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Diversity of centipedes (Chilopoda: Scolopendromorpha and Scutigleromorpha) in Xuan Nha Nature Reserve, Son La province, Vietnam

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ABSTRACT

This study on centipedes (Scolopendromorpha and Scutigleromorpha) was conducted in Xuan Nha Nature Reserve, Son La province in June and November 2018. A total of 47 specimens were collected from four types of habitats: broadleaf forest, broadleaf - bamboo mixed forest, bamboo forests, and residential - agricultural land. Data analysis results showed that a total of 14 species and subspecies was recorded in the study region. Of which, the order Scolopendromorpha has 12 recorded species and subspecies belonging to four genera (*Cryptops*, *Paracryptops*, *Otostigmus*, and *Scolopendra*), two families (*Cryptopidae* and *Scolopendridae*). The order Scutigleromorpha has only two species belonging to two genera (*Thereuopoda* and *Thereuonema*) and one family (*Scutigleridae*). All habitats have medium diversity of centipedes ($1.00 < H' < 3.00$). Broadleaf forest has the highest diversity ($H' = 2.11$), lower in mixed forest ($H' = 1.97$) and bamboo forest ($H' = 1.61$), residential - agricultural land has the lowest diversity ($H' = 1.01$). The highest density is in mixed forest (1.20 individuals/m²), followed by broadleaf forest (0.80 individuals/m²), and bamboo forest (0.20 individuals/m²). Those are the first data of centipedes in Xuan Nha Nature Reserve.

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1 INTRODUCTION

Located in the tropics of Southeast Asia, Vietnam is considered as a part of the Indo-Burmese biodiversity center (Sterling *et al.*, 2006). Vietnam has tropical forests, which hold treasures of extremely valuable biodiversity. Because of its significant north-south range, having areas of low to high altitudes and different climatic conditions, Vietnam is expected to harbor rich faunas of terrestrial arthropods, including centipedes. For example, there are twenty-two species and sub-species of centipede are

known only from Vietnam in total of 71 species has been recorded from Vietnam (Tran *et al.*, 2013). Not long ago, *Vinaphilus* is a new genus, and *Vinaphilus unicus* is a new species identified in Vietnam (Tran *et al.*, 2019). Xuan Nha Nature Reserve is one of the three nature reserves of Son La province (Xuan Nha, Ta Xua, Sop Cop) in Vietnam. Xuan Nha Nature Reserve was established according to Decision No. 194/CT dated on August 9, 1986 with the area of 16,316 ha in four communes of Tan Xuan, Xuan Nha, Chieng Xuan and Chieng Son. This is mostly

evergreen forest, but it includes 2,626 ha of limestone forests. Scientists state that 1,131 plant species (Tran Huy Thai, 2012), 133 mammals species (Nguyen Xuan Dang *et al.*, 2012), 39 reptile species and 27 amphibian species (Nguyen Van Sang *et al.*, 2010) occur at Xuan Nha Nature Reserve. However, up to now, there is little data on invertebrates and especially no data on centipedes which is an important group of soil organism. Centipedes play an important role in soil ecosystems because they are predator. They eat deleterious invertebrates such as cockroaches, termites, etc. In addition, some centipede species have practical significance which is used in traditional medicine for treating some diseases, or centipede venom can be used as painless treatment (Do Tat Loi, 2004; Yang *et al.*, 2013).

This paper presents centipedes, belonging to two orders Scolopendromorpha and Scutigleromorpha, species diversity, distribution and similarity in different habitats in Xuan Nha Nature Reserve, Son La province.

2 MATERIALS AND METHODS

A total of 47 specimens were collected from four habitats (broadleaf forest, bamboo forest, mixed forest, and residential-agricultural land). Two following surveyed routes were selected for collecting; each route has four types of habitats.



Fig. 1: Two survey routes in Xuan Nha Nature Reserve

S. Start point; F. final point

Route 1: samples were collected from Kho Hong village, Chieng Xuan commune, Van Ho district, Son La province ($20^{\circ}43'16.3''\text{N} - 104^{\circ}40'16.3''\text{E}$, elevation: 566 m) to the coordinates of $20^{\circ}41'44.41''\text{N} - 104^{\circ}38'44.45''\text{E}$, elevation: 1001 m (South to West). The distance is about 6 km.

Route 2: samples were also caught from Kho Hong village to the coordinates of $20^{\circ}41'44.41''\text{N} - 104^{\circ}41'58.53''\text{E}$, elevation: 1013 m (South to East). The distance is about 7 km.

Samples were collected in June and November 2018. Qualitative samples were collected using various ways such as stone flipping, leaf litter digging, soil digging, and Barber trapping method described

by Mesibov and Churchill (2003). Quantitative sample was collected using the soil-sieving method of Ghiliarov (1976) in broadleaf forests, bamboo forests and mixed forests. In each habitat, 20 points (50 cm² per point) were chosen to collect sample. After shaping, the samples were kept separately in centrifuge tubes with 70% ethanol.

Centipede specimens were classified and identified using morphological comparison according to characteristics of antennomeres, sternites, forcipular plate, terminal legs, spiracles, genitalia, etc. (Lewis, 2006). All specimens were observed under microscope (Olympus SZX10). The taxonomic documents used for comparison were Attems and

Schileyko (Attems, 1930, 1938 1953; Schileyko, 1992, 1995, 1998, 2007).

The community diversity was calculated using the software Primer V.5.2.4. The indexes, including number of species, individual abundance, diversity indexes (H'), homogeneous index (J), were also calculated for each habitat type in the study area.

3 RESULT AND DISCUSSION

3.1 Species composition

A total of 14 species and subspecies belonging to 2 orders (Scolopendromorpha and Scutigermorpha) were recorded in the study area (Table 1, Fig. 2). Scolopendromorpha has 12 species and subspecies belonging to 4 genera (*Cryptops*, *Paracryptops*, *Otostigmus*, *Scolopendra*), 2 families (Cryptopidae, Scolopendridae) (0.018% species, 0.118% genera and 0.400% family found in the world) while Scutigermorpha has only 2 species belonging to 2 genera, 1 family (Scutigeridae) (0.036% species, 0.010% genera and 0.330% family found in the world) (Minelli, 2011).

In the order Scolopendromorpha, the family Cryptopidae has 2 genera (*Cryptops*, *Paracryptops*) and the family Scolopendridae has 2 genera (*Otostigmus*, *Scolopendra*). The genus *Otostigmus* is most the diverse with six recorded species and subspecies, while the genus *Scolopendra* has 3 species and subspecies. *Cryptops* has 2 species and the genus *Paracryptops* has only 1 species. In the order Scutigermorpha, the family Scutigeridae has 2 genera (*Thereuopoda*, *Thereuonema*), each genus has only 1 species.

The results also contributed 2 subspecies new records for the Northwestern Vietnam *Scolopendra subspinipes dehaani* and *Otostigmus multidentis multidentis*. *S. subspinipes* is extensive distribution species. In Vietnam, *S. subspinipes* was previously found in Quang Binh, Nghe An, Dak Lak, Kon Tum, Ba Ria-Vung Tau (Tran *et al.*, 2013)., *S. subspinipes* was found in *Africa*: Ivory Coast; Liberia; Madagascar; Mauritius; Principe; Réunion; Rodrigues; São Tomé; Seychelles; in *Asia-Temperate*: Hong Kong; *Asia-Tropical*: Andaman Is.; Irian Jaya; Laos; Nicobar Is.; Philippines; Sarawak; Singapore; Sri Lanka; Sulawesi; Sumatera; Vietnam; in *South-*

ern America: Bermuda; Colombia; Dominican Republic; French Guiana; Guyana; Surinam (Chilobase 2.0). *Otostigmus multidentis multidentis* was previously found in Da Nang (Tran *et al.*, 2013), *Africa*: Namibia (Chilobase 2.0).

To compare with other neighboring areas, Xuan Nha Nature Reserve has a higher diversity of centipedes (14 species, 6 genera, 3 family) than that in Thuong Tien Nature reserve (13 species, 5 genera, 3 family) (Nguyen *et al.*, 2018), but lower than that in Ta Xua Nature Reserve (17 species, 9 genera, 4 family) (Tran Thi Thanh Binh *et al.*, 2018). It may be because the altitude of Xuan Nha Nature Reserve (564 m - 1013 m) has a higher than Thuong Tien Nature reserve (294 m – 618 m) but lower than that in Ta Xua Nature Reserve (400 m -1300 m) (Nguyen *et al.*, 2018, Tran Thi Thanh Binh *et al.*, 2018).

Centipede species, genera and families composition changes from habitat to habitat. Diversity is highest in mixed forest (9 species, 5 genera, 3 families), followed by broadleaf forest (9 species, 4 genera, 3 families), bamboo forest (5 species, 4 genera, 3 families), and the lowest is residential - agricultural land (3 species, 3 genera, 2 families).

Mixed forest is the most diverse in centipedes. This result is similar to the research at Ta Xua Nature Reserve (Tran Thi Thanh Binh *et al.*, 2018) and Thuong Tien Nature Reserve (Nguyen *et al.*, 2018).

No species has been found in all four habitats. There are three species/subspecies found in three habitats (*Cryptops tahitianus*, *Thereuonema* sp., *Otostigmus politus politus*) and 6 species/subspecies found in two habitats (*Scolopendra subspinipes dehaani*, *Otostigmus scaber*, *Otostigmus multidentis multidentis*, *Otostigmus astenus*, *Otostigmus aculeatus*, *Cryptops doriae*). Five species/subspecies were found in only a habitat. *Paracryptops indicus* was found only in mixed forests, while *Otostigmus voprosus*, *Scolopendra calcarata* and *Thereuopoda longicornis* were found only in broadleaf forest, and *Scolopendra subspinipes subspinipes* was found only in residential-agricultural land.

There are four species found at the altitudes lower than 700 m (tropical), five species were found at the altitude higher than 700 m (subtropical), and five species were found at both.

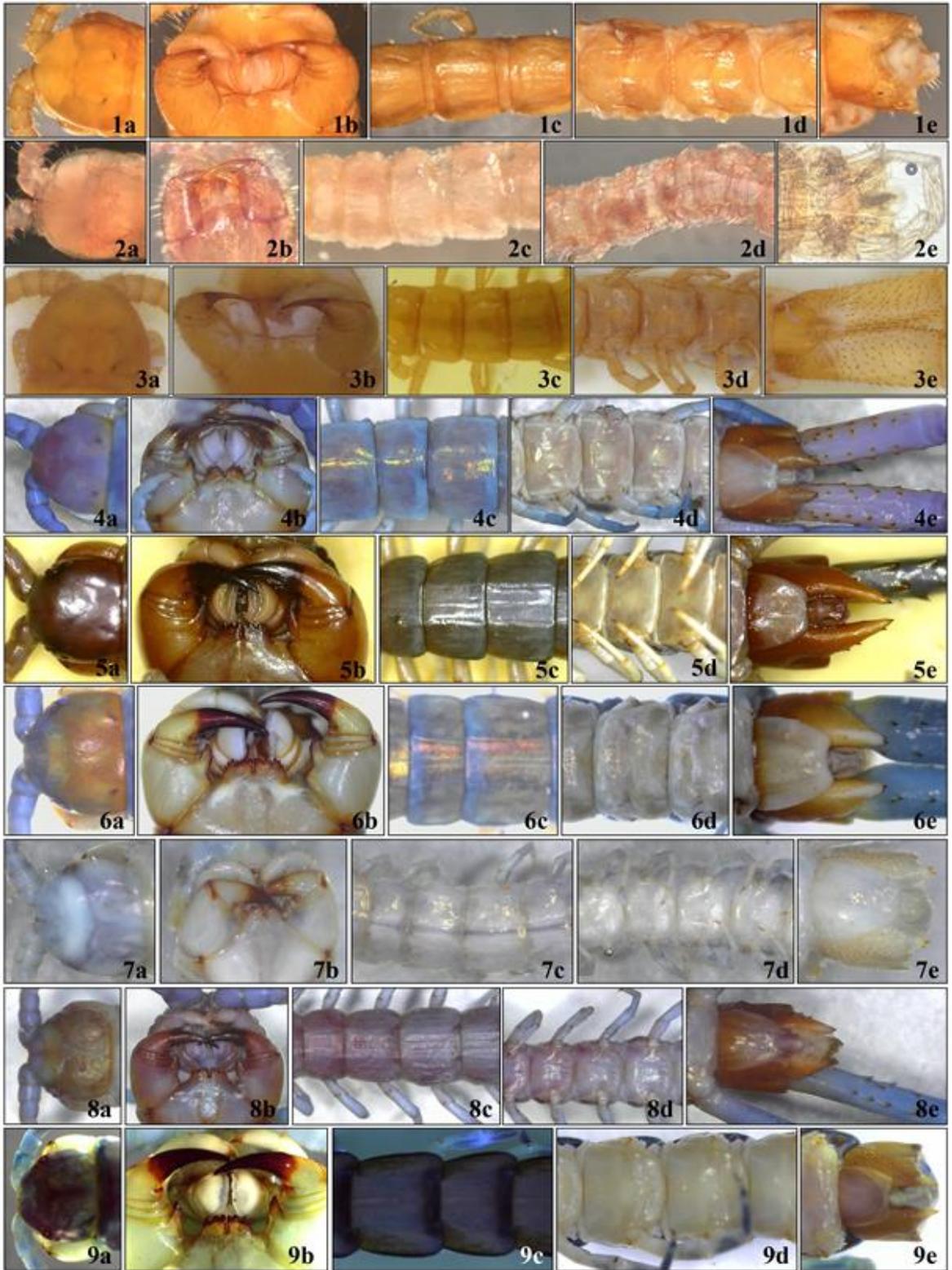
Table 1: Species composition of centipedes in the study area

Taxon	Type habitats				Altitude**	
	I	II	III	IV	< 700 m	> 700 m
SCOLOPENDROMORPHA						
CRYPTOPIDAE KOHLRAUSCH, 1881						
<i>Cryptops</i> Leach, 1815						
1			1	2	x	x
2		1	6	2	x	
<i>Paracryptops</i> Silvestri, 1924						
3			2			x
SCOLOPENDRIDAE POCOCK, 1895						
<i>Otostigmus</i> Porat, 1876						
4	3			1	x	x
5			4	2	x	x
6		1	4		x	
7		1	2	1	x	x
8			1	1		x
9				1		x
<i>Scolopendra</i> Linnaeus, 1758						
10				1		x
11	2				x	x
12		1	1		x	
SCUTIGEROMORPHA						
SCUTIGERIDAE LEACH, 1814						
<i>Thereuopoda</i> Verhoeff, 1904						
13				3		x
<i>Thereuonema</i> Verhoeff, 1904						
14	1	1	1		x	
Number of individuals						
	6	5	22	14		
Number of species						
	3	5	9	9	9	10

I: Residential - agricultural land; II: Bamboo forest; III: Mixed forest; IV: Broadleaf forest

*: New records for the Northwestern region, Vietnam.

**< 700 m (tropical), > 700 m (subtropical) (Le Thong, 2009).



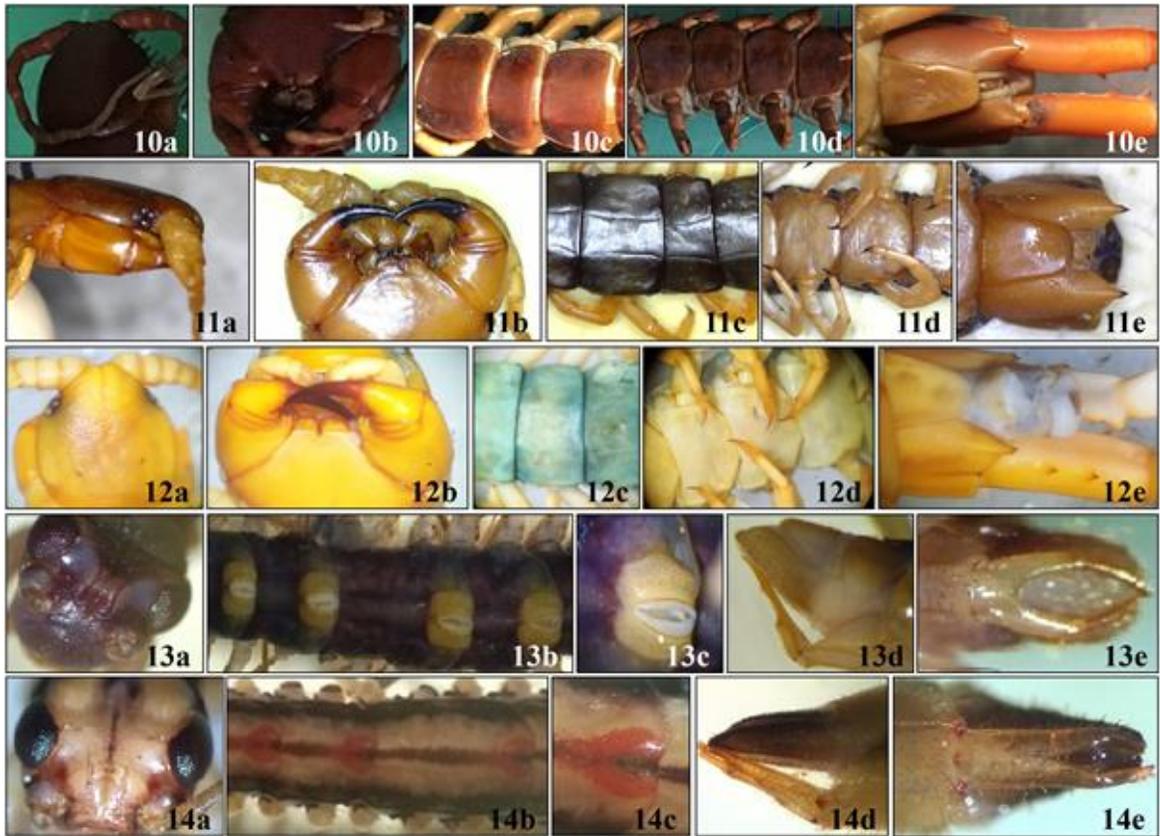


Fig. 2: External morphology of species in the study area

1. *Cryptops doriae*, 2. *Cryptops tahitianus*, 3. *Paracryptops indicus*, 4. *Otostigmus aculeatus*, 5. *Otostigmus astenus*, 6. *Otostigmus multidens multidens*, 7. *Otostigmus politus politus*, 8. *Otostigmus scaber*, 9. *Otostigmus voprosus*, 10. *Scolopendra calcarata*, 11. *Scolopendra subspinipes subspinipes*, 12. *Scolopendra subspinipes dehaani*, 13. *Thereuopoda longicornis*; 14. *Thereuonema sp.*

a. Dorsal view of the head, b. Tooth plate, c. Terga, d. Sterna, e. Sternite of last leg-bearing segment, f. Spiracles, g. Anal valves, h. Gonopods of female.

The similarity of species composition between habitats in the study area is presented in Table 2 and Figure 3.

Table 2: The similarity of centipede species composition between different habitats in the study area

	I	II	III
II	21.87		
III	11.48	54.71	
IV	13.23	25.04	48.06

I: Residential - agricultural land; II: Bamboo forest; III: Mixed forest; IV: Broadleaf forest

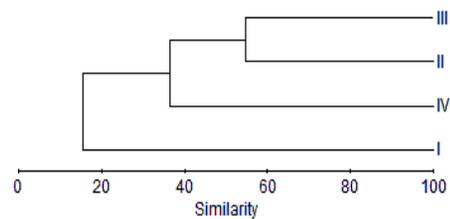


Fig. 3: The similarity of species composition of the habitats in study area

I: Residential - agricultural land; II: Bamboo forest; III: Mixed forest; IV: Broadleaf forest

The result shows that there is a low similarity in species composition between habitats in the study area (< 50%). Only bamboo forest and mixed forest are relatively similar in species composition (54,71%, Table 2). Figure 3 also shows that the residential-agricultural land is separated into a distinct branch. It is because this habitat has no litter layer, and is often affected by human activities; therefore, only widely distributed species or species adapted to this condition can exist here.

3.2 Biological indexes

Regarding the homogeneous index, the highest index is in bamboo forest ($J' = 1.00$), following by broadleaf forest ($J' = 0.96$), residential - agricultural land ($J' = 0.92$) and the lowest is in mixed forests ($J' = 0.90$). However, the Shanon-Wever Index (H'), broadleaf forest has the highest diversity ($H' = 2.11$), lower in mixed forest ($H' = 1.97$) and bamboo forest ($H' = 1.61$), residential - agricultural land has the lowest diversity ($H' = 1.01$) (Table 3). Therefore, the bamboo forest has few species but the number of

individuals is equally distributed and the mixed forest has many species but the number of individuals are mainly belonged to some species (*Cryptops taititianus*, *Otostigmus astenus*, *Otostigmus multidentis*).

Table 3: The diversity and similarity indexes of different habitats

Habitat	Number of individuals	Number of species	J'	H'
I	6	3	0.92	1.01
II	5	5	1.00	1.61
III	22	9	0.90	1.97
IV	14	9	0.96	2.11

I: Residential - agricultural land; II: Bamboo forest; III: Mixed forest; IV: Broadleaf forest

The average density of centipedes in Xuan Nha Nature Reserve is 0.73 individuals/m². The highest density is in mixed forest (1.2 individuals/m²), followed by broadleaf forest (0.80 individuals/m²), and the lowest is in the bamboo forest (0.2 individuals/m²) (Table 4).

Table 4: The centipede density in different habitats

	Habitat		
	(20 squares (50 cm x 50 cm)/habitat)		
	II	III	IV
Specimens	1	6	4
Density (individuals/m ²)	0.20	1.20	0.80
Average	0.73		

II: Bamboo forest; III: Mixed forest; IV: Broadleaf forest

The diversity and density are highest in mixed forest. It may be due to the diversity of vegetation in this habitat that leads to the development of animals which are food resources of centipedes.

4 CONCLUSIONS

A total of 14 species and subspecies belonging to 2 orders Scolopendromorpha and Scutigermorpha were recorded in four habitats (broadleaf forests, bamboo forests, mixed forests and residential - agricultural lands). The order Scolopendromorpha has 12 species and subspecies belonging to 4 genera (*Cryptops*, *Paracryptops*, *Otostigmus*, *Scolopendra*), 2 families (Cryptopidae, Scolopendridae), while the order Scutigermorpha has 2 species belonging to 2 genera (*Thereuopoda*, *Thereuonema*) and 1 family (Scutigeridae). Two subspecies *Otostigmus multidentis multidentis* and *Scolopendra subspinipes dehaani* are new records for the North-western region of Vietnam. There are four species found at the altitude lower than 700 m (tropical), five species at the altitude higher than 700 m (sub-tropical), and five species at both altitude range.

Among habitats in the study area, mixed forest has the highest diversity and lastly residential-agricultural land. The highest density is in mixed forest (1.2 individuals/m²), followed by broadleaf forest (0.80 individuals/m²), and bamboo forest (0.2 individuals/m²).

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