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SHORT COMMUNICATION

DIVERSITY AND DISTRIBUTION OF THE LARGE CENTIPEDES (CHILOPODA: SCOLOPENDROMORPHA) IN THE PHIA OAC - PHIA DEN NATIONAL PARK, VIETNAM

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Diversity and distribution of the large centipedes (Chilopoda: Scolopendromorpha) in the Phia Oac - Phia Den National Park, Vietnam

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Abstract. The scolopendromorph fauna of the Phia Oac - Phia Den National Park, northernmost Vietnam has been studied. As a result, a total of 17 species in eight genera and three families have been recorded in five different types of habitats (wood forest, bamboo forest, wood-bamboo mixed forest, pine forest, and grassland-shrubs) and from three elevation range (<1,000 m, 1,000–1,600 m, and >1,600 m). Scolopendridae is the most diverse family with nine recorded species. Of the five habitats, most species have been found in wood forests and wood-bamboo mixed forests (11 species each habitat), and at the elevation range of 1,000–1,600 m (15 species). The research also recommended that this number does not reflect the true biodiversity of this region; more intensive surveys are needed to have a better understanding of the scolopendromorph diversity in the Phia Oac - Phia Den National Park.

Keywords. Biodiversity, bioinventory, Cao Bang Province, high mountains, scolopendromorphs.

Centipedes play an important role in soil ecosystems. They participate in decaying process, returning and cycling nutrients (Lewis 1981). Some large centipedes could be used as a traditional medicine (Pham et al. 2000; Yang et al. 2013; Ma et al. 2014). To date, about 3,150 centipede species in 400 genera, 24 families,

and five orders have been reported worldwide, but it is estimated 8,000 species exist in nature (Minelli 2011).

In Vietnam, 73 species in 27 genera, 13 families, and four orders (Scolopendromorpha, Geophilomorpha, Lithobiomorpha, and Scutigeromorpha) have been recorded (Tran et al. 2013). Of the four orders, Scolopendromorpha has 35 species in 11 genera and three families. The data on their distribution is very limited as some of species have been known only in one or two locations. It is because there are not many studies on centipedes in Vietnam (Tran et al. 2013, 2019; Vu et al. 2020).

The Phia Oac - Phia Den National Park is located in Cao Bang Province, northernmost part of Vietnam. Its total area is about 10,593 ha including 8,146 ha of natural forests. This park has very complicated topology with high mountains (more than 1,000 m). The biodiversity of this park is very high and quite characteristic because of complicated combination of high mountains and geological & climatic conditions (Vietnam Administration of Forestry 2013). The recent report already recorded

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1,287 plant species in 786 genera, 202 families of six phyla, and 496 vertebrate species. Of which, 352 plants and 58 mammals are currently listed in the Vietnam Red Book (Pham 2014). Almost all field surveys have focused on only vertebrate animals, but not invertebrates, especially soil invertebrates including centipedes. Therefore, data on invertebrate fauna of the Phia Oac - Phia Den National Park is very limited, or even lacking. This work herein aims to provide the first preliminary data on centipedes including species diversity and distribution in the Phia Oac - Phia Den National Park.

MATERIALS AND METHODS

Collecting fieldworks were conducted in July 2017, August 2018 and August 2019 in five different types of habitats in Phia Oac - Phia Den National Park (Cao Bang Province), including wood forest (WF), bamboo forest (BF), wood-bamboo mixed forest (WBF), pine forest (PF), and grassland-shrub (GS). Specimens were also searched in three elevation ranges following the classification of Vu Tu Lap (2012): below 1,000 m; 1,000–1,600 m; and above 1,600 m.

Centipede specimens were collected using pitfall trapping (Mesibov & Churchill 2003), leaf-sifting (Górny & Grum 1993) in five habitats. A total of 95 specimens were collected and preserved in 75% ethanol.

Centipedes were identified following Attems (1930, 1938, 1953), Schileyko (1992, 1995, 2007), and Minelli (2011).

Ecological indices including number of species, Shanon-Weaver H', uniformity J' were calculated using the software Primer ver. 7.0 for each habitat type. Similarity index was calculated using the software R ver. 4.0.4.

RESULTS

Species composition and taxon diversity

From 95 specimens collected in Phia Oac - Phia Den National Park, 17 species of eight genera, three families (Scolopendridae, Cryptopidae, and Scolopocryptopidae) were recorded in the national park (Table 1). Three species, *Tonkinodentus lestes*, *Asanada brevicornis*, and *Rhysida longipes*, were recorded for the first time in northern Vietnam. These species were previously found in central and southern Vietnam, and two species *A. brevicornis* and *R. longipes* has been widely distributed in southeastern Asia (Tran et al. 2013). In addition, the distribution of two species, *Ostostigmus aculeatus* and *Ostostigmus multidens*, was also expanded northward (Vu et al. 2020).

Table 1 indicates that, two habitats, WF and WBF,

were the most diverse one in terms of number of species (11 for each habitat) and number of genera (six in WF and seven in WBF). The diversity reduced from BF habitat (8 species, 6 genera, 3 families) to PF (6 species, 4 genera, 2 families). The lowest number of species, genera and families were recorded in GS habitat (two species in one genus, one family).

Of 17 centipede species, three (*Asanada brevicornis*, *Cryptops spinipes*, and *Tokinodentus lestes*) were commonly found in four habitats; four (*Scolopendra subspinipes*, *Scolopendra cingulatoides*, *Scolopocryptops spinicaudus*, and *Scolopocryptops* sp.) were found in only three habitats; four (*Ostostigmus aculeatus*, *Cryptops doriae*, *Cryptops* sp., and *Scolopocryptops rubiginosus*) were found in only two habitats; two species (*Alluropus demangei* and *Rhysida longipes*) were recorded only in WBF while other two (*Ostostigmus voprosus* and *Ostostigmus multidens*) were found only in PF habitat.

Regarding topological distribution, the highest species diversity was recorded in the elevation range of 1,000–1,600 m (15 species, 7 genera, 3 families) while other elevation ranges had lower diversity (11 species, 6 genera, 2 families in >1,600 m and 9 species, 3 genera, 2 families in <1,000 m). However, this result may not reflect the true diversity of centipedes in different elevation. This may depend on our collecting efforts, and it requires more intensive surveys in the elevation range of less than 1,000 m.

Three species (*Asanada brevicornis*, *Scolopendra cingulatoides*, and *Cryptops spinipes*) were found in all three elevation ranges; nine species were recorded at two elevation ranges and five species were found at only one elevation ranges.

Taxon diversity

Of three families, Scolopendridae was recorded with nine species (accounting for 58.82% of the total number of recorded species) in five genera (accounting for 62.5% of the total number of recorded genera); Cryptopidae had four species (23.53%) in two genera (25.0%); and lastly Scolopocryptopidae recorded three species (17.65%) in only one genus (12.5%) (Table 2).

It can be seen the remarkable diversity in terms of number of species and genus of the family Scolopendridae in Phia Oac - Phia Den NP. This is also consistent with the study of Nguyen et al. (2019) when they studied the order Scolopendromorpha in Hoang Lien National Park in which climatic characteristics and high mountainous terrain are similar to Phia Oac - Phia Den National Park. According to Nguyen et al. (2019), Scolopendridae is the most diverse family with high

Table 1. Species composition and distribution of Scolopendromorpha in the Phia Oac - Phia Den National Park.

		Habitat					Elevation range (m)		
		WF	WBF	BF	PF	GS	<1.000	1.000–1.600	>1.600
	Family Scolopendridae Pocock, 1895								
	Genus Alluropus Silvestri, 1912								
1	<i>Alluropus demangei</i> Silvestri, 1912	-	+	-	-	-	-	+	-
	Genus Asanada Meinert, 1886								
2	<i>Asanada brevicornis</i> Meinert, 1886	+	+	+	+	-	+	+	+
	Genus Otostigmus Porat, 1876								
3	<i>Ostostigmus aculeatus</i> Haase, 1887	-	-	+	+	-	+	+	-
4	<i>Ostostigmus voprosus</i> Schileyko, 1992	-	-	-	+	-	-	+	-
5	<i>Ostostigmus multidens</i> Schileyko, 1995	-	-	-	+	-	-	+	-
	Genus Rhysida Wood, 1862								
6	<i>Rhysida longipes</i> Newport, 1845		+	-	-	-	-	-	+
	Genus Scolopendra Linnaeus, 1758								
7	<i>Scolopendra subspinipes</i> Leach, 1815	+	+	-	-	+	+	+	-
8	<i>Scolopendra dehaani</i> Brandt, 1840	+	-	-	-	-	-	+	+
9	<i>Scolopendra cingulataoides</i> Attems, 1938	+	+	-	-	+	+	+	+
10	<i>Scolopendra calcarata</i> Porat, 1876	-	-	+	-		+	-	-
	Family Cryptopidae Rausch, 1881								
	Genus Cryptops Leach, 1815								
11	<i>Cryptops spinipes</i> Pocock, 1891	+	+	+	+	-	+	+	+
12	<i>Cryptops doriae</i> Pocock, 1891	+	-	+	-	-	-	+	+
13	<i>Cryptops</i> sp.	+	+	-	-	-	-	+	+
	Genus Tonkinodentus Schileyko, 1992								
14	<i>Tonkinodentus lestes</i> Schileyko, 1992	+	+	+	+	-	-	+	+
	Family Scolopocryptopidae Pocock, 1896								
	Genus Scolopocryptops Newport, 1844								
15	<i>Scolopocryptops spinicaudus</i> Wood, 1862	+	+	+	-	-	-	+	+
16	<i>Scolopocryptops rubiginosus</i> L. Koch, 1878	+	+	-	-	-	-	+	+
17	<i>Scolopocryptops</i> sp.	+	+	+	-		-	+	+
	Total number of individuals	26	32	22	11	4	9	57	29
	Total species	11	11	8	6	2	6	15	11

WF—Wood forest | WBF—Wood-bamboo mixed forest | BF—Bamboo forest | PF—Pine forest | GS—Grass-shrub | +—present | -—absent.

Table 2. Taxon diversity of Scolopendromorpha.

Classification rank	Genus		Species	
	Amount	Ratio (%)	Amount	Ratio (%)
Scolopendridae	5	62.5	10	58.82
Cryptopidae	2	25.0	4	23.53
Scolopocryptopidae	1	12.5	3	17.65
Total	8	100	17	100

Table 3. Diversity index and uniformity index by habitat.

Habitat	Amount		Index	
	Species	Individual	J'	H'
WF	11	26	0.94	2.25
WBF	11	32	0.76	1.81
BF	8	22	0.85	1.77
PF	6	11	0.86	1.54
GS	2	4	0.81	0.56

WF—Wood forest | WBF—Wood-bamboo mixed forest | BF—Bamboo forest | PF—Pine forest | GS—Grass-shrub.

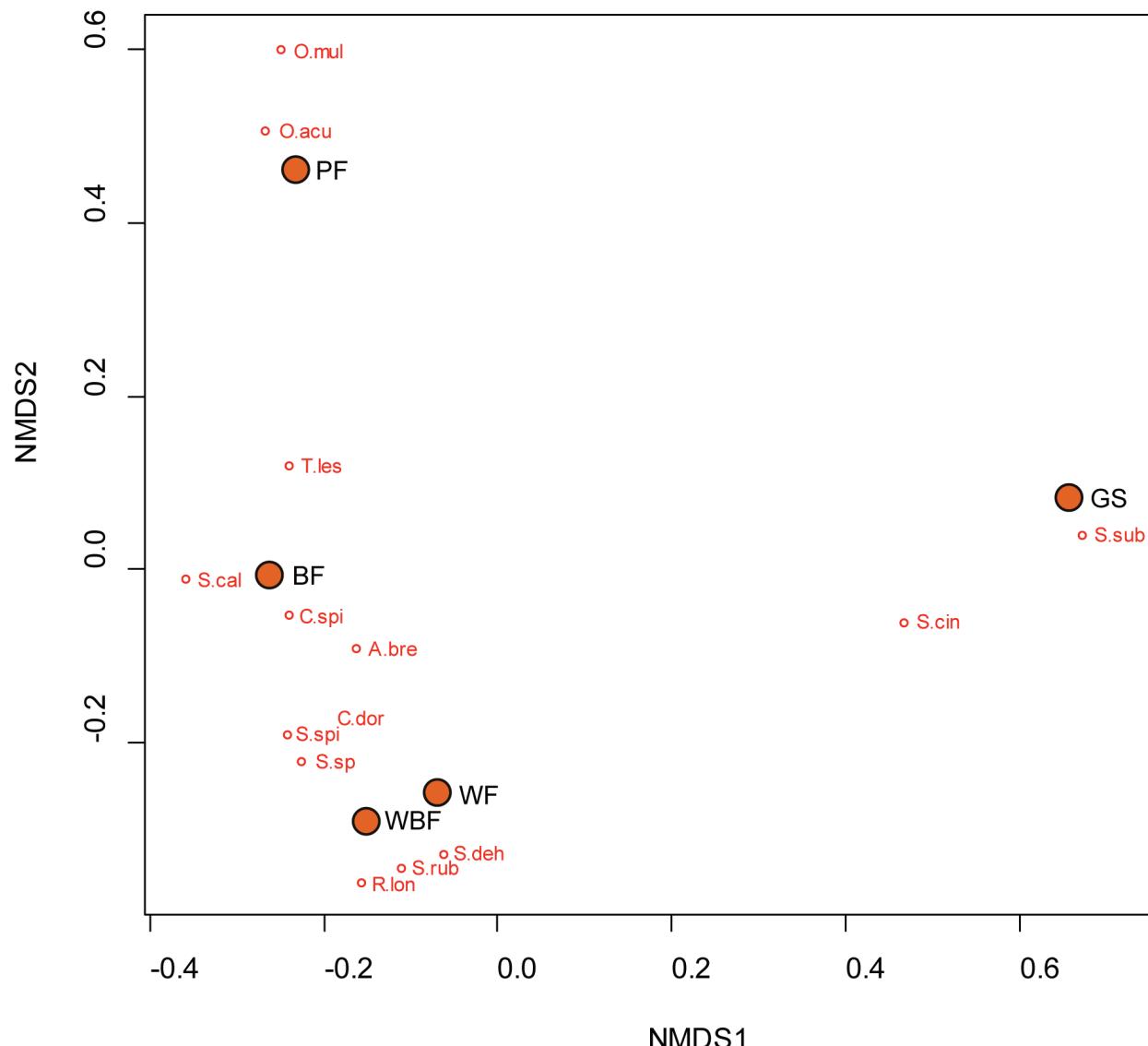


Figure 1. Non-metric multidimensional scaling (NMDS) analysis by habitat: S.cal—*Scolopendra calcarata* | S.sub—*Scolopendra subinotus* | S.cin—*Scolopendra cingulatoides* | S.deh—*Scolopendra dehaani* | S.rub—*Scolopocryptops rubiginosus* | S.spi—*Scolopocryptops spinicaudus* | O.acu—*Ostostigmus aculeatus* | O.mul—*Ostostigmus multidens* | C.spi—*Cryptops spinipes* | C.dor—*Cryptops doriae* | A.bre—*Asanda brevicornis* | R.lon—*Rhysida longipes* | T.les—*Tokinodentus lestes* | A.dem—*Alluropus demanhei*.

percentage of species (41.6%).

Biological indices

The species diversity index (H') is highest at WF (2.25), decreased to WBF (1.81), BF (1.77), PF (1.54), and lowest at GS (0.56). Similarly, the uniformity index (J') is also highest at WF (0.94), but lowest at WBF (0.76), and from 0.81 to 0.86 in other habitats (Table 3). The reversion between H' and J' indexes in two habitats (WF and WBF) indicates that there were several species with high individuals collected in WBF while species were collected in WF with relatively equal number of

individuals.

As be seen, three habitats (WF, WBF, and BF) can be classified into a group which have the high similarity in the species composition; of which, WF is closer to WBF than to BF. This highly homologous group is also different from the other two habitats (PF and GS). In addition, there was a close association between recorded species and habitats such as *Scolopendra dehaani*, *Scolopocryptops rubiginosus*, *Rhysida longipes* in WF and WBF, *Scolopendra calcarata* in BF, *Ostostigmus aculeatus* in PF, and *Scolopendra subspinipes* in GS.

DISCUSSION

The Phia Oac - Phia Den NP has a higher number of scolopendromorphs in comparison with other northern mountainous region, such as Hoang Lien NP (12 species), Ta Xua (15 species), Thuong Tien (12 species), Xuan Nha (12 species) (Nguyen et al. 2018, 2019; Tran et al. 2018). This might be due to the high diversity of habitats, wide range of elevations and different climatic characteristics (Vu Tu Lap 2012). However, most centipede specimens were collected in rainy season (July and August), it is, therefore, recommended to have more species not to be recognized in this region. More intensive surveys should be conducted in different time to have a better understanding of the centipede diversity in the national park.

Almost all previous studies in Vietnam indicated that the genus *Otostigmus* usually has the highest number of recorded species (Nguyen et al. 2018, 2019, Tran et al. 2018; Le et al. 2017). However, this is not true for the Phia Oac - Phia Den National Park where the genus *Otostigmus* has only three species while *Scolopendra* has four species. It might be explained that the genus *Otostigmus* is tropically distributed, and not be familiar with high mountains and cool climatic condition. This was also observed and reported by Nguyen et al. (2019) in Hoang Lien National Park.

Two species, *Scolopocryptops spinicaudus* and

Scolopocryptops rubiginosus, were previously recorded at the low elevations in China and Taiwan (Chao & Chang 2003; Song et al. 2004). These species were considered as temperate species inhabiting in cool climatic region. Therefore, they have been only found at the elevation range of more than 800 m, such as Hoang Lien National Park, Ta Xua Nature Reserve, Thach Nham (Le et al. 2017; Tran et al. 2018; Nguyen et al. 2019) and even more than 1,000 m in Phia Oac - Phia Den National Park

The species *Alluropus demangei* (Image 1) was originally described from Phu Ly, Ha Nam Province (Silvestri 1911), but it has never been recorded in other locations in Vietnam. All previous reports on this species were inherited from Silvestri (1911) (Schileyko 2007; Tran et al. 2013). Recently, Tran et al. (2018) reported this species from Ta Xua at the elevation range of 600–1,000 m. In this study, *Alluropus demangei* was also recorded in woody-bamboo forests at the elevation range of 1,000–1,600 m.

CONCLUSION

The scolopendromorphs fauna of the Phia Oac - Phia Den was recognized with 17 species in eight genera and three families. More intensive surveys in different times are needed to reveal a better understanding of the scolopendromorphs diversity in this park.



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Image 1. *Alluropus demangei*.

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