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Cover: Fish species recorded in the Gowthami-Godavari Estuary, Andhra Pradesh: *Lutjanus johnii* (top left), *Triacanthus biaculeatus* (top right), *Acentrogobius cyanomos*, *Elops machnata*, *Trypauchen vagina*, *Oxyurichthys microlepis*. © Paromita Ray.

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SHORT COMMUNICATION

Species diversity and distribution of large centipedes (Chilopoda: Scolopendromorpha) from the biosphere reserve of the western Nghe An Province, Vietnam

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Abstract. A total of 12 scolopendromorph species from five genera and three families were recorded in three different habitats (wooden forest, mixed timber-bamboo forest, and bamboo forest) and at three elevation ranges (>1,000 m, 700–1,000 m, and <700 m) from the biosphere reserve of the western Nghe An Province. Eleven species were recorded for the first time in the area. Scolopendridae is the most diverse family with nine species. The number of species was highest at elevation <700 m (9 species), and lowest at 700–1,000 m (4). By habitat distribution, the bamboo forest had the lowest number of species (3).

Keywords. Arthropoda, bioinventory, biodiversity, pitfall trap, Scolopendridae, southeastern Asia.

The biosphere reserve west of Nghe An province contains two protected areas, Pu Mat National Park (= Pu Mat NP) and Pu Hoat Nature Reserve (= Pu Hoat NR), located in northern part of the Truong Son mountain range. The elevation of this area ranges 100–2,500 m, and the forested areas are mainly found at 800–1,500 m, and in valleys. The area's difficult topography has partly helped to limit deforestation and hunting for rare animals. Located in the tropical monsoon region, atmospheric circulation in this area is influenced by the Truong Son mountain range, and by westerly winds (Laotian wind) that create harsh, dry, hot weather in the summer (Vietnam Administration of Forestry 2013). These conditions have allowed high biodiversity in the area, with many endemic and rare species.

Although biodiversity surveys have been conducted in the area, studies of centipedes are limited. Tran et al. (2013) compiled a list of centipedes in Vietnam and reported the occurrence of several species in the eastern region of Nghe An (Vinh City), including *Rhysida nuda*, *Scolopendra dehaani* and *Scolopendra morsitans*. Only Vu et al. (2020) recorded *Otostigmus aculeatus* in Pu Mat NP.

In order to facilitate further studies in the future, this article provides a list of species belonging to the large centipede order Scolopendromorpha, along with assessments of the diversity and distribution of species recorded in the biosphere reserve west of Nghe An.

Materials and Methods

A total of 71 specimens of Scolopendromorpha were collected in 2018–2020 in Pu Mat NP and Pu Hoat NR. The specimens were collected in three different habitats: woody forest (WF), mixed wood-bamboo forest (WBF), bamboo forest (BF), and at three elevation

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ranges: below 700 m, 700–1,000 m and >1,000 m (Vu 2012). All of these habitats are less affected by humans. The organic surface layer in habitats is very thick, may be up to 15 cm. In the woody forest habitat, many trees are over 1 m in diameter.

Specimens were collected by pitfall trapping following the instruction of Mesibov & Churchill (2003). The traps were made of a 500 ml plastic cup. A total of 15 traps containing ethanol 75% were placed in each habitat, and were collected after 7–10 days. Centipedes were also gathered by leaf-sifting (Górny & Grüm 1993). This method uses a sieve with a diameter of 30 cm and a mesh of 1 cm to remove the upper matter (leaves, twigs). The remaining matter after falling through the sieve was collected to find animals. Centipedes were also manually collected by hand sorting and digging. Centipede specimens were searched directly under decaying vegetation, stumps, rotting trunks, dry bark, and rocks.

Specimens were identified according to the references of Attems (1930), Bonato et al. (2011), Schileyko (1992, 1995, 2007, 2020), Siriwut et al. (2016, 2018). Ecological indices including the number of species, Shanon-Weaver H', uniformnity 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.

All specimens were preserved in 75% ethanol and kept at Vietnam-Russia Tropical Center (VRTC), Vietnam.

Results

Species composition and taxon diversity

We recorded 12 species belonging to five genera and three families in the study area (Table 1). Of these only *Otostigmus aculeatus* has been recorded from previous studies (Vu et al. 2020). Thus, our results contribute 11 new records to the centipede fauna of the biosphere reserve west of Nghe An. It also increases the total number of species recorded in Nghe An to 15 species (Tran et al. 2013).

Table 1 shows that BF habitat has the lowest diversity with only three species (three genera, three families) recorded. The WBF and WF habitats had the same number of recorded species (seven species, four genera, three families). Only *Scolopocryptops rubiginosus* was recorded in all three habitats. *Otostigmus multidens*, *Otostigmus scaber* and *Cryptops doriae* were recorded in two habitats, the rest were only recorded in one habitat.

The distribution of large centipedes according to the altitude shows they were concentrated mainly below 700 m (nine species, four genera, three families), followed by >1,000 m (six species, three genera, two families), with the lowest diversity at 700–1,000 m (four species, three varieties, three families). *Otostigmus scaber* was the only species recorded at all three different altitudes. *Scolopocryptops rubiginosus*, *Scolopocryptops* sp., *Scolopendra subspinipes*, *Otostigmus astenus*, and *Cryptops doriae* were recorded at two different elevations. *Scolopendra dawydoffi* was only recorded above 1,000 m; the other species were only recorded below 700 m. Although there have been initial results on the distribution by altitude in the study area, the results cannot fully represent the distribution of large centipedes, because the study area has a very complex terrain making it difficult to collect samples. Therefore, additional studies are needed.

Taxon diversity

Of the three families recorded, Scolopendridae was recorded with the highest species diversity (nine species, accounting for 75% of the total species; three genera, accounting for 60% of the total genera); Scolopocryptopidae has recorded with only two species (accounting for 17% of total species) in one genus (20% of total genera); Cryptopidae was recorded with just one species (accounting for 8.3%) (Table 2). With this result, it can be seen that the family Scolopendridae considerably dominates in the study region. This is similar to the previous studies by Le et al. (2021) at Phia Oac - Phia Den National Park and Nguyen et al. (2019) at Hoang Lien National Park.

Biological indices

Table 3 presents the results of the analysis of biological indicators, in which the H' index was highest in the WBF habitat (2,148), followed by WF (1,934) and finally BF (1,673). Therefore, WBF biodiversity was quite good (2<H'<3) while WF and BF were medium (1<H'<2). For the J' index, it shows that WBF and BF were similar with 0.9329 and 0.9335, respectively. And the J' index was lowest in WF, with 0.8801. With these values, it was shown that habitats have large differences in the number of individuals obtained between species.

According to the results of NMDS analysis, the habitats as well as the elevations were quite different in species composition recorded in the study area, as shown by the distance between each other in the Figure 1,2. Along with that was the close relationship of the species with different habitats and altitudes, specifically *Otostigmus astenus* with WF habitat, *Rhysida* sp. with WBF habitat and *Cryptops doriae* with BF habitat (Figure 1). *Scolopendra dawydoffi, Scolopocryptops rubiginosus, Scolopocryptops* sp. closely related to altitudes above

Table 1. Species composition and distribution of scolopendromorphs in the biosphere reserve west of Nghe An province.

	WF	WBF	BF	<700	700–1,000	>1,000
Family Scolopocryptopidae Pocock, 1896						
Genus *Scolopocryptops* Newport, 1844						
Scolopocryptops rubiginosus L. Koch, 1878	+	+	+		+	+
Scolopocryptops sp.	+				+	+
Family Scolopendridae Pocock, 1895						
Genus *Scolopendra* Linnaeus, 1758						
Scolopendra subspinipes Leach, 1815	+			+		+
Scolopendra dawydoffi Kronmüller, 2012	+					+
Genus *Otostigmus* Porat, 1876						
Otostigmus astenus (Kohlrausch, 1878)	+			+		+
Otostigmus multidens Schileyko, 1995		+	+	+		
Otostigmus scaber Porat, 1876	+	+		+	+	+
Otostigmus amballae Chamberlin, 1913		+		+		
Otostigmus aculeatus Haase, 1887		+		+		
Genus *Rhysida* Wood, 1862						
Rhysida immarginata Porat, 1876		+		+		
Rhysida sp.		+		+		
Family Cryptopidae Rausch, 1881						
Genus *Cryptops* Leach, 1815						
Cryptops doriae Pocock, 1891	+		+	+	+	
Total number of individuals	30	28	13	40	11	20
Total species	7	7	3	9	4	6

WF—Wood forest | WBF—Wood-bamboo mixed forest | BF—Bamboo forest | +—present.

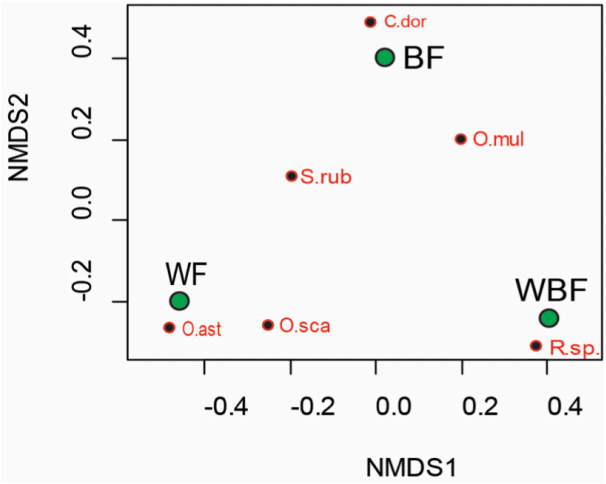

Figure 1. Non-metric multidimensional scaling (NMDS) analysis by habitat: S.rub—*Scolopocryptops rubiginosus* | O.ast—*Otostigmus astenus* | O.mul—*Otostigmus multidens* | O.sca—*Otostigmus scaber* | C.dor—*Cryptops doriae* | R.sp.—*Rhysida* sp.

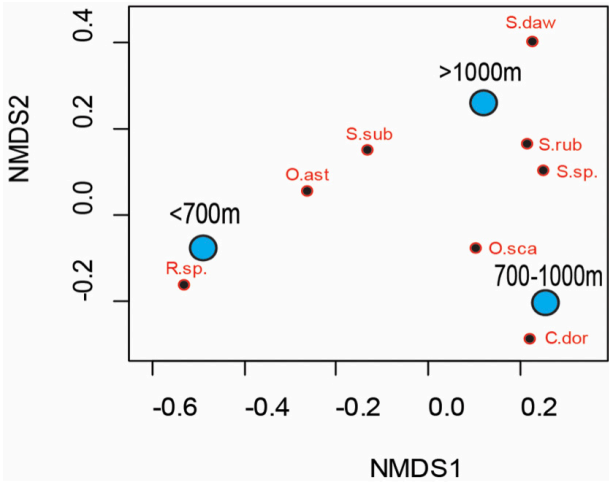

Figure 2. Non-metric multidimensional scaling (NMDS) analysis by Elevation: S.sub—*Scolopendra subinosus* | S.daw—*Scolopendra dawydoffi* | S.rub—*Scolopocryptops rubiginosus* | S.sp.—*Scolopocryptops* sp. | O.ast—*Otostigmus astenus* | O.sca—*Otostigmus scaber* | C.dor—*Cryptops doriae* | R.sp.—*Rhysida* sp.

Table 2. Taxon diversity of scolopendromorphs in the biosphere reserve west of Nghe An province.

Taxa	Genus		Species	
	Amount	Ratio	Amount	Ratio
Scolopendridae	1	20.00	9	75.00
Scolopocrypidae	3	60.00	2	16.67
Cryptopidae	1	20.00	1	8.33
Total	**5**	**100.00**	**12**	**100.00**

Table 3. Diversity index and uniformity index by habitat in the biosphere reserve west of Nghe An province.

Habitat	Amount		Index	
	Species	Individual	J'	H'
WF	9	29	0.8801	1.934
WBF	10	31	0.9329	2.148
BF	6	11	0.9335	1.673

WF—Wood forest | WBF—Wood-bamboo mixed forest | BF—Bamboo forest.

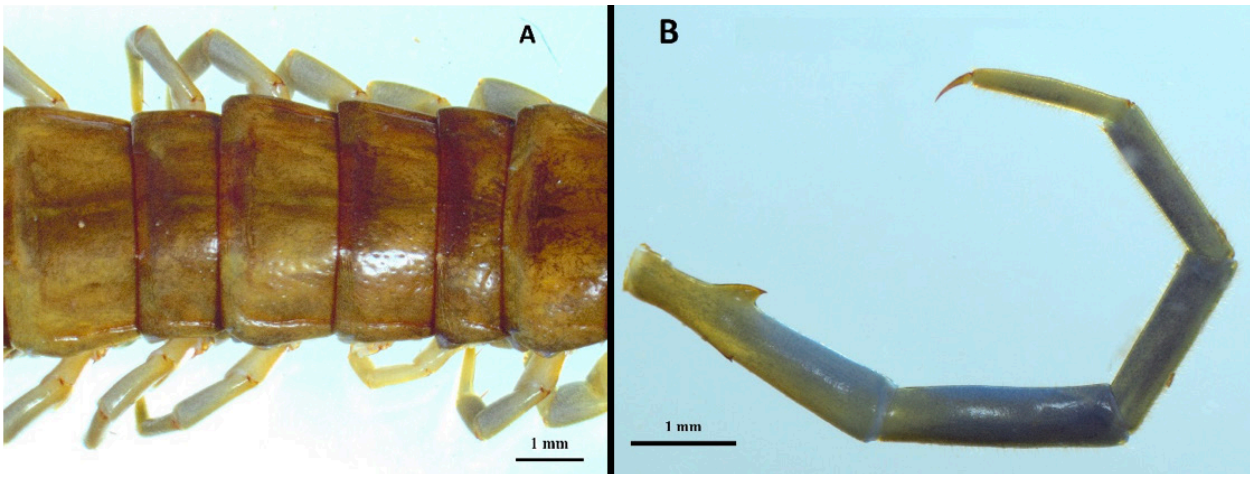

Image 1. *Scolopocryptops* sp. (specimen SVR.PH.048): A—Tergites | B—Ultimate.

1,000 m, while *Rhysida* sp. closely related to altitudes below 700 m, *Otostigmus scaber, Cryptops doriae* more closely related to altitude 700–1,000 m.

Discussion

With 12 recorded species, the diversity of large centipedes in the Biosphere Reserve West of Nghe An is similar to other regions, such as Hoang Lien, Thuong Tien, Xuan Nha (each with 12 recorded species) (Nguyen et al. 2018, 2019a, b), but is lower than Ta Xua, Phia Oac - Phia Den with 15 and 18 species, respectively (Tran et al. 2018; Le et al. 2021). Due to the complicated weather conditions and terrain of the study area, this study was conducted only at altitudes from 200 to 1,300 m, the species diversity of that area has not been fully understood. Additional studies are needed for high mountains (above 1,600 m) and in different seasons.

The results also show that Scolopendridae is the most common family in Vietnam, with the highest species diversity and superiority to other families, in which the genus *Otostigmus* is still the genus with the highest number of recorded species. This result is also consistent with the report of Tran et al. (2013) and Vu et al. (2020).

The genus *Scolopocryptops* was recorded at altitudes of over 700 m in the study area, specifically, specimens were collected at altitudes from 900–1,200 m. This complements the identification that *Scolopocryptops* species in Vietnam are temperate species, only recorded in cool climatic regions (Le et al. 2021). *Scolopocryptops* sp. has different characteristics from those known in Vietnam (*S. rubiginosus*, *S. spinicaudus*, and *S. melanotoma*) which are quite obvious in the tergites and ultimate legs (Image 1). With these other diagnosis, it may be a new record for the large centipede fauna in Vietnam. To be able to confirm this with certainty, further studies are needed.

Scolopendra dawydoffi, was formerly known as *Scolopendra subspinipes cingulatoides* (Attem, 1938; Schileyko 2007). However, Siriwut et al. (2016) combined both morphological and molecular analysis to confirm that this is an independent species. In Vietnam, it has been recorded in some areas such as Ha Giang, Hanoi, Thai Nguyen, and Ha Tinh (Attem 1938; Schileyko 2007).

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