MINISTRY OF EDUCATION AND TRAINING
HANOI NATIONAL UNIVERSITY OF EDUCATION

DO DUC SANG

FAUNA OF THE TERRESTRIAL GASTROPOD FROM SON LA PROVINCE

Specializaty: Zoology
Classification: 62.42.01.03

SUMMARY OF BIOLOGY PHD THESIS

HANOI – 2016

This research has been completed at

Hanoi National University of Education

Advisor: Assoc. Prof. Dr. Do Van Nhuong

Reviewer 1: Assoc. Prof. Dr. Nguyen Xuan Dang
Institute of Ecology and Biological Resources -
Vietnam Academy of Science and Technology

Reviewer 2: Assoc. Prof. Dr. Nguyen Van Vinh
University of Science -
Vietnam National University, Hanoi

Reviewer 3: Assoc. Prof. Dr. Tran Thi Thanh Binh
Hanoi National University of Education

The research will be defended in the Judging Committee at

Hanoi National University of Education

at ……hours…..date…….month…….2016

This research can be found in:

- National Library of Vietnam
- Library of Hanoi National University of Education

THE PAPER HAVE RELATED TO THE THESIS

1. Do Duc Sang, Do Van Nhuong (2014), Data on Landsnails (Mollusca: Gastropoda) in the Xuan Nha natural reserve, Son La province. *Journal of Nature sciences and technology*, 30(1S): 173-180.
2. Do Duc Sang, Do Van Nhuong (2014), Data on terrestrial snails (Mollusca: Gastropoda) along Da river's section, which passes through Son La and Hoa Binh. *Journal of sciences of the Earth*, 30(3): 27-36.
3. Do Duc Sang, Do Van Nhuong (2014), Composition and distribution of Terrestrial snails (Gastropoda, Mollusca) from Thuan Chau District, Son La Province, Vietnam. *Journal of Science, Hanoi National University of Education*, 59(5): 24-33.
4. Do Duc Sang, Do Van Nhuong (2014), The Landsnail family Subulinidae (Gastropoda, Mollusca) from Son La, Vietnam, with description of two new species. *Journal of Biology, Vietnam*, 36(4): 451-459.
5. Do Duc Sang (2015), Study on the composition and distribution of Land Prosobranch snails (Mollusca: Gastropoda: Prosobranchia) from Son La Province. *Journal of Natural Sciences and Technology*, 31(4S): 299-305.
6. Do Duc Sang, Do Van Nhuong (2015), The terrestrial snail family Clausiliidae (Gastropoda: Pulmonata) from Son La, Vietnam, with description of a new subspecies. *Ruthenica*, 25(1): 1-9.
7. Do Duc Sang, Do Van Nhuong (2015), The terrestrial snail family Streptaxidae J. Gray, 1860 (Gastropoda: Pulmonata) from Son La, Vietnam, with description of two new species. *Ruthenica*, 25(2): 37-43.
8. Do Duc Sang, Nguyen Thi Hong Thinh, Vo Van Be Hai, Do Van Nhuong (2015), Composition and orientation of terrestrial snails Cyclophoridae (Gastropoda: Prosobranchia) from Son La. *Proceedings of the 6th National conference on Ecology and Biological Resources, Hanoi*: 1213-1219.
9. Do Duc Sang, Do Van Nhuong (2015), A new species of the genus *Sinoennea* Kobelt, 1904 (Pulmonata: Diapheridae) from Son La, Northwestern Vietnam. *Raffles Bulletin of Zoology*, 63: 490-493.
10. Do Duc Sang, Nguyen Thi Hong Thinh, Do Van Nhuong (2015). A checklist and classification of terrestrial Prosobranch snails from Son La, north-western Vietnam. *Ruthenica*, 25(4): 117-132.

INTRODUTION

1. REASON OF SELECTING RESEARCH

A terrestrial Gastropods is any of the numerous species of snail and slug that live on land, as opposed to sea snails and freshwater snails. They belonging to Gastropoda class, Mollusca phylum. The huge role of terestrial Gastropods to humans are represented by their beneficial effects in many different fields. Terrestrial Gastropods have been eaten for thousands of years, going back at least as far as the Pleistocene. Archaeological evidence of snail consumption is especially abundant in Capsian sites in North Africa, but is also found throughout the Mediterranean region in archaeological sites dating between 12,000 and 6,000 years ago. Snail eggs, sold as snail caviar, are a specialty food that is growing in popularity in European cuisine.

With regard to ecosystem function, shelled terrestrial snails (as opposed to slugs) are important in calcium cycling. They glean calcium from their food, concentrate it in their shells that are made mainly from calcium carbonate, and pass it up the food chain as they are consumed by Predators. Both shelled snails and slugs can generally be categorized as decomposers, though they play only a small role compared to other decomposition organisms. They are considered to be an invertebrate biodiversity indicator.

However, wild-caught terrestrial Gastropods which are prepared for the table but are not thoroughly cooked, can harbor a parasite (*Angiostrongylus cantonensis*) that can cause a rare kind of meningitis.

To date, terrestrial Gastropods of Vietnam has not been fully research on species composition and distribution. Son La is a province in the northwestern Vietnam, with a territory of 14.125 km^2. Son La topography is deeply differentiated and splitted forming many valleys, basins and alternating mountains with an average elevation of 600-700 m a.s.l. and variety of different kinds of habitats, e.g. natural forest, limestone mountains, plantation, gardens. Thus, it is believed that Son La will have a rich fauna of terrestrial Gastropods, which are very little known so far.

With the above reasons, the research "*Fauna of the terrestrial Gastropods from Son La province*" have been proposed and implemented.

2. THE PURPOSE OF RESEARCH

Determined diversity of species composition, characteristics of distribution of terrestrial Gastropods, which made scientific basis for management, sustainable development and orientation.

3. LIMITATION OF RESEARCH

Characteristics of distribution in this research is only reviewed to habitats and elevations. Biogeographic is limited to zoogeographic elements, endemics to Vietnam, widespread species in the world.

4. THE CONTENT OF RESEARCH

- Review the level diversity of species composition of terrestrial Gastropods from Son La Province.
- Assess the level diversity of species composition of studied area.
- Establish list of terrestrial Gastropods from Son La.
- Determined zoogeographic elements, as well as role of terrestrial Gastropods Son La to Vietnam fauna.
- Determined species composition according habitats and elevation. Determined indicator of species diversity, dominant level, density in habitats.
- Situation of exploitation, orientation, threat facters, proposed resolution to sustainable development of the terrestrial Gastropods from Son La.

5. SCIENTIFIC AND PRACTICAL MEANING OF RESEARCH

The results of this study provides checklists of species and distribution characteristics of terrestrial Gastropods from Son La, contributed to the studied investigation, statistics terrestrial Gastropods of Vietnam. Additional identification keys of species, genera, and families of terrestrial Gastropods from Son La, contributed to scientific research and teaching.

The result and recommendation of this research are contributed to conservation of biodiversity resources.

6. THE NEW CONTRIBUTION OF THE RESEARCH

- Providing the checklist of terrestrial Gastropods from Son La, it includes 130 species, belonging to 64 genera, 23 families, 3 order in 2 subclass.
- The present research provides data relevant to these species and the description of six new species. Three genera and twelve species are recorded for the first time to Vietnam, 98 additional species are added to the list of Son La.

- Providing new distribution records of 130 species folowing habitats and elevations.

- Determined threat facters, proposed resolution to sustainable development of the terrestrial Gastropods of Son La

CHAPTER 1.
OVERVIEW ON THE DOCUMENT

1.1. SITUATION OF FAUNA STUDY ON TERRESTRIAL GASTROPODS

1.1.1. In the world

Studies on diversity of terrestrial Gastropods has done quite early and widespread at many countries and regions in the world. In the continents, the faune of European, America, and Australia are the most comprehensive study, followed by the fauna of Asia and Africa. Fauna of neighboring countries Vietnam are studied at different levels, of which the fauna of China, Thailand, Singapore, India, and Nepal have been studied the most completed.

1.1.2. In Vietnam

1.1.2.1. The research before 1945

The first study on terrestrial Gastropods of Indo-Chine of Souleyet (1841-1842), which recorded four new species in Da Nang province. The studies follows such as Pfeiffer (1848, 1862-1863), Crosse & Fischer (1863-1867), Mabille & Mesle (1866), Wattebled (1884), Dautzenberg & Hamonville (1887), Morlet (1884-1892), Mabille (1887-1889),...

Based on the published researchs in the second half of the 19th century of many authors, Fischer (1891) have gathered in the his study, which is the first sum nature of terrestrial Gastropods of Vietnam. During the period 1899-1915, Bavay & Dautzenberg had surveied in Indochina region, including in Vietnam, mainly from the mountain regions. 1904, Pavie's French Research Corporation surveyed across Indochina region. Results of the survey on terrestrial Gastropods had been aggregated and published by Fischer & Dautzenberg. Thus, it can be considered works of Fischer (1891), Fischer & Dautzenberg (1904) as the most fundamental document on fauna of Vietnam.

There is little research on terrestrial Gastropods of Vietnam for the period from 1916 to 1945, except research of Lindholm (1924). Such, it was found that there are 579 species of terrestrial Gastropods in Vietnam, belonging to 2 subclasses (Prosobranchia, Pulmonata). The Pulmonata are most diverse with 461 species, Prosobranchia were least diverse with only 118 species.

1.1.2.2. The research after 1945

During 1945-1975, the study on terrestrial Gastropods is interrupted by many causes. There are a few studies, such as Saurin (1953), Szekeres (1969-1970), Varga (1972), Loosjes & Loosjes (1973). The terrestrial Gastropods of Vietnam only much attentioned after 2000 year, such as Gittenberger & Vermeulen (2001), Vermeulen & Maassen (2003), Maassen (2006), Maassen & Gittenberger (2007), Nordsieck (2011), Schileyko (2011, 2015), Páll-Gergely *et al.* (2014, 2015). Researching by local author such as Dang Ngoc Thanh (2008), Do Van Nhuong *et al*. (2010-2016). Such, it was found that there are 711 species of terrestrial Gastropods in Vietnam.

1.1.3. In Son La Province

Until 2011 year, the study on terrestrial Gastropods of Son La is limited, there are only a few surveys are conducted, not many survey locations, mainly those where the French aimy stationed. The first, four new species of Clausiliidae was recorded by Bavay & Dautzenberg (1899-1912). Guide (1909) redorded *Plectopylis messageri* species from Gia Phu (Phu Yen). Right up to recent years, terrestrial Gastropods of Son La have been attentioned, but the results show that great potential, such as Nordsieck (2011), Do Van Nhuong & Tran Thap Nhat (2012), Páll-Gergely *et al*. (2014-2015).

1.2. SITUATION OF TAXONOMY STUDY ON GASTROPODA CLASS

1.2.1. Overview on Gastropoda classification

The classification of Gastropoda are interested by many authors, this is complex content, which is being debated. Many studies have been conducted to reflect relation between taxa, so classification of Gastropoda is continuously changes, the proposed version are more or less the difference. Recent period, there are huge steps on the classification, many doubts have been clarified by applying the modern classification methods, particularly the application of molecular biology.

1.2.2. Terrestrial Gastropods classification in Vietnam

The classification of species, genera of their families of terrestrial Gastropods are relatively stability and unity. In 2011, based on the sample source, which were collected on the territory of Vietnam is stored in a number of major museums around the world, a survey of this region showed that there are 447 species and subspecies, belonging to 96 genera, 20 families, 1 order of Pulmonata.

Whereas the classification of high taxa of Prosobranchia recorded their representatives, which belonging to 6 families, 4 superfamily, 3 order (Architaenioglossa, Cycloneritimorpha, and Littorinimorpha).

1.3. STUATION OF DISTRIBUTED STUDY ON TERRESTRIAL GASTROPODS

The data on distribution of terrestrial Gastropods in Vietnam are little known so far. In the surveyed landscapes, the mountains region (394 species, 27 families) is full study than the delta, coastal (265 species, 27 families) and island regions (129 species, 21 families). The results of the researchs in Vietnam showed that natural habitats with a variety of species composition than farmland habitat, in which they dominate species include Ariophantidae, Cyclophoridae, Camaenidae, Clausiliidae, Bradybaenidae, Pupinidae.

The result of studies on terrestrial Gastropods of Vietnam showed that the species composition of natural habitat is more diversity than others habitat, in which they dominate species include Ariophantidae, Cyclophoridae, Camaenidae, Clausiliidae, Bradybaenidae, Pupinidae, Streptaxidae and Subulinidae.

1.4. STUATION OF APPLIED STUDY ON TERRESTRIAL GASTROPODS

In Vietnam, the applied research on terrestrial Gastropods is little known. In the documentary "Medicinal Plants and animals as drugs in Vietnam", Do Huy Bich *et al.* (2004) noted *Achatina fulica* with effect as nourishing, detoxifying, antispasmodic, benefits urine, swelling and pain treatment. Nguyen Xuan Dong *et al.* (2005) study nutritional components *Cyclophorus anamiticus*, *C. martensianus* in Tay Ninh province, the results show a high nutritional value. These results are the basis for applied research direction in the near future on terrestrial Gastropods in Vietnam.

1.5. OVERVIEW ON NATURAL - SOCIAL CONDITIONS OF SON LA

1.5.1. Geographical location

Son La is located in the northwestern Vietnam, its geographic coordinates are $20^0 39' - 22^0 02'$ N, $103^0 11' - 105^0 02'$ E. There are 12 districs and city in Son La (Bac Yen, Moc Chau, Mai Son, Muong La, Phu Yen, Quynh Nhai, Thuan Chau, Song Ma, Sop Cop, Yen Chau, Van Ho, and city Son La).

1.5.2. Topography

Son La topography is deeply differentiated and splitted forming many valleys, basins and altern different kinds of habitats, e.g. natural forest, limestone mountains, plantation, gardens,...

1.5.3. Land

There are two major groups of land including barren soil developed on parent rocks (62.07%); mountain loam red gold (26.84%). Son La has a huge karst systems, which belong to limestone band formed during the from Carbon-Pecmi to middle Trias.

1.5.4. Climate

The region investigated has a tropical climate which is characterized by two seasons: a long dry season from April to September and a wet season from October to March (next year). Precipitation ranges from 1.200 - 1.600 mm per year, falling primarily in June, July and August. The evaporation rate is about 800 mm per year. The average annual temperature is 21.4^0 C. The average humidity is about 81%.

1.5.5. Hydrological type

System of rivers, streams of Son La are not evenly distributed. There are many streams which are tributaries of the Ma and Da rivers. Amplitude variation flow clearly between dry and rainy seasons.

1.5.6. Biological resources

There are four natural reserve (Copia, Ta Xua, Xuan Nha, and Sop Cop) - with a total area of 673.193 ha in which is found approximately 1.187 plant species belonging to 645 genera and 204 families. These plants are distributed in temperate forests, coniferous forests, plantation forests and savanna with most trees of the subfamily Bambusoideae and pine forests (Lycopodiella). There are 141 species of mammals, 347 birds, 72 reptiles, 50 amphibians have been recorded.

1.5.7. The population and life

There are 1.195.107 people of Son La (1/4/2015), belonging to twelve ethnics (Thai, H'Mong, Kinh, Muong, Kho Mu, Dao, Xinh Mun, La Ha, Khang, Lao, Tay, and Hoa. The population density is 83 people/km^2.

CHAPTER 2.
LOCATION, TIME, MATERIAL AND METHODS

2.1. LOCATION AND TIME OF RESEARCH

There are 124 surveyed locations have were collected in Son La. The samples concentrated in the limestone area, where forest development, the natural reserve, Moc Cha and Son La plateau regions.

Specimens were collected from September, 2012 to October, 2015 along the main routes. Along these routes are limestone, limestone forest, mountain forest, farmland & residential. Forty two surveys have been done with a total of 139 days in the field.

2.2. MATERIAL OF RESEARCH

This research was carried out based on the analysis results of 19.437 individuals of terrestrial Gastropods. 167 references have been cited in this research. In addition, there are 1.236 photos, which were photographed from the fielded survey and analysis.

2.3. METHOD OF RESEARCH

Field instruments: map, fabrical bags 40 x 30 cm in size, small plastic bags, specimen containers, plastic bags 80 x 50 cm in size, forceps, clamps, mesh sieve sample with 3-5 mm, labeled samples, flashlight, tape measure, shovel soil, GPS (Garmin GPSMAP 76CSx), camera (Canon SX240HS), diaries, 70% ethanol solution.

- *Divide habitats and determine elevation*: Divide habitats have been done based on observation and reference. Elevation of samples is determined by GPS. Divide elevations according to Vu Tu Lap (1976, 2012).

- *Collected method*: Terrestrial Gastropods have been collected according to Schilthuizen *et al*. (2002), Vermeulen & Maassen (2003). Samples were collected in areas 5 x 5 m^2 in size, collected 10 plots in each habitat.

- *Sample processing methods*: Living snails were drowned in water and transferred to ethanol 70% for fixation and preservation. Specimens were

shaped and conserved in ethanol 70%. Specimens that consisted only of shells were conserved in the dry condition.

- *Description of diagnosis characters*: The terminology used in the descriptions follows Nantarat *et al*. (2014), Nordsieck (2011), Tongkerd *et al*. (2013), Páll-Gergely *et al*. (2014), Wiktor *et al.* (2000).

- *Identificated methods*: Terrestrial Gastropods have been identificated acccording to documents of Bavay & Dautzenberg (1899-1912), Möllendorff (1901), Dautzenberg & Fischer (1905, 1906, 1908), Nordsieck (2011), Nantarat *et al*. (2014), Páll-Gergely *et al.* (2014, 2015), Wiktor *et al*. (2000), Gomes *et al.* (2007), etc.

Taxa of Prosobranchia are arranged according to Kantor *et al.* (2009), taxa of Pulmonata were arranged according to Scchileyko (2011), while genera and species names are arranged alphabetically.

- *Determine biological index*: Species diversity index ($H^{'}$), dominated level of species (D), similarity index (Sorensen index, SI), and density.

- *The basis for determination of zoogeographic*: Based on the summary of zoogeographic of freshwater snails Vietnam, Dang Ngoc Thanh *et al*. (2002) have divided by 4 components: 1. The widely distributed species; 2. The tropical species (Indian - Malaysia element); 3. The species of temperate and subtropical (China element); 4. The endemic to Vietnam.

- *Process the data*: The data of this study have were processed by Microsoft Excel 2010 and PAST Statistic software.

CHAPTER 3.
RESULTS AND DISCUSSION

3.1. DIVERSITY OF TERRESTRIAL GASTROPOD FROM SON LA

3.1.1. The checklist of terrestrial Gastropods from Son La

The results of analysis of specimens, which collected from 2012 to 2015, along with the reference sources, it was found that there are 130 species of terrestrial Gastropods from Son La (table 3.1).

Table 3.1. Species composition of terrestrial Gastropods of Son La.

Note: CNMC: Moc Chau plateau; CNSL: Son La plateau; LVSD: Da river basin; LVSM: Ma river basin; (*): Additional species are recorded for Son La, (**): Additional species are recorded for Vietnam, (***): New species are described to science.

No.	Species composition	Distribution			
		CN MC	CN SL	LV SĐ	LV SM
(1)	(2)	(3)	(4)	(5)	(6)
	GASTROPODA Cuvier, 1795				
	PROSOBRANCHIA Edwards, 1848				
	1. CYCLOPHORIDAE Gray, 1847				
1.	*Alycaeus depressus* Bavay et Dautzenberg, 1912*	+	+		
2.	*Alycaeus heudei* Bavay et Dautzenberg, 190)*	+	+		
3.	*Alycaeus paviei* Bavay et Dautzenberg, 1912**	+	+	+	
4.	*Alycaeus* sp.1*		+		
5.	*Alycaeus* sp.2*	+	+		
6.	*Alycaeus* sp.3*	+			
7.	*Cyclophorus cambodgensis* Morlet, 1884*	+	+	+	+
8.	*Cyclophorus implicatus* Bavay et Dautzenberg, 1908*		+		
9.	*Cyclophorus massiei* Morlet, 1891*			+	
10.	*Cyclophorus volvulus* (Müller, 1774)*	+	+		
11.	*Dioryx compactus* (Bavay et Dautzenberg, 1900)*	+	+	+	
12.	*Dioryx messageri* (Bavay et Dautzenberg, 1900)*	+	+	+	
13.	*Dioryx vanbuensis* (Bavay et Dautzenberg, 1900)	+	+	+	
14.	*Japonia hypselospira* (Möllendorff, 1901)*	+	+	+	
15.	*Japonia scissimargo* (Benson, 1856)	+	+		
16.	*Laotia christahemmenae* Páll-Gergely, 2014*	+	+		
17.	*Opisthoporus lubricus* Dautzenberg et Fischer, 1908*	+	+		
18.	*Platyrhaphe leucacme* Möllendorff, 1901*		+	+	
19.	*Platyrhaphe sordida* (Pfeiffer, 1855)*		+		
20.	*Pterocyclos prestoni* Bavay et Dautzenberg, 1909*			+	
(1)	(2)	(3)	(4)	(5)	(6)
21.	*Rhiostoma simplicilabre* Pfeiffer, 1862**		+	+	
22.	*Rhiostoma* sp.*	+	+	+	+
23.	*Scabrina laciniana* (Heude, 1885)**	+	+	+	+

24.	*Scabrina vanbuensis* (Smith, 1896)	+	+	+	
	2. DIPLOMMATINIDAE Pfeiffer, 1856				
25.	*Diplommatina balansai* Morlet, 1886*		+	+	
26.	*Diplommatina clausilioides* Bavay et Daut., 1912*	+	+	+	+
27.	*Diplommatina demangei* Bavay et Dautzenberg, 1912*	+	+	+	
28.	*Diplommatina messageri* Ancey, 1903*	+	+	+	+
	3. HELICINIDAE Férussac, 1822				
29.	*Geotrochatella jourdyi* Dautzenberg, 1895*	+	+	+	
	4. HYDROCENIDAE Troschel, 1856				
30.	*Georissa chrysacme* Möllendorff, 1900*		+	+	
	5. PUPINIDAE Pfeiffer, 1853				
31.	*Pseudopomatias amoenus* Möllendorff, 1885		+	+	
32.	*Pseudopomatias maasseni* Páll-Gergely & Hunyadi, 2015	+	+		
33.	*Pseudopomatias sophiae* Páll-Gergely, 2015*		+	+	
34.	*Pupina anceyi* Bavay et Dautzenberg, 1899*	+	+		
35.	*Pupina artata* Benson, 1856*		+	+	
36.	*Pupina exclamationis* Mabille, 1887*	+	+	+	
37.	*Pupina tonkiana* Bavay et Dautzenberg, 1899*	+		+	
38.	*Pupina* sp.1*	+	+	+	+
39.	*Pupina* sp.2*	+	+	+	
40.	*Pupina* sp.3*	+			
41.	*Pupinella mansuyi* (Dautzenberg et Fischer, 1908)*	+	+	+	
42.	*Rhaphaulus tonkinensis* Páll-Gergely, 2014	+	+		
	PULMONATA Cuvier, 1814				
	6. ACHATINIDAE Swainson, 1840				
43.	*Achatina fulica* Bowdich, 1822	+	+	+	+
	7. AGRIOLIMACIDAE Wagner, 1935				
44.	*Deroceras laeve* (*Müller*, 1774)**		+		
	8. ARIOPHANTIDAE Godwin-Austen, 1888				
45.	*Hemiplecta esculenta* Maassen, 2006*	+	+	+	+
46.	*Koratia pernobilis* (Férussac, 1821)*	+	+	+	
47.	*Macrochlamys despecta* (Mabille, 1887)*	+	+	+	+
48.	*Macrochlamys douvillei* Dautzenberg et Fischer, 1905*	+	+	+	+
49.	*Macrochlamys* sp.	+	+	+	
50.	*Megaustenia imperator* (Gould, 1858)	+	+	+	+
51.	*Megaustenia messageri* (Bavay et Dautzenberg, 1908)*	+	+	+	
(1)	(2)	(3)	(4)	(5)	(6)
52.	*Megaustenia siamense* (Haines, 1858)*		+	+	
53.	*Microcystina messageri* Ancey, 1903*		+		
54.	*Microcystina* sp.*		+		
55.	*Sesara bouyei* (Crosse et Fischer, 1863)*	+	+		

56.	*Sivella albofilosa* (Bavay et Dautzenberg, 1908)	+	+	+	
57.	*Sivella latior* (Bavay et Dautzenberg, 1908)*	+	+	+	
58.	*Sivella paviei* (Morlet, 1884)*	+	+	+	+
	9. BRADYBAENIDAE Pilsbry, 1934				
59.	*Aegista packhaensis* (Bavay et Dautzenberg, 1908)*		+		
60.	*Bradybaena jourdyi* (Morlet, 1886)	+	+	+	+
61.	*Bradybaena similaris* (Rang, 1831)		+		
62.	*Chalepotaxis infantilis* (Gredler, 1881)*	+	+	+	+
63.	*Plectotropis subinflexa* (Mabille, 1889)*	+	+	+	
64.	*Plectotropis xydaea* (Bavay et Dautzenberg, 1908)	+	+	+	
65.	*Thaitropis ptychostyla* (Martens, 1860)*	+	+		
66.	*Thaitropis* sp.*		+		
	10. CAMAENIDAE Pilsbry, 1895				
67.	*Amphidromus dautzenbergi* Fulton, 1899*	+	+	+	
68.	*Camaena cicatricosa cicatricosa* (Müller, 1774)*			+	
69.	*Camaena gabriellae gabriellae* (Dautzenberg et d'Hamoville, 1887)*	+			
70.	*Camaena illustris* (Pfeiffer, 1862)*	+	+	+	
71.	*Camaena longsonensis* (Morlet, 1891)*	+	+	+	
72.	*Camaena massiei* (Morlet, 1891)*	+	+	+	+
73.	*Camaena vanbuensis* Smith, 1896		+	+	+
74.	*Camaena* sp.1*	+			
75.	*Camaena* sp.2*	+		+	
76.	*Genesella acris perakensis* (Crosse, 1879)*	+	+	+	
77.	*Moellendorffia depressispira* (Bavay et Daut., 1908)*	+	+	+	
78.	*Neocepolis merarcha* (Mabille, 1888)*	+			
79.	*Trachia balansai* (Morlet, 1886)*	+	+	+	+
80.	*Trachia marimberti* (Bavay et Dautzenberg, 1900)*		+	+	+
81.	*Trachia nasuta* (Bavay et Dautzenberg, 1908)	+	+	+	
	11. CHRONIDAE Thiele, 1931				
82.	*Kaliella haiphongensis* Dautzenberg, 1893*	+	+	+	
83.	*Kaliella jucunda* Bavay et Dautzenberg, 1912*	+	+	+	
84.	*Kaliella ordinaria* Ancey, 1903*	+	+	+	+
85.	*Kaliella ornatissima* Bavay et Dautzenberg, 1912*			+	
86.	*Kaliella subelongata* Bavay et Dautzenberg, 1912*	+	+	+	
	12. CLAUSLIIDAE Gray, 1855				
(1)	(2)	(3)	(4)	(5)	(6)
87.	*Euphaedusa theristica* Mabille, 1887	+	+	+	
88.	*Garnieria mouhoti nhuongi* Do Duc Sang, 2015***			+	
89.	*Hemiphaedusa chiemhoaensis* (Sykes, 1902)*	+	+	+	
90.	*Megalauchenia proctostoma proctostoma* (Mabille, 1889)	+			

91.	*Oospira duci khanhi* Nordsieck, 2011	+			
92.	*Oospira oviformis* Nordsieck, 2011	+	+		
93.	*Oospira tryptix* Nordsieck, 2011		+		
94.	*Oospira vanbuensis* (Bavay et Dautzenberg, 1899)	+	+	+	
95.	*Phaedusa dichroa* (Bavay et Dautzenberg, 1899)*	+			
96.	*Phaedusa lypra lypra* (Mabille, 1887)	+	+	+	
97.	*Phaedusa lypra pereupleura* Nordsieck, 2011		+		
98.	*Phaedusa micropaviei* Nordsieck, 2011	+	+		
99.	*Phaedusa paviei* (Morlet, 1892)		+	+	+
100.	*Synprosphyma cervicalis* (Bavay et Daut., 1909)		+	+	
101.	*Synprosphyma suilla* (Bavay et Dautzenberg, 1909)			+	
	13. DIAPHERIDAE Panha & Naggs, 2010				
102.	*Sinoennea copiaensis* Do & Do, 2015***	+	+	+	
	14. ENIDAE Woodward, 1903				
103.	*Coccoderma macrostoma* (Bavay et Daut., 1912)*	+	+		
	15. GLESSULIDAE Godwin-Austen, 1920				
104.	*Glessula paviei* Morlet, 1892*	+	+	+	+
	16. HYPSELOSTOMATIDAE Zilch, 1959				
105.	*Anauchen gereti* (Bavay et Dautzenberg, 1903)*			+	
106.	*Boysidia robusta* Bavay et Dautzenberg, 1912*		+		
107.	*Gyliotrachela crossei crossei* (Morlet, 1886)*		+	+	
	17. PHILOMYCIDAE Gray, 1847				
108.	*Meghimatium pictum* (Stoliczka, 1873)**		+	+	
	18. PLECTOPYLIDAE Möllendorff, 1898				
109.	*Gudeodiscus hemmeni* Páll-Gergely & Hunyadi, 2015	+	+	+	
110.	*Gudeodiscus messageri raheemi* Páll-Gergely & Hunyadi, 2015	+	+		
111.	*Gudeodiscus phlyarius* (Mabille, 1887)	+	+	+	+
	19. RHYTIDIDAE Pilsbry, 1893				
112.	*Macrocycloides crenulata* Yen, 1939*	+	+	+	+
	20. STREPTAXIDAE Gray, 1860				
113.	*Haploptychius blaisei* (Dautzenberg et Fischer, 1905)*			+	
114.	*Haploptychius costulatus costulatus* (Möllendorff, 1881)*		+	+	
115.	*Haploptychius costulatus subcostulatus* (Möll., 1901)*		+		
116.	*Haploptychius* sp.*	+	+	+	
117.	*Huttonella bicolor* (Hutton, 1834)*		+	+	
(1)	(2)	(3)	(4)	(5)	(6)
118.	*Perrottetia dugasti* (Morlet, 1892)*	+		+	
119.	*Stemmatopsis nangphaiensis* Do & Do, 2015***			+	
120.	*Stemmatopsis vanhoensis* Do & Do, 2015***	+		+	
	21. SUBULINIDAE Fischer & Crosse, 1877				

121.	*Allopeas gracile* (Hutton, 1834)	+	+	+	+
122.	*Prosopeas anceyi* Pilsbry, 1906*	+	+	+	
123.	*Prosopeas excellens* Bavay et Dautzenberg, 1908		+		
124.	*Prosopeas muongbuensis* Do, 2014***		+	+	
125.	*Prosopeas ventrosulum* Bavay et Dautzenberg, 1908	+	+		
126.	*Subulina octona* (Bruguière, 1792)*		+	+	
127.	*Tortaxis comaensis* Do, 2014***		+		
128.	*Tortaxis* sp.*	+	+	+	
	22. SUCCINEIDAE Beck, 1837				
129.	*Succinea* sp.*		+		
	23. VERONICELLIDAE Gray, 1840				
130.	*Laevicaulis alte* (Férusac, 1822)**		+	+	+
Total		**86**	**109**	**89**	**25**

3.1.2. Characteristic of terrestrial Gastropods fauna from Son La

This is the first checklist of the terrestrial Gastropods from Son La. It includes 130 species and subspecies, belonging to 64 genera in 23 families, of which 10 species are endemic. There are 42 species of Prosobranchia (32.31%). This results is consistent to the properties of the terrestrial Gastropods of Indochina fauna: Prosobranchia usually occupies about 1/3 of total species. The families Cyclophoridae (24 species, 10 genera), Pupinidae (12 species, 4 genera), Diplommatinidae (4 species, 1 genus) are most dominant.

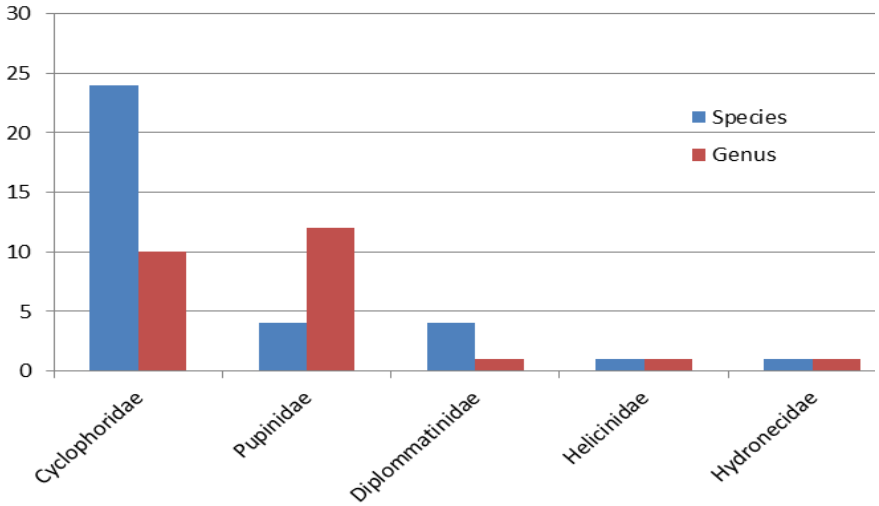

Fig. 3.1. The number of species and genus of families of Prosobranchia

Pulmonata is vary in number with 88 species, making up 67.69% of all species. Terrestrial Gastropods of Son La are most diverse in terms of family and genera with the Clausiliidae (15 species, 7 genera), Camaenidae (15 species, 6 genera), Ariophantidae (14 species, 7 genera), Bradybaenidae (8 loài,

5 genera), Subulinidae (8 species, 4 genera), Streptaxidae (8 species, 4 genera), Chronidae (5 species, 1 genus), Hypselostomatidae (3 species, 3 genera),...

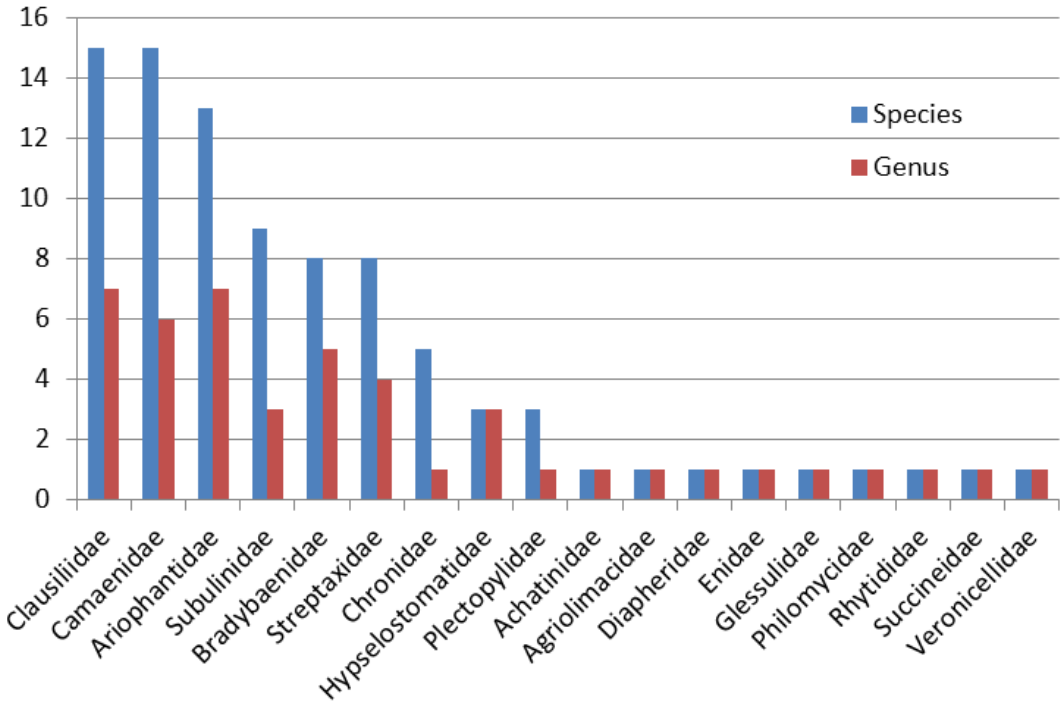

Fig. 3.2. The number of species and genus of families of Pulmonata

Diversity of genera: There are 2.78 genera in each families (64 genera/23 families). The families Cyclophoridae (10 genera), Ariophantidae, Clausiliidae (7 genera), Camaenidae (6 genera), Bradybaenidae (5 genera), Streptaxidae, Pupinidae, Subulinidae (4 genera), Hypselostomatidae (3 genera) are dominant.

Diversity of species: The families Cyclophoridae (24 species), Clausiliidae, Camaenidae (15 species), Ariophantidae (14 species), Pupinidae (12 species), Subulinidae, Bradybaenidae, Streptaxidae (8 species), Chronidae (5 species), Diplommatinidae (4 species), Hypselostomatidae, Plectopylidae (3 species) are dominat.

The genera are vary in number of species: *Camaena* (8 species), *Pupina* (7 species), *Alycaeus* (6 species), *Kaliella*, *Phaedusa* (5 species), *Diplommatina*, *Oospira*, *Cyclophorus*, *Haploptychius*, *Prosopeas* (4 species), *Dioryx*, *Gudeodiscus*, *Macrochlamys*, *Sivella*, *Trachia*, *Tortaxis* (3 species). There are 35 genera (accounting for 54.47%), whose are only discovered one species.

The new discoveries:

- ***New species to science*:** Six new species are described, namely *Prosopeas muongbuensis*, *Tortaxis comaensis*, *Stemmatopsis nangphaiensis*,

Stemmatopsis vanhoensis, *Sinoennea copiaensis*, and *Garnieria mouhoti nhuongi*, their holotype and paratype have been collected from Son La.

- *New discovered to Vietnam fauna*: This is the first species of genera *Garnieria* (Clausiliidae), *Deroceras* (Agriolimacidae), *Laevicaulis* (Veronicellidae) from Vietnam. Further, twelve additional species to the species list of Vietnam (*Prosopeas muongbuensis, Tortaxis comaensis, Stemmatopsis nangphaiensis, Stemmatopsis vanhoensis, Sinoennea copiaensis*, *Garnieria mouhoti nhuongi*, *Alycaeus paviei*, *Rhiostoma simplicilabre*, *Scabrina laciniana*, *Deroceras laeve*, *Meghimatium pictum*, and *Laevicaulis alte*).

- *Additional species were discovered to Son La*: In this research, 98 additional species and subspecies are added to the species list of Son La (see table 3.1).

- *The species has not been identified*: There are 15 taxa, which are identified only to genus (*Alycaeus* sp.1, *Alycaeus* sp.2, *Alycaeus* sp.3, *Rhiostoma* sp., *Pupina* sp.1, *Pupina* sp.2, *Pupina* sp.3, *Macrochlamys* sp., *Microcystina* sp., *Thaitropis* sp., *Camaena* sp.1, *Camaena* sp.2, *Haploptychius* sp., *Tortaxis* sp., and *Succinea* sp.), they may be new species to science, are being checked and awaiting publication,

- *Endemic species:* There are 10 endemic to Son La (*Scabrina vanbuensis*, *Prosopeas muongbuensis*, *Tortaxis comaensis*, *Oospira tryptix*, *Phaedusa lypra pereupleura*, *Phaedusa micropaviei*, *Garnieria mouhoti nhuongi*, *Stemmatopsis nangphaiensis*, *Stemmatopsis vanhoensis*, *Sinoennea copiaensis*).

Position of terrestrial Gastropods Son La to Vietnam fauna

The number of terrestrial Gastropods from Son La accounting for 18.28% of the total from Vietnam. Thus, it is believed that Son La will have a rich fauna of terrestrial Gastropods. Also, there are 64 genera (accounting for 46.04%) and 23 families (representing 71.87%). These results show a high degree of diversity in the classification taxon level of Son La.

The common species composition between investigated region and the North-East delta of Hong river (93 species) is higher than the species composition of Annam (41 species), and Cochinchina (14 species). In particular, have not recorded species of Pupinidae, Clausiliidae, Plectopylidae Chronidae between Son La and Cochinchina, although they are very diverse in the Northern region.

The zoogeographic elements of terrestrial Gastropods Son La fauna

Of the 115 species identified in Son La, 77 species (66.95%) of the endemic to Vietnam fauna. There are 2 endemic of genera to Vietnam (*Neocepolis*, *Stemmatopsis*), they heve been distributed in the North Vietnam. This results show the complexity of Son La fauna.

The tropical species, they are distributed in Indo-Malai subregion, including North Vietnam are recorded 18 species of 5 families (Cyclophoridae, Ariophantidae, Camaenidae, Bradybaenidae and Streptaxidae). There are 12 species and subspecies of the China element. The distribution of the species on this component extends from Northern Vietnam to Southern China (Yunnan, Guangxi, Guangdong, Chongqing, Sichuan). The widely distributed species in the world is not diverse, including 8 species (*Achatina fulica*, *Deroceras laeve*, *Bradybaena similaris*, *Meghimatium pictum*, *Huttonella bicolor*, *Laevicaulis alte*, *Subulina octona*, and *Allopeas gracilis*).

3.2. THE LIST AND IDENTIFICATION KEY TO THE TERRESTRIAL GASTROPODS OF SON LA

3.2.1. The list of terrestrial Gastropods of Son La

The contents are introducted: original data, type location, synonym, speciment, size, diagnosis, distribution (Son La, others of Vietnam and in the world), and remarks.

Example: *Cyclophorus implicatus* Bavay et Dautzenberg, 1908

Cyclophorus implicatus Bavay & Dautzenberg, 1908: J. Conch., 56: 249. *Type location*: Muong Bo, Muong Te, Lai Chau, Vietnam.

Specimens: 22A (Bon Phang, Thuan Chau; Co Noi, Mai Son), No. HNUE-OC 086.

Diagnosis: Shell biconcave, sinistral, yellow brown. 5 whorls, profile of shell whorls slightly convex, a large ridge running between the last whorl. Peristome are continuous and expanded. Callus thin.

Dimensions (mm)**:** H 20.3-23.1, D 28.2-33.1, WA 14.3-16.9, HA 14.3-16.9.

Distribution:

- *In Son La:* District Thuan Chau: Bon Phang; District Mai Sơn: Co Noi; City Sơn La: Chieng An.

- *In Vietnam:* Lai Châu: Muong Te, Tam Duong.

Remarks: Comparing with *Cyclophorus*, whose are discovered in Son La, this species has a lower real tower. *C. implicatus* is endermic to Northwestern Vietnam. Additional species is to the species list of Son La.

3.2.2. Identification key to the terrestrial Gastropods of Son La

This section introduces the identification keys to families, genera and species of Son La. Example:

Identification key to Gastropoda subclass from Son La

1 (2) There is operculum…….....Prosobranchia
2 (1) There is not operculum……..Pulmonata

Identification key to families of Prosobranchia from Son La

1 (2) There are ribs on last whorl. The bottom shell is flat……....Helicinidae
2 (1) There are not ribs on last whorl. The bottom shell is convex
3 (4) Shell dome or biconcave, there is umbilicus…….Cyclophoridae
4 (3) Shell heliciform, there is not umbilicus
5 (6) Aperture crescent, peristome is not expanded…….....Hydrocenidae
6 (5) Aperture circle, peristome is expanded
7 (8) There is canal on peristome……..Pupinidae
8 (7) There is not canal on peristome……....Diplommatinidae

Identification key to genera of Pupinidae from Son La

1 (2) There are ribs on the shell……....*Pseudopomatias*
2 (1) There are not ribs on the shell
3 (4) There are tubers on the parietal location……..*Rhaphaulus*
4 (3) There are not tubers on the parietal location.....……....*Pupina*

3.3. DISTRIBUTION OF TERRESTRIAL GASTROPODS OF SON LA

3.3.1. Distribution according to habitats

Son La is divided into 3 habitats: limestone forest (RTNDV), mountain forest (RTND), farmland & residential (DCT & KDC). When considering the relationship between diversity index, level of dominant and densities shows that these values varying regularity, consistent with the results of previous studies. The terrestrial Gastropods are distributed mainly in limestone forest (126 species and subspecies), followed by mountain forest (21 species), farmland & residential (18 species). Diversity index (H ') ranged from 0.92 to 2.00 indicates species composition of terrestrial Gastropods are differences according habitats,

the highest in limestone forests (H '= 2.00), followed by mountain forest (H' = 1.12), the lowest in farmland & residential (H '= 0.92). In contrast, the level of dominant (D) is highest in the farmland & residential (D = 0.199), followed by mountain forest (D = 0.168) and limestone forest (D = 0.020).

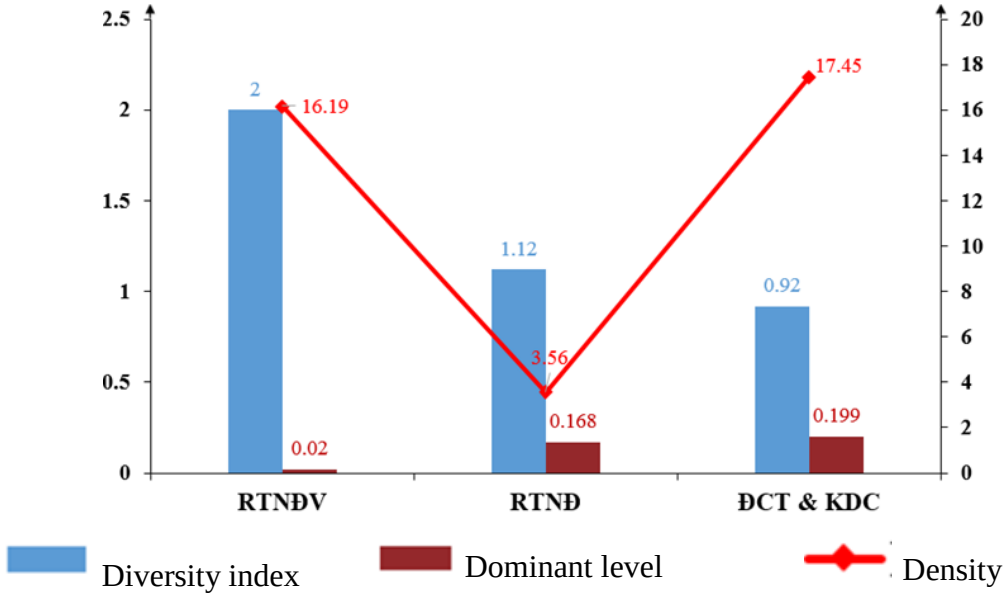

Fig. 3.3. The relationship between diversity index, dominant level, and density acccording to habitats from Son La

Terrestrial Gastropods of Son La has an average density of 12.40 individual/m^2, but there are differences from habitats, density decreases from farmland & residential (n = 17.45 individual/m^2), limestone forest (n = 16.19 individual/m^2) and lowest in the mountain forest (n = 3.56 individual/m^2).

There are 13 species of terrestrial Gastropods widely distributed simultaneously in three habitats, including 10 background species (*Cyclophorus cambodgensis, Macrochlamys despecta, Mac. douvillei, Megaustenia imperator, Sivella paviei, Bradybaena jourdyi, Chalepotaxis infrantilis, Trachia balansai, Glessula paviei*, and *Rhiostoma* sp.).

Limestone forest areas is the habitats that have the greatest species diversity in studied region (126 species and subspecies, accounting for 96.93% of the total). This habitat more favorable living conditions such as thick vegetation floor, big cover reduces heat and increases coming down the air humidity. There are ten endemic to Son La (*Scabrina vanbuensis, Prosopeas muongbuensis, Tortaxis comaensis, Oospira tryptix, Phaedusa lypra pereupleura, Phaedusa micropaviei, Garnieria mouhoti nhuongi, Stemmatopsis nangphaiensis, Stemmatopsis vanhoensis, Sinoennea copiaensis*).

There are 21 species in mountain forest (accounting for 16,16%), the area of this habitat large proportion of Son La, concentrated in Bac Yen, Phu Yen, Quynh Nhai, Song Ma, Sop Cop Districts. Two species according to Prosobranchia (*Cyclophorus cambodgensis*, *Rhiostoma* sp.) and 19 species according to Pulmonata (*Achatina fulica, Macrochlamys douvillei, Macrochlamys despecta, Megaustenia imperator, Sevilla paviei, Bradybaena jourdyi, Chalepotaxis infatilis, Plectotropis subinflexa, Trachia balansai, Glessula paviei, Allopeas gracile, Laevicaulis alte, Subulina octona, Sivella latior, Trachia marimberti, Phaedusa lypra lypra, Phaedusa paviei, Gudeodiscus phlyarius*, *Megaustenia messageri*).

There are 18 species in farmland & residential (accounting for 13,85%), the Pulmonata are most diverse with 15 specie, the Prosobranchia were least diverse with only two species (*Cyclophorus cambodgensis, Rhiostoma morleti*). Most prominent, farmland & residential is specific to the species, who are adapted from effected of human, include: *Achatina fulica, Deroceras laeve, Bradybaena jourdyi, Bradybaena similaris, Meghimatium pictum, Allopeas gracile, Subulina octona, Succinea* sp., and *Laevicaulis alte*.

3.3.2. Distribution according to elevation

There are 43 species of terrestrial Gastropods widely distributed simultaneously in three elevation, including two endemic species to Son La (*Scabrina vanbuensis, Phaedusa lypra lypra*). There are 53 species of terrestrial Gastropods widely distributed simultaneously in two elevation, mainly in the of 600-1.000 m and 1.000 m elevation, while 34 species are recorded only distribute from once elevation.

There are 53 species of terrestrial Gastropods (accounting for 40.77%) distributed in below 600m elevation, the families Ariophantidae (12 species), Cyclophoridae (9 species), Camaenidae (7 species) are dominant.

There are 115 species and subspecies of terrestrial Gastropods (accounting for 88.46%) distributed in 600-1.000 m elevation. There are 101 species and subspecies of terrestrial Gastropods (77.69%) distributed in over 1.000 m elevation.

The degree of similarity on species composition of elevations were evaluated by similarity index (SI). The results showed that values of SI range from 0.5584 to 0.7962, wherein the SI of 600-1000m & over 1.000m elevations

is highest (0.7962), represents high similarity on species composition between these two elevations. In contrast, species composition of the over 1,000 m & below 600m elevation is most difference (0.5584).

Table 3.8. Similarity index (SI) of terrestrial Gastropods of elevations

Elevation	Below 600 m	600-1.000 m	Over 1.000 m
Below 600 m	1,00	0,6347	0,5584
600-1.000 m		1,00	0,7962
Over 1.000 m			1,00

3.4. SUSTAINABLE DEVELOPMENT OF THE TERRESTRIAL GASTROPODS OF SON LA

3.4.1. Applied stuation of terrestrial Gastropods in Son La

Some species are used by local residents as food or livestock feed. In disadvantaged zone, people also used to treat certain common diseases. Some species can be used as a beautiful cover items such as key chain, wind chimes, decorated in the family.

3.4.2. Orientation of terrestrial Gastropods from Son La

3.4.2.1. Using in assessing the quality of the environment

This is the very first checklist of the terrestrial Gastropods of Son La. It includes 130 species and six subspecies, of which 10 species are endemic. This result shows that huge potential of terrestrial Gastropods of Son La to environmental quality assessment.

3.4.2.2. Using in theory and practice teaching

Two species of terrestrial Gastropods (*Achatina fulica, Cyclophorus cambodgensis*) can be the good representation to Gastropoda class. On morphological and anatomical, two species *Achatina fulica, Cyclophorus cambodgensis* has many advantages characters to observing the body structure and organ system such as good size, contribute additional objects in practice teaching of university and secondary school in Son La and the northwestern Vietnam in general.

3.4.2.3. Using in decorations and crafts production

Based on morphology, color, pattern, size and dominant, it showed that can be exploited from way, include 31 species: *Cyclophorus cambodgensis, Rhiostoma* sp., *Megaustenia imperator, Macrochlamys douvillei, Sivella*

albofilosa, Bradybaena jourdyi, Camaena illustris, Camaena vanbuensis, Amphidromus dautzenbergi, Trachia balansai, Moelendorffia depressispira.

3.4.3. Threat facters to fauna of terrestrial Gastropods of Son La

3.4.3.1. Deforest

Son La's population has increased dramatically from 1.076.055 individual (1/4/2009) to 1.195.107 individual (1/4/2015). Pressure from population growth is enormous, especially with the forest. The causes of deforestation due to the life of local residents is low, lack of productive land, and legal awareness of the role of forests limited.

3.4.3.2. Forest fires

Statistical results of the Son La department from 2012 to 2015 show that each year hundreds of hectares of forests are forested, many of which are special-use forests, watershed forests and forests are regenerated. Forest fires not only kill animals in general, including terrestrial Gastropods, but also alter the environmental characteristics such as background elements, moisture, land cover, soil properties,...

3.4.3.3. Pressure from construction of hydropower

There are 48 hydropower in the Son La province. A total land area to be sorted and arranged for the migrants from building hydroelectric 3.000 hectares of land for housing and production. The majority of the population uses firewood for daily life, the amount of use of up to 76.650m^3 wood/year, equivalent to 766-1.533 hectares of forest exploitation each year. This data suggest that the pressure on forests, soil, natural resources are huge of Son La.

3.4.3.4. Exploited limestone and mineral

Until the 2015, there are 150 mineral extraction in Son La, particularly mining limestone for construction materials and raw materials for production tends to increase. Besides the economic benefits, the mining and limestone also cause serious consequences to the environment and organisms, specifically loss of habitat, changes in soil properties, environmental pollution,... The terrestrial Gastropods has been hit hard from mining activities.

3.4.4. Proposed resolution to sustainable development of the terrestrial Gastropods Son La

3.4.4.1. Protecting the environment

Terrestrial Gastropods with sedentary features, such as narrow distribution, sensitive to environmental impact, these characteristics make them less able to adapt to the major changes from the environment. Protecting habitat of terrestrial Gastropods is prioritized protecting existing forest areas, including nature reserves, limestone areas, forest area, forest are recovering.

3.4.4.2. Assessment impact on environment

When conducting an environmental impact assessment should include assessment of the impact on terrestrial Gastropods group, which is important for conservation and sustainable development in the coming time. Additionally, environmental conditions need to be improved, tightly controlled importation of exotic species reduce the impact to native species groups.

3.4.4.3. Accelerate research activities

In-depth studies are necessary to help raise awareness of the community and allow better management resources of Son La. Contents of these study should focus on distribution characteristics, status of populations, resilience and adaptation to environmental pollution levels, the impact of exotic species, invasive species. Additionally, content taxonomical research should be concerned, based on knowledge of the classification, anatomical features, histological structure and chromosomes,...

3.4.4.4. Breeding economic value species

Formation models, encouraging local residents farmed terrestrial Gastropods, which are have value, such as *Cyclophorus cambodgensis, Cyclophorus volvulus, Camaena illustris, Camaena vanbuensis*. The farmed model's success will contribute to reducing fishing pressure from natural and improve the living conditions and income for local residents.

CONCLUSION AND RECOMMENDATION

CONCLUSION

1. This is the first checklist of the terrestrial Gastropods from Son La. It includes 130 species and subspecies, belonging to 64 genera, 23 families, 3 orders, 2 subclass, of which ten species are endemic to Son La. Construction identification key to the subclass, families, genera and species from Son La.

In this study, 98 additional species and subspecies are added to the species list of Son La. This is the first species of genera *Garnieria, Deroceras, Laevicaulis* to Vietnam. Further, twelve additional species to the species list of Vietnam. Six new species and subspecies are described, namely *Prosopeas muongbuensis*, *Tortaxis comaensis*, *Stemmatopsis nangphaiensis*, *Stemmatopsis vanhoensis*, *Sinoennea copiaensis*, and *Garnieria mouhoti nhuongi*.

2. Pulmonata vary in number with 88 species, making up 67.69% of all species. In the Prosobranchia, there are 42 species, making up 32.31% of the total number of species. Terrestrial Gastropods in Son La are most diverse in terms of family with the Cyclophoridae (24 speccies), Clausiliidae, Camaenidae (15 speccies), Ariophantidae (13 speccies), Pupinidae (12 speccies), Subulinidae (9 speccies), Bradybaenidae, Streptaxidae (8 speccies) are dominant. The terrestrial Gastropods of Son La, accounting for 18.28% of the total number of Vietnam fauna.

3. The terrestrial Gastropods are distributed mainly in limestone forrest (126 species and subspecies), followed by mountain forest (21 species), farmland & residential (18 species). There are 13 species of terrestrial Gastropods widely distributed simultaneously in three habitats, including 10 background species. There are 9 species of terrestrial Gastropods widely distributed simultaneously in two habitats. Terrestrial Gastropods of Son La has an average density of 12.40 individual/m^2, but there are differences from habitats.

There are 115 species and subspecies of terrestrial Gastropods (accounting for 88.46%) distributed in 600-1.000m elevation. There are 101 species and subspecies of terrestrial Gastropods (accounting for 77.69%) distributed in over 1.000m elevation, followed by below 600m (53 species). There are 43 species of terrestrial Gastropods widely distributed simultaneously in three elevations.

4. Terrestrial Gastropods of Son La can be orientated following three mainly way: using in assessing the quality of the environment, using in teaching practice, using in decoration and crafts production. The mainly factors threatening to terrestrial Gastropods Son La include: Deforest, forest fires, pressure from construction of hydropower, exploited limestone and mineral.

RECOMMENDATION

1. Planning and sustainable policy to development of karst areas of Son La, contributing to conservation terrestrial Gastropods resources of Son La.

2. Research the process and domesticated some species, which are economical value species, such as *Cyclophorus cambodgensis*, *Cyclophorus volvulus*, *Camaena illustris*, and *Camaena vanbuensis*.