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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 Scutigleromorpha) 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, Shannon-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, *Otostigmus aculeatus* and *Otostigmus multidentis*, 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 *Tonkinodentus lestes*) were commonly found in four habitats; four (*Scolopendra subspinipes*, *Scolopendra cingulatoides*, *Scolopocryptops spinicaudus*, and *Scolopocryptops* sp.) were found in only three habitats; four (*Otostigmus 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 (*Otostigmus voprosus* and *Otostigmus multidentis*) 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
	<b>Family Scolopendridae Pocock, 1895</b>								
	<b>Genus <i>Alluropus</i> Silvestri, 1912</b>								
1	<i>Alluropus demangei</i> Silvestri, 1912	-	+	-	-	-	-	+	-
	<b>Genus <i>Asanada</i> Meinert, 1886</b>								
2	<i>Asanada brevicornis</i> Meinert, 1886	+	+	+	+	-	+	+	+
	<b>Genus <i>Otostigmus</i> Porat, 1876</b>								
3	<i>Otostigmus aculeatus</i> Haase, 1887	-	-	+	+	-	+	+	-
4	<i>Otostigmus voprosus</i> Schileyko, 1992	-	-	-	+	-	-	+	-
5	<i>Otostigmus multidentis</i> Schileyko, 1995	-	-	-	+	-	-	+	-
	<b>Genus <i>Rhysida</i> Wood, 1862</b>								
6	<i>Rhysida longipes</i> Newport, 1845		+	-	-	-	-	-	+
	<b>Genus <i>Scolopendra</i> Linnaeus, 1758</b>								
7	<i>Scolopendra subspinipes</i> Leach, 1815	+	+	-	-	+	+	+	-
8	<i>Scolopendra dehaani</i> Brandt, 1840	+	-	-	-	-	-	+	+
9	<i>Scolopendra cingulatoidea</i> Attems, 1938	+	+	-	-	+	+	+	+
10	<i>Scolopendra calcarata</i> Porat, 1876	-	-	+	-		+	-	-
	<b>Family Cryptopidae Rausch, 1881</b>								
	<b>Genus <i>Cryptops</i> Leach, 1815</b>								
11	<i>Cryptops spinipes</i> Pocock, 1891	+	+	+	+	-	+	+	+
12	<i>Cryptops doriae</i> Pocock, 1891	+	-	+	-	-	-	+	+
13	<i>Cryptops</i> sp.	+	+	-	-	-	-	+	+
	<b>Genus <i>Tonkinodentus</i> Schileyko, 1992</b>								
14	<i>Tonkinodentus lestes</i> Schileyko, 1992	+	+	+	+	-	-	+	+
	<b>Family Scolopocryptopidae Pocock, 1896</b>								
	<b>Genus <i>Scolopocryptops</i> Newport, 1844</b>								
15	<i>Scolopocryptops spinicaudus</i> Wood, 1862	+	+	+	-	-	-	+	+
16	<i>Scolopocryptops rubiginosus</i> L. Koch, 1878	+	+	-	-	-	-	+	+
17	<i>Scolopocryptops</i> sp.	+	+	+	-		-	+	+
	<b>Total number of individuals</b>	<b>26</b>	<b>32</b>	<b>22</b>	<b>11</b>	<b>4</b>	<b>9</b>	<b>57</b>	<b>29</b>
	<b>Total species</b>	<b>11</b>	<b>11</b>	<b>8</b>	<b>6</b>	<b>2</b>	<b>6</b>	<b>15</b>	<b>11</b>

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
<b>Total</b>	<b>8</b>	<b>100</b>	<b>17</b>	<b>100</b>

**Table 3. Diversity index and uniformity index by habitat.**

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

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

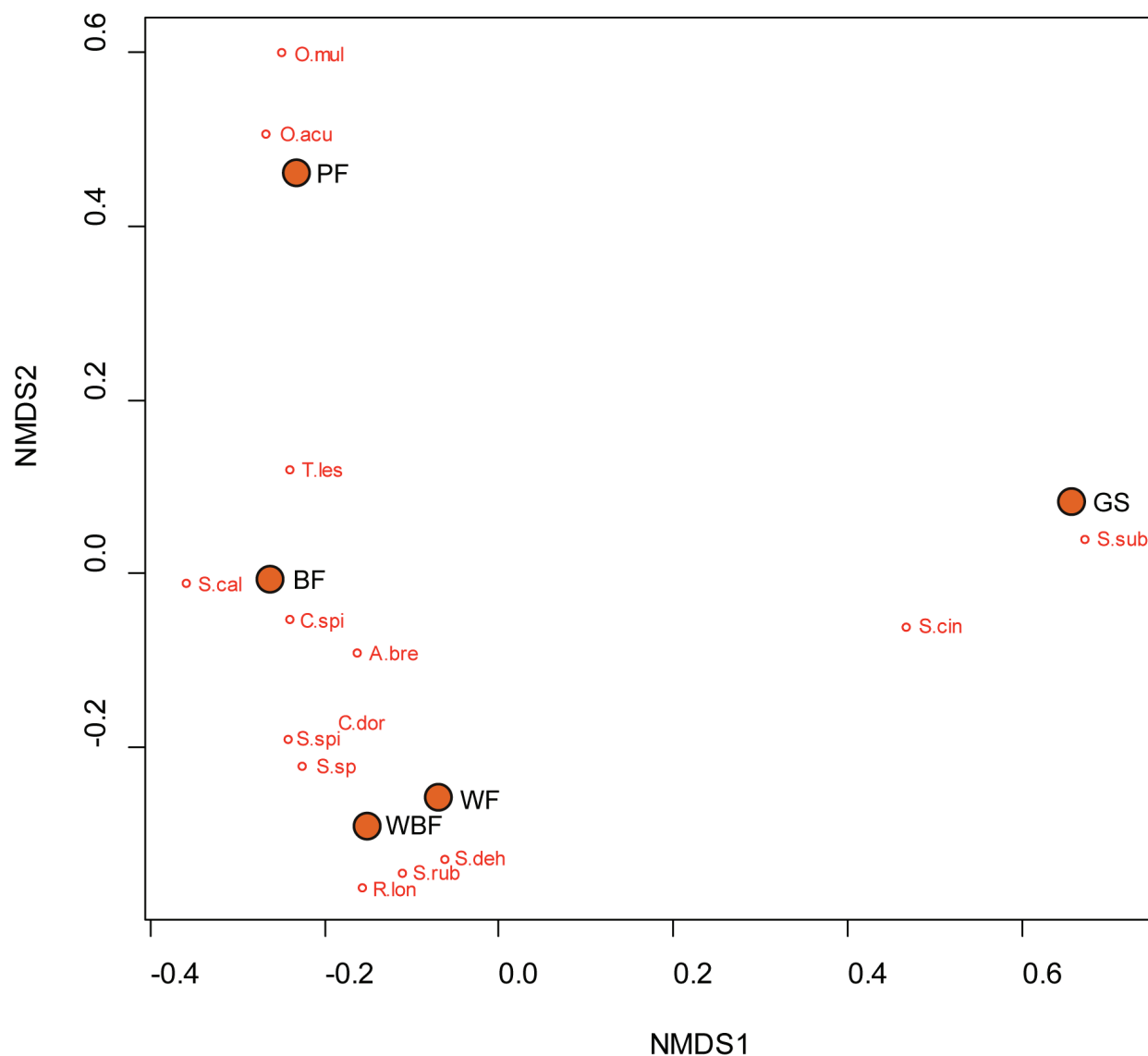


Figure 1. Non-metric multidimensional scaling (NMDS) analysis by habitat: S.cal—*Scolopendra calcarata* | S.sub—*Scolopendra subinosus* | S.cin—*Scolopendra cingulatoidea* | S.deh—*Scolopendra dehaani* | S.rub—*Scolopocryptops rubiginosus* | S.spi—*Scolopocryptops spinicaudus* | O.acu—*Otostigmus aculeatus* | O.mul—*Otostigmus 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, *Otostigmus 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 *Alluopus 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, *Alluopus 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. *Alluopus demangei*.



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#### Communications

**Distribution and habitat preferences of the Chinese Pangolin *Manis pentadactyla* (Mammalia: Manidae) in the mid-hills of Nepal**

– Suman Acharya, Hari Prasad Sharma, Rajeev Bhattarai, Beeju Poudyal, Sonia Sharma & Suraj Upadhaya, Pp. 18959–18966

**On the occurrence of the Himalayan Wolf *Canis lupus*, L. 1758 (Mammalia: Carnivora: Canidae) in the Gaurishankar Conservation Area, Nepal; its existence confirmed through sign and visual evidence in Rolwaling Valley**

– Bishnu Prasad Pandey, Shankar Man Thami, Rabin Shrestha & Mukesh Kumar Chalise, Pp. 18967–18974

**Group size, crowding, and age class composition of the threatened Sambar *Rusa unicolor* (Kerr, 1792) (Mammalia: Cetartiodactyla: Cervidae) in the semi-arid regions of northeastern Rajasthan, India**

– Deepak Rai & Kalpana, Pp. 18975–18985

**Study on the impacts of LULC change on the wildlife habitat and the livelihood of people in and around Dampa Tiger Reserve, Mizoram, India**

– Sushanto Gouda, Janmejaya Sethy, Netrapal Singh Chauhan & Harendra Singh Bargali, Pp. 18986–18992

**Characterisation of breeding habitat of Grizzled Giant Squirrel *Ratufa macroura* (Mammalia: Sciuridae) in Chinnar Wildlife Sanctuary, Western Ghats, India**

– Kiran Thomas & P.O. Nameer, Pp. 18993–19001

**Seasonal prey availability and diet composition of Lesser Asiatic Yellow House Bat *Scotophilus kuhlii* Leach, 1821**

– Shani Kumar Bharti & Vadmalai Elangovan, Pp. 19002–19010

**Bird composition, diversity and foraging guilds in agricultural landscapes: a case study from eastern Uttar Pradesh, India**

– Yashmita-Ulman & Manoj Singh, Pp. 19011–19028

**Identification of a unique barb from the dorsal body contour feathers of the Indian Pitta *Pitta brachyura* (Aves: Passeriformes: Pittidae)**

– Prateek Dey, Swapna Devi Ray, Sanjeev Kumar Sharma, Padmanabhan Pramod & Ram Pratap Singh, Pp. 19029–19039

**Moths of the superfamily Gelechioidea (Microlepidoptera) from the Western Ghats of India**

– Amit Katewa & Prakash Chand Pathania, Pp. 19040–19052

**On the diversity and abundance of riparian odonate fauna (Insecta) of the midstream Chalakkudy River, Kerala, India**

– C. Nitha Bose, C.F. Binoy & Francy K. Kakkassery, Pp. 19053–19059

**Species diversity and abundance patterns of epiphytic orchids in Aralam Wildlife Sanctuary in Kerala, India**

– Jis Sebastian, Durairaj Kathiresan & Giby Kuriakose, Pp. 19060–19069

**Status and conservation needs of *Cycas pectinata* Buch.-Ham. in its natural habitat at Baroiyadhala National Park, Bangladesh**

– M.K. Hossain, M.A. Hossain, S. Hossen, M.R. Rahman, M.I. Hossain, S.K. Nath & M.B.N. Siddiqui, Pp. 19070–19078

#### Review

**Limitations of current knowledge about the ecology of Grey Foxes hamper conservation efforts**

– Maximilian L. Allen, Alexandra C. Avrin, Morgan J. Farmer, Laura S. Whipple, Emmarie P. Alexander, Alyson M. Cervantes & Javan M. Baude, Pp. 19079–19092

#### Short Communications

**On the freshwater fish fauna of Krishna River, Sangli District, Maharashtra, India**

– Suresh M. Kumbhar, Shrikant S. Jadhav, Swapnali B. Lad, Abhijit B. Ghadage, Satyawar S. Patil & C. Shiva Shankar, Pp. 19093–19101

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

– Le Xuan Son, Nguyen Thi Tu Anh, Tran Thi Thanh Binh, Thu Anh T. Nguyen & Anh D. Nguyen, Pp. 19102–19107

**Diversity of ants in Aarey Milk Colony, Mumbai, India**

– Akshay Gawade & Amol P. Patwardhan, Pp. 19108–19117

**First record of ghost shrimp *Corallianassa coutierei* (Nobili, 1904) (Decapoda: Axiidea: Callichiridae) from Indian waters**

– Piyush Vadher, Hitesh Kardani, Prakash Bambhaniya & Imtiaz Beleem, Pp. 19118–19124

**A preliminary checklist of dragonflies and damselflies (Insecta: Odonata) of Vakkom Grama Panchayath, Thiruvananthapuram District, Kerala, India**

– J. Arunima & P.O. Nameer, Pp. 19125–19136

**Diversity pattern of butterfly communities (Lepidoptera) in different habitat types of Nahan, Himachal Pradesh, India**

– Suveena Thakur, Suneet Bahrdwaj & Amar Paul Singh, Pp. 19137–19143

**Descriptions of the early stages of *Vagrans egista sinha* (Lepidoptera: Nymphalidae) with notes on its host plant *Xylosma longifolia* Clos from the western Himalaya of India**

– Pranav Gokhale & M.A. Yathumon, Pp. 19144–19148

#### Notes

**First photographic record of Mishmi Takin *Budorcus taxicolor taxicolor* and Red Goral *Nemorhaedus baileyi* from Kamlang Tiger Reserve, Arunachal Pradesh, India**

– Cheshta Singh & Deepti Gupta, Pp. 19149–19152

**Utilisation of honey trap method to ensnare a dispersing sub-adult Bengal Tiger *Panthera tigris tigris* L. in a human dominated landscape**

– Gobind Sagar Bhardwaj, Balaji Kari & Arvind Mathur, Pp. 19153–19155

**First camera trap photographs of Indian Pangolin *Manis crassicaudata* (Mammalia: Pholidota: Manidae) from Pakistan**

– Misbah Bint Riaz, Faraz Akrim, Siddiq Qasim, Syed Afaq Bukhari, Asad Aslam, Muhammad Waseem, Rizwana Imtiaz & Tariq Mahmood, Pp. 19156–19158

**Photographic record of Lesser Flamingo *Phoeniconaias minor* (Aves: Phoenicopteridae) in Ramganga river, Bareilly, India**

– Pichaimuthu Gangaikaran, Aftab A. Usmani, G.V. Gopi, S.A. Hussain & Khursid A. Khan, Pp. 19159–19161

**Total length and head length relationship in Mugger Crocodiles *Crocodylus palustris* (Reptilia: Crocodylia: Crocodylidae) in Iran**

– Asghar Mobaraki, Elham Abtin, Malihe Erfani & Colin Stevenson, Pp. 19162–19164

**First record of the hoverfly genus *Spilomyia* Meigen (Diptera: Syrphidae) for Pakistan**

– Muhammad Asghar Hassan, Imran Bodlah, Riaz Hussain, Azan Karam, Fazlullah & Azaz Ahmad, Pp. 19165–19167

**Rediscovery of Watson's Demon *Stimula swinhoei swinhoei* (Elwes & Edwards, 1897) (Lepidoptera: Hesperidae: Hesperinae) in Meghalaya, India after 60 years**

– Suman Bhowmik & Atanu Bora, Pp. 19168–19170

**A record of *Ourapteryx dierli* Inoue, 1994 (Lepidoptera: Geometridae: Ennominae) from the Garhwal Himalaya, India**

– Arun P. Singh & Lekhendra, Pp. 19171–19172

**Report of *Bradinopyga konkanensis* Joshi & Sawant, 2020 (Insecta: Odonata) from Kerala, India**

– Muhammed Haneef, B. Raju Stiven Crasta & A. Vivek Chandran, Pp. 19173–19176

**A new distribution record of *Bianor angulosus* (Karsch, 1879) (Araneae: Salticidae) from Kerala, India**

– Nishi Babu, John T.D. Caleb & G. Prasad, Pp. 19177–19180

**Notes on lectotypification of the Assam Ironwood *Mesua assamica* (King & Prain) Kosterm. (Calophyllaceae)**

– Prantik Sharma Baruah, Sachin Kumar Borthakur & Bhoben Tanti, Pp. 19181–19184

**On the rediscovery of a rare root parasite *Gleadovia ruborum* Gamble & Prain (Orobanchaceae) from Uttarakhand, western Himalaya, India**

– Amit Kumar, Navendu V. Page, Bhupendra S. Adhikari, Manoj V. Nair & Gopal S. Rawat, Pp. 19185–19188

**Occurrence of vivipary in *Ophiorrhiza rugosa* Wall. (Rubiaceae)**

– Birina Bhuyan & Sanjib Baruah, Pp. 19189–19190

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