.1.2. New discovery for science

The diet of the *Lycodon meridionalis* in BV-NP: At 20:38 pm on 28th July 2018, in Ruins of Old French Church of Ba Vi National Park, Hanoi, Vietnam (21.07322°N, 105.35342°E, WGS 84; 801 m elev.), we observed an adult female *L. meridionalis* (SVL = 725.0 cm; tail length = 205.0 cm) on the branches of a tree, about 1.5 m above the ground in the process of consuming an adult male *A. lepidogaster*. At the time we saw the snake, it was swallowing the head of the *A. lepidogaster* and wrapping two coils around the prey at mid-body. We intervened to capture the snake when it began ingesting its prey. The specimen was deposited in the collections of the Vietnam National University of Forestry (VNUF), Hanoi, Vietnam (VNUF RBV 2018.17). The diet of the *Lycodon meridionalis* is virtually unknown. So we provide a record about the diet of *L. meridionalis* at Ba Vi National Park, Hanoi, Vietnam (Luu et al. 2019).



Figure. 4.3. An adult female *Lycodon meridionalis* consuming an adult male *Acanthosaura lepidogaster* on the branches of a tree, Ba Vi National Park, Hanoi, Vietnam. Photo by Vinh. Q. Luu

4.1.3. New records of snakes from BV-NP

Nine new recorded snake species for BV-NP have been discovered comprising: Rắn rào quảng tây *Boiga quangxiensis*, Rắn sọc xanh *Gonyosoma prasinum*, Rắn bình mũi sapa *Hebius chapaensis*, Rắn sãi bầu-len-giơ *Hebius boulengeri*, Rắn khuyết futsing *Lycodon futsingensis*, Rắn khuyết đốm *Lycodon ruhstrati abditus*, Rắn trán bên *Opisthotropis lateralis*, Rắn hoa cân vân đen *Sinonatrix percarinata*, Rắn hổ mây ham-ton *Pareas hamptoni*. This study also provide information of 9 species are new recorded for BV-NP, the description of each species morphology is presented below:.

Family Colubridae OPPEL, 1811

1. *Boiga quangxiensis* WEN, 1998

Guangxi Cat Snake / Rắn rào quảng tây

Specimen examined (n=1): one adult female, VNUF R.2018.7 (field number: BV.18.7) collected on 6 October 2018 in the ancient church area (21°04'421"N/105°21'865"E, elevation 801 m a.s.l) by V. Q. Luu et al.

Morphological characters: The specimen from BV-NP agreed well with the description of Ziegler et al. (2007): SVL 1290 mm, TaL 435 mm; head longer than wide (HL 31 mm, HW 21.1 mm), distinct from neck; pupil round; internasal shorter than prefrontal; loreal 1/1; preocular 1/1; postoculars 2/2; anterior temporals 2/2, posterior temporals 2/3; supralabials 8/8, third to fifth in contact with the eye, eighth largest; infralabials 13/12, third to fifth in contact with the eye, eighth largest; first to fourth (left side) and first to third (right side) bordering chin shields; dorsal scale rows 23–21–15, smooth; ventrals 270; cloacal single; subcaudals 145, divided.



Figure 4.4: (A) and (B) dorsal views of *Boiga quangxiensis* (VNUF R.2018.7)

Photos by Oanh. V. Lo

Coloration in life: Dorsum pale brown, with irregular black cross-bars, venter greyish-white.

Ecological notes: The specimen was found at 20:09 while crawling on the forest ground near a tourist road.

Distribution: In Vietnam, this species has been recorded from Lao Cai, Cao Bang, Lang Son, Tuyen Quang, Thai Nguyen, Vinh Phuc, Bac Giang, Quang Binh, Quang Nam, Phu Yen, Kon Tum, Gia Lai, Lam Dong, Tay Ninh, Dong Nai (Nguyen et al. 2009; Do et al. 2016; Phan et al. 2018). Elsewhere, this species is known from southern China and Laos (Nguyen et al. 2009).

2. *Gonyosoma prasinum* (BLYTH, 1854)

Green bush ratsnake / Rắn sọc xanh

Specimen examined (n=1): one adult female, VNUF R.2018.30 (field number: BV3.18.10) collected on 15 November 2018 in the ancient church area (21°04'363"N/105°21'886"E, at an elevation of 805 m) by V. Q. Luu et al.

Morphological characters: The specimen from BV-NP agreed with the description of Hecht et al. (2013), SVL 820 mm, Tal 330 mm; head longer than wide (HL 30.9 mm, HW 16 mm), head distinct from neck; pupil round; internasal suture 1.6 mm; prefrontal suture 4.3 mm; loreal 1/1, not touching the eye; preocular 1/1; postoculars 2/2; anterior temporals 2/2, posterior temporals 2/2; supralabials 9/9, fourth to sixth in contact with the eye, eighth largest; infralabials 10/10; first to fourth (both sides) bordering chin shields; dorsal scale rows 21–19–15, keeled; ventrals 197; cloacal divided; subcaudals 106, divided.

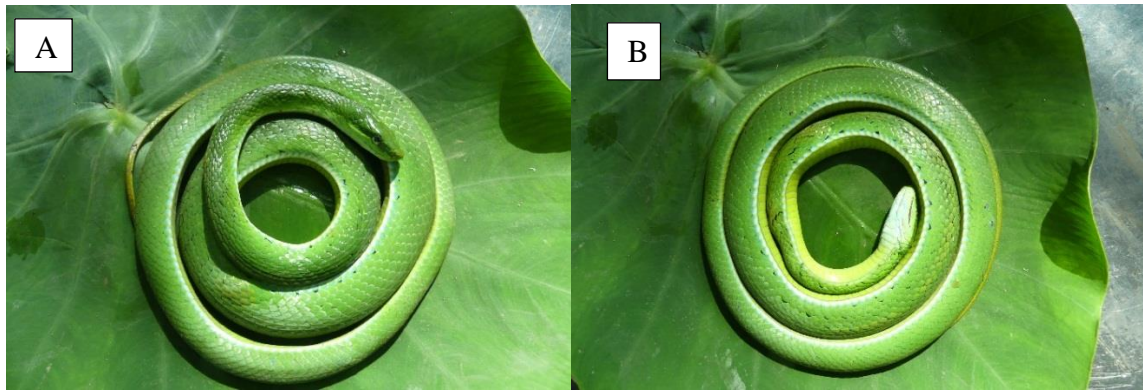


Figure 4.5: (A) Dorsal and (B) ventral views of *Gonyosoma prasinum* (VNUF R.2018.30).

Photos by Oanh. V. Lo

Coloration in life: Dorsal surface of head, back and tail green. The upper lip, lower throat, venter and lower surface of tail light green. Each side of the ventrolateral fold has a pale whitish stripe that runs from the neck to cloaca.

Ecological notes: The specimen was found in the evening on the wall of the Ruins of Old French Church

Distribution: In Vietnam, this species was reported from Lao Cai, Yen Bai, Bac Kan, Thai Nguyen, Bac Giang, Vinh Phuc, Nghe An, Thanh Hoa, Quang Binh, Gia Lai. (Nguyen et al. 2009; Hecht et al. 2013; Le et al. 2018). Elsewhere, the species is known from India, Southern China, Myanmar, Laos, Thailand, Malaysia (Nguyen et al. 2009).

Remarks: The specimen from Ba Vi differs from those in the descriptions of Smith (1943) and Hecht et al. (2013) by having more dorsal scale rows at neck (21–19–15 versus 19–19–15).

3. *Hebius boulengeri* (GRESSITT, 1937)

Boulenger's Keelback / Rắn sãi bầu-lên-gơ

Specimen examined (n=1): one adult female, (BV2.19.03) collected on 6th June 2019 (21°04'409"N/105°21'902"E, at an elevation of 805 m), by V. Q. Luu et al.

Morphological characters: the specimen from BV-NP agreed with the description of Ziegler et al. (2007); Nguyen et al. (2016); Le et al. (2018) : SVL 410 mm, Tal 150 mm; head longer than wide (HL 17.3 mm, HW 9.87 mm), distinct from the neck; pupil round; loreal 1/1, not touching the eye; preocular

1/1; postoculars 1/1; anterior temporals 1/2, posterior temporals 2/2; supralabials 9/9, fourth to sixth in contact with the eye, 8th largest; infralabials 10/10, first to seventh (both sides) bordering chin shields; dorsal scale rows 19–19–17, strongly keeled except outer row smooth ; ventrals 146; cloacal undivided; subcaudals 60, divided.

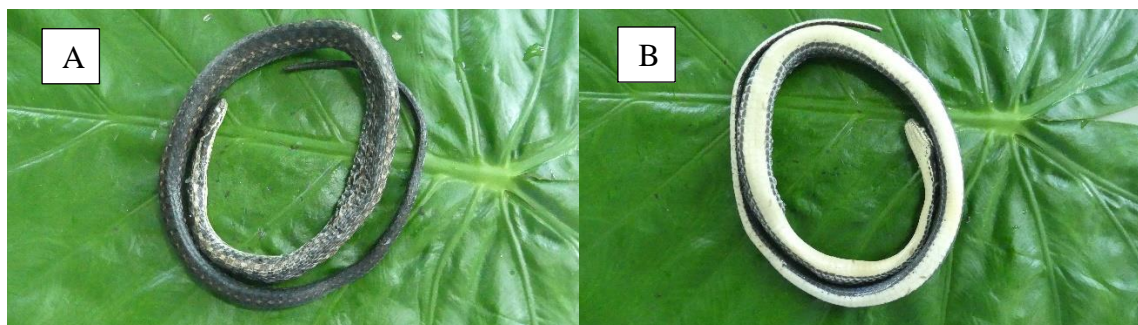


Figure 4.6:(A) Dorsal and (B) ventral views of *Hebius boulengeri* (BV2.19.03) in preservative. Photos by Tuong, S. Dinh

Coloration in preservative: Dorsal surface of body dark grey, dorsolateral stripe extends from the neck to the base of the tail. Posterior supralabials black with a median elongated cream blotch or streak, forming a postocular stripe extending on the neck; anterior supralabials white; first dorsal scale row smooth. The venter uniformly cream (Ziegler et al. 2007, Nguyen et al. 2016).

Ecological notes: The specimen was found in the evening on the ground. The surrounding habitat was nature forest, big tree, soil mountain and shrub.

Distribution: In Vietnam, this species is known from Lao Cai and Ha Giang provinces southwards to Dak Lak and Lam Dong provinces. Elsewhere, the species is recorded from China, Laos, Cambodia, and Thailand (Nguyen et al. 2009; Nguyen et al. 2016; Le et al. 2018)

Remarks: The specimen from Ba Vi differs from the descriptions of Nguyen et al. (2016) by having more fewer postocular (1 versus 3) and more posterior temporals (2 versus 1), cloacal divided (versus entire).

4. *Hebius chapaensis* (BOURRET, 1934)

Sapa Flat-nosed Snake / Rắn bình mũi sa pa

Specimen examined (n=1): one adult female, VNUF R.2018.8 (field number: BV.18.8) collected on 15th November 2018 (21°04'821"N/105°22'190"E, at an elevation of 402 m), by V. Q. Luu et al.

Morphological characters: the specimen from BV-NP agreed with the description of Le et al. (2018): SVL 440 mm, Tal 140 mm; head longer than wide (HL 13.6 mm, HW 8.82 mm), distinct from the neck; pupil round; loreal 1/1, not touching the eye; preocular 2/2; postoculars 2/2; anterior temporals 1/1, posterior temporals 2/2; supralabials 9/9, fifth to sixth in contact with the eye, 7th largest; infralabials 10/10, first to fifth (both sides) bordering chin shields; dorsal scale rows 17–17–17, feebly keeled; scales of the outer row enlarged; ventrals 170; cloacal divided; subcaudals 70, divided.



Figure 4.7: (A) Dorsal and (B) ventral views of *Hebius chapaensis* (VNUF R.2018.8).

Photos by Vinh. Q. Luu

Coloration in life: Dorsal surface of head, body and tail blackish grey, with two broader light yellow dorsolateral stripes along the body; ventral surface and lower surface of tail black.

Ecological notes: The specimen was found in the evening in a stream while being kept by a crab.

Distribution: In Vietnam, this species was reported from Lao Cai, Son La, and Yen Bai provinces. Elsewhere, the species is known from China (Uetz et al. 2019).

Remarks: *Pararhabdophis chapaensis* was originally described from Sa Pa, Lao Cai Province by Bourret (1934) and it was considered as a poorly known

species, known only from northwestern Vietnam and Yunnan Province of China. This species was recently transferred to the genus *Hebius* by Kizirian et al. (2018).

5. *Lycodon futsingensis* (POPE, 1928)

Futsing Wolf Snake / Rắn khuyết fut-sing

Specimens examined (n=3): three adult male, VNUF R.2018.5 (field number: BV.18.5) collected on 6th October 2018 in the ancient church area (21°04'383"N/105°21'856"E, at an elevation of 800 m), (BV2.19.02) collected on 6th June 2019 (21°04'529"N/105°21'862"E, at an elevation of 741 m) by V. Q. Luu and (BV4.19.01) collected on 13th July 2019 (21°06'994"N/105°35'772"E, at an elevation of 1068 m) by Ngoan. V. Ha and Tuong. S. Dinh.

Morphological characters: the specimen from BV-NP agreed well with the description of Hecht et al. (2013); Luu et al. (2013); Nguyen et al. (2016); Nguyen et al. (2018); Luu et al. (2019): SVL 680–580–650 mm, Tal 160–160–120 mm; head distinct from neck; pupil round; nasal divided; loreal 1/1, not touching the eye; preocular 1/1; subocular absent; postoculars 2/2; anterior temporals 2/2, posterior temporals 2/2 or 3/3; supralabials 8/8, third to fifth in contact with the eye, sixth or seventh largest; infralabials 10/10, first to third (left side) and first to fifth (right side) bordering chin shields; dorsal scale rows 17–17–15, smooth; ventrals 204–198–195; cloacal single; subcaudals 74–79–45, divided.



Figure 4.8: (A) Dorsal and (B) ventral views of *Lycodon futsingensis* (VNUF R.2018.5).

Photos by Oanh. V. Lo

Coloration in life: Dorsum chocolate brown with (29–31) white brown bands on the body and (7–13) bands on the tail. Ventral surface white with dirty brown marbling, dark brown posteriorly.

Ecological note: The specimen was found at the evening on the forest ground. The surrounding habitat was nature forest and banana forest. The relative temperature was about 22.6 - 25.5 °C and the humidity 49 - 60%.

Distribution: In Vietnam, this species was reported from Lao Cai, Ha Giang, Cao Bang, Quang Ninh, Bac Giang, Vinh Phuc, Son La, Hoa Binh, Thanh Hoa, Ha Tinh, Quang Binh, Thua Thien Hue, Da Nang. Elsewhere, the species is known from China, Laos, Japan, Taiwan, Myanmar (Nguyen et al. 2009; Hecht et al. 2013; Luu et al. 2013; Nguyen et al. 2016; Pham et al. 2017; Nguyen et al. 2018; Nguyen et al. 2019).

Remark: The specimen from Ba Vi (BV4.19.01) differs from the descriptions of Luu et al. (2019) have few subcaudals (45 versus 72–85) because of tail broken.

6. *Lycodon ruhstrati abditus* (Vogel, David, Pauwels, Sumontha, Norval, Hendrix, Vu & Ziegler, 2009)

Mountain Wolf Snake / Rắn khuyết đốm

Specimen Examined (n=1): one adult male, VNUF R.2018.10 (field number: BV.18.10) collected on 26 July 2018 in the camping area (21°04'526"N/105°22'189"E, at an elevation of 672 m) by V. Q. Luu et al.

Morphological characters: the specimen from BV-NP agreed with the description of Vogel et al. (2009), SVL 696 mm, TaL 190 mm; TL 886 mm; body elongate; head moderately distinct from neck, head longer than wide (HL 19.4 mm, HW 12.2 mm) rather flattened; snout projecting anteriorly beyond lower jaw; pupil vertically oval; tail tapered and thin; loreal 1/1; loreal not in contact with eye; supralabials 8/8, third to fifth in contact with the eye, sixth largest; infralabials 9/8, first to fifth (left side) and first to fourth (right side) bordering chin shields; posterior chin shields a little shorter than anterior ones; preocular 1/1; postoculars 2/2; anterior temporals 1/1, posterior temporals 3/2;

dorsal scale rows 17–17–15, keeled; ventrals 229; subcaudals 100, divided; cloacal single.

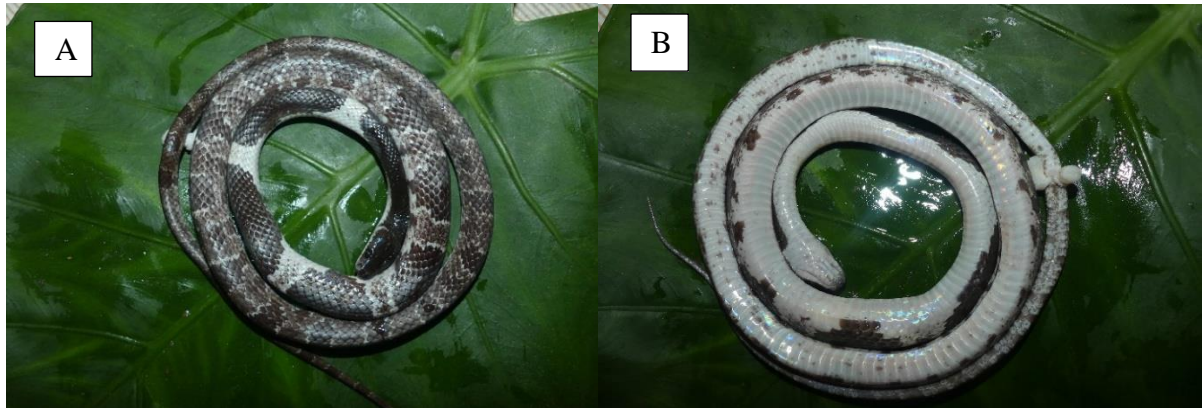


Figure 4.9: (A) Dorsal and (B) ventral views of *Lycodon ruhstrati abditus* (VNUF R.2018.10). Photos by Oanh, V. Lo

Coloration in life: Dorsal surface of body greyish black with 26 cross-bars, including two white bands near the neck and 24 brown bands on body. Ventral surface white with some small brown spots posteriorly. Dorsal surface of tail greyish brown with 16 cream rings, extending towards the lower surface of the tail.

Ecological notes: The specimen was found at 21:18 in the shrub near a forest path. The surrounding habitat was secondary forest mixed with bamboos. The relative temperature was 25.1°C and the humidity was 71%.

Distribution: In Vietnam, this species was previously known from Vinh Phuc and Quang Binh provinces. Elsewhere, this species is known from Taiwan, China and Laos (Vogel et al. 2009; Luu et al. 2013)

Remarks: The specimen from BV-NP differs from the description of Vogel et al. (2009) by having more ventrals (229 *versus* 214-224) and the first body band starting at ventral 24 (*versus* at ventrals 12-17).

7. *Opisthotropis lateralis* BOULENGER, 1903

Tonkin Mountain Keelback / Rắn trăn bên

Specimen examined (n=1): one adult male, VNUF R.2018.37 (field number: BV3.18.07) collected on 15 November 2018 (21°04'821"N/105°22'190"E, at an elevation of 400 m) by V. Q. Luu et al.

Morphological characters: the specimen from BV-NP agreed with the description of Hecht et al. (2013): SVL 470 mm, Tal 85 mm; head length larger than wide (HL 17.5 mm, HW 10.3 mm), rostral broader than high; internasals paired; prefrontal single; frontal longer than wide, shorter than parietals, twice as broad as supraocular; nostrils directing upwards, in the upper part of single nasal; internasal suture 1 mm; prefrontal suture 2.4 mm; loreal 1/1, not touching the eye; preocular 1/1; postoculars 2/2; anterior temporals 1/1, posterior temporals 2/2; supralabials 9/9, fifth to sixth in contact with the eye, eighth largest; infralabials 10/10, first to fourth (both sides) bordering chin shields; dorsal scale rows 17–17–17, keeled; ventrals 182; cloacal divided; subcaudals 50, divided.

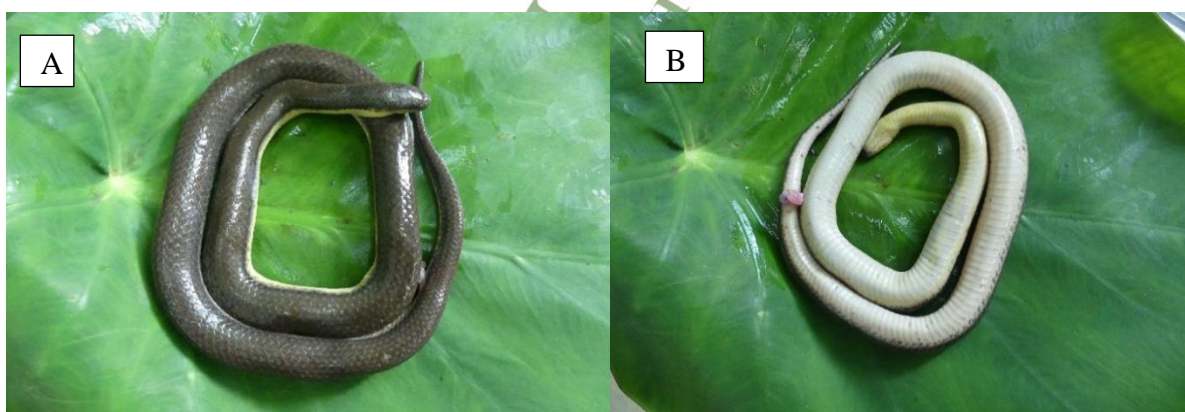


Figure 4.10: (A) Dorsal and (B) ventral views of *Opisthotropis lateralis* (VNUF R.2018.37). Photos by Vinh. Q. Luu

Coloration in life: Dorsal surface of head and body dark greyish brown, ventral surface yellowish white.

Ecological notes: The specimen was found at night in a stream after heavy rain.

Distribution: In Vietnam, this species was reported from Cao Bang, Lang Son, Vinh Phuc, Quang Ninh, Bac Giang, Hai Duong, and Hoa Binh provinces (Nguyen et al. 2009, Hecht et al. 2013, Gawor et al. 2016). Elsewhere, the species is reported from China (Nguyen et al. 2009).

8. *Sinonatrix percarinata* (BOULENGER, 1899)

Eastern Water Snake / Rắn hoa cân vên đen

Specimen examined (n=1): one adult female, BV4.19.02 collected on 13th July 2019 (21°07'614"N/105°36'766"E, at an elevation of 702 m), by Ngoan. V. Ha and Tuong. S. Dinh.

Morphological characters: the specimen from BV-NP agreed with the description of Smith (1943); Nguyen Van Sang (2007); Ziegler et al. (2007); Hecht et al. (2013); Le et al. (2015); Ha Van Nghia (2018); Le et al. (2018): SVL 565 mm, Tal 215 mm; head longer than wide (HL 24.63 mm, HW 13.65 mm), distinct from the neck; pupil round; loreal 1/1, not touching the eye; preocular 1/1; postoculars 4/4; anterior temporals 2/2, posterior temporals 3/3; supralabials 9/9, fourth to fifth in contact with the eye, 7th largest; infralabials 10/10, first to fourth (both sides) bordering chin shields; dorsal scale rows 19–19–17, keeled; except the outer row; ventrals 141; cloacal divided; subcaudals 81, divided.



Figure 4.11: (A) Dorsal and (B) ventral views of *Sinonatrix percarinata* (BV4.19.02).

Photos by Ngoan. V. Ha

Coloration in life: Dorsal head olive-grey, brown body with 31 Y-shape bands on back, ventral yellowish-cream anteriorly and turning into dark grey posteriorly.

Ecological notes: The specimen was found in the evening at 22:12pm in a stream. The surrounding habitat was stream and shrub. The relative temperature was 22.3°C and the humidity was 49%.

Distribution: In Vietnam, this species was reported from Lao Cai, Yen Bai, Ha Giang, Cao Bang, Bac Kan, Lang Son, Thai Nguyen, Phu Tho, Vinh Phuc, Quang Ninh, Bac Giang, Bac Ninh, Son La, Hoa Binh, Ha Tinh, Thanh Hoa, Quang Binh, Thua Thien Hue, Kon Tum, Gia Lai, Dong Nai . Elsewhere, the species is known from China, India, Taiwan, Myanmar, Laos, Thailand (Nguyen Van Sang 2007; Nguyen et al., 2009; Hecht et al. 2013; Le et al. 2015; Le et al. 2018; Ha Van Nghia et al. 2018).

Family Pareasidae ROMER, 1956

9. *Pareas hamptoni* (BOULENGER, 1905)

Hampton's Slug Snake / Rắn hổ mây ham-ton (Fig.2h)

Specimens examined (n=2): One adult female VNUF R.2018.18 (field number: BV.18.18) collected on 28 July 2018 in the orchid garden (21°04'529"N, 105°22'719"E, at elevation of 719), and one adult male VNUF R.2018.04 (field number: BV.18.04) on 6 October 2018 in the ancient church area (21°04'397"N/105°21'845"E, at an elevation of 400 m) by V. Q. Luu et al.

Morphological characters: the specimen from BV-NP agreed with the description of Ziegler et al. (2007); Pham et al. (2018); Nguyen et al. (2018); SVL 453–480 mm, TaL 141–160 mm; body strongly compressed; head distinct from neck; head longer than wide (HL 15.8–17.3 mm, HW 8.7–11.1 mm); nasal undivided; loreal 1/1, not touching the eye; preoculars 2/2; postoculars 2/2; subocular 2/2, long and slender; anterior temporals 2/2, posterior temporals 3/2; supralabials 8/7; infralabials 8/8; mental groove absent; dorsal scales smooth in the male and feebly keeled in the female; dorsal scale rows 15–15–15; ventrals 188–189; cloacal single; subcaudals 89–100, divided.



Figure 4.12: (A) Dorsal and (B) ventral views of *Pareas hamptoni* (VNUF R.2018.18).Photos by Vinh. Q. Luu

Coloration in life: Dorsal surface of head and body reddish brown, with vertical black body bands; ventral scales from chin to lower surface of tail orange with black spots in the female, dorsal surface of tail with black stripe.

Ecological notes: The female was found at 20:30 on a the road in the heavy rain and the male was found at 20:48 on the roadside.

Distribution: In Vietnam, this species has been recorded from Lao Cai Province in the North southwards to Lam Dong and Dong Nai provinces (Nguyen et al. 2009; Nguyen et al. 2018; Phan et al. 2018; Le et al. 2018). This is the first record of *P. hamptoni* for BV-NP and for Hanoi City. Elsewhere, the species is known from China, Myanmar, Laos, and Cambodia (Nguyen et al. 2009).

4.2. Distribution of snakes species across habitat types and elevations in the study site

4.2.1. Distribution by elevation

Based on the results, there were 7 species (with 3 family and 6 genera) recorded at the elevation 400-600 m, including: Rắn lá khô thường *Sinomicrurus maclellandi*; Rắn trán bên *Opisthotropis lateralis*; Rắn bình mũi Sapa *Hebius chapaensis*; Rắn hổ mây Ham-ton *Pareas hamptoni*; Rắn hoa cân vân đen *Sinonatrix percarinata*; Rắn mai gầm bắc *Calamaria septentrionalis*; Rắn hổ mây ngọc *Pareas margaritophorus*.

The elevation 600-800 m, there were 4 species (with 2 family and 3 genera) have been recorded including: Rắn khuyết futsing *Lycodon futsingensis*; Rắn khuyết đốm *Lycodon ruhstrati abditus*; Rắn hổ mây Ham-ton *Pareas hamptoni*; Rắn hoa cân vân đen *Sinonatrix percarinata*.

The elevation 800-1000 m, there were 8 species (with 2 family and 7 genera) was recorded including: Rắn rào quảng tây *Boiga quangxiensis*, Rắn khuyết futsing *Lycodon futsingensis*, Rắn lệch đầu kinh tuyến *Lycodon meridionalis*, Rắn sãi bau-len-giơ *Hebius boulengeri*, Rắn sọc xanh *Gonyosoma prasinum*, Rắn nhiều đai *Ptyas multicinctus*, Rắn hổ mây hom ton *Pareas hamptoni*, Rắn hoa cỏ nhỏ *Rhabdophis subminiatus*.

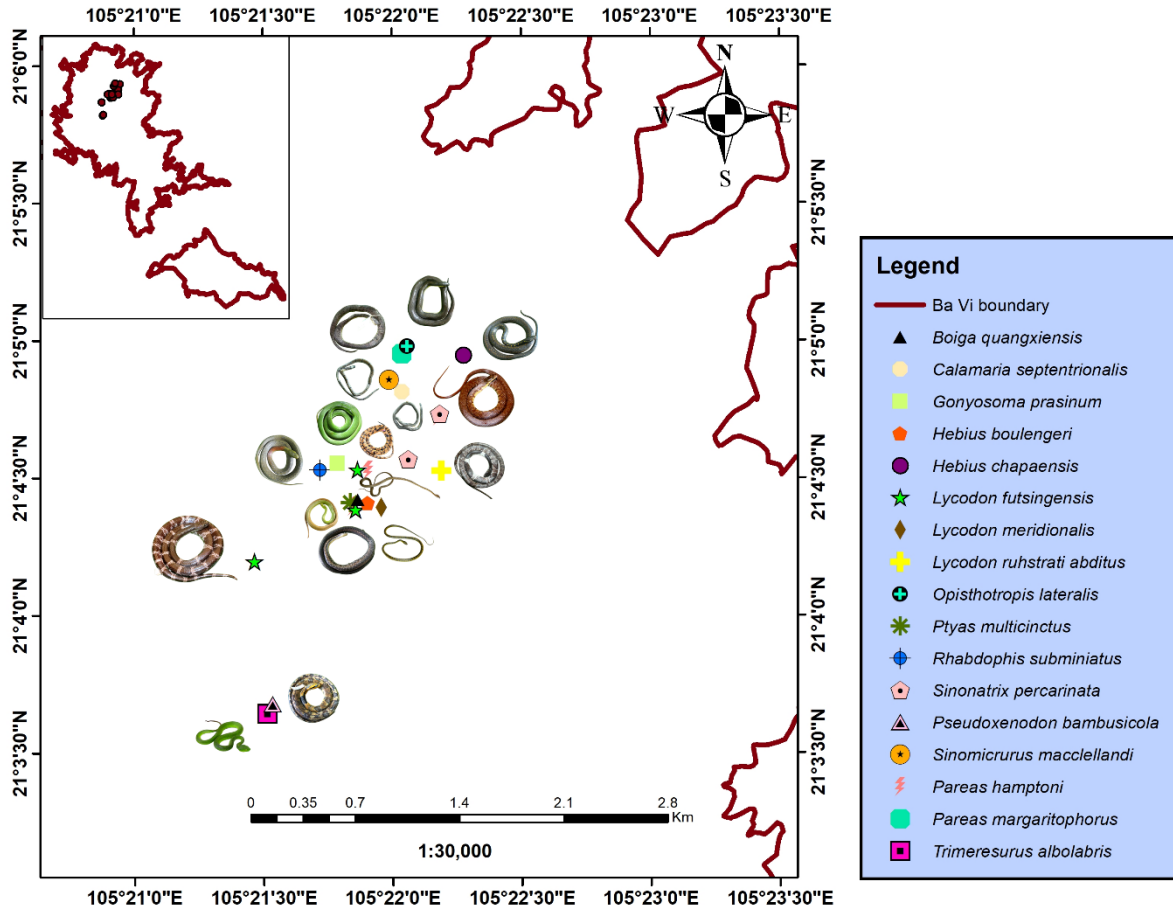


Figure 4.13: Map of snakes distribution in the study site

The elevation 1000-1200 m, there were 3 species (with 3 family and 3 genus) including: Rắn khuyết futsing *Lycodon futsingensis*, Rắn hổ xiên tre *Pseudoxenodon bambusicola*, Rắn lục mép trắng *Trimeresurus albolabris*.

Based on the elevation classification of Bain and Hurley (2011), we can see there were 11 species (with 3 family and 6 genus) that distribution below 800 m and above 800 m we also have 11 species (with 4 family and 9 genus).

Most of species distribution in the elevation from 800 - 1000 m and 400 - 600 m. *Pareas hamptoni* and *Lycodon futsingensis* are 2 species that have elevation distribution in both of below 800 m and above 800 m.

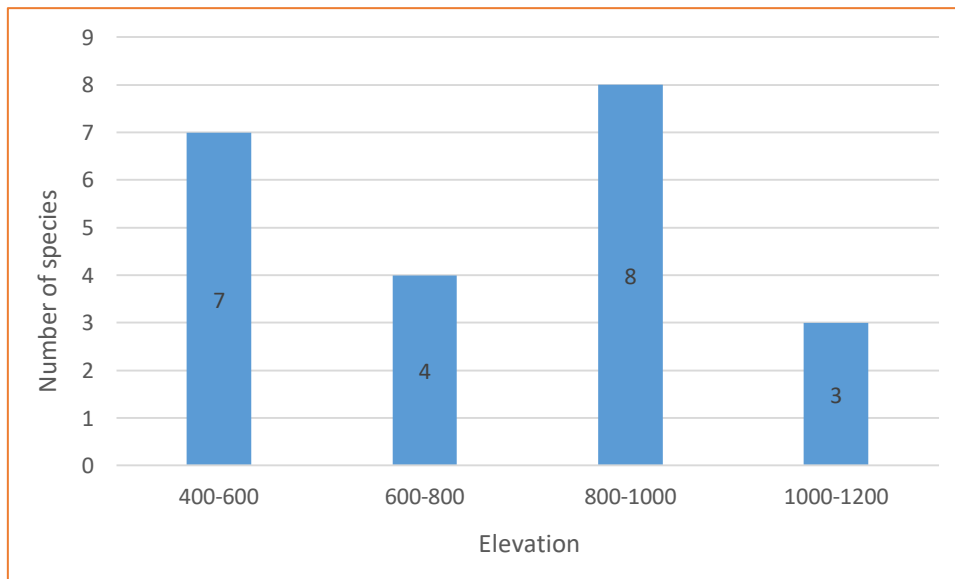


Figure 4.14: Number of species distribution by elevation

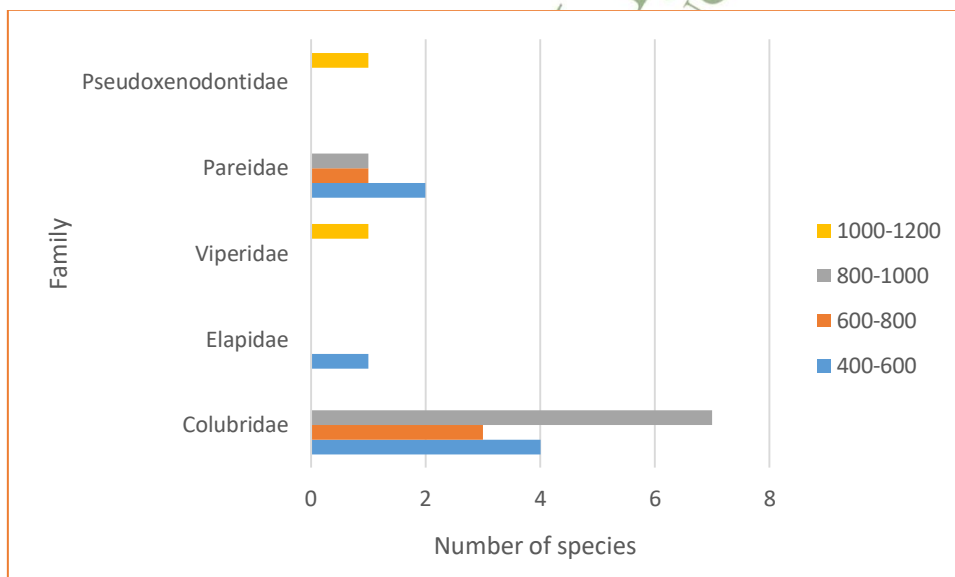


Figure 4.15: Number of family and speies distribution by elevation

Look at the figure below, we can see there were only 3 families: Colubridae, Elapidae and Pareidae, that found at the elevation 400-600m. The elevation 1000-1200m also found 3 families: Colubridae, Pseudoxenodontidae and Viperidae. The elevation 600-800m and 800-1000m found only 2 families: Colubridae and Pareidae. Based on the results, we can see family Colubridae widely distributed in all of the elevation than other family,

4.2.2. Distribution by habitat

Based on the UNESCO vegetation classification in 1973 and the extent of human impact on vegetation cover according to the document “Manual notebook for biodiversity survey and monitoring (2003), and based on the current forest status in BV-NP, we divided into 2 types of habitat including: nature forest and stream.

First habitat was Nature forest including: shrub, big wooden tree, small wooden tree, bambo forest, banana forest and soil mountain. This area is less impact, in this habitat, we recorded 14 species with 10 genus. Species recorded in this habitat are often common and widely distributed such as Rắn khuyết futsing *Lycodon futsingensis*; Rắn hổ mây ham-ton *Pareas hamptoni*; Rắn hổ mây ngọc *Pareas margaritophorus*; Rắn nhiều đai *Ptyas multicinctus*.

Second habitat was Stream including: bamboo forest, small wooden tree, shrub. This area also less impact, in this habitat we recorded 3 species with 3 genus. The common species is Rắn hoa cân vân đen *Sinonatrix percarinata* and uncommon species is Rắn trán bên *Opisthotropis lateralis*; Rắn bình mũi Sapa *Hebius chapaensis*.

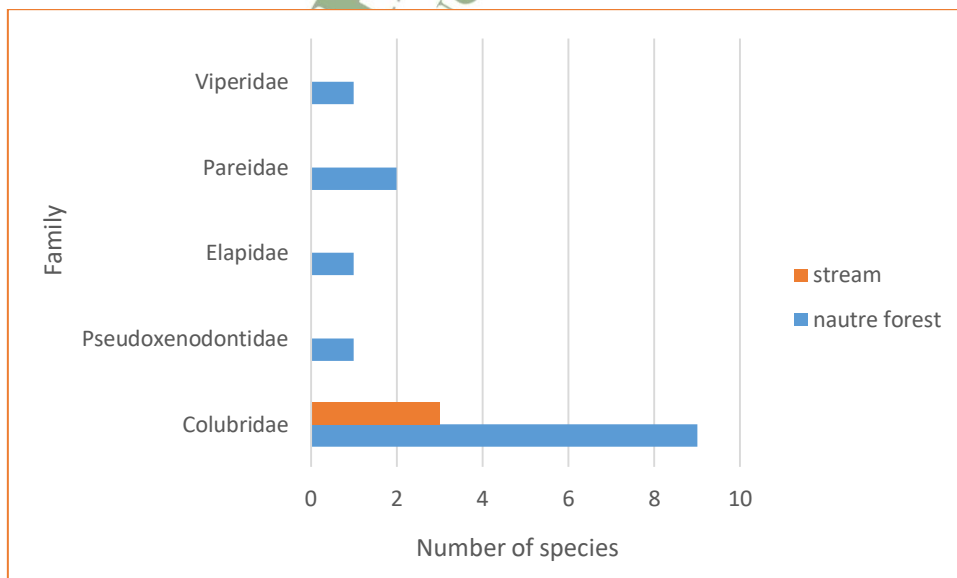


Figure 4.16: Graph show the number of family and species distribution by habitat

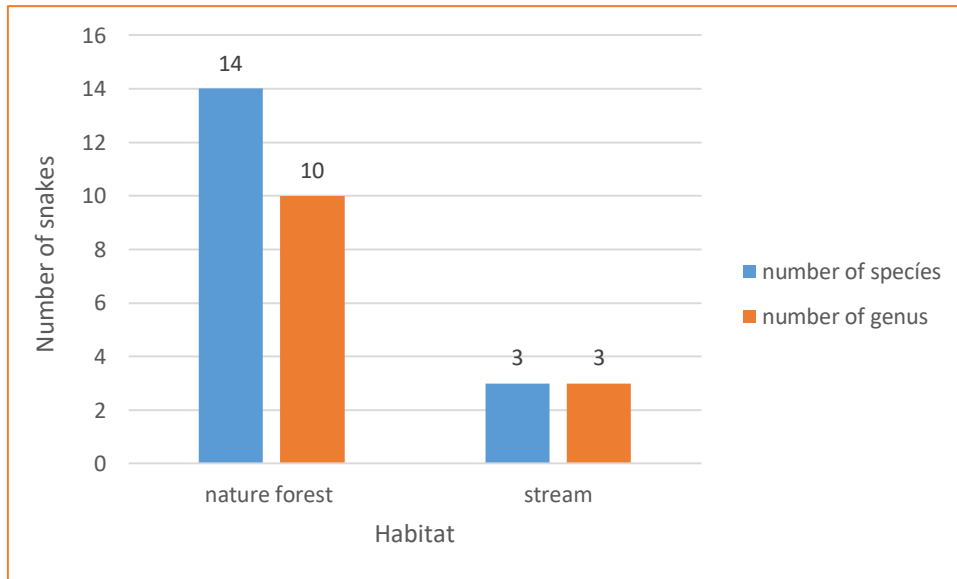


Figure 4.17: Graph show the number of species and genus distribution by habitat

4.2.3. Distribution by microhabitat

Based on the record position on the field, we divided the position of snake in 5 forms: on the tree, one the ground, road, under the stream and on the wall.

The resulted show that, there were 8 species have position on the ground, 5 species on the tree, 3 species under the stream, 1 species on the wall, 5 species found on the road (3 accident and 2 crawl on the road). Rắn hổ mây ham-ton *Pareas hamptoni* is the species can found in 3 position, in this research we found 3 specimen of *Pareas hamptoni*, 1 crawl on the road, 1 on the gound and 1 on the tree. Rắn hổ mây ngọc *Pareas margaritophorus*; Rắn mai gầm bắc *Calamaria septentrionalis* and Rắn lá khô thường *Sinomicrurus macclellandi* are 3 species that accident on the road. This mean, the main microhabitat of snakes were on the gound and on the tree.

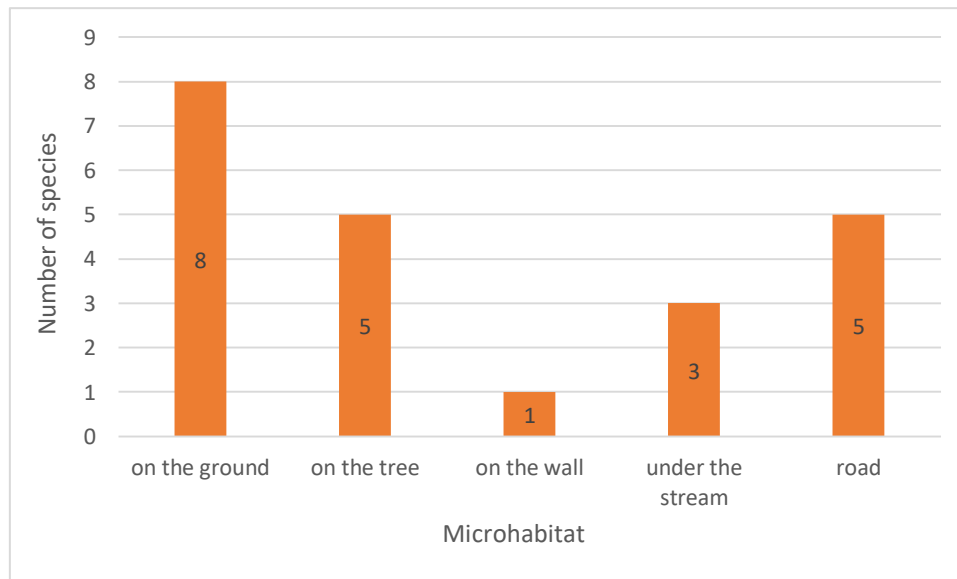


Figure 4.18: Graph show the number of species distribution in microhabitat

4.3. Conservation issues

4.3.1. Evaluate species have conservation value

Snake species with conservation value in BV-NP are listed and compared to the current national and international legal documents including: Vietnam Red Data Book – RBVN (2007); The IUCN Red List of Threatened Species – IUCN (2019), Governmental Decree No 06/2019/ND-CP – Degree 06 (2019). Species distributed only in Vietnam are endemic and conserved.



Table 4.2: List of threatened species

No	Vietnamese name	Scientific name	IUCN (2019)	RBVN (2007)	Decree 06 (2019)
1	Rắn sọc dưa	<i>Coelognathus radiatus</i>		EN	
2	Rắn sọc xanh	<i>Gonyosoma prasinum</i>		VU	
3	Rắn ráo thường	<i>Ptyas korros</i>		EN	
4	Rắn cạp nong	<i>Bungarus fasciatus</i>		EN	
5	Rắn hổ mang trung quốc	<i>Naja atra</i>	VU	EN	IIB
6	Rắn hổ chúa	<i>Ophiophagus hannah</i>	VU	CR	IB

Decree 06 (2019) = Governmental Decree No 06/2019/ND-CP by the Government of Vietnam on the management of endangered wild flora and fauna. Group IB: prohibited exploitation and use for commercial purpose and Group IIB: limited exploitation and use for commercial purpose; RBVN (2007) = Vietnam Red Data Book. Part I. Animals. Descriptions of nationally endangered species of wild animals. CR = Critically Endangered, EN = Endangered, VU = Vulnerable; IUCN (2019) = The IUCN Red List of Threatened Species. CR = Critically Endangered, EN = Endangered, VU = Vulnerable, LR/nt = Lower Risk/Near Threatened.

In this research, we recorded 6 threatened species including: 2 species in The IUCN Red List of Threatened Species (2019): Rắn hổ mang trung quốc *Naja atra* and Rắn hổ chúa *Ophiophagus hannah* is threatened with level VU (Vulnerable); 6 snake species are listed in Vietnam Red Data Book (2007): Rắn sọc dưa *Coelognathus radiatus*; Rắn sọc xanh *Gonyosoma prasinum*; Rắn ráo thường *Ptyas korros*; Rắn cạp nong *Bungarus fasciatus*; Rắn hổ mang trung quốc *Naja atra* and Rắn hổ chúa *Ophiophagus hannah*; and 2 snake species are listed in the Governmental Decree No 06/2019/ND-CP by the Government of Vietnam on the management of endangered wild flora and fauna have: Rắn hổ mang trung quốc *Naja atra* is threatened with level IIB (limited exploitation and use for commercial purpose) and Rắn hổ chúa *Ophiophagus hannah* is threatened with level IB (prohibited exploitation and use for commercial purpose).

4.3.2. Threat to snakes fauna in the study site

At the study site, there were no record or no cases of deforestation, wood exploitation, poultry and cattle breeding. Habitat of snakes are narrowed, divided and degraded by tourism, transport construction and tourist routes.

- Construction of road and tourist routed

In BV-NP, there is only one highway run from the gateway to the top elevation 1100 m. In addition, along of this route have many turning points to tourist route: Cactus garden (elevation 400 m), Ba Vi resort (elevation 600 m), The French camping area (elevation 600-700 m), the Ruins of Old French Church (elevation 800 m), the Tan Vien Son temple (elevation 1100m), the Uncle Ho temple - Peak King (elevation 1227m). Currently, this road still being wide to improve the traffic in BV-NP. The road construction have divided the habitat of snakes.

- Tourism activities

Inside BV-NP, there are many area to people come for camping and tourism such as: The French camping area (elevation 600-700 m), the Ruins of Old French Church (elevation 800 m), Thuong temple (elevation 1100 m). The route that mention above at these points also related with tourism activites, which also cause the snake habitat loss and reduce the number of snakes. Because when the habitat is seperated or fragmentation, snakes need to crawl from side to side of the road to find food, and when in the middle of the road some of cars or motobike go through and crush that snakes, and that we call "Road Kill". Beside that, the garbage and wastewater from tourism activities also impact on the habitat and food of snakes here.



Figure 4.19: One unknown snakes have been crushed on the road from the gateway to the fire protection and prevention station (elevation 400). Photo by Ngoan. V. Ha





Figure 4.20: A baby king cobra dead on the road by road kill near the environment education center (elevation 400 m). Photo by Huy. Q. Nguyen

4.4. Solutions for conservation and management of snake fauna in the study site.

4.4.1. Forest patrolling

Based on the practical situation and assessment of the impact factors above, we propose some solution for the conservation of snakes in Ba Vi National Park:

- Increasing and maintaining activities of forest patrolling is important and necessary to reduce the impact on forest to protect the habitat of wildlife specially is snakes.

- Monitoring the tourism activities and camping to limit the impact on the habitat of snakes. Must focus at the elevation 400 m and 800 m because the tourist always come for camping at elevation 400 m and visit the ruins of old french church.

- Patrolling should focus on the habitat from the elevation 400 to 1000 m, where the highest number of snakes distribution and to maintain the habitat of snakes here. Patrolling time at the morning for monitoring and controlling the impact of tourism activities to snake fauna, in the evening for checking and reducing the effect of road kill.

4.4.2. Awareness raising

- Focus on improving the capacity and understanding about biological resources of the staff in the park, thereby improving the quality of supervision and propagation to people and visitors.

- Create and develop community education programs for local people, local student and tourist about biodiversity and the value of conservation through displaying some of specimen and image of species of this study in the park to increase the awareness of snake protection including: not kill snakes and not crushed snakes on the road.

Chapter V: Conclusion

(1) Species composition: 20 species of 23 genera and 6 families were identified based on 23 collected specimens. In which 9 new recorded snake species were found for the first time from BV-NP. Combination with the snake number of Nguyen et al. (2009). This findings bring the total snake number to 39. The new recorded snakes comprising: Rắn rào quang tây *Boiga quangxiensis*, Rắn sọc xanh *Gonyosoma prasinum*, Rắn bình mũi sapa *Hebius chapaensis*, Rắn sãi bâu-len-giơ *Hebius boulengeri*, Rắn khuyết futsing *Lycodon futsingensis*, Rắn khuyết đốm *Lycodon ruhstrati abditus*, Rắn trán bên *Opisthotropis lateralis*, Rắn hoa cân vân đen *Sinonatrix percarinata*, Rắn hổ mây ham-ton *Pareas hamptoni*.

New discovery for science: The record about new diet of *Lycodon meridionalis*.

(2) Distribution: Elavtion: we divide into 4 types of elevation including 400-600m, 600-800m, 800-1000m, 1000-1200m and the number of species that record by elevation is 7, 4, 8, 3 respectively. **Habitat:** There are 2 kinds of habitat nature forest and stream. All most species record in nature forest 14 species with 10 genus, 3 species with 3 genus that record in the stream. **Microhabitat:** with 5 different position on the tree, one the ground, road, under the stream and on the wall. Most of species found on the ground 8 species, only 1 species *Gonyosoma prasinum* that found on the wall.

(3) Conservation issues: Species have conservation value: There are 6 species that have conservation value including 2 species threatened with level VU (Vulnerable) in IUCN (2019), 6 species in RBVN (2007) with 1 species threatened by CR (Critically Endangered), 1 species VU (Vulnerable) and 4 species EN (Endangered), 2 species in Degree 06 with 1 species IB (prohibited exploitation and use for commercial purpose) and 1 species IIB (limited exploitation and use for commercial purpose). **Threat of snakes:** Tourism.

(4) Solution: Increasing and maintaining activities of forest patrolling, monitoring the tourism activities and camping, create and develop community education programs for local people.

Two of article related with this thesis

1. Vinh Quang Luu, **Tuong Sy Dinh**, Oanh Van Lo, Linh Khanh Luong (2019), *Lycodon meridionalis* (Vietnamese Large-tooth Snake), DIET., Natural History Notes. Herpetological Review 50(1), 161.
2. Vinh Quang Luu, **Tuong Sy Dinh**, Oanh Van Lo, Truong Quang Nguyen, Thomas Ziegler (2019), New record and an updated list of reptiles in Ba Vi National Park, Vietnam. Bonn zoological Bulletin (in review).



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Appendix

Appendix 1: Picture of habitat, survey activities and specimens

Habitat



Picture 1: Habitat types (a,b,c,d: nature forest and e: stream). Photo by Ngoan.V. Ha

Survey activities



Picture 2: Survey activities in the forest. Photo by Oanh. V. Lo and Ngoan. V. Ha



Specimens



Picture 3: *Ovophis monticola*. Photo by Vinh. Q. Luu



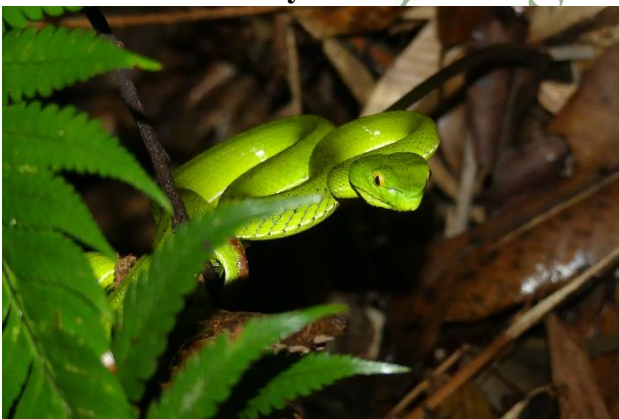
Picture 4: *Naja atra*. Photo by Oanh. V. Lo



Picture 5: *Protobothrops mucrosquamatus*.
Photo by Oanh. V. Lo



Picture 6: *Lycodon meridionalis*. Photo by Vinh. Q. Luu



Picture 7: *Trimeresurus albolabris*. Photo by Oanh. V. Lo



Picture 8: *Ptyas multicinctus*. Photo by Oanh. V. Lo



Picture 9: *Rhabdophis subminiatus*. Photo by Oanh. V. Lo



Picture 10: *Pseudoxenodon bambusicola*. Photo by Tuong. S. Dinh



Picture 11: *Calamaria septentrionalis*. Photo by Oanh. V. Lo



Picture 12: *Sinomicrurus macclellandi*. Photo by Oanh. V. Lo



Picture 13: *Hebius boulengeri*. Photo by Tuong. S. Dinh

Appendix 2: Distribution of snake by habitat and elevation

No	Scientific name	Nature forest	Stream	400-600	600-800	800-1000	1000-1200
1	<i>Calamaria septentrionalis</i>	P	A	P	A	A	A
2	<i>Boiga quangxiensis</i>	P	A	A	A	P	A
3	<i>Gonyosoma prasinum</i>	P	A	A	A	P	A
4	<i>Hebius chapaensis</i>	A	P	P	A	A	A
5	<i>Hebius boulengeri</i>	P	A	A	A	P	A
6	<i>Lycodon futsingensis</i>	P	A	A	P	P	P
7	<i>Lycodon meridionalis</i>	P	A	A	A	P	A
8	<i>Lycodon ruhstrati abditus</i>	P	A	A	P	A	A
9	<i>Opisthotropis lateralis</i>	A	P	P	A	A	A
10	<i>Ptyas multicinctus</i>	P	A	A	A	P	A
11	<i>Rhabdophis subminiatus</i>	P	A	A	A	P	A
12	<i>Sinonatrix percarinata</i>	A	P	A	P	A	A
13	<i>Pseudoxenodon bambusicola</i>	P	A	A	A	A	P
14	<i>Sinomicrurus macclellandi</i>	P	A	P	A	A	A
15	<i>Pareas margaritophorus</i>	P	A	P	A	A	A
16	<i>Trimeresurus albolabris</i>	P	A	A	A	A	P
17	<i>Pareas hamptoni</i>	P	A	P	P	P	A

A: absent; P: present



Appendix 3: Distribution of snake by record position

No	Scientific name	On the wall	On the ground	Under the stream	On the road	On the tree
1	<i>Calamaria septentrionalis</i>	A	A	A	P	A
2	<i>Boiga quangxiensis</i>	A	P	A	A	A
3	<i>Gonyosoma prasinum</i>	P	A	A	A	A
4	<i>Hebius chapaensis</i>	A	A	P	A	A
5	<i>Hebius boulengeri</i>	A	A	A	P	A
6	<i>Lycodon futsingensis</i>	A	P	A	A	A
7	<i>Lycodon meridionalis</i>	A	A	A	A	P
8	<i>Lycodon ruhstrati abditus</i>	A	P	A	A	A
9	<i>Opisthotropis lateralis</i>	A	A	P	A	A
10	<i>Ptyas multicinctus</i>	A	A	A	P	A
11	<i>Rhabdophis subminiatus</i>	A	A	A	A	P
12	<i>Sinonatrix percarinata</i>	A	A	P	A	A
13	<i>Pseudoxenodon bambusicola</i>	A	P	A	A	A
14	<i>Pareas margaritophorus</i>	A	A	A	P	A
15	<i>Trimeresurus albolabris</i>	A	A	A	A	P
16	<i>Pareas hamptoni</i>	A	A	A	P	P
17	<i>Sinomicrurus macclellandi</i>	A	A	A	P	A

A: absent; P: present



Appendix 4: Table about some of morphology measurement index (unit: mm)

Calamaria septentrionalis

Field number	Sex	SVL	Tal	TL	HL	H W	ASR	DSR	PSR	Keel/smooth	VEN	SC	SL	IL	PreOc	PostOC	Atem	Ptem
BV1.19.02	♂	400	240	640	13.68	6.31	13	13	13	smooth	185	9	4/4	5/5	1/1	1/1	1/1	1/1

Boiga quangxiensis

Field number	Sex	SVL	Tal	TL	HL	HW	ASR	DSR	PSR	Keel/smooth	VEN	SC	SL	IL	PreOc	PostOC	Atem	Ptem
BV.18.07	♂	1290	435	1725	31	21.06	23	15	15	smooth	270	145	8/8	8/8	1/1	2/2	2/2	2/3

Gonyosoma prasinum

Field number	Sex	SVL	Tal	TL	HL	H W	ASR	DSR	PSR	Keel/smooth	VEN	SC	SL	IL	PreOc	PostOC	Atem	Ptem
BV3.18.09	♂	680	210	890	28.4	15.4	17	17	15	keel	168	79	8/7	10/10	1/1	3/3	2/2	2/2

Hebius boulengeri

Field number	Sex	SVL	Tal	TL	HL	H W	AS R	DS R	PS R	Keel/smoo th	VE N	S C	S L	IL	PreO c	PostO C	Ate m	Pte m
BV2.19. 03	♂	410	150	560	17.3	9.8 7	19	19	17	keel	146	60	9/ 9	8/8	1/1	1/1	1/2	2/2

Hebius chapaensis

Field number	Sex	SVL	Tal	TL	HL	H W	AS R	DS R	PS R	Keel/smoo th	VE N	S C	S L	IL	PreO c	PostO C	Ate m	Pte m
BV3.18. 08	♂	440	140	580	13.6	8.8 2	17	17	17	keel	170	70	9/ 9	10/1 0	2/2	2/2	2/1	2/1

Lycodon futsingensis

Field number	Sex	SVL	Tal	TL	HL	HW	AS R	DS R	PS R	Keel/smoo th	VE N	S C	S L	IL	PreO c	PostO C	Ate m	Ptem
BV.18.0 5	♀	680	160	84 0	23.3 2	13.0 1	17	17	15	smooth	204	74	8/ 8	10/1 0	1/1	2/2	2/2	3/3
BV2.19. 02	♀	580	160	74 0	21.5 1	12.4	17	17	15	smooth	198	79	8/ 8	10/1 0	1/1	2/2	2/2	2/2
BV4.19. 01	♀	650	120	77 0	23.1 2	14.4 2	17	17	15	smooth	195	45	8/ 8	10/1 0	1/1	2/2	2/2	2/3

Lycodon meridionalis

Field number	Sex	SVL	Tal	TL	HL	HW	ASR	DSR	PSR	Keel/smooth	VEN	SC	SL	IL	PreOc	PostOC	Atem	Ptem
BV.18.17	♂	720	203	923	18.41	12.63	17	17	15	keel	242	115	8/8	10/10	1/1	2/2	2/2	3/3

Lycodon ruhstrati abditus

Field number	Sex	SVL	Tal	TL	HL	HW	ASR	DSR	PSR	Keel/smooth	VEN	SC	SL	IL	PreOc	PostOC	Atem	Ptem
BV.18.10	♀	696	190	886	19.36	12.23	17	17	15	keel	229	100	8/8	9/8	1/1	2/2	1/1	3/2

Opisthotropis lateralis

Field number	Sex	SVL	Tal	TL	HL	HW	ASR	DSR	PSR	Keel/smooth	VEN	SC	SL	IL	PreOc	PostOC	Atem	Ptem
BV3.18.07	♀	470	85	555	17.54	10.3	17	17	17	keel	182	50	9/9	10/10	1/1	2/2	1/1	2/2



Ptyas multicinctus

Field number	Sex	SVL	Tal	TL	HL	HW	AS R	DS R	PS R	Keel/smooth	VE N	S C	SL	IL	PreO c	PostO C	Ate m	Pte m
BV1.19.02	♂	700	240	940	26.05	16.4	15	15	15	smooth	164	73	7/7	5/6	1/1	2/2	1/1	2/2

Rhabdophis subminiatus

Field number	Sex	SVL	Tal	TL	HL	HW	AS R	DS R	PS R	Keel/smooth	VE N	S C	SL	IL	PreO c	PostO C	Ate m	Pte m
BV3.18.09	♂	680	210	890	28.4	15.4	17	17	15	keel	168	79	8/9	10/10	1/1	3/3	2/2	2/2

Sinonatrix percarinata

Field number	Sex	SVL	Tal	TL	HL	HW	AS R	DS R	PS R	Keel/smooth	VE N	S C	SL	IL	PreO c	PostO C	Ate m	Pte m
BV.19.02	♂	210	80	290	9.06	8.27	19	19	17	keel	141	80	9/10	10/10	1/1	5/4	2/2	3/3
BV4.19.02	♂	565	215	780	24.53	13.65	19	19	17	keel	141	81	9/9	10/10	1/1	4/4	2/2	3/3

Pseudoxenodon bambusicola

Field number	Sex	SVL	Tal	TL	HL	H W	AS R	DS R	PS R	Keel/smooth	VE N	S C	S L	IL	PreO c	PostO C	Atem	Ptem
BV3.18.18	♂	545	130	675	26.95	16.4	18	17	15	keel	138	56	8/8	10/10	1/1	3/3	2/2	2/2

Sinomicrurus maclellandi

Field number	Sex	SVL	Tal	TL	HL	H W	AS R	DS R	PS R	Keel/smooth	VE N	S C	S L	IL	PreO c	PostO C	Atem	Ptem
BV3.18.05	♂	185	25	210	6.6	3.41	13	13	12	smooth	226	31	7/7		1/1	2/2	1/1	1/1

Pareas hamptoni

Field number	Sex	SVL	Tal	TL	HL	HW	AS R	DS R	PS R	Keel/smooth	VE N	SC	SL	IL	PreO c	PostO C	Atem	Ptem
BV.18.18	♂	453	141	594	15.75	8.72	15	15	15	smooth	189	89	7/7	8/8	2/2	2/2	2/2	3/2
BV.18.04	♀	480	160	640	17.33	11.06	15	15	15	smooth	188	100	8/7	8/7	3/2	2/2	2/2	3/2
BV.19.01	♀	460	165	625	17.37	11.76	15	15	15	smooth	188	95	7/9	7/7			2/2	3/2

Pareas margaritophorus

Field number	Sex	SVL	Tal	TL	HL	H W	AS R	DS R	PS R	Keel/smooth	VE N	S C	S L	IL	PreOc	PostOC	Atem	Ptem
BV.19.01	♂	350	60	410	14.6	7.16	15	15	15	smooth	148	34	8	9/9	2/2	1/2	1/1	1/1

Trimeresurus albolabris

Field number	Sex	SVL	Tal	TL	HL	H W	AS R	DS R	PS R	Keel/smooth	VE N	S C	SL	IL	PreOc	PostOC	Atem	Ptem
BV3.18.16	♂	600	120	720	28.4	21.3	21	21	15	keel	158	63	10/10	12/12	1/1	1/1	1/1	1/1

