



## Taxonomic Study on Geometrid Moths (Lepidoptera: Geometridae) Diversity in Chirpine Forest of Himachal Pradesh

Manoj Kumar<sup>1,2</sup>, Pawan Kumar<sup>1\*</sup> & Akhil Kumar<sup>1</sup>

<sup>1</sup> Himalayan Forest Research Institute, Conifer campus, Shimla-09, INDIA

<sup>2</sup> Faculty of Biotechnology, Shoolini University, Bhajol, Solan, INDIA

\* Correspondence: Himalayan Forest Research Institute, Conifer campus, Shimla-09, INDIA.

E-mail: [pawan\\_hfri@rediffmail.com](mailto:pawan_hfri@rediffmail.com)

(Received 25 Feb, 2018; Accepted 14 Mar, 2018; Published 27 Mar, 2018)

**ABSTRACT:** The present biodiversity study was conducted in Himachal Pradesh, India to find the status of geometrid moth diversity in Chirpine forest. During the study, about 212 specimens of moths were collected with the help of light trap from different selected sites of Chirpine forest. All the specimens were sorted into thirty six species of geometrid belonged to 27 genera and three subfamilies. The subfamily Ennominae was represented with maximum 67% species followed by the subfamily Geometrinae (22%) and the subfamily Sterrhinae (11%). The population of the Geometrinae subfamily was moderate, which may be due to the lack of specific host availability and desired habitat preference. This is the first record of geometrid moth diversity study in the Chirpine forest of Himachal Pradesh.

**Keywords:** Geometrid moth; Taxonomy; Chirpine; Diversity; Ennominae; Geometrinae and Sterrhinae.

**INTRODUCTION:** Taxonomic assignments are fundamental for successful communication of biological research, enabling comparability between studies. India is mega diversity country and signatory to The Convention on Biological Diversity and hence it is mandatory for India to study and conserve the entire spectrum of its biodiversity. It comprises of various floral and faunal habitats ranging from subtropical alpine region to deserts. Its diversified landforms, mountains and environmental boundaries support various types of vegetation and in this wide spectrum of biodiversity insects are an important component owing to the wide range of species that exist in India. Insects are the most primitive, dominant and ecologically significant component of the animal kingdom.

Insects were the first organism among the animal species those successfully colonized land.<sup>1</sup> Insects are classified into 121 families under 27 super families<sup>2-3</sup>. 7, 90,000 insects were globally quoted by May<sup>4</sup> whereas Hammond<sup>5</sup> estimated 9, 50,000 species of Insects. Lepidoptera is one of the largest order of the class Insecta.<sup>6-7</sup> Moths and butterflies were grouped in order Lepidoptera. Most of these moth-species are herbivorous and serve as primary herbivores in the food-chain and assist in the propagation of a variety of flowering plants which are very much dependent on these tiny animals for pollination.<sup>8-9</sup> Moths are also good bio-indicators for environmental monitoring and can be used to identify ecologically important areas for conservation purposes.<sup>10-15</sup> The Chirpine forests

have peculiar climatic conditions and it is certain that moth species belonging to these forests will be different from other forests types. Many researchers have reported the distribution, diversity and relative abundance of Lepidoptera from various regions of the Indian sub-continent.<sup>14-21</sup>

The family Geometridae is the one of the largest family in the order Lepidoptera. All around the world approximately 23,000 species have been described<sup>22-23</sup> under this family. Scoble<sup>22</sup> mention this family as only second to the maximum recorded species after family Noctuidae of Lepidoptera. Holloway<sup>24</sup> published volume named as 'Moths of Borneo' of subfamily Larentiinae. In this volume, Holloway described as many as 199 species under 56 genera by including figures and details of their male and female genitalic structures, out of which 37 species under 26 genera were reported from India.

**MATERIAL AND METHODS:** Biosystematics study was conducted to determine the diversity and distribution of geometrid moth species present in different Chirpine forests of Himachal Pradesh. An extensive survey was undertaken to Chirpine forest of three districts namely Bilaspur, Shimla and Solan for collection of geometrid moths during July, 2013 to October, 2016. Study was conducted to examine various taxonomically significant morphological features and wing venation for characterizing the different species of geometrid moths. Collection of geometrid

fauna was during the night as plenty of specimens of different species keep arriving. Employment of this methodology of procuring collection not only helped in the collection of fresh fauna emerging late in the night or the ones travelling from far off places to their host plants, but also prevented their consumption by predatory birds possessing variety of techniques. Collection, preservation and storage of specimens of Geometrid moths were done with light trap.<sup>25-28</sup>

**Collection and Preservation:** Nocturnal species were collected by using light to attract them to a sheet or a trap. Light lure system were installed in open area and near woods where light can attract moths from a wide area. A light lure system comprising of a 3 × 3 meters' white sheet were tied between a pair of vertical poles and sheet nicely illuminated by two mercury lamps of 160W each was used to attract the moths. A wide variety of insects were attracted to light including beetles and other moths. Moths belonging to geometrid family were collected in killing jar. Moth specimens were annihilated and stored in sterile collection tube. Specimens were kept in a desiccator for relaxing of muscles along with thymol crystal and phenol crystal. Starched and dried specimens were labeled with information of collection viz, date, place, name of collector and preserved in fumigated insects box.

**Arrangement of collection and Identification:** The collected moth samples were taxonomically arranged into various families, genera and species. The identification of different species has been done with the help of keys and descriptions documented in 'Fauna of British India Moths' Vol. III and IV<sup>29</sup> and scattered publications by Warren, Prout, and Inoue etc. In addition to this, World Catalogue of Geometrid Moths by Scoble<sup>22</sup> has been consulted to determine the present status of the studied species as per nomenclature available in British Museum (Natural History), London. Species were identified after their comparison with reference collection housed at Indian Agriculture Institute (I.A.R.I.), New Delhi; Zoological survey of India (Z.S.I.), Kolkata, Himalayan Forest Research Institute, Shimla and Forest Research Institute (F.R.I.), Dehradun.

**RESULTS AND DISCUSSION:** In natural ecosystem, moths play important role as pollinators and as prey in food chain. Herbivorous insects include a significant percentage of any insect's fauna due to their complete majority.<sup>30-32</sup> The larva of these moths destroyed vegetables plants because their main food sources is live plant and act as pest in agriculture. These Lepidoptera species have great economic importance because of their role as pollinators, honey producer, silk producer and as pest species. Insects are

good indicator of deforestation and subsequent forest regeneration because they have close relationships with the vegetation they live.

During the present investigation, thirty six geometrid moth species (Table 1) were identified out of the 212 specimens. Lot of work has been done by various taxonomists on moth diversity, taxonomic composition and biomass in different forest ecosystems throughout the world<sup>33-38</sup>; but a little attention has been given to such studies in India.<sup>39-41</sup> Therefore, there is no scientific taxonomic report about the systematic studies of geometrid moths from Chirpine habitats of Himachal Pradesh, so literature reference is relative scarce as compare to other Lepidoptera families.

**Table 1: Overview of the identified Geometrid moth species of Chirpine forest of Himachal Pradesh, India.**

S. No.	Name of species	Sub family
1.	<i>Agathia hilarata</i> Guenee	Geometrinae
2.	<i>Eucyclodes divapala</i>	Geometrinae
3.	<i>Comostola subtiliaria</i>	Geometrinae
4.	<i>Timandra resposaria</i>	Sterrhinae
5.	<i>Chiasmia eleonora</i> (Cramer)	Ennominae
6.	<i>Cleora acaciaria</i>	Ennominae
7.	<i>Heterostegane subtessellata</i> (Walker)	Ennominae
8.	<i>Chiasmia frugaliata</i>	Ennominae
9.	<i>Cleora cornaria</i>	Ennominae
10.	<i>Chiasmia emersaria</i>	Ennominae
11.	<i>Ourapteryx marginata</i> Hampson	Ennominae
12.	<i>Pelagodes veraria</i> (Guenee)	Geometrinae
13.	<i>Agathia hemithearia</i>	Geometrinae
14.	<i>Protuliocnemis castalaria</i> Oberthür	Geometrinae
15.	<i>Herochroma cristata</i> Warren.	Geometrinae
16.	<i>Ascotis selinaria</i>	Ennominae
17.	<i>Psilalcis inceptaria</i>	Ennominae
18.	<i>Hyposidra talaca</i> Walker	Ennominae
19.	<i>Chiasmia nora</i> (Walker)	Ennominae
20.	<i>Iotaphora admirabilis</i> (Oberthür)	Geometrinae
21.	<i>Biston suppressaria</i> Guenee	Ennominae
22.	<i>Timandra correspondens</i>	Sterrhinae
23.	<i>Problepsis deliaria</i>	Sterrhinae
24.	<i>Problepsis vulgaris</i>	Sterrhinae
25.	<i>Zamarada apospatulata</i>	Ennominae
26.	<i>Thinopteryx crocoptera</i> Koll.	Ennominae
27.	<i>Zeheba marginata</i>	Ennominae

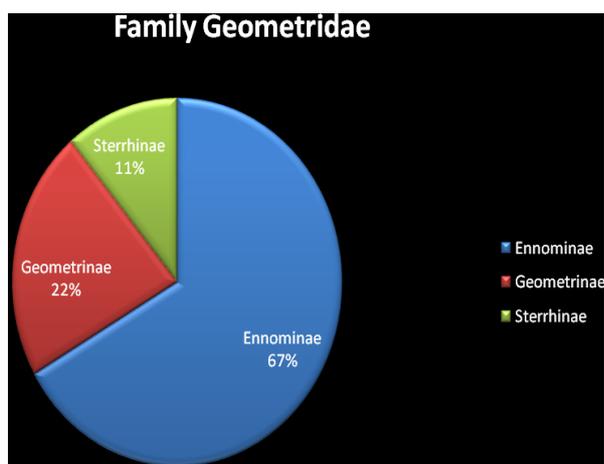
28.	<i>Ectropis crepuscularia</i>	Ennominae
29.	<i>Opisthograptis luteolata</i>	Ennominae
30.	<i>Hypomecis transscissa</i>	Ennominae
31.	<i>Hypomecis infixaria</i> Walker	Ennominae
32.	<i>Corymica arnearia</i>	Ennominae
33.	<i>Dasyboarmia delineate</i> Walker	Ennominae
34.	<i>Abraxas sylvata</i>	Ennominae
35.	<i>Abraxas leucostala</i>	Ennominae
36.	<i>Lomographo Inamata</i> Warren.	Ennominae

Family wise distribution of geometrid moth species (Table-2) revealed that the Subfamily Ennominae is represented by maximum number of 24 species (19 genera) followed by 8 species belong to 7 genera of subfamily Geometrinae further having maximum number of 4 species under subfamily Sterrhinae (2 genera). Maximum number of species belonging to subfamily Ennominae (24) followed by Geometrinae (8) and further followed by Sterrhinae (4).

**Table: 2 Sub-Family wise distribution of geometrid moth from Himachal Pradesh, India.**

S. No.	Sub-Family	Percentage
1.	Ennominae	67
2.	Geometrinae	22
3.	Sterrhinae	11

Among subfamilies maximum number of percentage of individual were 66.6% Ennominae (Fig.1), 22.22% Geometrinae and 11.11% Sterrhinae. 36 species were represented by 27 genera of three subfamilies namely Ennominae, Geometrinae, Sterrhinae of family Geometridae.



**Figure 1: Pie chart of Sub-family wise distribution of Geometrid moth in Himachal Pradesh, India.**

The Geometrid fauna of India has received attention and taxonomic treatment from a good number of taxonomists. A few great and pioneer workers are

Walker, Guenee, Butler, Swinhoe, Warren, Hampson and Prout who made tremendous contribution between 1854 and 1940. The efforts of all these researchers resulted in the collection and description of about 1300 species from different parts of India. Due to lot of environmental degradation and deforestation during last few centuries, it is responsible for loss of many insect's populations which ultimately lead to extinction of many insect's species.

The perusal of relevant literature reveals that the first published account on the family Geometridae was 17<sup>th</sup> century back when *militarius* Linnaeus of this group was described by Linnaeus<sup>42</sup> from India. Walia<sup>43</sup> had done exclusive work on geometrid moths of Chandigarh and Himachal Pradesh and reported 184 species of this family. Out of these 86-species referable to 50 genera were listed under the subfamily Ennominae, 46 species under 11 genera in subfamily Sterrhinae, 38 species belonging to 27 genera under subfamily Geometrinae, 13 species belonging to 11 genera of subfamily Larentiinae and a single species under subfamily Desmobathrinae. Kirti<sup>44</sup> reported 20 species belonging to this family from Himachal Pradesh. Later, they also published publication on economic importance of Geometrid Ennominae moths in Himachal Pradesh<sup>45</sup>. This author also studied genitalic structure of six commonly known geometrid species from Himachal Pradesh in this year<sup>46</sup>. Sanyal<sup>47</sup> documents 168 species of Geometridae belonging to 99 genera and 5 subfamilies from different Protected Areas in a Western Himalayan state, Uttarakhand in India.

The descriptions of the species are too brief and the collection remarks are incomplete and usually missing in many cases. Moreover, the placement of species under different taxa is also out of date in the light of fresh knowledge accumulated in the field of Geometrid taxonomy during the last seven decades.

**CONCLUSION:** During the study thirty-six species of geometrid moths were identified belonging to 28 genera and three sub-families. Most of the geometrid moth population (67%) belong to the sub-family Ennominae; whereas, least population (22%) was recorded from sub-family Geometrinae. The geometrid moth species of Sterrhinae sub-family was moderate (11%) in the experimental Chirpine forest.

In future, the reconciliation of the identified and systematic of the reported unidentified species through molecular markers is suggested for better systematic placement of these moth species in their respected phylogenetic tress.

**ACKNOWLEDGEMENT:** The authors are grateful to the Director, Himalayan Forest Research Institute,

Shimla and Vice-chancellor, Shoolini University, Solan for providing necessary facility and help in this research work.

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