GENERAL CONCLUSIONS

AND

SCOPE FOR FURTHER RESEARCH
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As mentioned earlier, Hampson (1894) made the most significant contribution on Indian Noctuidae. His monumental work in the form of a faunal treatise on the Noctuidae in the Fauna of British India, series, Moths, volume II & III was a unique contribution and laid basic foundation for taxonomy of Noctuidae in India. Hampson depended upon various morphological features like, antennae, eyes, labial palpi, wing maculation, wing venation, thorax, legs and abdomen to characterize various taxa. One of the serious drawback in his great work was that he could not study external male and female genitalic structures. An attempt has been made to describe these species-specific characteristics in all the 90 species studied here in this manuscript.

During the present studies, intensive and extensive collection-cum-survey tours were conducted in far-flung localities of Jammu and Kashmir. As many as 2356 adult Noctuid specimens were collected. A total number of 90 species of the family Noctuidae, referable to 58 genera and 15 subfamilies i.e., Acronictinae, Amphipyrinae, Calpinae, Catocalinae, Chloephorinae, Cucullinae, Euteliinae, Hadeninae, Heliothinae, Hermaninae, Hyponinae, Noctuinae, Plusiinae, Sarrothripinae, Stictopterinae were captured from diverse localities of Jammu and Kashmir. All these species were identified with the help of literature and authentically confirmed by comparison with reference collections lying in the different National museum. A record number of 19 genera and 48 species have been recorded for the first time from Kashmir Himalayas. Two new species have been reported to science from this beautiful valley. Both of these species have been diagnosed and illustrated in detail. Four genera Simplicia Guenee, Lacanobia Billberg, Lophotyna Hampson
and Characoma Walker and 8 species viz., Amphipyra herrichschaefleri Hacker and Pek, 1998, Catocala amnonfriedbergi Kravchenko et al., 2007; Cucullia splendida Cramer, 1777, Lacanobia oleracea (Linnaeus, 1858), Lophotyna albosignata Moore, 1881, Characoma ruficirra Hampson, 1905, Simplicia caeneusalis (Walker, 1879) and Noctua orbona Hufnagel have been recorded for the first time from India. Taxonomic keys have been devised for quick and easy identification of this group from Jammu and Kashmir. Comprehensive diagnosis of various taxa based on characters that differentiate similar taxa and those that unite related taxa have been given besides their first reference, material examined and distribution. Subfamily Catocalinae is found to be most diverse at species level with 22 species followed by Hadeninae and Noctuinae with 18 and 16 species respectively. The predominant subfamilies recorded throughout the study period were Noctuinae, Catocalinae and Hadeninae with 24.55%, 22.48% and 18.62% catch respectively. It was observed during the last four years that Noctuid pest activity begin since 1st weak of April and continued till the last week of October. The maximum population of the pest species was noticed within the range of one month i.e. in the month of July and most of the pests remain active from June to October. There existed a definite relationship between maximum and minimum catches and two important meteorological factors like temperature and rainfall.

Some of the general conclusions on the basis of external male and female genitalia of 15 subfamilies studied here are discussed below.

Subfamliy Acronictinae:

Subfamily Acronictinae is separated from the rest of the Noctuidae by having larvae more or less hairy. This group is mainly characterized by fully developed proboscis and naked eyes, cryptic and elongate forewing. Two species belonging to
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genus *Acronicta* Ochsenheimer have been investigated in this subfamily. *Acronicta rumicis* (Linnaeus) has been reported as new record from Kashmir Himalayas. This genus is mainly characterized by spatulate uncus, well developed tegumen mostly inverted u-shaped. While saccus poorly developed in *rumicis* (Linnaeus). Valvae narrow, T-shaped at apex in *Acronicta maxima* Moore and leaf like in *Acronicta rumicis* (Linnaeus).

**Subfamily Amphipyrae:**

This subfamily is represented by five species referable to three genera in the present work. *Euplexia lucipara* (Linnaeus), *Triphaenopsis pulcherrima* Moore and *Amphipyra herrichschaefferi* Hacker and Peks have been reported for the first time from Kashmir Himalayas and the last one from India also. This subfamily is characterized by variable uncus. It is lingulate, flat at apex or tongue like in *Amphipyra* Ochsenheimer, curved, needle like and sclerotized in *Euplexia* Stephans. Tegumen is of equal length in this group. Valves fully developed and long, except *Amphipyra herrichschaefferi* Hacker and Peks in which it is short and broad. Aedeagus tube like with vesica bearing cornuti in *Amphipyra* Ochsenheimer and absent in *Triphaenopsis* Butler.

**Subfamily Calpine:**

This subfamily has mainly fully developed proboscis, tibial spines absent on mesothoracic leg. This group is represented by three species referable to two genera in the present work. *Calyptera rectistria* Guenee and *Calyptra bicolor* Moore have been reported for the first time from Jammu and Kashmir. Uncus is simple and long, valvae long, vinculum broad and u-shaped in case of *Oraesia emarginata* (Fabricius) and *Calyptra rectistria* (Guenee), while short and v-shaped in *Calyptra bicolor* Moore.
Subfamily Catocalinae:

This subfamily is mainly characterized by fully developed eyes without overhanging cilia and spinose middle tibiae. The species are generally of large size and strongly built. As many as 22 species belonging to 15 genera have been investigated in this group. Nine species viz., *Arcte coerula* (Guenee), *Arcte taprobana* Moore, *Melapia electaria* Bremer, *Ophiusa trapezium* (Guenee), *Thyas honesta* Hubner, *Grammodes stolida* (Fabricius), *Artena dotata* (Fabricius), *Catocala amnonfreidbergi* Kravchenko *et al.* and *Eupsilia transversa* (Hufnagel) have been reported for the first time from the Kashmir Himalayas and the latter two are also new record from India.


Subfamily Chleophorinae:

This group is characterized by eyes without cilia and raised scales. Single species belonging to this group has been studied for the first time from the Kashmir
Himalayas and was characterized by short and straight uncus, valva long, ampulla pointed and costal margin furnished with apical plumose dense hairs. Vesica of aedeagus armed with pointed cornuti.

**Subfamily Cucullinae:**

Present subfamily is characterized by the possession of 'lashed eyes' with long overhanging cilia. Forewings elongate and tibiae unspined. As many as six species belonging to single genus have been investigated in this subfamily. Four species *viz.*, *Cucullia nigrifascia* (Hampson), *Cucullia biornata* Fischer de Waldheim, *Cucullia convexipennis* (Grote and Robinson) and *Cucullia splendida* (Cramer) have been reported first time from Kashmir Himalayas and the last one is also new record from India. This group is mainly characterized by short and curved uncus, harpe well developed and pointed vinculum. Aedeagus armed with cornuti. Female genitalia having elongate corpus bursae.

**Subfamily Euteliinae:**

Two diagnostic characteristics of this group are, a single long tubular process and simple frenulum. A total number of two species referable to single genus has been studied. Both species have been recorded for the first time from Kashmir Himalaya. Uncus is triangular, arm like valve and vinculum cup-shaped. Female genitalia with corpus bursae kidney shaped.

**Subfamily Hadeninae:**

This subfamily is recognized by large eyes, covered with very fine short erect hairs. As many as 18 species referable to 15 genera have been studied in this subfamily. A total number of 9 species are reported as first record from Jammu and Kashmir. Two genera and two species *viz.*, *Lophotyna albosignata* Moore and
Lacanobia oleracea (Linnaeus) are new records from India. Apart from this, two new species have been reported to science. This group is mainly characterized by well developed and variable uncus. It is spoon like in Hadena Schrank and Mamestra Ochsenheimer, short and curved in Orthosia Ochsenheimer, Conservula Grote, Lacanobia Billberg and Leucania Ochsenheimer, spatulate in Felioniopsis Roepke and fan like in Hecatera dysodea Moore. Cucullus with neck, except in Spodoptera Guenee. Corpus bursae ball shaped in Mamestra Ochsenheimer, Mythmina Ochsenheimer, Hadena Schrank, Conservula Grote and Aletia Hubner, elongate in Leucania Ochsenheimer, Orthosia Ochsenheimer, Cosmia affinis Walker, Lacanobia Billberg and Felioniopsis Roepke.

**Subfamily Heliothinae:**

As many as five species of this subfamily have been studied with Helicoverpa zea (Boddie) and Heliothis ononis (Denis and Schiffermuller) being reported for the first time from Kashmir Himalayas. Uncus short, valva elongate, aedeagus with numerous cornuti in Helicoverpa Hardwick. Tegumen of same size in all genera, coronate with a row of setae on the interior of the distal margin. Female genitalia with corpus bursae ballon like and having four rows of signa.

**Subfamily Hermaninae:**

The subfamily is characterized by prominent palpi, counter-tympanal hood prespiracular; and antennae of males with a central swelling and fore tibia produced into a sheath and with an elongate first tarsal segment. Simplicia caeneusalis (Walker) has been reported for the first time from Kashmir Himalayas and also from India. Uncus is linguiform, broad at centre and tapering towards apex, valve narrow, tegumen inverted u-shaped. Corpus bursae elongate, flask like and decorated with numerous small granules.
Subfamily Hypeninae:

Only two species were studied from this group during the course of present investigation. Genus *Bomolocha* Hubner has been reported for the first time from the study area. Uncus hook like and aedeagus armed with apical cornuti. Corpus bursae funnel like, with or without signum.

Subfamily Noctuinae:

The diagnostic characteristic of this group is the absence of spines on the middle tibiae, fore tibia with multiple claws whereas rows of spines present on the hind tibia. A total number of 16 species referable to 7 genera have been investigated in this subfamily. Out of these, 6 species have been reported as new records from Himalayan Kashmir and *Noctua orbina* Hufnagel is a new record from India. As for as genitalic attributes are concerned, uncus shows great variation, meticulously curved in genus *Agrotis* Ochsenheimer, beak like in *Ochropleura* Hubner and short in *Noctua* Linnaeus. Tegumen is of same size, corona fringed with strong hairs in all studied genera except *Noctua* Linnaeus. Juxta highly variable in this group. Female genitalia usually characterized by a bilobed corpus bursae.

Subfamily Plusiinae:

The forewings usually adorned with metallic spots or blotches in this group. Prothorax and dorsum strongly tufted. Five species belonging to four genera have been observed in this subfamily. Two genera viz., *Ctenoplusia* Dufey and *Macdunnoughia Kostrowicki* and 4 species of this subfamily are first time records from Kashmir Himalayas. This group is characterized by a sickle shaped uncus and broad tegument. Harpe present in all the studied genera except *Chrysodeixis* Hubner. Corpus bursae elongate, oblong and membranous in *Macdunnoughia Kostrowicki*, but bag like in *Chrysodeixis* Hubner. Ductus bursae quite long in this group.
Subfamily Sarrothripinae:

This subfamily is characterized by arched forewing at base, bar-shaped retinaculum in the male, and tufts of raised scales. Two species and genus Characoma Walker have been recorded for the first time from Kashmir Himalayas. Uncus elongate and bifid apically in Characoma Walker, whereas digitate in Nycteola Hubner. Vinculum very broad and elongate. Aedeagus moderately long in Characoma Walker, short in Nycteola Hubner. Ductus ejaculatorius entering at middle portion of aedeagus. Corpus bursae funnel like.

Subfamily Stictopterinae:

This group is distinguished by a single frenulum in female and with raised scales. One species has been studied during the present research work from the Jammu and Kashmir. It can be diagnosed with long and curved uncus, valve bifid, triangular saccus and boat shaped aedeagus.

SCOPE FOR FURTHER RESEARCH

Taxonomic studies on various groups of Insects are very much required in India. There are very few revisionary works being taken up by leading taxonomists in this country. Most of the collections lying in different National museums like Forest Research Institute (FRI), Dehradun, Indian Agricultural Research Institute (IARI), New Delhi and Zoological Survey of India (ZSI), Calcutta are still carrying old nomenclature. It is the need of the hour to conduct revisionary studies on various groups by conducting intensive and extensive collection cum survey tours from far flung localities of various states of India. After giving proper taxonomic treatment to various species the authentic identification is required. This becomes essential in view of the knowledge accumulated during the last 7-8 decades. Taxonomic revision of Noctuidae becomes utmost and very important.
With this background the state of Jammu and Kashmir was selected for the study on the taxonomy of family Noctuidae. The results obtained are quite exciting, rewarding and very successful. The collection surveys yielded a good harvest of 90 species of Noctuid moths during the last 4 years study period. It is tangible and first step ahead in the stairway pathway to the taxonomic revision of Noctuidae. Much more can be achieved with more intensive and extensive collection-cum-survey tours in more localities of this state. Future studies should be encouraged along with other important aspects like ecotaxonomy, molecular taxonomy along with morphological systematics. It can be concluded here that the outcome of the present research work will provide a motivation impel to the future Noctuidae workers.