INTRODUCTION
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The Superfamily Noctuoidea is one of the important and perhaps the largest groups of the order Lepidoptera. It includes a variety of moths, which are generally large-sized and often darkly colored, under seven recognized families viz., Notodontidae, Syntomidae, Noctuidae, Lymantridae, Hypsidae, Agarsitidae, and Arctiidae. Morphologically, the noctuoids are distinguished by a characteristic venation of the wings, with vein Cu₂ absent from both wings, with M₂ basally approximated to M₃ and 1A + 2A not forming a definite basal fork in the fore wings. The maxillary palpi are minute and the tympanal organs are present in the metathorax. The individual families are further characterized by specific patterns of venation. The robust structure of the body and the relatively thicker abdomen also provide quick identification marks for these moths.

This group of moths is of extreme economic importance because many of the included species are pests of crops and are responsible for serious losses. These include the well known cut-worms of the genera like Cirphis Wlk., Spodoptera Guen., Agrotis Ochs., Laphygma Guen., Heliothis Ochs., and Euxoa Hubn., attacking sorghum, maize, ragi, rice, gram, cowpea, peas, barley, sugarcane, jowar, wheat seedlings, and tobacco; pod-
borers from genera Adisura Moore, Heliothis Ochs., and Plusia Hubn. damaging the pods of lablab, gram, red gram, cowpea; semiloopers under genera Achaea Hubn., Parallelia Hubn., Prodenia Guen., Grammodes Guen., Euproctis Hubn., Anomis Hubn., Acontia Ochs., Spodoptera Guen. and Plusia Hubn. associated with crops like castor, linseed, mustard, sesame, cowpea, groundnuts, lady's finger and cabbage; fruit sucking moths from genera Anua Wlk., Oraesia Guen., Arcina Hubn., Achaea Hubn., Othreis Hubn., Parallelia Hubn., Pandesma Guen., Remigia Guen., Pericyma Herr-Shaff. and Anomis Hubn., sucking the fruits of banana, grapevine, guava, pomegranate, orange and other citrus species. In addition, there are other individual species which cause serious damage to their host plants e.g., the stem borer of wheat (Sesamia uniformis Dudg.), Pink borer of ragi (Sesamia inferens Wlk.), Capsule borer of castor (Heliothis obsolete Fabr.), the red hairy caterpillar of groundnuts (Amsacta albistria Moore) and the spotted boll worms (Faries fabia Stoll. and E. insulana Boisd.). In order to take effective control measures against the numerous pest species detailed above, a correct identification of these pests, among other requirements, is of utmost importance. This is all the more essential as many of these species are widely distributed and are reported to be not only polytypic with distinct subspecies but also to occur as species-complexes. The Noctuoid fauna of this country has been largely studied by
Hampson (1892, 1894, 1895) in three volumes of "Fauna of British India" in which he has described as many as two thousand two hundred and thirty nine species under different families. There are hardly any other studies pertaining to Indian noctuoid fauna except that of Warren (1916), Seitz (1926), Trauti (1933) and, Bhattacherjee and Gupta (1972) who have added a few new species. It is, however, very disconcerting to note that most of the descriptions of Indian species recorded by Hampson (1892, 1894, 1895) do not include the accounts of the male and female genitalia. These structures are now universally accepted as of great taxonomic significance and in fact very valuable for the discrimination of the species in particular and other higher taxa in general. A study of the male and female genitalia of the described Noctuoid fauna is therefore an urgent task for completing the descriptions of the species and for making the old works more meaningful. In addition, the studies on the external genitalia will furnish the much needed information on the general pattern of the structure of these organs in the Noctuoidea and, for that matter, in the order Lepidoptera as a group. The interpretation of different parts of the genitalia in the light of the knowledge accumulated during the last half a century would bring these findings to an up-to-date level for their comparison with other groups of Lepidoptera. The present investigations have been accordingly initiated to fill the gap in the existing knowledge of the taxonomy of Indian Noctuoidea.
A large number of workers have worked out the structure of genitalia in Noctuoidea and other Lepidopterous groups. This study was actually started on the male genitalia of Lepidoptera more than three centuries ago. Malpighi (1669) briefly described the male genitalia of *Bombyx mori* Linn. in connection with his studies on the reproductive system of this insect. After a long gap, Swammerdam (1737) gave the gross structure of the genitalia in the European butterfly, *Vanessa urticae* Linn. Reamur (1742) gave a brief description of the genitalia while describing the physiology of the reproductive system in male Lepidoptera. The work of these authors are characterized by a tendency to emphasize the physiology of the reproductive system and include very poor descriptions of the external genitalia.

The other workers such as Kirby and Spence (1828), Burmeister (1832) and Siebold and Stannius (1848) made the first attempts to describe the more visible parts of the genital armature. These writers used the term 'valvae' or valves to denote the paired lateral appendages. De Haan (1842) gave an account of the male genitalia of Papilionidae and used the term "klappen" for the valvae and 'zijdelingsche aanhangrels' for the inner lateral appendages of the valvae, popularly termed as harpe and ampulla. In discussing the
assymetry of parts in the male genital armature in *Misoniades tristis* Boisd., Scudder and Burgess (1870) used the term 'clasp' for the valvae and 'upper organ' for dorsal parts of the genitalia. These authors were the first to emphasize the usefulness of genitalia for the differentiation of allied species. The genital armature of the European Rhopalocera was studied by Buchanan-White (1876) who discussed the genitalic parts in detail and used the terms 'tegumen' and 'harpagones' respectively for 'upper organ' of Scudder and Burgess (1870) and for the valvae. Gosse (1881, 1883) described clasping organs of certain Lepidopterans by introducing a new nomenclature for them. He retained the name 'valvae' but introduced the term 'harpe' for the appendage formed on the mesal surface of each valva. He compared these with the 'lateral appendages' ('zijdelingsche aanhangsels') of the papilionidae, described previously by De Haan (1842). The term 'tegumen' used by Buchanan-White (1876) was found hardly appropriate for the posterior most spine like modification and called it the 'uncus'. The term 'scaphium' was used to denote the dorsal sclerotization of tuba analis and 'penis' for the central intromittent organ but the vesica was left unnamed. Cholodkovsky (1884, 1885) while working on the genitalia in the adelid moth, *Nemotois metallicus* Pod. recognised 'vinculum' as the sternite of ninth segment, and the 'tegumen' as the combined ninth and tenth terga, the latter being rudimentary or embryonic. He used the term 'kleppen' for valvae and
suggested that these might represent larval appendages. Smith (1889, 1898) demonstrated the value of the harpes (valvae) for separating closely related species of Noctuidae and inspired Pierce (1909) to make a more comprehensive study of the genitalia in this family. Peytoureau (1895) interpreted the morphology of the genitalia from the study of the pupal development and the nerve supply of the genital appendages. He recognized a close connection among the valves, the ninth sternum and formation of saccus. Stitz (1900) employed the term 'Scaphium' for the uncus and presented the latter as a sub-anal structure while discussing the genital armature in some families of the Lepidoptera. Zander (1903) published a comprehensive account of the genital armature in the Lepidoptera. He partly accepted the terminology of Gosse (1881, 1883) and referred tegumen to the ninth abdominal segment and the uncus and scaphium as dorsal and ventral processes respectively of the tenth segment. Zander (1903) also worked out the development of the penis and suggested the term 'ring wall' for its ventral supporting structure i.e., juxta. Pierce (1909, 1914, 1942, 1952) and, Pierce and Metcalfe (1922, 1935, 1938) studied the genitalia of other groups of Lepidoptera. McDonough (1911) proposed a nomenclatorial scheme out of the available literature on the subject. Bethune-Baker (1914) identified the great value of genitalia in Taxonomy and phylogeny and considered their structure of utmost importance in the discrimination of the
species and the genera but warned that the separation of the genera should be pursued with extreme caution. Eyer (1926a) discussed the morphological significance of the juxta in the male genitalia of the Lepidoptera and considered the loss of juxta to mark a high degree of genital specialization. Mehta (1933) made significant contribution to the structure of male genitalia in different groups of Lepidoptera. Forbes (1939) worked out the morphology and musculature of Lepidopterous male genitalia throwing light on the homologies of different parts. Engelhardt and McElvare (1941) stressed the importance of the genitalia at the specific level and suggested that in the revisional studies greater dependence should be placed on the internal genitalia. The other workers like Warneckle (1938), Stemfifer (1947), Povolny (1957) and Niculescu (1967, 1967a, 1967b, 1968, 1969) also considered genitalia as a reliable taxonomic tool. Beirne (1942) supplemented the observations of Forbes (1939) and based his conclusions on the study of about seven hundred species belonging to different groups of Lepidoptera. Beirne (1942a) also gave an account of the female genitalia and stressed the use of the term 'colliculum' for the sclerotization of any part of the ductus bursae. Viette (1948) gave a general account of the structure and nomenclature of male genitalia and compared it with those of Trichoptera and Hymenoptera. Sibatani et al (1954) in their first paper of
the series "on the morphology and nomenclature of the male genitalia of Lepidoptera" described only the division of the valva in Rhopalocera, Noctuidae and Geometridae. Okagaki et al. (1955) gave an account of the sacculus and furca and elaborated their morphological significance. Klots (1956) wrote an essay on the morphology and terminology of the male and the female genitalia, a revised version of which appeared in 1970. Ogata et al. (1957) gave a detailed account of the appendages of the tenth segment of male Lepidoptera and discussed the modifications of the uncus and the gnathos. Stekolnikov (1967) discussed the functional morphology and evolution of the genitalia in Lepidoptera. Zangheri (1969), commenting on the use of the male genitalia in Lepidoptera, confirmed its variable value in different groups. Mutuura (1972) has recently given an up-to-date account of the female genitalia in relation to its taxonomic significance. The old schemes of the higher classification of Lepidoptera were revised by him on the basis of female genitalia by recognising four major groups. Sibatani (1972) suggested a new composite term 'sociuncus' for the socii and the uncus together and highlighted the importance of a few more structures which were not recognized by Klots (1970). Dugdale (1975) discussed the significance of the genital configuration in the classification of Lepidoptera based on the chitinized (ectodermal) structure of the internal female genitalia in Lepidoptera and related
endopterygotes like Megaloptera. Out of the works on individual groups, the genitalia of the family Sphingidae have been studied by Rothschild and Jordan (1903) whereas Busck and Heinrich (1921) have discussed the systematic importance of male genitalia in Microlepidoptera. Eidemann (1930) and Busck (1931) likewise discussed the taxonomic importance of female genitalia in Microlepidoptera. Eyer (1924) made a comparative study on the male genitalia of the Primitive Lepidoptera as compared to those found in the nearly related orders. Philpott (1923, 1926, 1927) described male genitalic organs in the Primitive Lepidoptera and his conclusions furnished additional evidence on the phylogeny of Homoneura. Skinner and Williams (1924), Roswell and Williams (1927) and, Warren (1926) and Nakahara (1927) have successfully utilized the genitalic characters for the discrimination of closely allied genera and species in the Hesperoidea and the Papilio-machaeon group of the Papilionina. Philpott (1929, 1929a) recognized the significance of the structure of genitalia in his studies relating to the Pyralidoidea and Rose (1976) made an important contribution to the taxonomy of the same group with particular reference to the structure of genitalia. Eyer (1926) laid stress on the use of the male genitalia in the characterization of Homoneura and Heteroneura, in the separation of their constituent families and in the determination of relationship among them.
As far as the Superfamily Noctuoidea is concerned, Pierce (1909, 1942, 1952) has published brief descriptions of male and female genitalia of more than 300 species. However, he has followed old terminology and classification, has given very brief descriptions and included rather sketchy figures which do not permit any useful conclusions. Mehta (1933) while discussing the comparative morphology of the male genitalia included 144 species of Noctuoidea from various families/subfamilies. Richards (1938) drew attention to the "Remarkable setae" present on the lateral lobes of the tegumen of male genitalia of the north American species of genus *Amyna* Guen. Bayer (1960) gave a comparative account of the valvae of male genitalia in the genera *Prodenia* Guen., *Laphygma* Guen. and *Spodoptera* Guen. of subfamily Acromyctinae, describing one, three and two species respectively. Later on, Bayer (1964) described the valvae of 44 species under 8 genera belonging to subfamily Agrotinae and suggested several categories on the basis of their structure. Bayer (1965) also discussed the comparative morphology and musculature of the male genital segments in six species representing each of the six categories into which he divided the selected 25 species of subfamily Plusiinae. Birket-Smith (1965) revised the West African Eilemic moths of Arctiidae on the basis of the male genitalia. Franclemont (1966) described two new species of family Arctiidae based on their male and female genitalia.

The genitalia of a few individual species have also been described by workers like Silverly (1947) who gave an account of the male and female genitalia of *Heliothis armigera* Hubn. (*H. obsoleta* Fabr.) and Todd (1960) worked out the genitalia of *Acontia isolata* Todd. Betala and Kushwaha (1967) wrote a few lines on the male and female genitalia of the cabbage semi-looper, *Plusia niornisigna* Wlk. Srivastva and Bogawat (1968) discussed only the male genitalia of one of the fruit sucking moths, *Othreis materna* Linn. while describing its morphology, musculature and innervation of the external genitalia. Nagaraja et al. (1968) described briefly the male and female genitalia of *Lymantria obfuscata* Wlk. and *L. dispar* Linn. Bhattacheryee and Gupta (1972) gave brief descriptions of the male and female genitalia of four species of *Heliothis* Ochs. Ahmad and Ahmed (1976) described in detail the male and female genitalic
It is evident from the foregoing account that although much work has been done on the study of the genitalia in different species and genera under various families of Lepidoptera, yet exhaustive studies at the level of families/ superfamilies for assessing the role of these organs in their taxonomy are rather quite limited. In so far as the Superfamily Noctuoidea is concerned, Pierce (1909, 1942, 1952) is the only worker who has attempted a treatment of the genitalia in the family Noctuidae while describing the male and female genitalia in 314 and 318 species respectively. The rest of the observations are far less extensive and cover only some parts of the genital organs. Moreover, the species worked out by Pierce (1909, 1942, 1952) have been very briefly described and their illustrations are not up to the mark. On account of the assignment of the species to different groups according to the old scheme of classification, it is very difficult to draw correct conclusions regarding the taxonomic evaluation of the genital structures. Out of a total of 502 and 365 species studied for male and female genitalia by Pierce (1909, 1942, 1952), Mehta (1933) and Van Den Berg (1968, 1969), the three main contributors, observations have been made only on 30 Indian species. Accordingly, a good deal of work remains to be carried out on the genitalia of Indian genera and species. A detailed study of the parts of the organs of Diacrisia obliqua Wlk.
genitalia of Indian Noctuoidea and their proper interpreta-
tion in the light of the available information is the very
much needed type of work to be accomplished urgently. The
results of these findings will richly add to our knowledge
of the general characteristics of the male and female genitalia
in the Noctuoidea as well as in Lepidoptera in general. The
complete information on the structure of these organs in the
individual species and genera will also greatly help in
strengthening the characterisation of these taxa, more so, as
the previous descriptions of these species lack the structure
of the genital organs.

The present investigations accordingly include the de-
tailed observations on the male and female genitalia of 217
species of Noctuoidea under seven families and sixteen Sub-
families. As some of the species are represented by only
males or the females, the male genitalia have been actually
studied in 175 species and female genitalia in 183 species.
The identification of the species has been arrived at by
following the Keys and descriptions to the moths of India by
Hampson (1892, 1895, 1903, 1906) and confirmed by the
staff of Forest Research Institute, Dehra Dun. Some of the
examples were also compared with identified collection in
the Indian Agricultural Research Institute, New Delhi.