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Preliminary Data on Species Composition and Distribution of Scolopendromorph Centipedes (Chilopoda: Scolopendromorpha) in Kon Ka Kinh National Park and Kon Chu Rang Nature Reserve (Gia Lai Province)

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Abstract: This study investigates the species composition of Scolopendromorpha in Kon Ka Kinh National Park (NP) and Kon Chu Rang Nature Reserve (NR) (Gia Lai province) during the rainy season (May, June) and the dry season (November, December) in 2017 and 2018. Twelve species of 3 genera and 2 families were found. Among these species, *Otostigmus striolatus,* (Verhoeff, 1937), has been recorded for the first time for Vietnam and six other species, including *Cryptops tahitianus*, *Otostigmus amballae*, *Otostigmus reservatus*, *Otostigmus astenus*, *Otostigmus reservatus*, *Scolopendra subspinipes,* recorded for the first time for the studied area. The Scolopendridae Pocock (1895) was dominant with 11 species while Cryptopidae Kohlarausch (1881) had only one species reported. Most of the species were recorded in the primary forests and a few species were found in the pine forest. In addition, the number of species recorded in the rainy season was higher than that in the dry season; and the *Cryptops* Leach (1815) was found only in the rainy season.

Keywords: Chilopoda, Scolopendromorpha, Kon Ka Kinh, Kon Chu Rang, centipedes.

1. Introduction

Centipedes belong to the class Chilodopa of the subphylum Myriapoda, Anthropoda. Chilopoda consists of 6 orders: Scolopendromorpha, Geophilomorpha, Lithobiomorpha, Scutigeromorpha, Craterostigmomorpha and Devonobiomorpha; of which the Devonobiomorpha was extinct, the Craterostigmomorpha has been not reported in Vietnam, so far [1, 2].

Most of centipede species are predators, which play an important role in the ecosystem. Through their activities, centipede helps

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decompose organic compounds, recycles nutrients in the ecosystem. Besides, it also helps to balance the ecosystem [1, 2]. In addition to role in nature, many scolopendromorph centipedes are still valuable as a medicine, e.g. long ago in Vietnamese traditional medicine it was used in the treatment for seizures in children, diarrhoea, pain and swollen joints [3].

Kon Ka Kinh National Park and Kon Chu Rang Nature Reserve are located in the North Central Highlands, which belong to the Kon Ha Nung Plateau and are the contiguous part with the Pleiku Plateau, creating a large unbroken space. It is also an interactive area of atmospheric circulation from Cambodia, Laos to the East Sea, forms a special climate type with two distinct seasons: dry and rainy season.

The ecosystem of Kon Ka Kinh National Park and Kon Chu Rang Nature Reserve is characterized by sub-tropical forests on the plateau and the upstream of many important river systems such as Con river, Ba river, Se San river... The unique natural conditions, make this area highly biodiverse and many endemic species. Until now, the centipede in the Central Highlands in general and in this area in particular have not been investigated much. Tran et al. (2013) developed the Vietnamese centipede catalogue, in which some species have been recorded, but not specific localities, in Gia Lai [4]. However, these results are still fragmented, discrete and not systematic. To contribute to knowledge on centipede fauna, our report presents the results of study on the diversity of scolopendromorph species, their taxonomy and distributional characteristics in the two studied locations, namely Kon Ka Kinh National Park and Kon Chu Rang Nature Reserve. This is the first data on centipedes in both those protected areas.

2. Materials and methods

2.1. Location and field sampling

Samples are collected from 2017 to 2018 in different habitats of Kon Ka Kinh NP and Kon Chu Rang NR. In Kon Ka Kinh NP, the studied habitats include primary forest (K-PF), regenerated forest (K-RF), mixed bamboo-tree forest (K-MBF) and pine forest (K-Pine F). In Kon Chu Rang Nature Reserve, the studied habitats include primary forest (R-PF), pine forest (R-Pine F) and mixed broadleaves - coniferous forest (R-MBCF). Three field surveys were conducted in rainy and dry seasons in Kon Ka Kinh National Park (NP) and Kon Chu Rang Nature Reserve (NR). In Kon Ka Kinh NP, three surveys were in rainy season (5 - 17 May 2017; 29 June - 10 July 2018) and in dry season (26 October to 5 November 2017). In Kon Chu Rang NR, three surveys were in rainy seasons (18-28 May 2017 and 4-15 May 2018) and in dry season (6-17 November 2017).

Sample collection methods have been used, including:

Digging: Using the collecting methods of Ghilarov (1975) and Górny & Grüm (1994) [5, 6]. The collecting methods are popularly used to evaluate the density of centipede in each site.

Barber trapping: The collection method will be used for assessing the diversity of surface soil-dwelling centipedes. About 15 traps will be set up for each site during 5 - 7 days. Traps will be filled with ethanol 75% or formalin 4%.

2.2. Analysis of laboratory samples

Analysis of samples in laboratory: samples were separated into each individual test tube, information on samples were sufficiently recorded. Stereo microscope was used to observe morphological characteristics of specimens and identify according to the documents of Attems (1953); Schileyko (1992, 1995, 2007) [7-10].

The Sorensen index (SI) is used to compare the similarity between studies habitats.

3. Result and discussion

3.1. The composition of the Scolopendromorpha

The result of the investigation on the scolopendromorph species composition in Kon Ka Kinh NP and Kon Chu Rang NR is shown in

Table 1. A total of 12 species of 3 genera and 2 families were found. Of them *Otostigmus striolatus* Verhoeff, 1937 was recorded for the first time in Vietnam and six species were new for studied area, including *Cryptops tahitianus, Otostigmus amballae, O. reservatus, O. astenus, O. reservatus, Scolopendra subspinipes*.

Table 1. List of species of Scolopendromorpha in Kon Ka Kinh NP and Kon Chu Rang NR

No	Name of species	Kon Ka Kinh NP	Kon Chu Rang NR
	Family: Cryptopidae Kohlarausch, 1881		
	Genus: *Cryptops* Leach, 1815		
1	*Cryptops (C.) tahitianus** Chamberlin, 1920		x
	Family: Scolopendridae Pocock, 1895		
	Genus: *Otostigmus* Porat, 1876		
2	*Otostigmus aculeatus* Haase, 1887	x	
3	*Otostigmus amballae** Chamberlin, 1913	x	x
4	*Otostigmus astenus** Kohlausch, (1881)	x	
5	*Otostigmus reservatus** Schileyko, 1995	x	
6	*Otostigmus scaber* Porat, 1876	x	x
7	*Otostigmus* sp1.	x	
8	*Otostigmus* sp2.		x
9	*Otostigmus striolatus*** Verhoeff, 1937		x
	Genus *Scolopendra* Linnaeus, 1758		
10	*Scolopendra dehaani* Brandt, 1840		x
11	*Scolopendra* sp.	x	
12	*Scolopendra subspinipes** Leach, 1815	x	x
	Total number of species	8	7

Note :

x - Recorded

* - New species for local fauna

** - New species for Vietnam fauna

Table 1 shows that in Kon Ka Kinh NP recorded 8 species centipede of 2 genera, 1 family were found while Kon Chu Rang NR had 7 species of 3 genera, 2 families. In general, there is a comparable number of recorded species between the two studied locations. However, there are some differences in recorded species between these two locations, e.g. *Scolopendra* sp., *Otostigmus aculeatus, Otostigmus astenus, Otostigmus reservatus, Otostigmus* sp1. were recorded only in Kon Ka Kinh NP, whereas, *Scolopendra dehaani, Otostigmus* sp2., *Otostigmus striolatus* only in Kon Chu Rang NR.

Otostigmus striolatus is a new record to the centipede fauna of Vietnam. Our specimens definitely agree with morphological descriptions of *Otostigmus striolatus* in Lewis (2014). The species has been only known from Malacca Isl. (Malaysia) [11].

Of 12 recorded species, three are identified to generic level, namely *Otostigmus* sp.1 *Otostigmus* sp.2 and *Scolopendra* sp. Three species, *Otostigmus aculeatus*, *Otostigmus scaber* and *Scolopendra dehaani*, were previously reported from the Highlands of Vietnam. Six species, *Cryptops tahitianus, Otostigmus amballae, O. reservatus, O. astenus, O. reservatus,* and *Scolopendra subspinipes*, are all new records for the Highlands of Vietnam [4].

The diversity of species composition in the studied area is proved by the number of recorded families, genera and species, as shown in Table 2.

Table 2. Scolopendromorph species in the study area

Family	Number of species	Percentage %	Genus	Number of species	Percentage %
Scolopendridae	11	91,67	Scolopendra	3	25,00
			Otostigmus	8	66,67
Cryptopidae	1	8,33	Cryptops	1	8,33
Tổng số	12	100	3	12	100

In terms of family level, the results in the table 2 showed that 2 families, Cryptopidae and Scolopendridae were determined in the study area, of which the Scolopendridae was dominated with 11 species (91.67%), while the species number of Cryptopidae recorded was only 1 (8.33%). Thus, the structural diversity of the centipede's family is relatively low. Unfortunately, the Scolopocryptopidae did not appear, our studies of the centipede regional fauna in the vicinity of these two locations with a relatively large numbers of individual [12].

In terms of generic level, three genera were recorded: *Cryptops*, *Scolopendra* and *Otostigmus*. There was a large difference in the proportion of species among three genera. Genus *Otostigmus* was dominated with 66.77% of total number of species, followed by *Scolopendra* with 25% and *Cryptops* with 8.33%. This reflects the more diversity of the *Otostigmus* in the studied area. *Otostigmus* was the genus with the largest number of species and had the widest distribution in Scolopendromorpha. This result is consistent with the previous research by Tran Thi Thanh Binh et al. [4].

Distribution of Scolopendromorpha

In Kon Ka Kinh NP

Distribution of scolopendromorph species according to study habitat is presented in Table 3.

Table 3. Distribution of Scolopendromorph species in Kon Ka Kinh NP habitats

No	Name of species	Distribution			
		K-PF	K-RF	K-MBF	K-Pine F
	Family: Scolopendridae Pocock, 1895				
	Genus *Scolopendra* Linnaeus, 1758				
1	*Scolopendra subspinipes* Leach, 1815	×	×	×	
2	*Scolopendra* sp.	×			
	Genus *Otostigmus* Porat, 1876				
3	*Otostigmus aculeatus* Haase, 1887	×			
4	*Otostigmus amballae* Chamberlin, 1913	×			
5	*Otostigmus astenus* Kohlausch, (1881)	×		×	
6	*Otostigmus reservatus* Schileyko, 1995	×			
7	*Otostigmus* sp1.		×	×	
8	*Otostigmus scaber* Porat, 1876	×	×	×	×
	Total	7	3	4	1

The results presented in Table 3 show that in the primary forest, the number of species is highest with 7 species (accounting for 87.5% of total number of recorded species). Next to the mixed bamboo-tree forest with 4 species (50.0%) and 3 species (37,85%) were recorded in regenerated forest. There is only 1 species in the pine forest (accounting for 14.28% of total species) being recorded. These results were suitable with the natural conditions of the studied

area. The primary forest has rich organic materals, many trees, and relatively high humidity, so it is an ideal place to feed and shelter for Subterranean fauna in general and centipede in particular. In the pine forest only 1 species was recorded, because in this habitat organic materials layers are very thin, single species, resin pine, low moisture, not suitable for the life of Scolopendromorpha species.

Table 3 also shows that the *Otostigmus scaber* was recorded in all four habitats with the largest number of specimens (9 specimens). The *Scolopendra subspinipes* were found in three habitats (except pine forest habitats) with the second highest number of specimens (8). The remaining species were recorded in only one or two habitats with fewer specimens (1-3 samples). This shows the remarkable abundance in the number of individuals recorded by the two species *Otostigmus scaber* and *Scolopendra supspinipes*.

An assessment of the similarity between the habitats of Kon Ka Kinh NP, using the Sorensen (SI) index. The results are shown in Table 4.

Table 4. The similarity between the habitats of Kon Ka Kinh NP in Scolopendromorpha species

	K-PF	K-RF	K-MBF	K-Pine F
K-PF	1	0,40	0,55	0,25
K-RF		1	0,86	0,50
K-MBF			1	0,40
K-Pine F				1

Table 4 shows that the Sorensen index (SI) between habitats fluctuate from 0,25 to 0,86. In particular, the highest value between mixed bamboo-tree forest and regenerated forest is 0,86. The lowest one is 0,25 between pine forest and primary forest. There is a great difference between the two habitats because of a significant difference in habitat conditions for the centipedeas mentioned above. Among other habitats, the values of the similarity index of species composition was moderate levels (SI = 0.40 - 0.55).

The seasonal distribution of Scolopendromorpha in Kon Ka Kinh NP is shown in Figure 1.

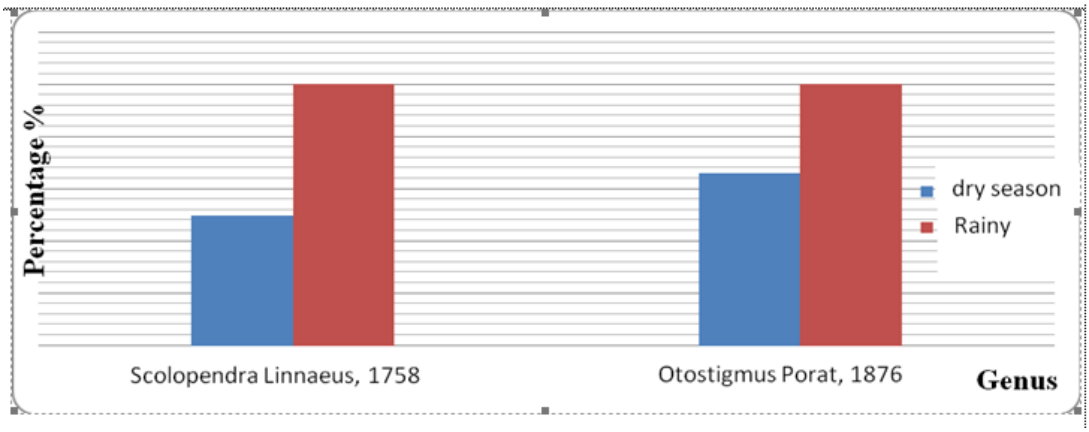

Figure 1. Seasonal distribution of Scolopendromorpha in Kon Ka Kinh NP.

In general, the number of recorded species of *Scolopendra* and *Otostigmus* in the rainy season was higher than that in the dry season. Genus *Scolopendra* with 2 species recorded, only 1 was found in the dry season (50%) and 2 species (100%) in the rainy season. While genus

Otostigmus has 4 species (66.7%) recorded in the dry season and 6 species (100%) in rainy season. There is more variety in the rainy season because the climatic conditions at the beginning of the rainy season is more suitable for the life of the centipede than that in dry season. In addition, the May, June are the time of mating activities and reproduction of the centipede so the paired activities also take place more. Therefore, the ability to catch centipede will be higher, in comparison within dry season.

In Kon Chu Rang NR

Species composition of scolopendromorph and their distribution in Kon Chu Rang NR are shown in Table 5.

Table 5. Distribution of Scolopendromorph species according to habitats in Kon Chu Rang NR

No	Name of species	Distribution		
		R-PF	R-Pine F	R-MBCF
	Family Cryptopidae Kohlarausch, 1881			
	Genus *Cryptops* Leach, 1815			
1	*Cryptops (C.) tahitianus* Chamberlin, 1920			x
	Family Scolopendridae Pocock, 1895			
	Genus *Scolopendra* Linnaeus, 1758			
2	*Scolopendra subspinipes* Leach, 1815	x		x
3	*Scolopendra dehaani* Brandt, 1840	x		
	Genus *Otostigmus* Porat, 1876			
4	*Otostigmus amballae* Chamberlin, 1913	x	x	x
5	*Otostigmus* sp2.			x
6	*Otostigmus scaber* Porat, 1876	x	x	x
7	*Otostigmus striolatus* Verhoeff, 1937	x		
	Total	5	2	5

Result in Table 5 shows that 5 species were found in primary and mixed broadleaves - coniferous forests, accounting for 71.43% of total number of species. At the same time, in the pine forest, the number of found species was 2 species, (28.57%). This result also shows the less diversity of Scolopendromorph in pine forest, similar to the result in Kon Ka Kinh NP above.

Among recorded species, two species were found in all three habitats: *Otostigmus amballae* and *Otostigmus scaber*. The *Scolopendra subspinipes* were recorded in two habitats. These were three species with the highest number of individuals encountered during field surveys. The other species were found only in one habitat, and the number of their specimens was also very little, e.g. *Otostigmus striolatus* had only one speciemen.

Seasonal distribution characteristics of Scolopendromorpha in Kon Chu Rang NR are shown in Figure 2.

As it can be seen in Figure 2, Among the three genera recorded, *Cryptops* was found only in the rainy season and not in the dry season.

Scolopendra had the same number of species found in both seasons (2 species). *Otostigmus* also didn't have significant differences between the two seasons (rainy season recorded 3 species, dry season recorded two species). During the study, the field survey at the study area showed that the terrain conditions here were relatively flat, homogeneous, thick vegetation with many canopy layers almost completely closed. This can make good conditions for the maintenance of the humidity in the organic materials (living environment of centipede) in both dry and rainy seasons, so it has little effect on the seasonal activity of the centipede. Therefore, the number of recorded species did not change significantly by the season.

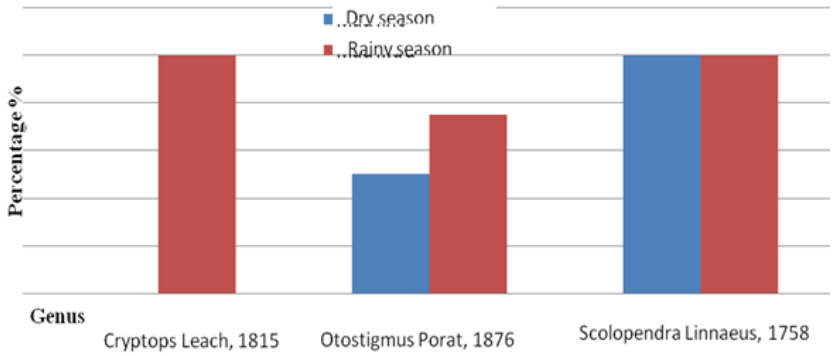

Figure 2. Seasonal distribution of Scolopendromorpha in Kon Chu Rang NR.

4. Conclusion

1. In Kon Ka Kinh NP and Kon Chu Rang NR, 12 scolopendromorph species were found in 3 genera and 2 families. One species (*Otostigmus striolatus* Verhoeff, 1937) was recorded for the first time in Vietnam and six species were recorded in local fauna for the first time, include *Cryptops tahitianus, Otostigmus (O.) amballae, O. reservatus, O. astenus, O. reservatus, Scolopendra subspinipes.*

2. In Kon Ka Kinh National Park, there are 8 species belong 2 genera, 1 family were recorded. The distribution of species is highly concentrated in primary forests with 7 species, followed by mixed forests with 4 species, regenerated forests with 3 species, the lowest number is in pine forests with only 1 species. During rainy season, the number of species was recorded is more than in the dry season.

3. At Kon Chu Rang NR, 7 species belong 3 genera and 2 families were recorded. In the primary forests and mixed broadleaf - coniferous forests, there are 5 species were recorded, the pine forests only 2 species were recorded. Fluctuations in the numbers of species are not clear.

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Dẫn liệu về thành phần loài và phân bố của khu hệ rết lớn (Chilopoda: Scolopendromorpha) tại Vườn quốc gia Kon Ka Kinh và Khu bảo tồn thiên nhiên Kon Chư Răng, tỉnh Gia Lai

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Tóm tắt: Nghiên cứu khu hệ rết lớn tại Vườn Quốc gia (VQG) Kon Ka Kinh và Khu bảo tồn thiên nhiên (KBTTN) Kon Chư Răng, tỉnh Gia Lai đã được thực hiện trong thời gian 2017 - 2018, vào hai mùa chính là mùa mưa (tháng 5, 6) và mùa khô (tháng 11, 12).

Đã xác định được12 loài thuộc 3 giống và 2 họ. Trong đó, có 1 loài lần đầu tiên ghi nhận được ở Việt Nam và 6 loài lần đầu tiên ghi nhận cho khu hệ. Trong hai họ ghi nhận được tại khu vực thì họ Scolopendridae Pocock, 1895 chiếm ưu thế hơn với 11 loài, còn họ Cryptopidae Kohlarausch chỉ có 1 loài duy nhất. Các loài ghi nhận được phân bố tập trung nhiều nhất ở sinh cảnh rừng nguyên sinh, còn ở rừng thông ít đa dạng nhất. Vào mùa mưa, số lượng loài ghi nhận được nhiều hơn ở mùa khô. Riêng với giống *Cryptops* Leach, 1815 chỉ ghi nhận được vào mùa mưa.

Từ khóa: Chilopoda, Scolopendromorpha, Kon Ka Kinh, Kon Chư Răng, Rết.