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First report of *Phyllium* (*Pulchriphyllium*) *bioculatum* Gray, 1832 (Phylliidae: Phasmatodea): An addition to the fauna of Nagaland, North-East India

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Abstract
Phyllium (*Pulchriphyllium*) *bioculatum* Gray, 1832 (Phasmida) is a leaf insect which is the most incredible, attractive and wonderful one. It was reported earlier from some places of India *viz.*, Andaman and Nicobar Islands, West Bengal and Assam. This is for the first time report from Medziphema in Dimapur district of Nagaland, North-East India. Three male individuals of this species were collected from the light source. The species has been properly diagnosed and the description has been made based on the morphological characters using morphometric measurement. To know the distribution pattern, abundance, behavior and biology of this amazing species in this region further study is needed.

Keywords: *Phyllium* (*Pulchriphyllium*) *bioculatum*, leaf insect, Nagaland, North-East India

Introduction
Phyllium (*Pulchriphyllium*) *bioculatum* Gray, 1832 belongs to the order Phasmatodea or Phasmida, popularly known as Leaf-insect. This order consists of nearly 3000 species worldwide [1] and about 146 species was reported from India [2]. In India, the first Phasmida study was carried out by Westwood (1859) [3]. Some foremost workers on Indian Phasmida were Redtenbacher (1908), Carl (1913), Günther (1938) and Bradley *et al.* (1977) [3]. The *Phyllium* (*Pulchriphyllium*) *bioculatum* Gray, 1832 comes under the family Phyllidae. The genus *Phyllium* Illiger, 1798 is further sub-divided into 2 sub-genus, *Phyllium* and *Pulchriphyllium* Griffini, 1898 [4]. The family Phyllidae Redtenbacher, 1908 contains 5 species [2] of both of these sub genera [3] from India. The sub-genus *Pulchriphyllium* Griffini, 1898 includes 22 species all over the World [5], among them only *Phyllium* (*Pulchriphyllium*) *bioculatum* Gray, 1832 was reported from India. The genus *Phyllium* Illiger, 1798 are incredibly attractive and wonderful owing to their leaf-like appearance as well as intense coloration. The most remarkable feature in this species is two prominent dots or circles located on the abdomen. They are especially not often seen in nature due to their brilliant camouflage. The distribution of *Phyllium* (*Pulchriphyllium*) *bioculatum* Gray, 1832 has been recorded from Andaman and Nicobar Islands, West Bengal and Assam in India [3, 6]. The species are not reporting to the Nagaland. Hence, the present study was carried out about the new distributional record of *Phyllium* (*Pulchriphyllium*) *bioculatum* Gray, 1832 from Nagaland, North-East India.

Materials and Methods
(i) Study Area: The study area is located in the School of Agricultural Sciences and Rural Development, a campus of Nagaland University, Medziphema (25˚45'13.83"N – 93˚51'19.28"E) under the Dimapur district of Nagaland, India (Fig. 1) and is very near to ICAR – National Centre on Mithun, Jharnapani, Nagaland. The campus is situated at the height of 360m from the sea level, where the annual rainfall varies from 2000 - 2500mm and the annual maximum and minimum temperature ranges from 23 - 35˚C and from 9 - 22˚C, respectively. This campus is located in hilly terrain and the neighboring vegetation is characterized by tropical semi evergreen deciduous secondary forest (Fig 2A). The campus covers an area of approximately 250 acres.

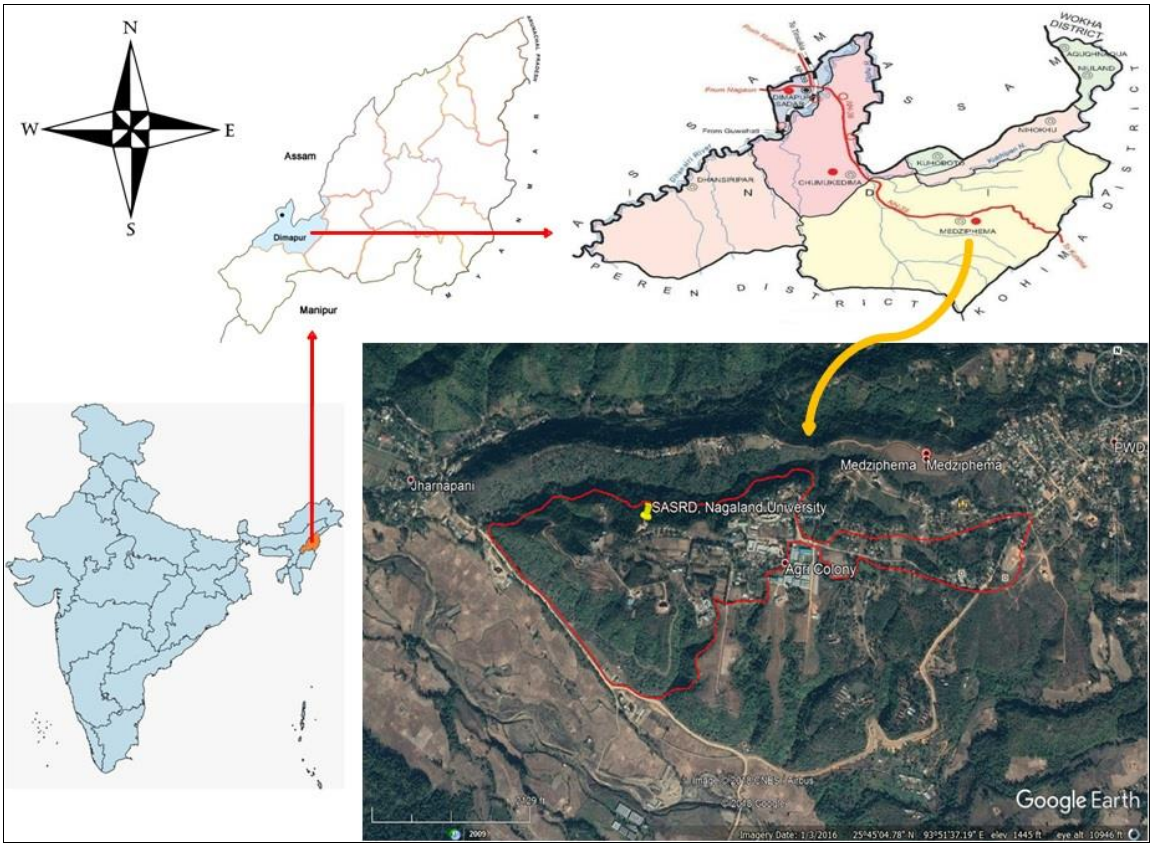

Fig 1: Location of SASRD, Nagaland University, Medziphema campus, Dimapur, Nagaland.

(ii) Methods: Three specimens were collected by hand-picking method in the month of September, 24 (4:30 am) 28 (8:30 pm); October, 7 (5:00 am) of the year 2018 and collected specimens were killed into jars containing ethyl acetate soaked cotton. Later on, they were stretched and pinned for study. All the specimens were attracted by the same light source (Bajaj 15 watt CFL bulb) (Fig 2B). Photographs were taken by SONY Cyber-shot (Model No: DSC HX400V) Camera. The specimens were deposited to the Department of Entomology, SASRD, Nagaland University, Medziphema campus, Nagaland, India.

A. **B.**

Fig 2: A. Vegetation of the Study area **B.** *P. bioculatum* attracted by light source.

Results and Discussions

Based on the external morphological characters and literature by Zompro O, Größer D(2003) [7], Hennemann F, Conle O, Gottardo M, Bresseel J(2009) [4], Mandal SK, Yadav K(2010) [3] and Srinivasan G, Surendar C, Chatterjee P, Mukherjee TK(2017) [6] all the species was identified as male *Phyllium* (*Pulchriphyllium*) *bioculatum* Gray, 1832. The detail of the species is discussed below:-

Systematic Position

Kingdom Animalia
Phylum Arthropoda
Class Insecta
Order Phasmatodea / Phasmida
Superfamily Phyllioidea Brunner von Wattenwyl, 1893
Family Phylliidae Redtenbacher, 1908
Subfamily Phylliinae Brunner von Wattenwyl, 1893

Tribe *Phyllium* Brunner von Wattenwyl, 1893
Genus *Phyllium* Illiger, 1798
Subgenus *Pulchriphyllium* Griffini, 1898

Synonyms
Phyllium (*Pulchriphyllium*) *bioculatum* Gray, 1832: 191.
Phyllium agathyrsus Gray, 1843: 122.
Phyllium crurifolium Audinet-Serville, 1838: 291.
Phyllium dardanus Westwood, 1859: 176.
Phyllium gelonus Gray, 1843: 121.
Phyllium magdelainei Lucas, 1857: 147.
Phyllium pulchrifolium Audinet-Serville, 1838: 292.
Phyllium scythe Gray, 1843: 122.
Phyllium (*Pulchriphyllium*) *giganteum* Hausleithner, 1984: 39.
Phyllium (*Pulchriphyllium*) *sinense* Liu, 1990: 227.

Diagnosis
The species is diagnosed under the genus *Phyllium* Illiger, 1798 for having the prominent and broad exterior lobe of the tibiae, and the mesonotum in front of tegmina which is about quadrate but not remarkably transverse[4, 7]. Further, the species is characterized by the subgenus *Pulchriphyllium* Griffini, 1898 by the presence of interior lobes on the prefemora [7].

Description
Male (Fig. 3): *n* = 3. Body large, 50 – 60 mm long; width of the abdomen is 22 – 23 mm (Table 1). Color usually light green with yellow and brown patches.

Head: small, smooth vertex with convex boundaries, squared in dorsal view. Large bulging brown colored compound eyes with 3 numbers of ocelli. Antennae light brown, larger than head with 20 segments, long and slender with setae. Antennomeres pectinate or angulate and tooth-like apical portion ventrally.

Thorax: *Pronotum* has almost similar length of head, roundly trapezoid in shape. Mesonotum is slightly larger than pronotum and wider. Tegmen small, reaching to the middle of the abdominal segment I. Length of the hind wing is variable. Hind wing reaches almost at the end of the abdomen.

Legs: Presence of lobes in the legs. Exterior lobes of profemora are larger, almost triangular in shape, irregularly serrate with 10 teeth and quite larger than interior lobes which are curved at the base followed by 4 irregular teeth and 1 rounded tooth. Mesofemora are brown colored with large exterior and interior lobes, triangular and serrate. Exterior lobe with 5 irregular teeth in apical half and interior lobe with about 8 teeth dispersed over entire length. Metafemora are long with rounded exterior lobe denoting 4 minute teeth and triangular interior lobe. Interior lobe with about 9 teeth which increase at the apex. All tibiae with more or less distinct exterior lobe with brown markings. Protibiae with distinctive curved exterior and roundly triangular interior lobes. Meso and metatibiae only with roundly exterior lobe.

Abdomen: broad, leaf like. Narrower at the base. Shape of the abdomen with segment II – III gradually widening, Segment IV is wider than other abdominal segments. Two small transparent eyes like spot are aligned almost at the middle of the segment IV. Eyespots are surrounded by brown ring which varies in diameter. Segment V and VII more or less rounded. Segment VIII extending posterior. Anal segment has a rounded apex.

Table 1: Measurements (in mm) of body parts of three male *P. bioculatum.*

S. No.	Variable	Male 1	Male 2	Male 3	Range
1	Length of Body	50.00	50.00	60.00	50.00-60.00
2	Head	3.10	3.00	3.50	3.00-3.50
3	Antennae	23.00	26.00	28.00	23.00-28.00
4	Pronotum	3.00	3.00	3.00	-
5	Mesonotum	5.00	5.00	6.00	5.00-6.00
6	Profemora	11.00	13.00	13.00	11.00-13.00
7	Protibiae	7.00	7.00	7.00	-
8	Protarsi	4.50	5.00	5.00	4.50-5.00
9	Mesofemora	9.00	8.50	10.00	8.50-10.00
10	Mesotibiae	6.00	6.00	6.00	-
11	Mesotarsi	4.00	4.50	4.50	4.00-4.50
12	Metafemora	9.00	9.00	9.00	-
13	Metatibiae	8.00	8.00	8.00	-
14	Metatarsi	4.50	4.50	4.50	-
15	Forewing	11.00	11.00	12.00	11.00-12.00
16	Hindwing	42.00	44.00	46.00	42.00-46.00
17	Width of abdomen	22.00	22.00	23.00	22.00-23.00
18	No. of antennomere	20.00	20.00	20.00	-
19	Diameter of transparent spot	2.00	2.00	3.00	2.00-3.00

Female: Female specimens of this species were not found.

Fig 3: *P. bioculatum* **A.** Dorsal view, **B.** Ventral view, **C-E.** The diameter of eyespot in abdominal segment IV varies in all three male specimens.

Distribution

Africa; Bangladesh: Sylhet; Borneo; China; Java; Mauritius; Peninsular Malaysia; Myanmar; Seychelles; Singapore; Sri Lanka; Sumatra; India: Andaman and Nicobar Islands, West Bengal, Assam[3, 6], Nagaland (Medziphema) (*New report).

Discussion

It is obvious from the literature study that the species were predominantly reported from South-East Asia. Such a vast country like India, it was reported only from two provinces and one union territory [3, 6] but not from Nagaland till date. In the present study, the species is reported for the first time from Nagaland. The study also reveals that the largest male (Body length 60 mm.) of this species was encountered for the first time only from Nagaland respecting to the other areas of India [3, 6]. There is no report of food or host plant of this species from India. This may indicate a lack of collection activity and systematic interest on this particular entomo-fauna. Otherwise, there is a possibility that this species is endemic to India.

Conclusion

The purpose of the study is to provide the new distributional information regarding *P. bioculatum* of the family Phyllidae Redtenbacher, 1908 along with the morphological descriptions and measurements of the body parts of male specimens. Furthermore, extensive surveys would help to know the distribution pattern, abundance, behavior, ecology and biology of this amazing species in India. Awareness about this species among the entomologists will lead to encounter more specimens from this area in near future. Apart from the species, the family Phyllidae Redtenbacher, 1908 is also a first record from Nagaland, India.

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