COMPARATIVE MORPHOLOGY OF THE MALE GENITALIA IN LEPIDOPTERA.

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INTRODUCTION.

In the domains of both Morphology and Taxonomy the study of Insect genitalia has evoked considerable interest during the past half century. Zander (1900, 1901, 1903) suggested a common structural plan for the genitalia in various orders of insects. This work stimulated further research and his conclusions were amplified by Crampton (1920) who homologized the different parts in the genitalia of Hymenoptera, Mecoptera, Neuroptera, Diptera, Trichoptera Lepidoptera, Hemiptera and Strepsiptera with those of more generalized insects like the Ephemeroptera and Thysanura. During this time the use of genitalic characters for taxonomic purposes was also realized particularly in cases where the other imaginal characters had failed to serve. In this connection may be mentioned the work of Buchanan White (1876), Gosse (1883), Bethune Baker (1914), Pierce (1909, 1914, 1922) and others. Also, a comparative account of the genitalia, as a basis for the phylogenetic study of different insect orders, was employed by Walker (1919), Sharp and Muir (1912), Singh-Pruthi (1925) and Cole (1927), in Orthoptera, Coleoptera, Hemiptera and the Diptera respectively. It is surprising, work of this nature having been found so useful in these groups, that an important order like the Lepidoptera should have escaped careful analysis at the hands of the morphologists. Bethune Baker (1914) emphasized the taxonomic importance of the genitalia in Lepidoptera but his observations were too restricted. Eyer (1924) has attempted to work out the natural relationships of the primitive Lepidoptera and the allied insect groups and in a later contribution (1926), he has established characters of family and superfamily significance in the male genitalia of Microlepidoptera. A strict perusal of the rather enormous literature on the genitalia of Lepidoptera (which has been

[1] For explanation of lettering of text-figures see bottom of p. 208.

supplemented from time to time) convinces one of the scantiness of information regarding the phylogeny of this group. The truth is that we have no work dealing with the morphology of the whole order in a comprehensive manner.

Several attempts have been made to work out the true phylogenetic relationships of Lepidoptera based on characters of the egg, caterpillar, pupa and the imago, with the result that many divergent views have been expressed. It would, therefore, seem perfectly justifiable to look for another set of stable characters in the adult which could, at least, without being unnecessarily speculative be a useful aid in a natural classification of the Lepidoptera. With this end in view, I have attempted to give a comparative morphological account of the male genitalia in this order and to trace as far as is practicable the different lines of structural variation in the phylogeny of Lepidoptera. It must be admitted that no single structure can form the basis of a classification. Phylogenetic speculation, therefore, has only been indulged in after due cognizance has been taken of characters other than genitalia.

The nomenclature on the male genitalia of Lepidoptera is very complicated. An endeavour has been made in this paper to apply the names correctly to the various parts of the male genitalia as determined strictly by the laws of priority. In this way much of the confusion which is usually experienced in a study of this nature has been eliminated.

As in all systematic work, much difficulty has been found in grouping the different families in a regular order. I have mainly restricted myself to Meyrick's arrangement of the British Lepidoptera (1927) and in some cases as in Imms's 'General Textbook of Entomology' (1929). For the superfamily Noctuina, reference is made to Hampson's catalogue of the Lepidoptera Phalaenae in the British Museum (1898-1926).

The nomenclatorial accuracy of the specimens has been checked by Mr. W. H. T. Tams and Capt. N. D. Riley of the British Museum (Natural History), London.

All the drawings have been made by the Camera lucida. In most cases the ventral aspect was found most convenient to examine but in certain forms, *e.g.*, Papilionina, lateral views were found more convenient.

This problem was suggested to me by Mr. L. E. S. Eastham (my supervisor of research studies), whom I take this opportunity of thanking for his sympathetic interest and able guidance. His enthusiasm for this problem has been a great stimulus to me. To Professor J. Stanley Gardiner, I am much indebted for providing me with every facility for work in the Zoological Laboratory, Cambridge.

Much of the material for this investigation was obtained from the British Museum (Natural History), London, with the kind permission of the Trustees. I wish to express my sincere thanks to Sir Guy Marshall and Major E. E. Austen, for permission to work in the Natural History Museum, and to Mr. W. H. T. Tams and Capt. N. D. Riley for several courtesies enjoyed at their hands during the course of this investigation.

Lastly, I wish gratefully to acknowledge to the Government of the Punjab the grant of a University scholarship which I held during the progress of this research.

HISTORICAL REVIEW.

Early record of the male genitalia in Lepidoptera may be discovered in the works of Malpighi (1669) Kirby and Spence (1828), Burmeister (1832) and Siebold and Stannius (1848). These authors used the term ' Valvae ' or the ' Valves ' for the lateral outer appendages.

In 1842, De Haan fully described the male genital armature in the Papilionidae and employed the term ' Klappen ' for the valvae and ' Zijdelingsche aanhangsels ' for the two lateral appendages concealed in them. His account of the rest of the parts as translated by Gosse (1883) is reproduced below.[1] " The truncated and sometimes even hollow end of the hinder part of the body, which lies within these valves, bears upon the upper edge a pointed spine bent downwards, with the two lateral plates (Zijdelings plaatjes) which lie close to it. From the middle of the hinder part of the body the penis (roede) is exposed, which is gristly (Kraakbeenig), straight, blunt, and shorter than the lateral valves."

In discussing the asymmetry of parts in the male genital armature of *Nisoniades tristis* Boisd. ; Scudder and Burgess (1870) used the term " Clasp " for the valvae and the " Upper organ " for the dorsal portion of the genitalia. The terms " Main body " and the " Dorsal crest " were used to describe the proximal portion of the upper organ. A pair of lateral arms which arise from the upper organ and extend ventrally were termed the " Inferior armature " These authors were the first to emphasize the usefulness of genitalic characters for the differentiation of closely related species.

Mc'Lachlan (1872) described the genitalia of *Acentropus* and applied the terms " Appendices inferiores ", " Boat-shaped lobes ", " Superior processes ", and " Penis " for the different parts, which had been previously used for the description of similar organs in the Trichoptera.

Buchanan White (1876) gave a clearer account of the male genital armature in the European Rhopalocera. He replaced the term " Upper organ " of Scudder and Burgess by " Tegumen " which signified both the tergal and sternal parts of the terminal segment. The term " Harpagones " was used for the lateral valves.

Gosse (1881, 1883) introduced a new nomenclatorial scheme for the description of copulatory organs. The term " Valvae " was retained and he introduced the term " Harpe " for a peculiar prehensile organ found on the inner surface of each valve. He compared these to the ' lateral appendages ' (' Zijdelingsche aanhangsels ') of the Papilionidae, previously described by De Haan (1842). The term ' tegumen ' adopted by Buchanan White (1876) was found hardly appropriate for the apical spinose, often wiry point and so he called it the " Uncus " (drag hook). Arising from the base of the uncus, he noticed a mass of shining white tissue occupying the chief place in the genital cavity and owing to its resemblance to a boat, he termed it the " Scaphium " The term " Penis " was employed for the central intromittent organ and its inner soft white tissue was left unnamed.

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[1] Cited from Gosse, *Trans. Ent. Soc. London* (1883).

Various articles were published in the ensuing period and the chief contributions were made by Cholodkovsky (1884, 1885), Hofman (1895), Smith (1889, 1898), Jackson (1889), Peytoureau (1895), Stichel (1889) and Peterson (1900), on the morphology of the male genitalia in Lepidoptera.

In 1900, Stitz, using Gosse's nomenclature gave a comprehensive account of the genital armature in some families of this order. His work is usually discredited since he erroneously employed the term 'scaphium' for the uncus and represented the latter as a sub-anal structure.

Poljanec (1902) referred to the modifications in the eighth abdominal sternite and used the term " Rami " for the distal processes of the post-segmental margin.

Zander (1903) published a very comprehensive account of the genital armature in the Lepidoptera. He partly accepted Gosse's terminology and referred the tegumen to the ninth segment and the uncus and scaphium as dorsal and ventral processes respectively of the tenth segment, which is membranous and lies concealed below the tegumen. Like several others, he too was mistaken in representing the scaphium as sub-anal. The penis and its development were fully worked out and he suggested the term " Ringwall " for its ventral supporting structure. His work has dual importance since he also studied the development of these organs to pick up their real morphological significance.

The value of genitalic characters for taxonomic purposes was also realized and Rothschild and Jordan (1903) and Pierce (1909) described the male genitalia in the Sphingidae and the Noctuidae respectively.

In 1911, McDunnough worked out a nomenclatorial scheme out of the existing literature on the subject. He also erroneously described the scaphium as sub-anal.

Bethune Baker (1914) gave a comparative account of the copulatory organs in the Lepidoptera and emphasized their systematic importance. In this connection he modified the existing nomenclature and invented a terminology which was not universally accepted.

The warm reception of his publication on the male genitalia of the British Noctuidae encouraged Pierce to describe on similar lines the families Geometridae (1914) and Tortricidae (1922). At this stage he revised the nomenclature and invented new names for the different elements in these two families. The terminology adopted by this author is usually employed in all modern descriptions of the genitalia in the Lepidoptera.

Busck and Heinrich (1921) revised the nomenclature in the light of Pierce's work and emphasized the taxonomic value of the genital armature.

In the recent years considerable attention has been focussed on the taxonomic use of the genitalia. In this connection Burrows (1924), Eyer (1924, 1926) and Philpott (1923, 1927) published general accounts of the copulatory organs in different groups of Lepidoptera.

Eyer (1924) and Philpott (1923, 1926, 1927) described these organs in the primitive Lepidoptera, and their conclusions furnish additional evidence regarding the phylogeny of Homoneura. Skinner and Williams

(1924), Roswell and Williams (1927), Warren (1926) and Nakahara (1927) have been able successfully to utilize the genitalic characters for the discrimination of closely allied genera and species in the Hesperoidea and the Papilio-machaon groups of the Papilionina respectively.

TECHNIQUE.

For the preparation of genitalia, the methods suggested by Tams (1926) have been successfully employed. In the case of large forms such as the Sphingidae, wood naphtha is applied to the terminal segments of the abdomen, these being subsequently treated with potash. With smaller forms following method was adopted.

The entire abdomen is dipped in 90 per cent. alcohol. The alcohol penetrates the entire specimen rapidly with the result that it readily absorbs water when later it is dropped in it. The specimens are then left from 10-24 hours in a solution of 10 per cent. KOH. In the case of very small insects like some of the Tineidae, Eriocraniidae, and Micropterygidae a solution of 3 per cent. KOH gave very satisfactory results. No boiling in potash is required unless the parts are too rigid to soften otherwise. After proper dehydration the genitalia are dissected in clove oil before mounting the specimens in Canada Balsam.

For minute forms like *Micropteryx aruncella* Scop, a blue stain considerably improves the preparation and brings out the sclerites and sutures between them. For this purpose I have used with advantage the stain Carbol Methylene Blue as recommended by Pierce (1909). It is usually sold prepared in the liquid state and a few drops put in the alcohol for dehydration are enough to give a deep blue stain which may be slowly differentiated in oil of cloves ; or clearing in xylol is also recommended.

Picric acid dissolved in oil of cloves stains the membranous parts. This has also been frequently used in my preparations.

NOMENCLATURE.

References to the nomenclature for describing the male genitalia have been made in the preceding pages. It is seen that the first serious attempt to organize such a scheme was made by Gosse in 1883. He was followed by Zander (1903) and Pierce (1909). The latter author introduced several new names to represent the complicated genitalia in the family Noctuidae. The existing terminology was found confusing in several respects and in 1911, McDunnough developed a more or less conciliatory system of nomenclature purely on the basis of priority. Bethune Baker (1914) started a new terminology for these structures but it was not universally accepted. The real contribution of some importance was made by Pierce (1914) who outlined the structural details in the genital armature of the families Geometridae and the Tortricidae. He invented several new terms for accessory structures developed in connection with the valvae and the tegumen. Later, in 1921, Busck and Heinrich presented another nomenclatorial scheme in the light of Pierce's work. They do not appear to have adopted all his terms.

The absence of a uniform nomenclature for genitalia in Lepidoptera has its origin in incomplete morphological study, homologies being impossible to determine. A comprehensive analysis of existing nomenclatorial systems is therefore desirable. To avoid confusion the law of priority must be adhered to as strictly as the special conditions allow.

The ninth and tenth abdominal segments in the adult Lepidopteron are involved to form the genitalia proper with occasional modifications of the eighth sternite. In the list of names reproduced below, a brief explanation is also appended to describe each structure. The segment to which each of them belongs is also referred to.

Seventh Abdominal Segment.

COREMATA. (Pierce, 1914).

In some of the Geometridae, an extensile bag clothed with hair and bearing a spiracle is developed on either side of the seventh segment. This seems to bear no particular relation to the copulatory organs (Text-fig. 82, *Cr.*)

Eighth Abdominal Segment.

RAMI. (Poljanec, 1902).

In several Lepidoptera, the eighth sternite consists of a large chitinous piece and is distally produced into long often asymmetrical arms " The Rami " (text-fig. 95). Pierce (1914) used the term " The Cerata " for similar structures in the Acidaliinae (Geometridae).

MAPPA. (Pierce, 1914).

Covering the ' cerata ' (Pierce) is a loose semicircular flap clothed with long scales. This flap is termed " The Mappa " It is developed in connection with the eighth sternite.

ABDOMINAL PLATE. (Buchanan White, 1891).

This is a distinct ventral plate sometimes developed on the eighth sternite into which the genitalia are usually withdrawn. It has been noticed in the Eupitheciinae amongst the Geometridae, some of the Nymphalidae and in the Species *Perrisectis australasiae* Don., amongst the Hepialidae (Text-fig. 4, *Vp.*).

Ninth Abdominal Segment.

TEGUMEN. (Buchanan White, 1876).

This term is now employed to denote the dorsal part of the ninth segment. Buchanan White used this term in a collective sense to signify both the tergite and the sternite of the ninth segment.

PENICULUS. (Pierce, 1909).

A densely hairy lobiform basal process is situated on either side of the tegumen which in some of the Noctuidae attains the form of broad lateral expansions (Text-fig. 97, *Pn*).

VINCULUM. (Pierce, 1909).

Saccus in part. (Bethune Baker, 1891).

This is a ventral chitinized band which represents the sternite of the ninth segment. Pierce (1914) discarded it in favour of the term " The Saccus " (B. Baker, 1891) which signified both the vinculum and the saccus. In this paper, the term ' vinculum ' has been retained for the ninth sternite. The saccus in the family Tineidae and the Nymphalidae, is a conspicuous structure while it is hardly represented as such in several other families. I have, therefore, adopted this term ' saccus ' for the prolongation of the vinculum which in some of the Nymphalidae (Papilionina) extends as far as the fifth abdominal somite (Text-fig. 103, *S*).

VALVAE. (Burmeister, 1832).

These are paired clasping organs which basally articulate with the vinculum. Pierce (1909, 1914) has given the most adequate description of these organs and I have adopted his terminology for the Noctuidae and the Geometridae. In such cases the valvae may be divided into three parts which are more or less fused together (Text-figs. 96, 97). To these parts he has given the names " The Costa ", " The Valvula " and " The Sacculus " In his account of the Noctuidae the term " Cucullus " is used for the distal part of the valve while the basal half is called the " Sacculus " The upper edge of the cucullus is called " The Margin ", to which is often attached a uniform row of incurved spines which he terms as " The Corona " Besides these, there are attached to the edge of the valvae long spines which he designates as the " Marginal Spines " The outer margin of the cucullus is termed the " Anal Margin " and where the division occurs the name " Anal Angle " has been given. The inner border of the valves is called the " Costal Margin "

The central area of the valvae is occupied by a complicated series of prehensile organs. Gosse (1883) used the term " Harpe " for similar structures in the Papilionidae. The position of the harpe is variable. Pierce (1909) divided the whole organ into " Clasper " and " Ampulla " two closely situated structures and sometimes with different appearance. The former term is confusing since it has been commonly applied to the valvae. The " Ampulla " is a process arising on the inner side of the central area. Like the harpe, this too is a variable organ and at times is hard to locate.

The sacculus is the proximal portion of the valvae. It also assumes a variety of form. A small organ called the " Clavus " (Pierce, 1909) is developed from the base of the sacculus on the costal margin (Text-fig. 97, *cl*). It is highly developed in the family Noctuidae. Sometimes the two sacculi may project centrally quite apart from the valvae and are even fused together. To the organ thus formed Pierce has given the name of " The Furca " (Text-fig. 25, *F*).

TRANSTILLA. (Pierce, 1914).

This is a cross-bar which arises from the costal margin of the valvae. It may assume variable shape and is particularly well developed in the Tortricidae (Text-fig. 33, *Ts*).

LABIDES. (Pierce, 1914).

This term denotes two long arms each bearing a soft hairy pad and united by a thin membrane. They arise from the points where the transtilla meets the sacculus on the costal margin. These are prominent organs in the family Geometridae (Text-fig. 79, *Lb*).

Tenth Abdominal Segment.

UNCUS. (Gosse, 1883).

The uncus forms a dorsal process of the tenth segment which remains membranous and retracted within the tegumen. The anal opening lies just below the uncus and sometimes projects some distance away from it.

SCAPHIUM. (Gosse, 1883).

Gosse (1883) applied this term to a mass of shining white tissue arising from the base of the uncus and occupying the chief place in the genital cavity. It has been erroneously described as sub-anal by several authors. In 1911, Chapman correctly located this organ after making a thorough comparison in different forms, and he came to the conclusion that it is situated dorsally to the anus. Pierce (1909) compared it to a similarly situated organ in the Noctuidae Catocalinae. In fact this supra-anal process in the family Noctuidae is not the " Scaphium of Gosse " The latter structure is only a chitinous shield usually attached to the dorsal surface of the anal tube, and is conspicuous in the Papilioninae and some members of the Heterocera. For this supra-anal process (Text-fig. 96, ' Sp. an. p.'), found in the Catocalinae (Noctuidae), Thyrididae and other groups of Lepidoptera, the term " Subuncus " has been proposed by Pierce (1909), but I have not adopted it.

SOCII. (Pierce, 1914).

These are paired hairy pads or lobiform processes which arise from the base of the uncus and lie on either side of the anal tube. The form assumed is variable in different families of the Lepidoptera (Text-fig. 35, *Si*).

SIDE LOBE. (Buchanan White, 1876).

On either side of the tegumen and near its apex, arises a slender, curved spine-like lobe which is termed the " Side lobe " It is variable in form and is a conspicuous organ in the Papilionina (Text-fig. 101, *Sl*).

GNATHOS. (Pierce, 1909).

This term indicates a sub-anal structure hinged to the base of the uncus. It has two arms or ' brachia ' which meet medially at a point

often described as the central lip. The arms may be free, in the form of a loop (Text-fig. 82, *Gn*), or, may be fused to the tegumen. This organ has frequently been mistaken for the ' scaphium of Gosse ' (Zander and others).

Sexual organs.

PENIS. (Gosse, 1883).

The Penis forms the central (*intromittent*) organ and it consists of a strong tube called the " *Aedœagus* " which is kept in position by a sleeve-shaped eversible membranous tube named " *Manica* " by Pierce (1914). The Penis encloses a membranous tube, the " *Ductus ejaculatorius* " which enters the central organ near its blind end or ' blindsack ' (Zander. 1903). The extrusible part of this duct which comes in contact with the bursa of the female is termed " The *Vesica* " by Pierce (1909) (Text-fig. 91, *D Ej*). It is usually armed with small spines or denticles which he has termed the " *Cornuti* " (Text-fig. 91, ' *Cn*).

RINGWALL. (Zander, 1903).

Anellus and Juxta. (Pierce, 1909, 1914).

It is a cone-like tube or a small more or less triangular plate which is ventrally supported by the vinculum and on either side by the valvae. It is subject to great modification and may be extended into lateral processes, the " Anellus lobes " (Text-fig. 53, ' *An* ') which in the Geometridae and some other Heterocera are sometimes united so as to produce a single arm called the " Calcar " (Text-fig. 82, *Cal*).

" The Juxta " is a shield or plate borne on the ventral surface of the anellus. It is often decorated on either side by a pad covered with hairs or scales which Pierce (1914) has termed " The Cristae " (Text-fig. 84, *C*).

TRULLEUM. (Philpott, 1927).

This is apically connected with the tegumen and is produced into lower processes. The organ is found only in the Hepialidae and is particularly well devloped in *Perrisectis australasiae* Don. (Text-fig. 4, *Tr*).

Function.

On the function of copulatory organs in the Lepidoptera much attention has not been focussed. Apart from the biological significance of copulation, Muir (1928) has held that the consideration of this function is of value both to Taxonomy and Morphology. Only casual notes may be discovered in the literature more or less of the nature of assumptions regarding the actual use of the organs during coitus.

The process of paring consists essentially in the conjunction of the male and female tubes, and the relative station taken up by the individuals, just previous to pairing or the ' pose ' (Lamb, 1922), is that in which the insects are collinear. This condition is described as the " Linear pose " by Lamb (1922) in which the moths copulate and lie tail to tail and the ' necessary reaction to the pairing forces is provided

for by the presence of a common platform' It is generally agreed that the genital armature of Lepidoptera has the function of a special prehensile apparatus during copulation. It is very complicated in more specialized families such as the Noctuidae, Geometridae and the Sphingidae. Gosse (1883) and others have shown that the valvae are the chief clasping organs and the accessory structures like the harpe, ampulla, etc., are calculated to increase their efficiency. Jordan (1896) observed the actual mating in *Papilio memnon* and he found that the male claspers seize the protruding vaginal bulbs, taking hold on chitinous folds and ridges. In this respect he contradicted Gosse (1883) who maintained that the terminal segments were grasped by the valvae during copulation.

Pierce (1909) could not assign any definite function to the uncus and he believed that it is used to grasp the female dorsally or perhaps it may be thrown back and act as a guide, sometimes fitting between the ovipositor lobes. Michael (1923) also held that in *Bombyx mori* Linn., the uncus formed a part of the prehensile apparatus. In the family Psychidae, Jones (1927) has attributed a peculiar function to this organ. The female in this family is enclosed in her case and the male alights on it and as a preliminary to coitus, seeks access into the interior by using the awl-like uncus.

The supra-anal process such as the scaphium, etc., and the sub-anal 'gnathos' or the sub-anal 'sub-scaphium' are merely chitinous pieces which form the armature of the anal tube and are also sometimes used for grasping the female.

The penis is the central intromittent organ and the ductus ejaculatorius with its vesica are extruded into the bursa of the female. Evidence of this has been secured by Chapman (1913) who discovered the shedding of cornuti in the bursa of the female Pyralids, and Jones (1927) dissected the mated pairs of Psychids to ascertain the actual length of the extruded seminal duct.

It is supposed by Pierce (1909) that the densely hairy lobiform 'peniculus' in the Noctuidae appears to act as brush for the penis.

The juxta forms a ventral support for the penis and according to Pierce (1914), it may possibly act as a guide to this organ when it is produced centrally in the form of a long lip or spout.

The genitalia are usually covered all over the surface with hairs which probably have a sensory or tactile function.

Comparative Morphology.

The abdomen, in the male adult Lepidopteron, is composed of ten distinct somites, the last two being involved in the formation of the genitalia, with occasional modifications of the eighth sternite. There is no indication of the existence of an eleventh abdominal segment though some workers have described it.

The first abdominal segment bears no sternite and the tergite is closely applied to the thorax. The spiracles are usually borne on somites 1-7 and in the Hepialidae a distinct spiracle is also present on the eighth segment.

In some of the Hepialidae, there occur a number of unchitinized areas or fossae on the 3-8 somites and on the fifth sternite in the Eriocraniidae. The seventh segment is highly developed in some of the Geometridae, being produced on either side to form the extensile pouch clothed with hair, the ' Coremata ' (Pierce, 1914). These are also found in connection with the ninth somite in some of the Eupitheciinae. The eighth segment shows occasional modifications, being produced distally into paired, elongated sometimes curved arms or " Rami " (Poljanec, 1902), and in some Bombycidae such processes arise proximally as well and are directed anteriorly (Text-fig. 95). The details of such structural variation in the eighth, ninth and the tenth abdominal segments have been incorporated in the ensuing systematic account.

Order LEPIDOPTERA.

Sub-Order HOMONEURA.

This is an archaic group comprising the families Micropterygidae, Mnesarchaeidae, Hepialidae, Prototheoridae, and Eriocraniidae. Their inter-relationships based on characters of the male genitalia have been extensively described by Eyer (1924) and Philpott (1923). In this study material for the families Mnesarchaeidae and Prototheoridae was not available, consequently I have depended on the observations of these authors.

Family MICROPTERYGIDAE.

The eighth sternite is very much reduced.

Valvae simple, elongate, costal margin convex, apex broad, lobiform, sparsely spinose. Between the valvae and the ninth sternite lies a small sclerite termed the " Horizontal Plate " (' H ', fig. 1) by Philpott (1923).

The ninth sternite is broad, well developed and fused with the tegumen by a distinct suture. Philpott (1923) failed to observe any indication of such a line of fusion between the tegumen and the ninth sternite in *Micropteryx aruncella* Scop., and inferred that ' the tergite has disappeared entirely, its place being taken and its functions carried out by outgrowths from the sternite.' The tegumen is a short piece and is continued dorsally into an erect process, the uncus. Ventrally it is produced into a pair of lateral plates which are curved upwards apically to a point. From the base on each of these arises a short blunt process with hair on the apex. Philpott regarded them as ' surgonopods ' or ' surstyli '

Penis long. Cornuti distinct.

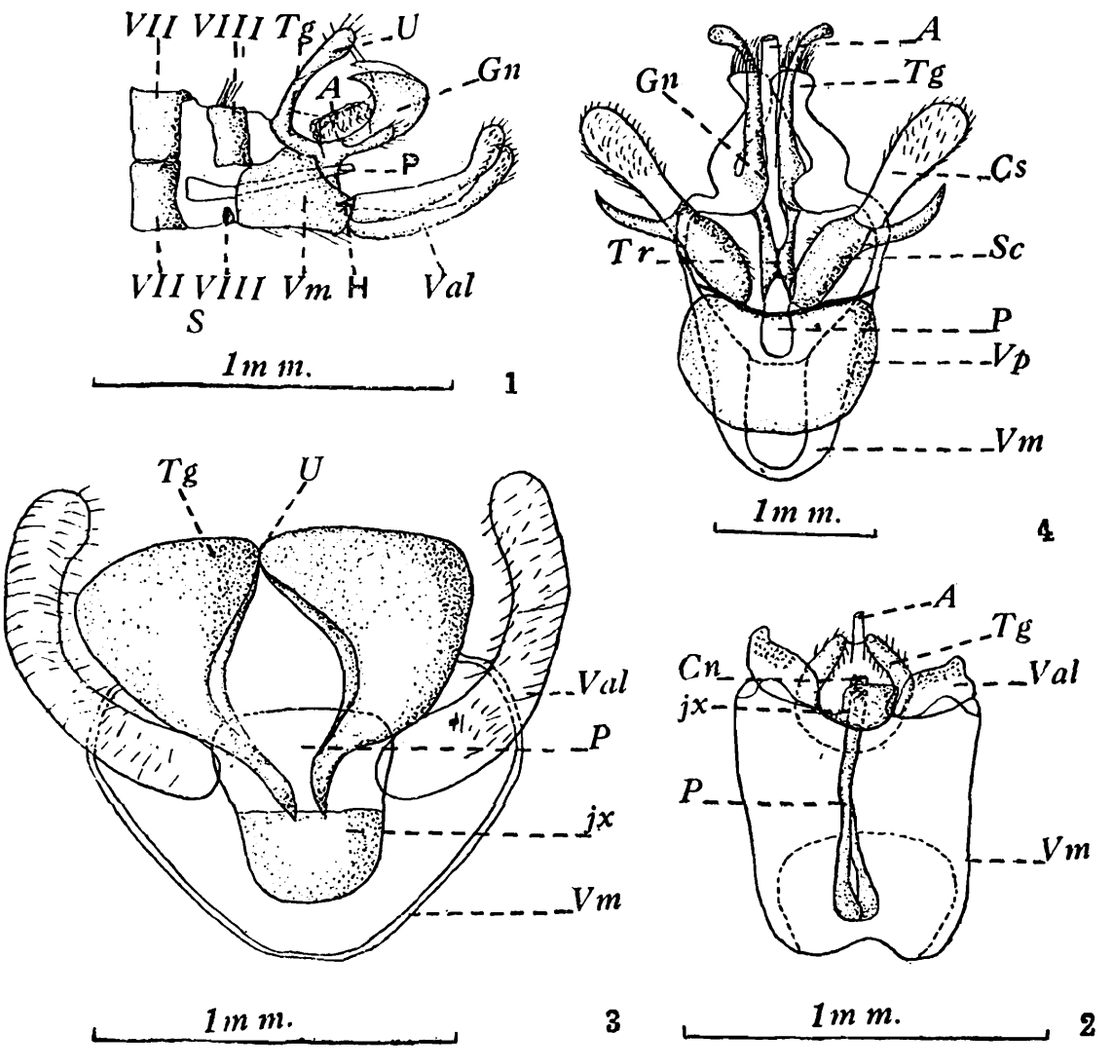
Species examined. Micropteryx aruncella Scop. (Text-fig. 1).

Family ERIOCRANIIDAE.

Fifth sternite with unchitinized areas or fossae.

Valvae short, reduced and scobinated. Tegumen with distinct lateral lobes connected with each other by a chitinous membrane. Vinculum broad and elongated.

Penis long, dorsal and ventral surfaces heavily chitinized and so it has the appearance of two separate pieces united basally. Juxta a strongly chitinized plate.



TEXT-FIG. 1.—*Micropteryx aruncella* Scop.
TEXT-FIG. 2.—*Eriocrania semipurpurella* Steph.
TEXT-FIG. 3.—*Hepialus lupulinus* Linn.
TEXT-FIG. 4.—*Perrisectis australasiae.* Don.

Species examined. Eriocrania semipurpurella Steph. (Text- fig. 2); *Mnemonica subpurpurella* Haw.

Family HEPIALIDAE.

The eighth sternite with a median ventral plate (' Vp ', fig. 4) lying beneath the vinculum (*e.g., Perrisectis australasiae* Don.).

LETTERING FOR TEXT-FIGURES.

A., Anal tube; *An.*, Anellus; *Ap.*, Ampulla; *C.*, Cristae; *Ca.*, Costal margin; *Cl.*, Clavus; *Cn.*, Cornuti; *Cr.*, Coremata; *Cs.*, Cucullus; *D. ej.*, Ductus ejaculatorius (' Vesica ' in part); *F.*, Furca; *Gn.*, Gnathos; *H.*, Horizontal plate; *Hp.*, Harpe; *Jx.*, Juxta; *Lb.*, Labide; *P.*, Penis; *Pn.*, Peniculus; *S.*, Saccus; *Sc.*, Sacculus; *Si.*, Socius; *Sl.*, Side lobe; *Tg.*, Tegumen; *Tr.*, Trulleum; *Ts.*, Transtilla; *U.*, Uncus; *Vm.*, Vinculum; *Vp.*, Ventral plate.

Valvae simple, narrow, slightly arched (e.g., *Hepialus lupulinus* Linn., *Porina vexata* Wlk.), or, with membranous, broad cucullus, sacculus produced distally into a curved process (e.g., *Perrisectis australasiae* Don.).

Tegumen lobes broad and curved. On their inner margin they are produced towards each other and bear a pair of erect processes (' Gn ', fig. 4) enclosing the anal tube on each side (e.g., *Perrisectis australasiae* Don.). Ventrally the tegumen is produced into short and pointed paired processes (e.g., *Hepialus lupulinus*, Linn.), with dentate basal arms (e.g., *Porina vexata* Wlk.). This structure has been described as the " Suspensorium " by Eyer (1924) in his account of the Hepialidae. In *Perrisectis australasiae* Don., and other allied Hepialidae, Philpott has termed a similarly situated structure as the " Trulleum " (' Tr ', fig. 4), and since no homologous structure is found in any of the other Lepidoptera, he suggests that ' it is simply a development of the connecting membrane beyond the juxta ' In my preparation of this species, this piece or the ' trulleum ' is perfectly continuous with the lateral lobes of the tegumen and is apically attached to them. Vinculum broad and ' U ' shaped.

Penis membranous.

Species examined. Hepialus lupulinus Linn. (Text-fig. 3) ; *Porina vexata* Wlk. *Perrisectis australasiae* Don.).

Concluding Remarks on the genitalia of Homoneura.

From the forms studied above, I conclude that the Homoneura are characterized by the following genitalic features.

The ninth sternite or the ' vinculum ' is characteristically broad or ' U ' shaped and saccus is absent. The valvae are usually simple except in some of the Hepialidae, e.g., *Perrisectis australasiae* Don. The tegumen is hood-shaped and there is no well defined uncus or gnathos present in this group except in some of the Micropterygidae. The penis is membranous and the juxta lightly chitinized. A well developed trulleum is present in some of the Hepialidae.

Sub-Order HETERONEURA.

Superfamily TINEINA.

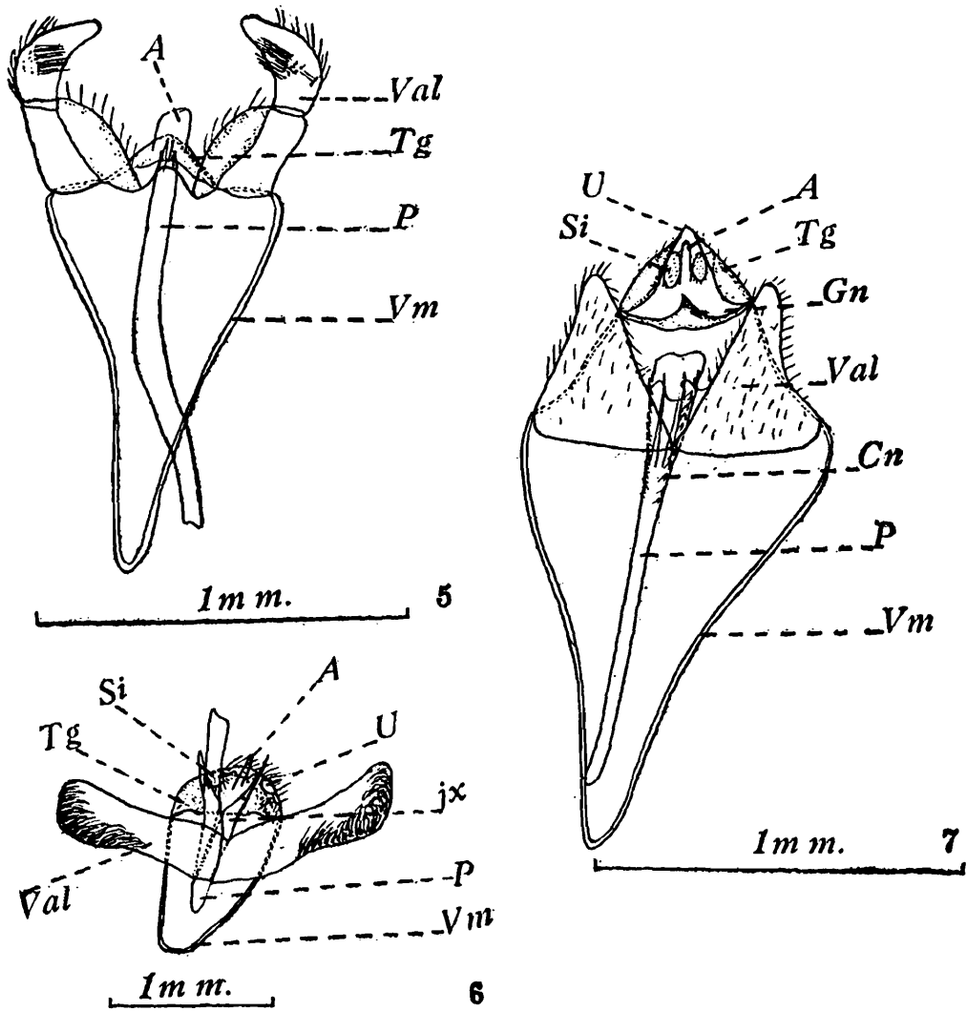
Family LAMPRONIADAE.

Valvae simple, short or digitate with two palpous lobes, sacculus broad (e.g., *Incurvaria morosa* Zell.).

Tegumen short, more or less rounded. Uncus absent or represented by setigerous lobes (e.g., *Lampronia capitella* Clerck). Socii also in the form of two small setigerous lobes. Vinculum long and ' V ' shaped.

Penis long with terminal spines (e.g., *Incurvaria morosa* Zell.). Juxta well developed in *Lampronia capitella* Clerck.

Species examined. *Incurvaria morosa* Zell. (Text-fig. 5) ; *Lampronia capitella* Clerck (Text-fig. 6).



Txet-fig. 5.—*Incurvaria merosa* Zell.
Text-fig. 6.—*Lampronia capitella* Clerck.
Txet-fig. 7.—*Nemophora schwarziella* Zell.

Family Adelidae.

Valvae simple and reduced.

Tegumen small, hood-shaped. Uncus rudimentary except in *Nemophora swammerdammella* Linn. Socii hairy. Anal tube long. Gnathos with central lip pointed (e.g., *Nemophora schwarziella* Zell.). Vinculum long and shaped like a ' V '

Penis very long with several rows of cornuti.

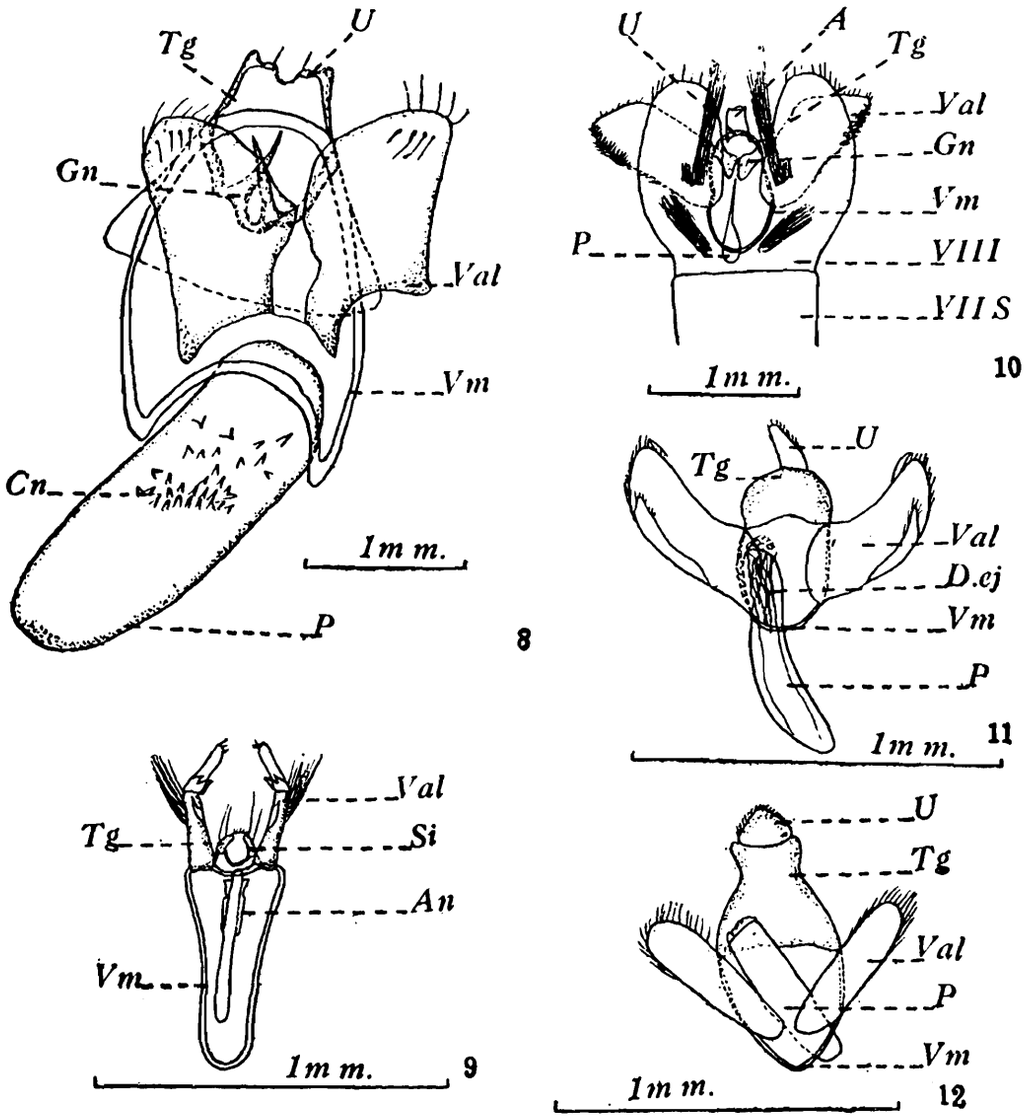
Species examined. *Nemophora swammerdammella* Linn. ; *Adela croesella* Scop. ; *Nemophora schwarziella* Zell. (Text-fig. 7) ; *Adela fibulella* Schiff. ; *Nematois degeerella* Linn.

Family Nepticulidae.

Valvae simple with process on costal margin. Tegumen broad with small rudimentary uncus. Gnathos well developed. Vinculum broad, basally concave.

Penis stout with thick-set cornuti.

Species examined. *Trifurcula immundella* Zell.; *Nepticula* basella Hs. (Text-fig. 8).



TEXT-FIG. 8.—*Nepticula basella* Hs.
TXET-FIG. 9.—*Heliozela sericiella* Haw.
TEXT-FIG. 10.—*Plutella porrectella* Linn.
TEXT-FIG. 11.—*Phaulernis dentella* Zell.
TEXT-FIG. 12.—*Augasma aeratellum* Zell.

Family HELIOZELIDAE.

Valvae simple, narrow, digitiform with process on costal margin.

Tegumen small, hood-shaped. Uncus absent. Socii present. Vinculum long and ' U ' shaped.

Penis long. Anellus lobes present.

Species examined. *Heliozela sericiella* Haw. (Text-fig. 9).

Family PLUTELLIDAE.

The eighth abdominal sternite is divided distally by median notch into two distinct lobes which enclose the genitalia (e.g., *Plutella porrectella* Linn.).

Valvae broad, highly spinose (e.g., *Eidophasia messingiella* Fisch.).

Tegumen short. Uncus reduced or absent. Gnathos present, bifid (e.g., *Plutella porrectella* Linn.; *Plutella maculipennis* Curt.). Anal tube projects above the gnathos. Vinculum 'U' shaped. Saccus present or absent.

Penis bulbous at the base and gradually tapers towards the apex. Anellus lobes often present.

Species examined. Eidophasia messingiella Fisch.; *Plutella porrectella* Linn. (Text-fig. 10); *Plutella maculipennis* Curt.

Family EPERMENIADAE.

Valvae simple, broad with process on costal margin near apex (e.g., *Phaulernis dentella* Zell.).

Uncus well developed, coniform. Gnathos absent, vinculum 'U' shaped.

Penis long, stout.

Species examined. Epermenia sp.; *Phaulernis dentella* Zell. (Text-fig. 11).

Family HELIODINIDAE.

Valvae simple.

Uncus distinct, papilliform with marginal spines (e.g., *Augasma aeratellum* Zell.), or curved (e.g., *Stathmopoda pedella* Linn.). Vinculum broadly 'V' shaped. Saccus absent.

Penis stout.

Species examined. Augasma aeratellum Zell. (Text-fig. 12); *Stathmopoda pedella* Linn.

Family GRACILARIADAE.

Valvae simple.

Tegumen elongated, broad at the apex. Uncus rudimentary. Gnathos absent. Vinculum 'V' shaped. Saccus short when present.

Penis long with linear rows of small cornuti (e.g., *Parectopa ononidis* Zell.).

Species examined. Parectopa ononidis Zell. (Text-fig. 13); *Lithocolletis schreberella* Fabr.; *Gracilaria* sp.

Family GLYPHIPTERYGIDAE.

Valvae simple, leaf-like.

Uncus elongate (e.g., *Glyphipteryx equitella* Scop.; *Simaethis pariana* Clerck), or broad with marginal denticles. Socii present (e.g., *Choreutis myllerana* Fabr.). Anal tube long. Vinculum 'U' shaped. Saccus usually present.

Penis with several rows of cornuti.

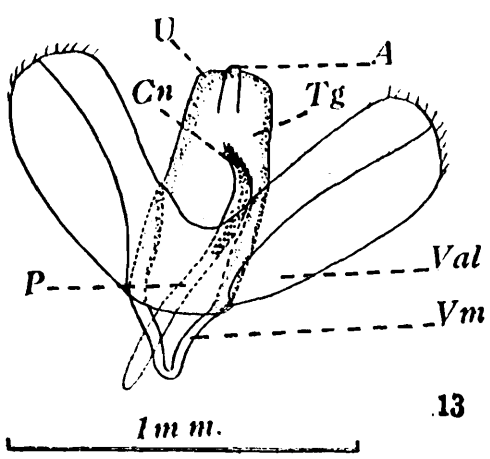
Species examined. Glyphipteryx equitella Scop. (Text-fig. 14); *Choreutis myllerana* Fabr.; *Simaethis pariana* Clerck.

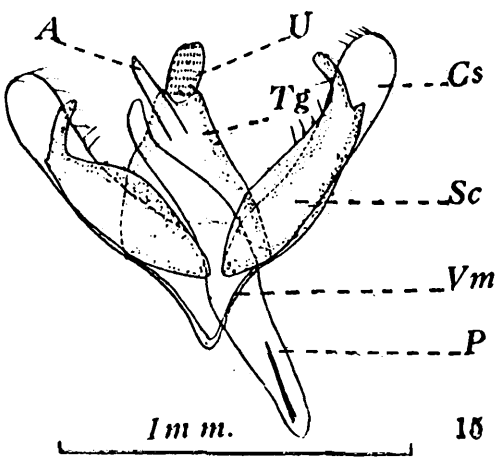
Family COLEOPHORIDAE.

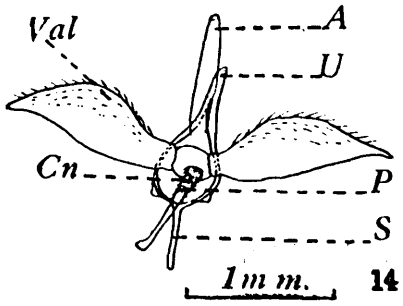
Valvae complex. Sacculus heavily chitinized and produced into a curved terminal process.

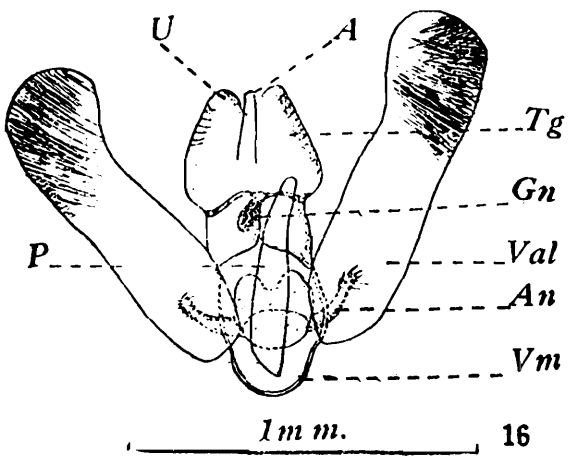
Uncus small, papilliform with several transverse rows of minute spines. Anal tube long. Vinculum ' V ' shaped.

Penis long. Cornuti present.









TEXT-FIG. 13.—*Parectopa ononidis* Zell.
TEXT-FIG. 14.—*Glyphipteryx equitella* Scop.
TEXT-FIG. 15.—*Coleophora artemisiella* Scott.
TEXT-FIG. 16.—*Elachista argentella* Clerck.

Species examined. Coleophora artemisiella Scott (Text-fig. 15); *Metriotes modestella* Dup.

Family ELACHISTIDAE.

Valvae simple, apex narrow, (e.g., *Perittia obscuripunctella* Stn.).

Tegumen medially cleft at the apex and produced into lateral lobes. Uncus rudimentary, peg-like (e.g., *Perittia obscuripunctella* Stn.). Gnathos with central lip conspicuous, scobinate and supported on lateral chitinous arms. Vinculum ' U ' shaped.

Penis long. Anellus lobes well developed.

Species examined. Elachista argentella Clerck (Text-fig. 16); *Elachista magnificella* Tengst.; *Perittia obscuripunctella* Stn.

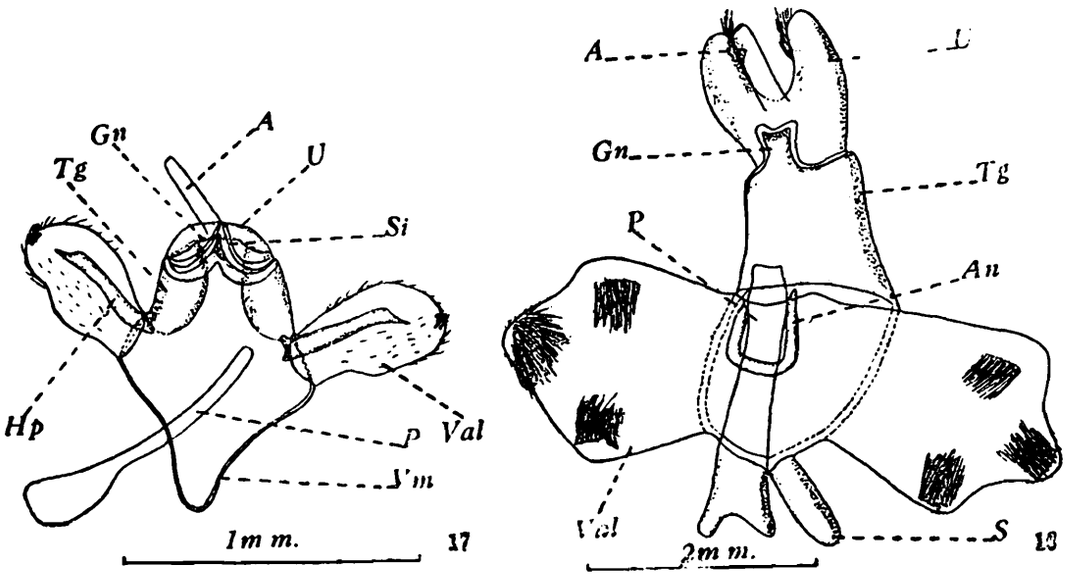
Family HYPONOMEUTIDAE.

Valvae usually simple, broad. Sacculus sometimes with elongated basal processes. (e.g., *Ethmia decemguttella* Hubn.). Sacculi sometimes united to form a vertical chitinous process (e.g., *Scythropia crataegela* Linn.).

Uncus disciform. Socii curved. Anal tube projects between the socii. Gnathos when present hinged to the base of the uncus, central lip acuminate, (e.g., *Ethmia decemguttella* Hubn.; *Atemelia torquatella* Zell.; *Scythropia crataegella* Linn.). Vinculum 'V' shaped. Saccus sometimes present.

Penis long usually bulbous at the base.

Species examined. Hyponomeuta padella Linn.; *Ethmia decemguttella* Hubn. (Text-fig. 17); *Scythropia crataegella* Linn.; *Atemelia troquatella* Zell.



TEXT-FIG. 17.—*Ethmia decemgutella* Hubn.
TEXT-FIG. 18.—*Trochilium apiforme* Clerck.

Family AEGERIADAE.

Valvae simple, broad, with clusters of spines distributed on three patches, (e.g., *Trochilium apiforme* Clerck).

Uncus well developed, long, (e.g., *Aegeria tipuliformis* Clerck.), bifid with two separate lobes, (e.g., *Trochilium apiforme* Clerck.). Gnathos disciform. Anal tube projects between the uncus and the gnathos. Vinculum 'U' or 'V' shaped. Saccus present.

Penis broad, angulate basally. Anellus lobes present.

Species examined. Trochilium apiforme Clerck (Text-fig. 18); *Aegeria tipuliformis* Clerck.

Family ORNEODIDAE.

Valvae simple, bulbous on costal margin, (e.g., *Orneodes hexadactyla* Linn.).

Tegumen broad, with uncus slightly raised. Gnathos absent. Vinculum 'U' shaped and elongated.

Penis proportionately long. Anellus lobes vertical, long.

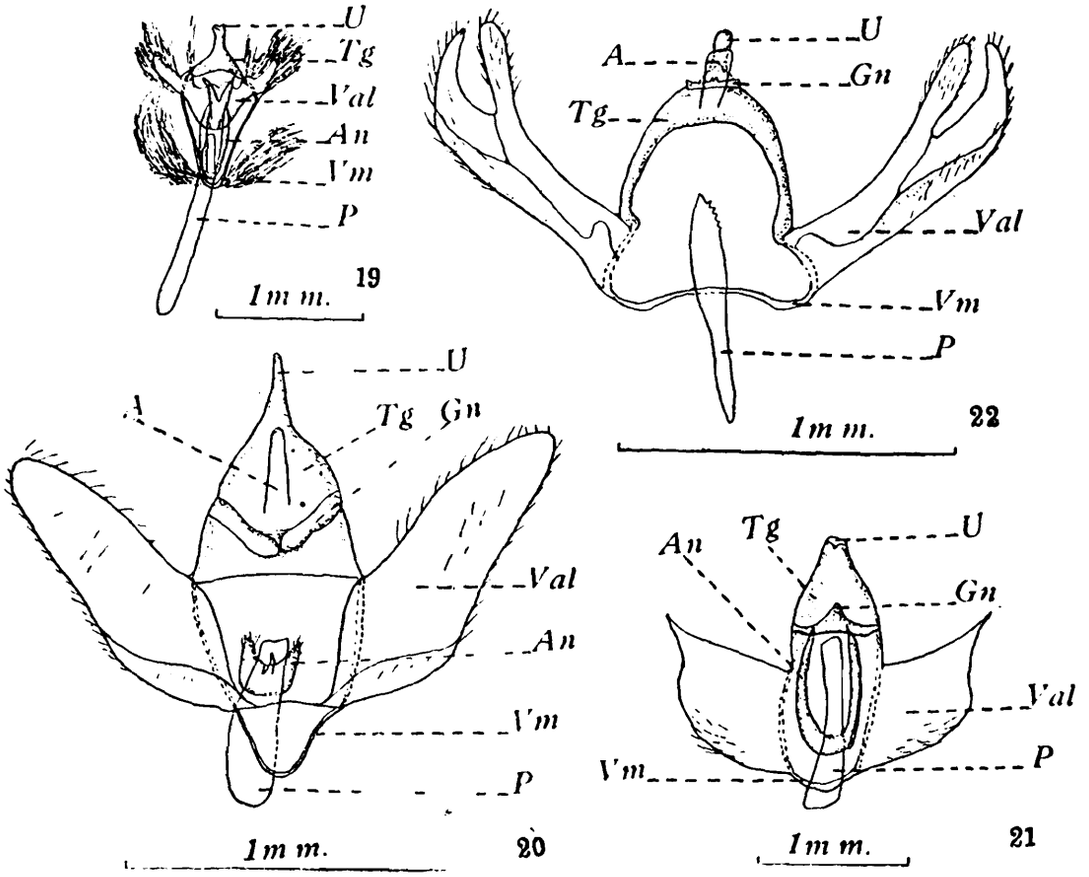
Species examined. Orneodes hexadactyla Linn. (Text-fig. 19).

Family OECOPHORIDAE.

Valvae simple, broad, leaf-like, bilobed near apex, (e.g., *Carcina quercana* Fabr.).

Uncus straight, pointed (e.g., *Hypercallia christiernana* Fabr.), usually as coniform continuation of tegumen, (e.g., *Chimabache phryganella* Hubn.; *Depressaria angelicella* Hubn.). Gnathos flap-like, curved acuminate at the tip, (e.g., *Chimabache fagella* Fabr.; *Depressaria angelicella* Hubn.), round with spinous rays, (e.g., *Exaeretia allisella* Stn.), lobiform (e.g., *Hypercallia christiernana* Linn.). Vinculum 'U' or 'V' shaped. Saccus not distinct.

Penis well developed. Cornuti band of teeth, saw-like, or single long cornutus present. Anellus lobes run on either side of penis, (e.g., *Endrosis lactella* Schiff.; *Carcina quercana* Fabr.; *Chimabache fagella* Fabr.).



TEXT-FIG. 19.—*Orneodes hexadactyla* Linn.
TEXT-FIG. 20.—*Hypercallia christiernana* Linn.
TEXT-FIG. 21.— *Chimabache fagella* Fabr.
TEXT-FIG. 22.—*Blastobasis phycidella* Zell.

Species examined. *Endrosis lactella* Schiff.; *Carcina quercana* Fabr.; *Exaeretia allisella* Stn.; *Hypercallia christiernana* Linn. (Text-fig. 20); *Chimabache phryganella* Hubn.; *Chimabache fagella* Fabr. (Text-fig. 21); *Depressaria angelicelea* Hubn.

Family BLASTOBASIDAE.

Valvae with cucullus medially cleft into two lobes, (e.g., *Blastobasis phycidella* Zell.).

Uncus bulbous at the apex. Gnathos a chitinous plate with median protuberances. Anal tube lies between the uncus and the gnathos. Vinculum usually 'U' shaped sometimes with basal concavity. Saccus absent.

Penis well developed with margin slightly dentate.

Species examined. Blastobasis phycidella Zell. (Text-fig. 22) *Auximobasis glandulella* Riley.

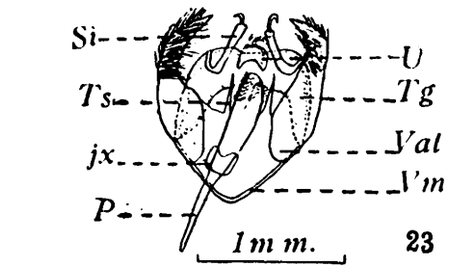
Family CARPOSINIDAE.

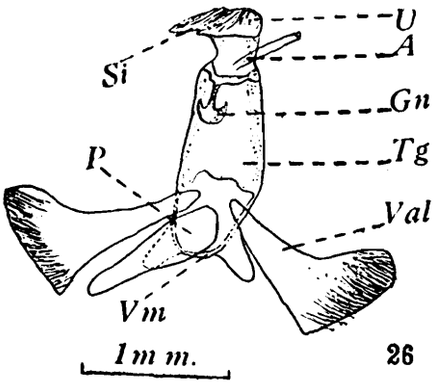
Valvae simple, transtilla erect.

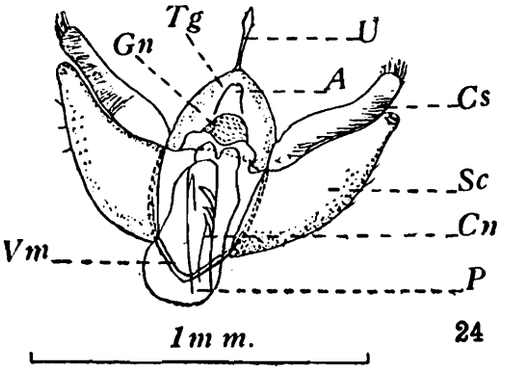
Tegumen broad. Uncus short. Socii long, curved, with hooked process at the tip. Vinculum ' V ' shaped. Saccus absent.

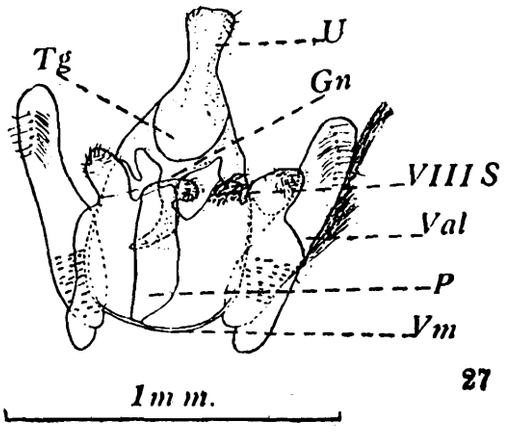
Penis distally broad. Cornuti numerous. Anellus plate broad.

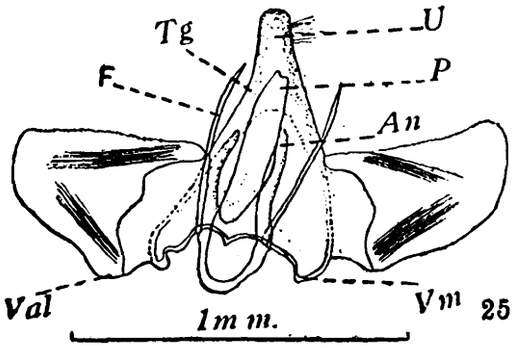
Species examined. Carposina subumbrata Wlsm. (Text-fig. 23).











TEXT-FIG. 23.—*Carposina subumbrata* Wlsm.
TEXT-FIG. 24.—*Mompha fulvescens* Haw.
TEXT-FIG. 25.—*Telphusa fugitivella* Zell.
TEXT-FIG. 26.—*Platyedra malvella* Hubn.
TEXT-FIG. 27.—*Gelechia obscurella* Hein.

Family COSMOPTERYGIDAE.

Valvae divided. Sacculus heavily chitinized, (e.g., *Mompha lacteella* Steph.).

Uncus long, (e.g., *Mompha fulvescens* Haw.), ornamented with scale-like processes, (e.g., *Cosmopteryx eximia* Haw.). Gnathos distinct, central lip broad. Vinculum ' U ' or ' V ' shaped. Saccus present or absent.

Anellus lobes prominent and lie on either side of penis. Cornuti large.

Species examined. Cosmopteryx eximia Haw.; *Mompha fulvescens* Haw. (Text-fig. 24); *Mompha lacteella* Steph.

Family GELECHIADAE.

The eighth abdominal sternite divided into distal lobes (e.g., *Gelechia obscurella* Hein.; *Anacampsis populella* Clerck).

Valvae usually simple, broad (e.g., *Telphusa fugitivella* Zell.), thin and elongated (e.g., *Dichomeris marginella* Fabr.). Furca long and erect (e.g., *Telphusa fugitivella* Zell.).

Tegumen elongated flat plate (e.g., *Platyedra malvella* Hubn.). Uncus broad and spatulate. Gnathos often present, central lip well developed. Anal tube long and dorsally covers the gnathos. Vinculum 'U' or 'V' shaped, sometimes with lateral arms (e.g., *Platyedra malvella* Hubn.).

Penis stout. Cornuti present. Anellus lobes erect (e.g., *Telphusa fugitivella* Zell.).

Species examined. Oegoconia quadripuncta Haw.; *Parachronistis albiceps* Zell.; *Dichomeris marginella* Fabr.; *Paltodora cytisella* Curt.; *Metzneria metzneriella* Stn.; *Telphusa fugitivella* Zell. (Text-fig. 25); *Platyedra malvella* Hubn. (Text-fig. 26); *Anacampsis populella* Clerck; *Stomopteryx vorticella* Scop.; *Gelechia obscurella* Hein. (Text-fig. 27).

Family COPROMORPHIDAE.

The eighth abdominal sternite divided into lateral lobes.

Valvae complex. Costa produced into an apically pointed process. Sacculus with vertical spinose arm.

Uncus long tapered and curved. Vinculum broad with lateral processes.

Penis stout. Cornuti small.

Species examined. Copromorpha sp. (Text-fig. 28).

Family LYONETIADAE.

The eighth sternite divided and the genitalia are withdrawn in it (e.g., *Leucoptera scitella* Zell.).

Valvae simple, broad, bulbous at the apex by constriction on anal margin (e.g., *Oinophila v-flava* Haw.).

Tegumen rounded. Uncus rudimentary or absent. Vinculum and saccus long (e.g., *Oinophila v-flava* Haw.).

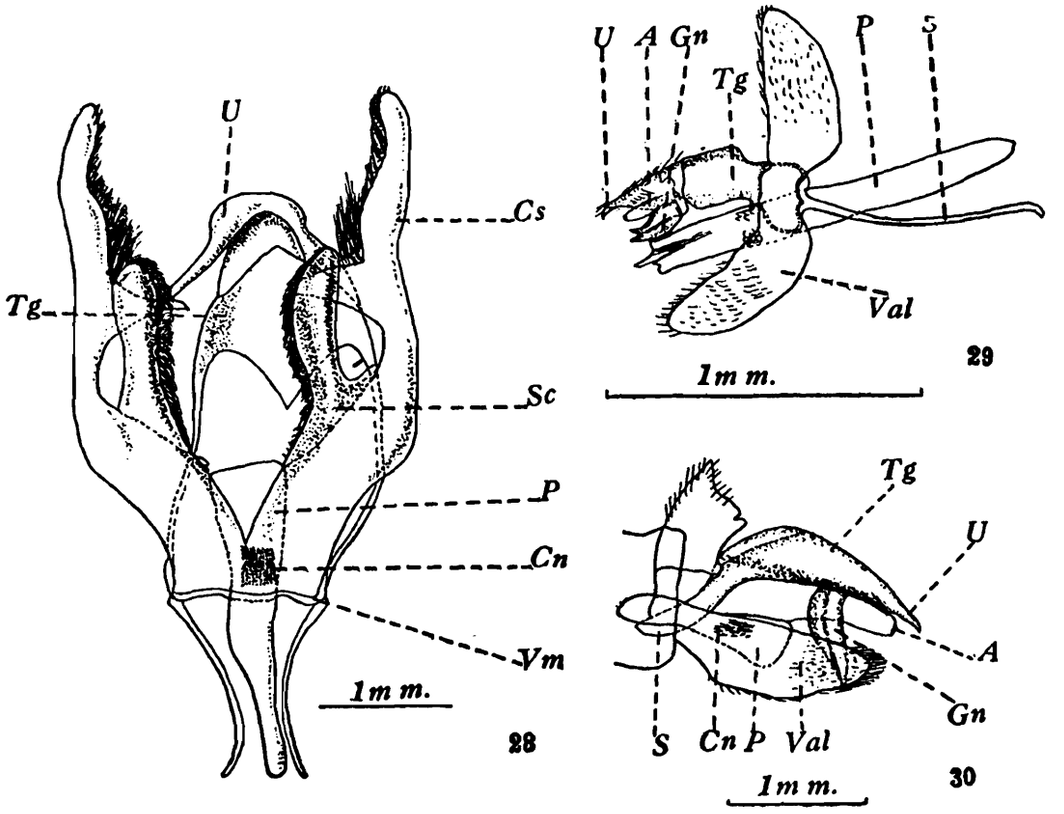
Penis long, tapered.

Species examined. Leucoptera scitella Zell.; *Oinophila v-flava* Haw.; *Bucculatrix cristatella* Zell.

Family TINEIDAE.

There are three conspicuous types of male genitalia recognised in the family.

Valvae simple, broad and elongated, e.g., *Tinea pellionella* Linn. (Text-fig. 29).



TEXT-FIG. 28.—*Copromorpha* sp.
TEXT-FIG. 29.—*Tinea pellionella* Linn.
TEXT-FIG. 30.—*Tinea albipunctella* Haw.

Uncus long, acuminate. Gnathos large. Anal tube passes between the uncus and the gnathos. Vinculum small. Saccus very long.

Penis very long with several spicule-like or small peg-like spine.

Valvae with narrow cucullus. Costal margin produced into inwardly directed process (e.g., *Solenobia inconspicuella* Stn.).

Tegumen broad. Uncus reduced or absent. Vinculum ' U ' shaped. Saccus absent.

Penis very long and recurved.

Valvae with margin indented (e.g., *Meesia richardsoni* Wlsm.).

Uncus well developed, conical. Anal tube long. Vinculum with a pair of lateral processes (Sacci ?).

Penis swollen at the base.

Species examined. Tinea pellionella Linn. (Text-fig. 29); *Tinea albipunctella* Haw. (Text-fig. 30); *Solenobia inconspicuella* Stn. (Text-fig. 31); *Meesia richardsoni* Wlsm.

Concluding Remarks on the genitalia of Tineina.

In the Aculeate series, the primitive features are essentially retained. The ninth sternite forms a broad or elongated usually ' U ' or ' V ' shaped chitinized band and saccus is not developed. The tegumen bears a pair of lateral setigerous lobes or ' socii ' while the uncus and gnathos are hardly represented. The valvae are short and simple. The penis is long and develops a lightly chitinized anellus or juxta.

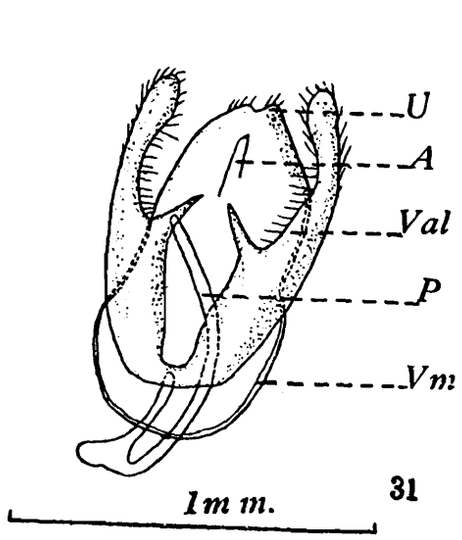
Amongst the Non-Aculeate families the ninth sternite is 'U' or 'V' shaped and develops a long saccus (*e.g.*, Tineidae, Lyonetiadae, Aegeridae and Glyphipterygidae). The valvae exhibit slight complexity in form and may be emarginate (*e.g.*, Blastobasidae) or partially divided into sacculus and cucullus. In the more advanced families a distinct harpe may also be present.

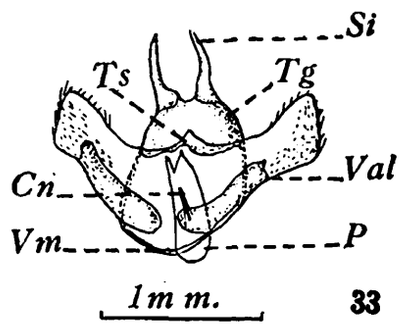
Superfamily TORTRICINA.

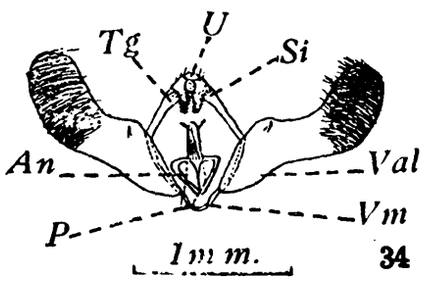
Family PHALONIADAE.

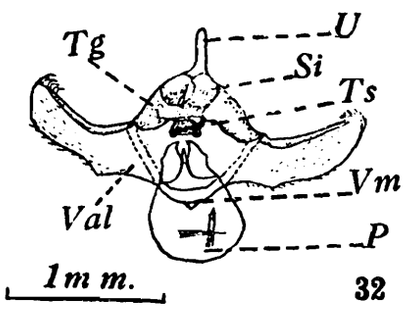
Valvae simple, short and broad. Sacculus sometimes heavily chitinized. Cucullus membranous (e.g., *Phalonia tesserana* Treits.). Transtilla well developed with central lip broad and spinose [e.g., *Phtheochroa sodaliana* Haw.; *Lozopera* (*Aethes*) *dilucidana* Steph.], bifid with raised, pointed processes (e.g., *Chlidonia baumanniana* Schiff.).

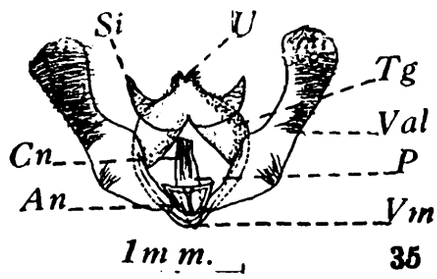
Uncus long and straight (e.g., *Phtheochroa sodaliana* Haw.), bifid (e.g., *Phalonia tesserana* Treits.), short, curved at the apex (e.g., *Phalonia ciliella* Hubn.) or reduced (e.g., *Chlidonia baumanniana* Schiff.; *Argyrolepia baumanniana* Schiff.), short, lobiform [e.g., *Lozopera* (*Aethes*) *dilucidana* Steph.], broad, flap-like (e.g., *Phtheochroa sodaliana* Haw.). Vinculum 'U'-shaped, broad.











TEXT-FIG. 31.—*Solenobia inconspicuella* Stn.
TEXT-FIG. 32.—*Phtheochroa sodaliana* Haw.
TEXT-FIG. 33.—*Euxanthis aeneana* Hubn.
TEXT-FIG. 34.—*Pardia stripunctana* Fabr.
TEXT-FIG. 35.—*Phlaeodes tetraquetrana* Haw.

Penis stout, bifurcate with dentate cornuti near the orifice, usually a single pair present [e.g., *Lozopera* (*Aethes*) *dilucidana* Steph.]. Penis base sac-like, cornuti long (e.g., *Phtheochroa sodaliana* Haw.).

Species examined. Phalonia tesserana Treits.; *Chlidonia baumanniana* Schiff.; *Phalonia ciliella* Hubn.; *Lozopera* (*Aethes*) *dilucidana* Steph.; *Phtheochroa sodaliana* Haw. (Text-fig. 32); *Euxanthis aeneana* Hubn. (Text-fig. 33).

Family EUCOSMIDAE.

The genitalia in this family are of four distinct types.

Valvae simple, costal margin curved.

Uncus short, hood-shaped. Socii present, usually drooping. Vinculum 'U' shaped. Penis short and straight with a vertical band of cornuti. Anellus broad.

Species examined. Laspeyresia janthinana Dup.; *Pardia tripunctana* Fabr. (Text-fig. 34); *Lobesia permixtana* Hubn.; *Laspeyresia nigricana* Steph.

Valvae with a convexity on the costal margin. Sacculus angulate.

Tegumen broad, uncus characteristically bifid. Socii well developed and erect. Vinculum 'U' or 'V' shaped.

Penis short with thick-set cornuti. Anellus broad.

Species examined. Eucosma ramella Linn. (*Lithographia paykulliana* Schiff.); *Phlaeodes tetraquetrana* Haw. (Text-fig. 35); *Cartella bilunana* Haw.

Valvae with cucullus sometimes narrow; sacculus produced on the anal margin and swollen into highly spinose bulbous process (e.g., *Argyroploce arcuella* Linn.).

Uncus elongated, depressed (e.g., *Argyroploce semifasciana* Haw.; *Argyroploce arcuella* Linn.), short and conical (e.g., *Argyroploce micana* Frol.; *Argyroploce urticana* Hubn.), or reduced. Socii usually broad. Gnathos present, central lip sometimes short, curved and spinose (e.g., *Argyroploce urticana* Hubn.). Vinculum 'U' or 'V' shaped, usually broad. Saccus absent.

Penis short, pistol-like with variable number of cornuti. Sometimes a single large cornutus present (e.g., *Argyroploce semifasciana* Haw.).

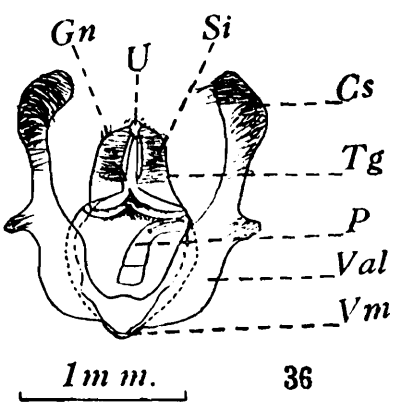
Species examined. Argyroploce striana Schiff.; *Argyroploce arcuella* Linn.; *Argyroploce micana* Frol.; *Argyroploce semifasciana* Haw.; *Bactra lanceolana* Hubn.; *Argyroploce urticana* Hubn. (Text-fig. 36).

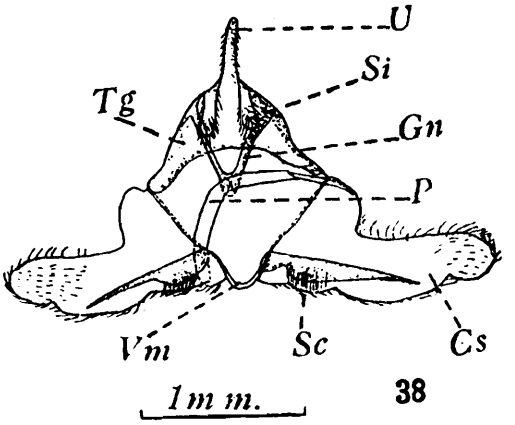
Valvae with cucullus distinct, usually disciform, pad-like with deep costal convexity, profusely hairy. Sacculus narrow or broad.

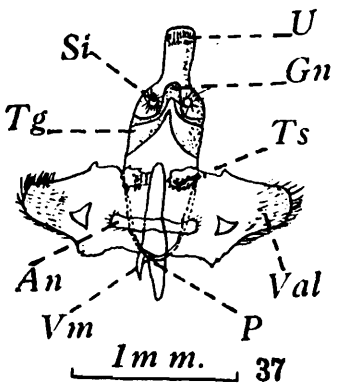
Tegumen broad with rudimentary uncus (e.g., *Evetria sylvestrana* Curt.; *Notocelia uddmanniana* Linn.; *Ancylis achatana* Fabr.; *Ancylis mitterbacheriana* Schiff.), short and conical (e.g., *Hemimene alpinana* Herr-Schaff.; *Hypermecia augustana* Hubn.), rounded (e.g., *Eucosma brunnichiana* Frol.). Socii present. Usually long and drooping, broad or sometimes absent. Gnathos absent. Vinculum 'U' or 'V' shaped, often reduced.

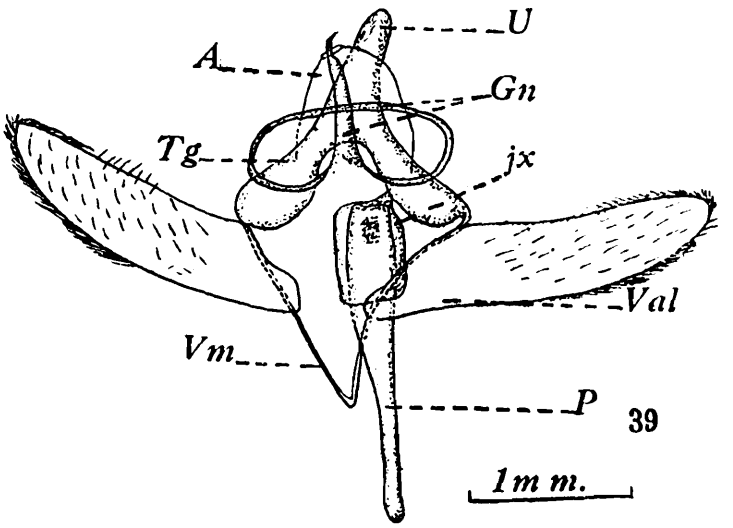
Penis short, pistol-like. Cornuti usually present, number variable, small denticles or large band of spines. Anellus lobes united medially. Juxta sometimes present.

Species examined. *Hemimene alpinana* Herr-Schaff.; *Ancylis mitterbacheriana* Schiff.; *Eucosma scopoliana* Haw.; *Hypermecia augustana* Hubn.; *Eucosma brunnichiana* Frol.; *Dichrorampha ulicana* Guen. (*Hemimene plumbana* Scop.); *Evetria sylvestrana* Curt.; *Notocelia uddmanniana* Linn.









TEXT-FIG. 36.—*Argyroploce urticana* Hubn.
TEXT-FIG. 37.—*Tortrix rusticana* Treits.
TEXT-FIG. 38.—*Tortricodes tortricella* Hubn.
TEXT-FIG. 39.—*Tyndis proteanalis* Hmpsn.

Family TORTRICIDAE.

Coremata present in connection with the eighth abdominal segment (e.g., *Cacoecia rosana* Linn.).

Valvae simple flap-like expansions sometimes feather-like with curved spines arising from the mid-rib (e.g., *Peronea holmiana* Linn.). Sacculus angulate and spinose (e.g., *Cnephasia longana* Haw.), sometimes with a basal process margin sinuate (e.g., *Tortricodes tortricella* Hubn.). Transtilla spinose and lobiform (*Tortrix rusticana* Treits.).

Uncus long and straight, usually with marginal spines, terminal bulb spinose (e.g., *Pandemis ribeana* Hubn.), broad at the tip (e.g., *Tortrix rusticana* Treits.), reduced (e.g., *Argyrotoxa forskaleana* Linn.). Socii present, broad, drooping. Gnathos well developed with central lip curved, pointed or sometimes broad. Vinculum 'U' shaped.

Penis long and straight, short or stumpy (e.g., *Argyrotoxa forskaleana* Linn.), serrate at the orifice (e.g., *Cnephasia longana* Haw.). Cornuti variable. Anellus lobes usually present.

Species examined. Pandemis corylana Fabr.; *Cacoecia rosana* Linn.; *Tortrix* sp.; *Peronea holmiana* Linn.; *Pandemis ribeana* Hubn.; *Cnephasia logiana* Schiff.; *Argyrotoxa forskaleana* Linn.; *Batodes angustiorana* Haw.; *Cnephasia longana* Haw.; *Tortrix musculana* Hubn.; *Tortrix rusticana* Treits. (Text-fig. 37); *Tortricodes tortricella* Hubn. (Text-fig. 38).

Concluding Remarks on the genitalia of Tortricina.

The copulatory organs in this group correspond very much to those in the Superfamily Tineina. The ninth sternite is broadly 'U' or 'V' shaped and saccus is distinctly absent. The valvae usually remain simple and are connected by a transverse chitinous band—the 'transtilla', which assumes a characteristic form in this group. The penis is short and stumpy or shaped like a pistol. The anellus is broad and distinct.

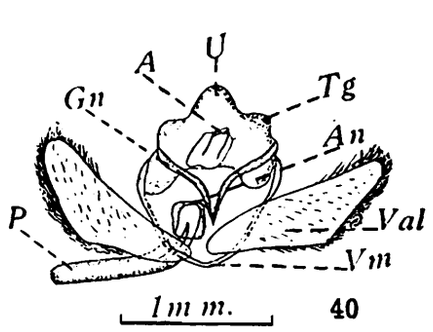
Superfamily PYRALIDINA.

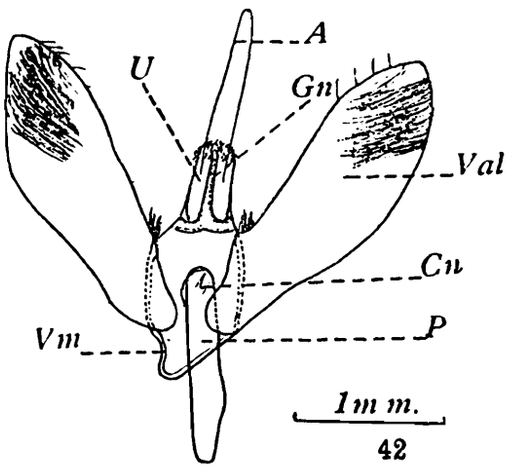
Family PYRALIDAE.

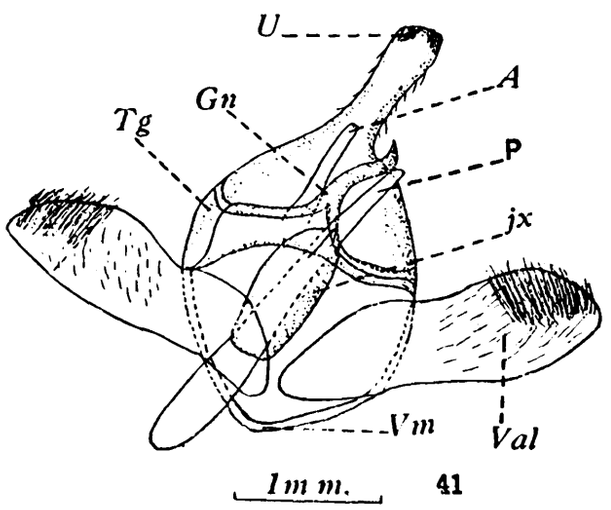
Sub-family PYRALINAE.

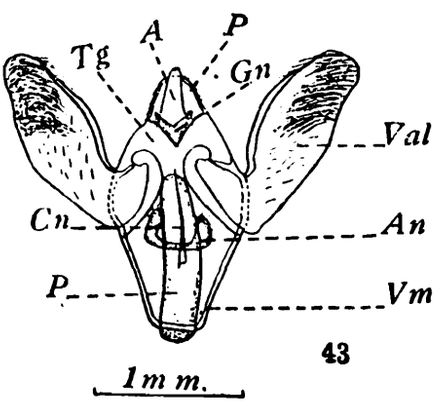
Valvae simple.

Uncus short and broad (e.g., *Tamraca torridalis* Led.; *Pyralis farinalis* Linn.; *Stemmatophora erebalis* Hmpsn.), long and straight (e.g., *Tyndis proteanalis* Hmpsn.). Gnathos with central lip curved or









TEXT-FIG. 40.—*Pyralis farinalis* Linn.
TEXT-FIG. 41.—*Orthaga basalis* Wlk.
TEXT-FIG. 42.—*Cotachena histricalis* Wlk.
TEXT-FIG. 43.—*Ephestia elutella* Hubn.

pointed, or sometimes turned up dorsally (e.g., *Tyndis proteanalis* Hmpsn.). Vinculum 'U' or 'V' shaped. Saccus rudimentary or absent.

Penis long. Cornuti spicule-like or as a band of teeth. A single large cornutus also present.

Species examined. Tyndis proteanalis Hmpsn. (Text-fig. 39); *Paractenia allutalis* Zell.; *Tamraca torridalis* Led.; *Stemmatophora erebalis* Hmpsn.; *Aglossa pinguinalis* Linn.; *Udea (Pionea) ferrugalis* Hubn.; *Pyralis farinalis* Linn. (Text-fig. 40).

Sub-family EPIPASCHIINAE.

Valvae simple, usually broad.

Uncus broad at the tip. Gnathos with the central lip long, curved and hooked at the tip. Vinculum broadly 'V' shaped.

Penis proportionately long. Cornuti present. Juxta well developed.

Species examined. Orthaga basalis Wlk. (Text-fig. 41).

Sub-family ENDOTRICHINAE.

Valvae simple and long.

Uncus well developed with a spinose, bulbous tip. Gnathos membranous. Anal tube passes between the uncus and the gnathos. Vinculum 'V' shaped.

Penis with two prominent cornuti at the tip.

Species examined. Cotachena histricalis Wlk. (Text-fig. 42).

Sub-family PHYCITINAE.

Valvae simple, a small process sometimes arises from the base of the sacculus (e.g., *Nephopteryx roborella* Zinck.; *Myelois advenella* Zinck.; *Pempelia palumbella* Fabr.). Another pair of chitinous processes arise from the base of the tegumen (e.g., *Eurhodope advenella* Zinck.; *Nephopteryx roborella* Zinck.).

Uncus broad. Gnathos with prominent central lip. Vinculum long and broadly 'V' shaped.

Penis stout with several thick-set or spicule-like cornuti. Anellus lobes usually present.

Species examined. Homeosoma sinuella Fabr.; *Eurhodope advenella* Zinck.; *Acrobasis tumidella* Zinck.; *Hypochalcia ahenella* Hubn.; *Myelois advenella* Zinck.; *Ephestia elutella* Hubn. (Text-fig. 43); *Pempelia palumbella* Fabr. (Text-fig. 44); *Nephopteryx roborella* Zinck.

Sub-family ANERASTIINAE.

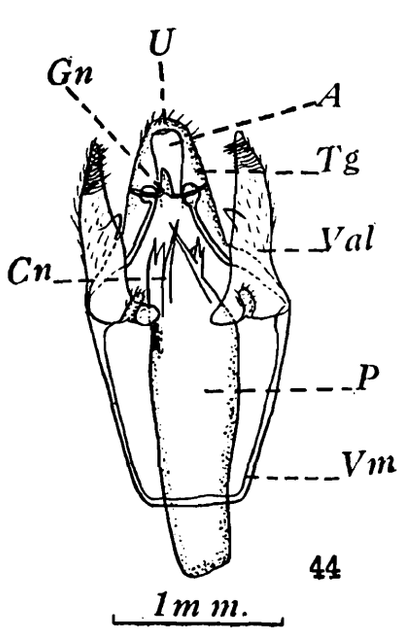
The eighth abdominal sternite in some forms is divided distally into a pair of lobes (e.g., *Alamosa piperatella* Hmpsn.; *Biafra concinella* Rag.).

Valvae simple and (along with the rest of genital armature) enclosed within the eighth segment.

Tegumen broad. Uncus characterized by pair of lateral horns, except in *Hypsotropha rhodochroella* Hmpsn.; where two pairs are present.

Gnathos usually disciform and well developed. It may be serrated. Sometimes central disc of gnathos produced into lateral arms (e.g., *Commotria rosella* Hmpsn.) or bears median knob-like process (e.g., *Biafra concinella* Rag.). Vinculum 'U' or 'V' shaped.

Penis stout with strong cornuti. Anellus distinct.



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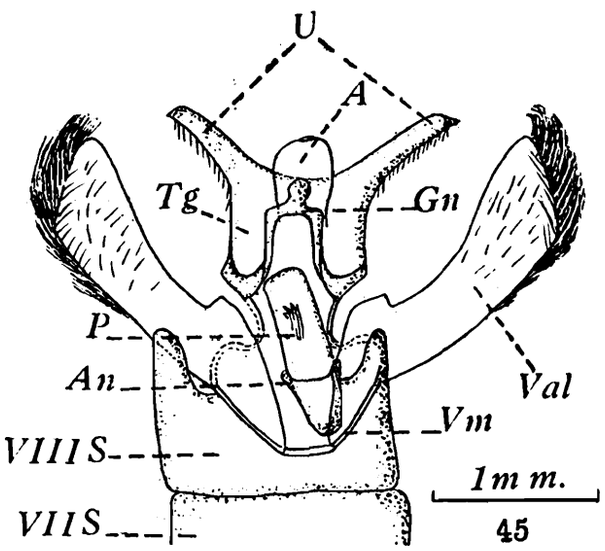

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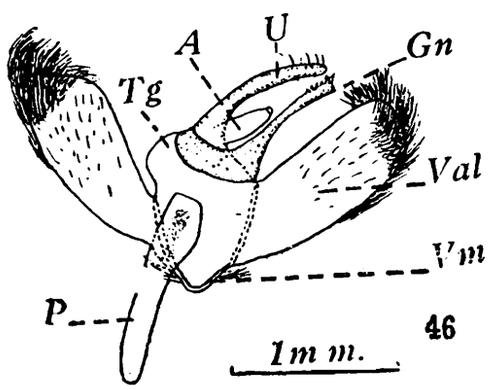

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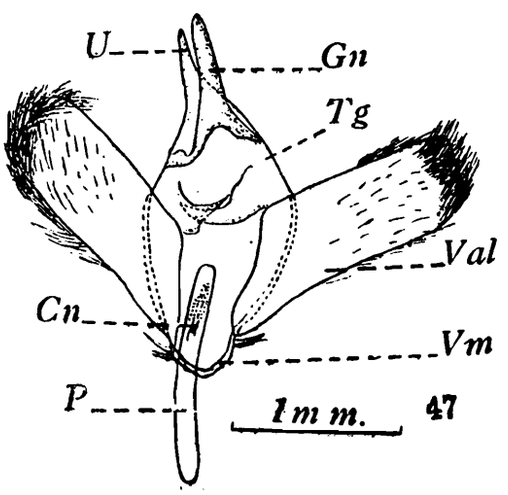

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TEXT-FIG. 44.—*Pempelia palumbella* Fabr.
TEXT-FIG. 45.—*Biafra concinella* Rag.
TEXT-FIG. 46.—*Patissa virginea* Zell.
TEXT-FIG. 47.—*Schoenobius incertellus* Wlk.

Species examined. *Alamosa piperatella* Hmpsn.; *Biafra concinella* Rag. (Text-fig. 45); *Ematheudes straminella* Snell.; *Commotria rosella* Hmpsn.; *Saluria macrella* Rag.; *Hypsotropha rhodochroella* Hmpsn.; *Dembea venulosella* Rag.

Sub-family SCOPARINAE.

Valvae simple, usually short and broad.

Uncus simple and straight. Gnathos well developed. Anal-tube lies between the uncus and the gnathos.

Penis short and broad with cornuti at the tip.

Species examined. *Microglossa scoparialis* Warr.; *Alucita pentadactyla* Linn.; *Scoparia crataegella* Linn.

Sub-family SCHOENOBIINAE.

Valvae simple, short and broad or linear and leaf-like. A pair of hooked processes arise from the costal margin of the valvae (e.g., *Schoenobius incertellus* Wlk.).

Uncus long. Gnathos well developed and sometimes serrated at the tip (e.g., *Patissa virginea* Zell.). Anal tube passes between the uncus and the gnathos. Vinculum ' U ' or ' V ' shaped.

Penis long with several cornuti, spicule-like (e.g., *Patissa virginea* Zell.), a band of teeth (e.g., *Brihaspa chrysostomus* Zell.), or a few stout spines may also be present.

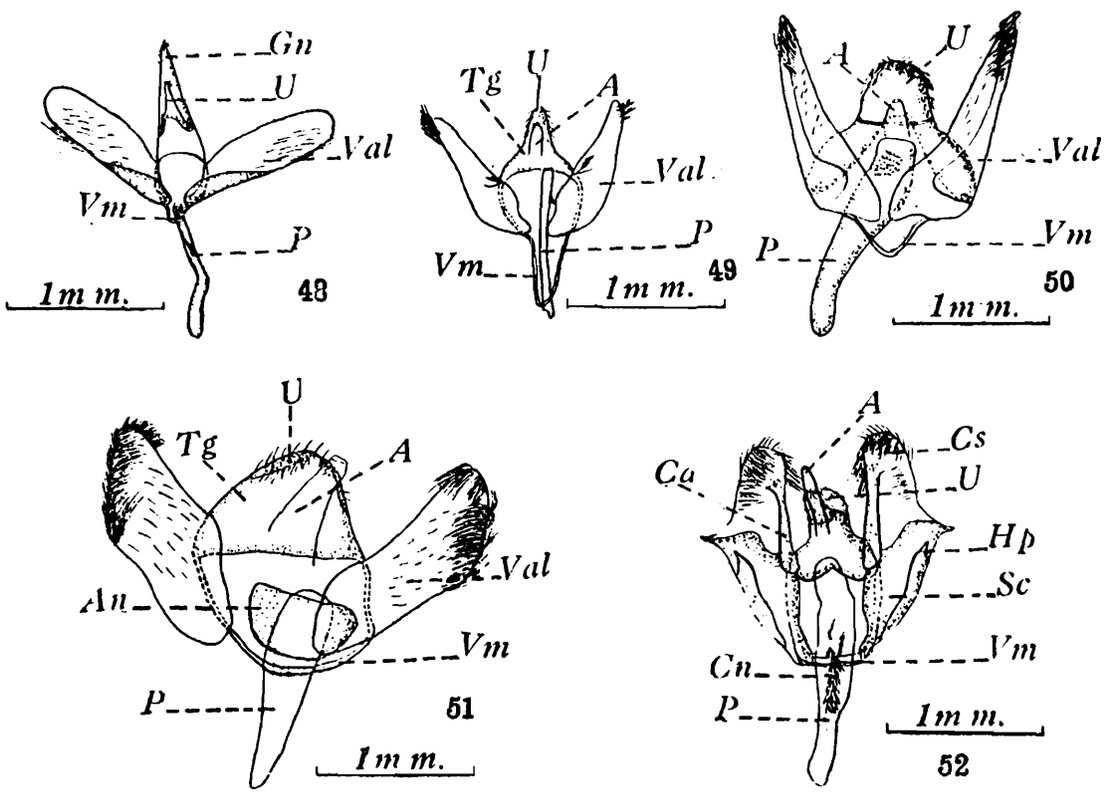
Species examined. Brihaspa chrysostomus Zell.; *Patissa virginea* Zell. (Text-fig. 46); *Schoenobius incertellus* Wlk. (Text-fig. 47); *Schoenobius translinealis* Hmpsn.).

Sub-family HYDROCAMPINAE.

Valvae simple, broad.

Uncus conical. Gnathos present or absent. Anal tube passes between the uncus and the gnathos. Vinculum short or elongated and ' V ' shaped.

Penis long. Cornuti present.



TEXT-FIG. 48.—*Cataclysta perirrorata* Hmpsn.
TEXT-FIG. 49.—*Diathrausta fulviceps* Hmpsn.
TEXT-FIG. 50.—*Aphomia colonella* Linn.
TEXT-FIG. 51.—*Galleria ceriana* Linn.
TEXT-FIG. 52.—*Eurrhyparodes bracteolalis* Zell.

Species examined. Argyractis sp.; *Cataclysta perirrorata* Hmpsn. (Text-fig. 48); *Tatobotys biannulalis* Wlk.; *Bradina admixtalis* Wlk.; *Diathrausta fulviceps* Hmpsn. (Text-fig. 49); *Coptobasis mesopsectralis* Hmpsn.

Sub-family GALLERINAE.

Valvae simple, long or broad.

Tegumen broad with uncus short and hood-shaped (e.g., *Galleria ceriana* Linn.). A transverse fringe of hair characteristically present (e.g., *Aphomia sociella* Linn.; *Aphomia colonella* Linn.). Gnathos absent. Anal tube usually short. Vinculum ' U ' or ' V ' shaped.

Penis long and stout with several dentate cornuti.

Species examined. Aphomia sociella Linn.; *Aphomia colonella* Linn. (Text-fig. 50); *Myelobia smerintha* Hubn.; *Galleria ceriana* Linn. (Text-fig. 51).

Sub-family PYRAUSTINAE.

Valvae belong to two main types :—

(i) Simple, usually elongated, sometimes short, broad, leaf-like, and with distinct harpe (e.g., *Bocchoris acamasalis* Wlk.; *Samea samealis* Dyar.; *Cnaphalocrocis medianalis* Guen.; *Marasmia venilialis* Wlk.; and others).

(ii) Valvae with membranous cucullus distinct from the thick-set highly chitinized sacculus. Harpe distinct. A longitudinal ridge of chitin supports the costal margin of the valvae.

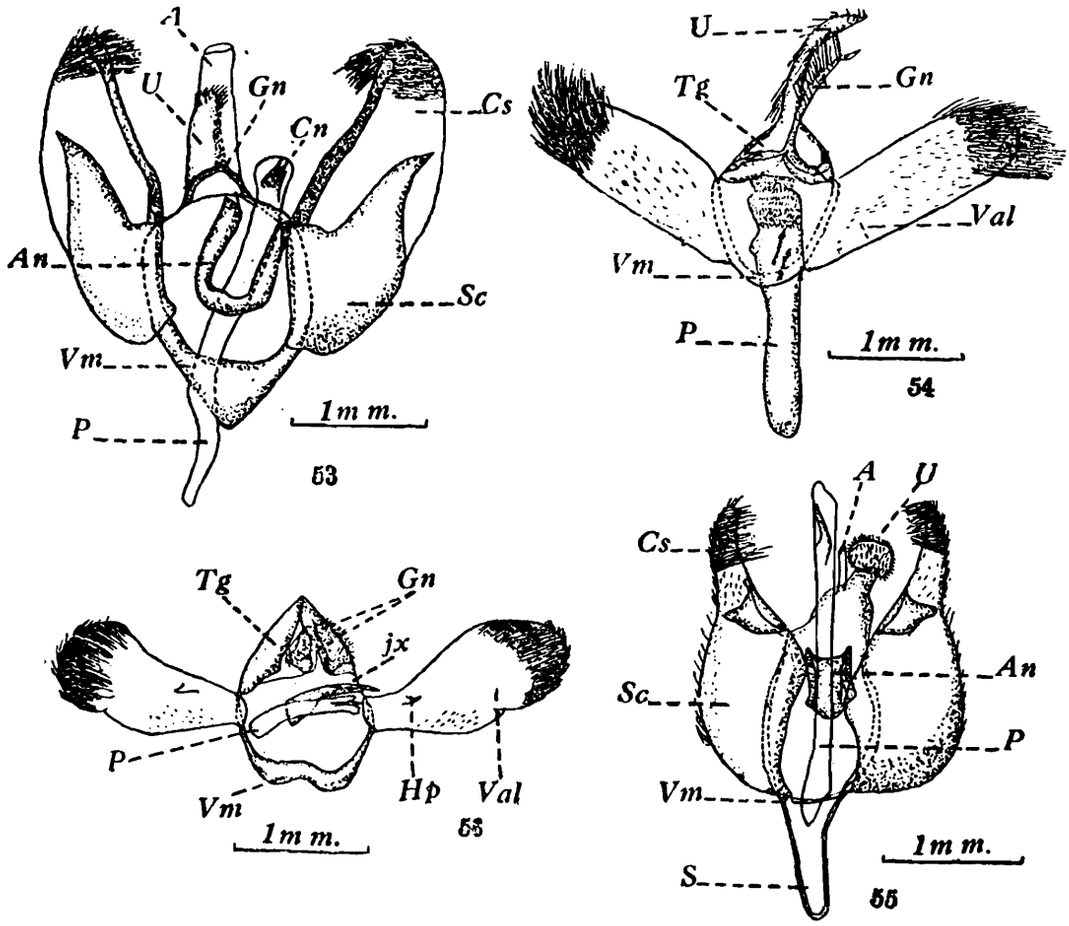
Uncus tall or curved, usually bulbous at the apex (e.g., *Tabidia insanalis* Snell.; *Hymenia Zinckenia perspectalis* Hubn.; *Spilomela perspicata* Fabr.; *Caprinia conchylalis* Guen.; *Pagyda traducalis* Zell.; *Sylepta angustalis* Snell.; and others). Sometimes it is broad (e.g., *Ulopeza latiferalis* Wlk.), diamond-tipped or tongue-shaped, or may be a simple blade without the terminal bulb (e.g., *Crocidolomia binotalis* Zell.; *Uresphita polygonalis* Schiff.). Uncus is bilobed in *Eurrhyparodes bracteolalis* Zell.; and very much reduced in *Noctuelia floralis* Hubn. *Sub-uncus* (Pierce) is sometimes present below the uncus (e.g., *Margaronia euryzonalis* Hmpsn.).

Anal tube projects ventral to the uncus and may be enclosed in a dorsal and ventral piece of chiten. Gnathos present or absent, when present it is free or plastered ventrally to the anal tube. Vinculum ' U ' or ' V ' shaped—the latter may sometimes be very long. Saccus present only in a few cases.

Penis usually long with a variable number of thick-set cornuti. Anellus-lobes present as vertical chitinous bars on either side of penis.

Species examined. Eurrhyparodes bracteolalis Zell. (Text-fig. 52); *Tabidia insanalis* Snell.; *Hymenia* (*Zinckenia*) *perspectalis* Hubn.; *Bocchoris acamasalis* Wlk.; *Samea samealis* Dyar.; *Rhimphalea trogusalia* Wlk.; *Syngamia floridalis* Zell.; *Paraponyx bryophilalis* Hmpsn. (Text-fig. 53); *Ercta ornatalis* Dup.; *Cnaphalocrocis medinalis* Guen.; *Marasmia venilialis* Wlk.; *Filodes costivitralis* Guen.; *Spilomela perspicata* Fabr.; *Caprinia conchylalis* Guen.; *Pagyda traducalis* Zell.; *Dichocrocis punctiferalis* Guen.; *Phostria obscurata* Moore; *Ulopeza latiferalis* Wlk.; *Tyspanodes linealis* Moore.; *Botyodes caldusalis* Wlk.; *Lamprosema niphealis* Wlk.; *Agathodes designalis* Guen.; *Margaronia euryzonalis* Hmpsn.; *Sylepta angustalis* Snell.; *Terastia meticulosalis* Guen.; *Hyalobathra gripusalis* Wlk.; *Evergestis straminalis* Hubn.

(Text-fig. 54); *Orenia alpestralis* Fabr.; *Ischnurges gratiosalis* Wlk. *Crocidolomia binotalis* Zell.; *Epipagis trisemalis* Dogn.; *Thliptoceras*



TEXT-FIG. 53.—*Paraponyx bryophilalis* Hmpsn.
TEXT-FIG. 54.—*Evergestis straminalis* Hubn.
TEXT-FIG. 55.—*Sceliodes laisales* Wlk.
TEXT-FIG. 56.—*Noctuelia floralis* Hubn.

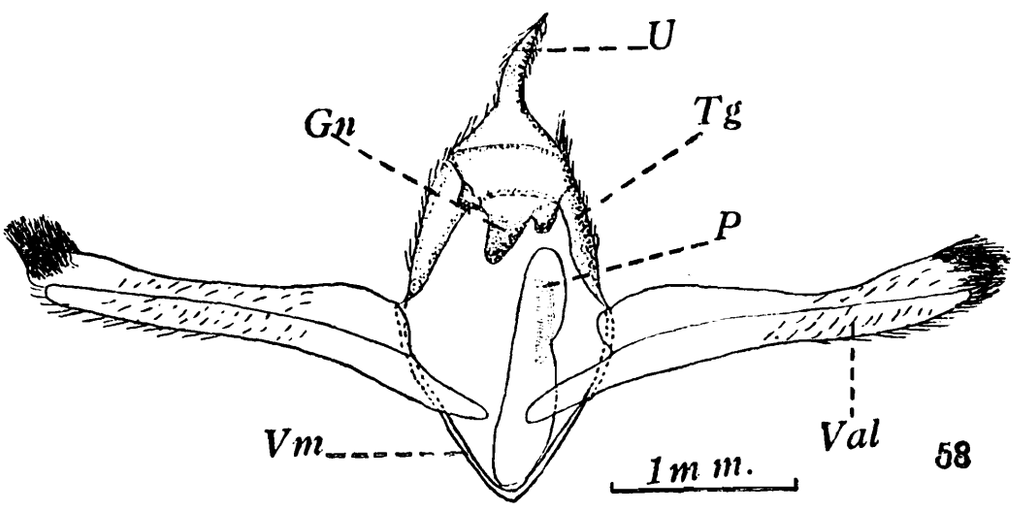
xanthomeralis Hmpsn.; *Archernis capitalis* Fabr.; *Phylactaenia tyres* Cram.; *Polygrammodes ponderalis* Guen.; *Antigastra catalaunalis* Dup.; *Diasemia accalis* Wlk.; *Uresphita polygonalis* Schiff.; *Condylorrhiza vestigialis* Guen.; *Anarmodia majoralis* Guen.; *Psara pallidalis* Hmpsn.; *Loxostege mancalis* Led.; *Prooedema inscisalis* Wlk.; *Cybolomia ossealis* Hmpsn.; *Titanio pollinalis* Schiff.; *Metasia arida* Hmpsn.; *Tegostoma comparalis* Hubn.; *Sceliodes laisalis* Wlk. (Text-fig. 55); *Noctuelia floralis* Hubn. (Text-fig. 56); *Pyrausta ostrinalis* Hubn.; *Rhodaria sanguinalis* Linn.; *Psamotis lancealis* Schiff.; *Psamotis hyalinalis* Hubn.; *Zebronia phenice* Cram.

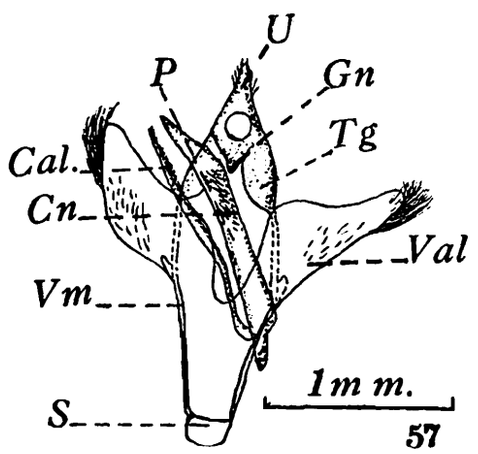
Sub-family CRAMBINAE.

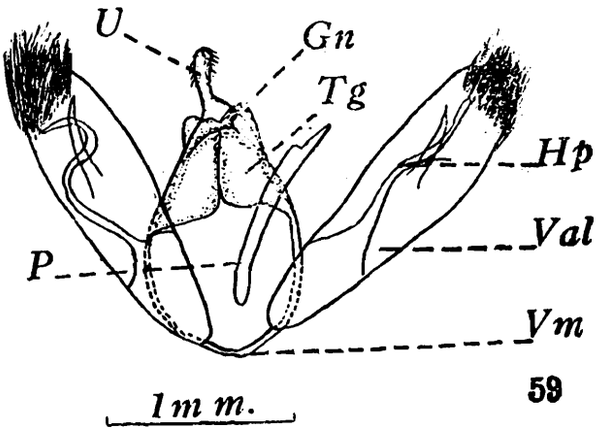
Valvae simple, blade-like (e.g., *Diatraea argentisparsalis* Hmpsn.; *Argyria parallelus* Zell.), or divided (e.g., *Conotalis nigroradius* Mab.; *Ommatopteryx californicalis* Pack.). Sometimes short and broad.

Uncus simple and straight. Gnathos well developed. Anal tube lies between the uncus and the gnathos. Vinculum 'U' or 'V' shaped. Saccus rudimentary or absent.

Penis long with several linear rows of cornuti. These may be spicule-like and well developed.







TEXT-FIG. 57.—*Diatraea argentisparsalis* Hmpsn.
TEXT-FIG. 58.—*Chilo lativittalis* Wlk.
TEXT-FIG. 59.—*Pterophorus pterodactyla* Hubn.

Species examined. *Ommatopteryx californicalis* Pack.; *Diatraea argentisparsalis* Hmpsn. (Text-fig. 57); *Prosmixis quercella* Schiff.; *Conotalis nigroradius* Mab.; *Platytes cersella* Schiff.; *Argyria parallelus* Zell.; *Chilo lativittalis* Wlk. (Text-fig. 58).

Family PTEROPHORIDAE.

Valvae simple, with prominent harpe.

Uncus straight. Gnathos reduced. Vinculum 'U' shaped. Saccus absent.

Penis long.

Species examined. *Pterophorus pterodactyla* Hubn. (Text-fig. 59).

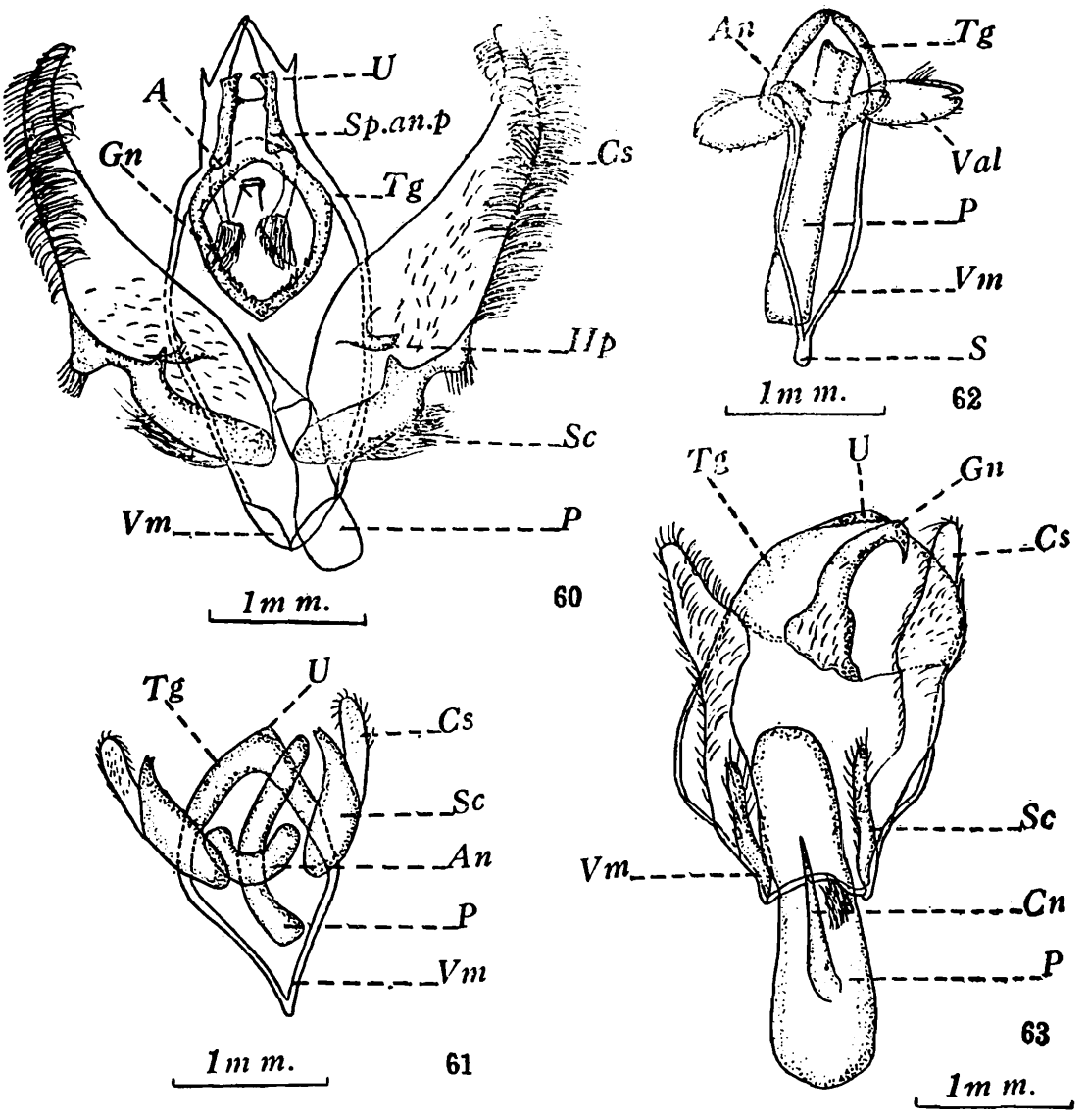
Family THYRIDIDAE.

Valvae simple, long, with or without basal process of the sacculus (Harpe).

Tegumen with large lateral expansions (e.g., *Rhodoneura taeniata* War.). Uncus simple acuminate (e.g., *Rhodoneura taeniata* War.; *Sercophora hypoxantha* Hmpsn.), broad and produced into paired lateral and terminal processes (e.g., *Thyris fenestrella* Scop.; *Brixia myrtea*

Drury.). A supra-anal process (' Scaphium of Gosse ' ?) arises from the base of the uncus (e.g., *Thyris fenestrella* Scop.). It is paired in *Brixia myrtea* Drury. Gnathos large. Vinculum ' U ' or ' V ' shaped.

Penis short or long. Cornuti variable. Anellus often well developed.



TEXT-FIG. 60.—*Brixia myrtea* Drury.
TEXT-FIG. 61.—*Pumea comitella* Ld.
TEXT-FIG. 62.—*Amicta tedaldi* Heyl.
TEXT-FIG. 63.—*Megalopyge ornata* Druce.

Species examined. Thyris fenestrella Scop., *Rhodoneura taeniata* War.; *Sericophora hypoxantha* Hmpsn.; *Brixia myrtea* Drury. (Text-fig. 60).

Concluding Remarks on the genitalia of Pyralidina.

In the genital armature, this superfamily resembles the Tineina and is probably derived from it. The organs exibit a common structure though some of the members of this group are very much specialized (*e.g.*, Thyrididae).

The ninth sternite or the vinculum is ' U ' or ' V ' shaped and saccus is rudimentary or absent. The valvae, except in some of the Pyraustinae and the Crambinae, are simple. The uncus is usually straight or curved.

The gnathos has well developed arms or ' brachia ' and often elongated central lip is present. The anal tube passes between the uncus and the gnathos. A supra-anal structure may also be present below the uncus.

The penis is long, armed with several cornuti and supported on a large anellus or juxta.

Superfamily Psychina.

Family Psychidae.

The seventh abdominal sternite bears a pair of anteriorly directed processes (e.g., *Oreopsyche leschenaulti* Stdgr.).

Valvae usually simple, elongate or broad. Sacculi fused (e.g., *Oreopsyche leschenaulti* Stdgr.), or produced into feer arms which bear small apical spines (e.g., *Fumea comitella* Ld.). The inner mesial surface of the valvae sometimes with an elongated process. Anal margin may be produced into a fold.

Tegumen broad, usually hood-shaped. Uncus also hood-shaped, rudimentary or absent. Vinculum broad and drawn into a long ' V ' Saccus distinct and long (e.g., *Oreopsyche leschenaulti* Stdgr.).

Penis usually long, arcuate (e.g., *Oiketicus kirbyi* Guild. ; *Fumea comitella* Ld.). Anellus lobes prominent, long and broad (e.g., *Amicta tedaldi* Heyl. ; *Oiketicus kirbyi* Guild. ; *Fumea comitella* Ld.).

Species examined. *Fumea comitella* Ld. (Text-fig. 61) ; *Oreopsyche leschenaulti* Stdgr. ; *Amicta tedaldi* Heyl. ; (Text-fig. 62) ; *Oiketicus kirbyi* Guild.

Family Zygaenidae.

Valvae long. Anal margin thickened and produced into an elongate pointed arm.

Tegumen broad. Uncus long, tapered, very much pointed at the tip. Vinculum broad.

Penis stout.

Species examined. *Procris statices* Linn.

Family Lacosomidae (Perophoridae).

The genitalia are very peculiar.

Valvae simple and broad. Transtilla in the form of chitinous plates covered with long thin spines.

Uncus short and coniform. Gnathos with large central lip. Vinculum broad and basally concave.

Penis narrow at the base. Cristæ present. Anellus distinct.

Species examined. *Pamea excavata* Wlk.

Family Megalopygidae (Lagoidae).

Valvae simple, broad (e.g., *Brachysoma codeti* Aust.), elongate, narrow (e.g., *Megalopyge ornata* Druce. ; *Megalopyge tharops* Stoll. *Megalopyge pedacia* Druce). A pair of elongate, lobiform processes

arise from the sacculus and the penis passes between them (e.g., *Megalopyge tharops* Stoll.).

Tegumen broad. Uncus reduced, hood-shaped or absent. Gnathos present with central lip sharply curved. Vinculum 'U' or 'V' shaped.

Penis straight with a prominent, vertical single cornutus. Cluster of cornuti also present (e.g., *Megalopyge ornata* Druce).

Species examined. Megalopyge ornata Druce.; (Text-fig. 63); *Megalopyge tharops* Stoll.; *Megalopyge pedacia* Druce.; *Brachysoma* (*Somabrachys* Kirby) *codeti* Aust.

Family LIMACODIDAE.

The eighth abdominal somite encloses the genitalia and is posteriorly extended into terminal lobes (e.g., *Thosea syrtis* Schaus).

Valvae simple, elongate or broad. Sacculus broad sometimes with erect basal processes (e.g., *Setora nitens* Wlk.; *Gavara velutina* Wlk.). Valvae complex (e.g., *Casphalia extranea* Wlk.) with membranous costal region and heavily chitinized anal part. A basal process from the sacculus runs along the inner mesal surface of the valvae. Sacculus with margin sometimes dentate.

Uncus simple, short (e.g., *Macroplectra fuscifusa* Hmpsn.; *Altha nivea* Wlk.), spinose (e.g., *Thosea syrtis* Schaus), or, long, apex pointed (e.g., *Setora nitens* Wlk.; *Contheyla chara* Swinh.), straight (e.g., *Ceratonema retracta* Wlk.; *Phocoderma ocellata* Moore.). Gnathos present with central lip elongated (e.g., *Macroplectra fuscifusa* Hmpsn.; *Setora nitens* Wlk.; *Contheyla chara* Swinh.), curved at the base (e.g., *Ceratonema retractata* Wlk.; *Gavara velutina* Wlk.; *Natada quadrata* Wlk.; *Asbolia sericea* Moschler.; *Taeda aetitis* Wallengren.), heavily chitinized (e.g., *Casphalia extranea* Wlk.). Vinculum usually broad or 'U' shaped. Saccus absent.

Penis usually long, stout, sometimes curved (e.g., *Macroplectra fuscifusa* Hmpsn.; *Taeda aetitis* Wallengren; *Asbolia sericea* Moschler). Cornuti variable thick-set, saw-like (e.g., *Ceratonema retracta* Wlk.), band of teeth (e.g., *Natada quadrata* Wlk.), linear rows of spines (e.g., *Libine prorsa* Schaus).

Anellus usually present, anellus lobes more than one pair, spinose (e.g., *Asbolia sericea* Moschler), flap-like (e.g., *Casphalia extranea* Wlk.), margin of juxta dentate (e.g., *Phocoderma ocellata* Moore.). Calcar elongate.

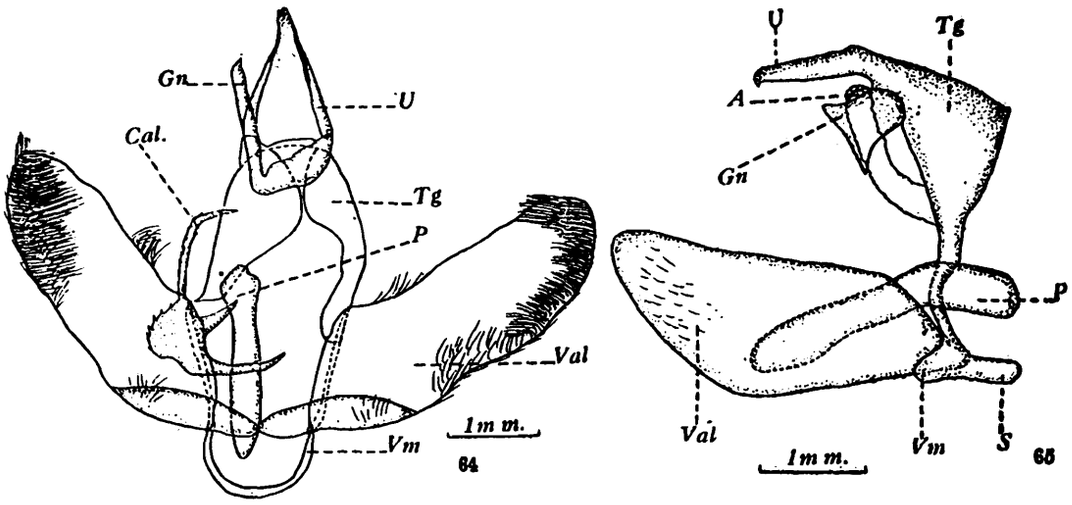
Species examined. Macroplectra fuscifusa Hmpsn.; *Thosea syrtis* Schaus.; *Setora nitens.* Wlk.; *Contheyla chara* Swinh.; *Altha nivea* Wlk.; *Ceratonema retractata* Wlk.; *Gavara velutina* Wlk.; *Natada quadrata* Wlk.; *Taeda aetitis* Wallengren; *Casphalia extranea* Wlk.; *Parasa lepida* Cram.; *Libine prorsa* Schaus.; *Phocoderma ocellata* Moore. (Text-fig. 64); *Somara albicosta* Hmpsn.; *Asbolia sericea* Moschler.

Family COSSIDAE.

Valvae simple, usually broad.

Tegumen triangular, very much like some of the Papilionina. Uncus long and well developed. Gnathos rarely present. Vinculum 'U' or 'V' shaped. Saccus when present short (e.g., *Givira lasia* Druce).

Penis usually straight sometimes slightly arcuate. Anellus lobes well developed in *Phragmataecia castaneae* Hubn.



TEXT-FIG. 64.—*Phocoderma ocellata* Moore.
TEXT-FIG. 65.—*Givira lasia* Druce.

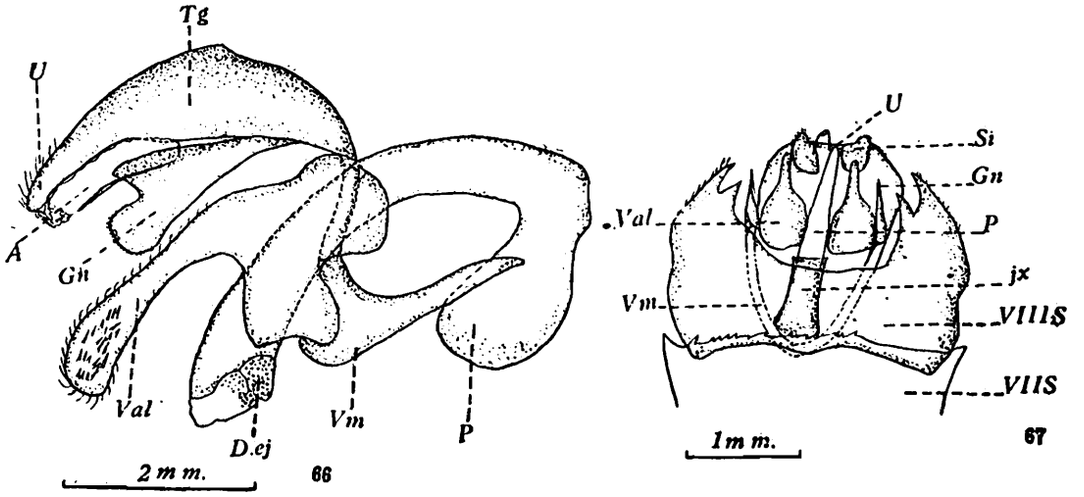
Species examined. *Phragmataecia castaneae* Hubn.; *Givira lasia* Druce (Text-fig. 65); *Xyleutis kilimandjarensis* Auriv.; *Azygophleps albovittata* B-Baker.

Family CASTNIIDAE.

The genitalia are heavily chitinized.

Valvae simple. Cucullus narrow, apex spinose. Sacculus broad.

Tegumen as viewed from the side is somewhat triangular as in the Papilionina. Hind margin concave. Uncus long and pointed at the tip. Gnathos well developed with margin minutely dentate. Vinculum with a short saccus.



TEXT-FIG. 66.—*Castnia eudesmia* Gray.
TEXT-FIG. 67.—*Malacosoma neustria* Linn.

Penis long, curved and swollen at the base.

Species examined. *Castnia eudesmia* Gray (Text-fig. 66).

Concluding remarks on the genitalia of Psychina.

This group has retained some of the primitive features. The vinculum is elongate, broad, 'U' or 'V' shaped and sometimes develops a long saccus (*e.g.*, Psychidae). The valvae are simple or divided. The tegumen is sometimes hood-shaped with a reduced uncus (*e.g.*, Psychidae) but in other families it is large and tapers to a point. The gnathos is usually large except in the Psychidae and Zygaenidae in which it is wanting. The penis is often long and stout with anellus lobes and juxta well developed.

Superfamily LASIOCAMPINA.

Family LASIOCAMPIDAE.

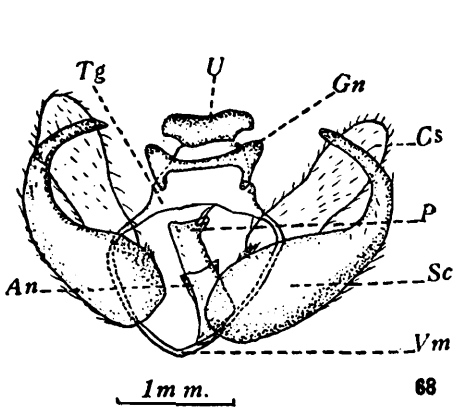
The eighth abdominal sternite medially cleft and produced into a pair of curved processes (e.g., *Cosmotricha potatoria* Linn. ; *Malacosoma neustria* Linn.), or elongated median process, heavily chitinized and bifurcate at the tip (e.g., *Odonestis pruni* Linn.).

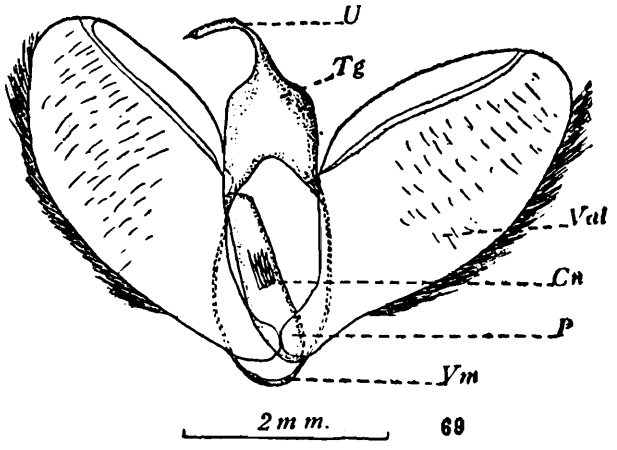
Valvae short, broad. Sometimes with inner lobiform process (e.g., *Chondrostega powelli* Oberth.), or much reduced, thick-set, heavily chitinized, margin serrate (e.g., *Dendrolimus pini* Linn.). Cucullus membranous, sacculus sharply curved (e.g., *Trichiura crataegi* Linn.).

Tegumen broad with small terminal lobes (*Epicnaptera ilicifolia* Linn. ; *Malacosoma neustria* Linn. ; *Dendrolimus pini* Linn.). Uncus reduced, hood-shaped sometimes broad, tubular (e.g., *Chondrostega powelli* Oberth.), or disciform and heavily chitinized (e.g., *Trichiura crataegi* Linn.). Socii present, lobiform (e.g., *Anchirithra insignis* Butl.), usually absent. Gnathos often with free curved arms except in *Trichiura crataegi* Linn. ; where it is heavily chitinized and disciform. Vinculum broad. Saccus absent.

Penis long, curved or short and straight. Cornuti present or absent. Anellus distinct.

Species examined. *Cosmotricha potatoria* Linn. ; *Chondrostega powelli* Oberth. ; *Dendrolimus pini* Linn. ; *Borocera madagascariensis* Boisd. ; *Anchirithra insignis* Butl. ; *Malacosoma neustria* Linn. (Text-fig. 67) ;





TEXT-FIG. 68.—*Trichiura crataegi* Linn.
TEXT-FIG. 69.—*Cleosiris erycinoides* Wlk.

Trichiura crataegi Linn. (Text-fig. 68) ; *Odonestis pruni* Linn. ; *Chrysopsuche imparilis* Auriv. ; *Dipluriella loti* Ramb. ; *Lasiocampa quercus*

Linn. ; *Poecilocampa populi* Linn. ; *Olyra reducta* Wlk. ; *Trabala vishnu* Lef. ; *Epicnaptera ilicifolia* Linn.

Family Endromidae.

Valvae broad, heavily chitinized.

Uncus shaped like a beak. Gnathos present. Vinculum round.

Penis short and stumpy. Anellus distinct.

Species examined. *Endromis versicolor* Linn.

Family Callidulidae.

Pencils of hair present. Valvae simple and broad.

Uncus long, curved and pointed at the tip. Vinculum ' U ' shaped.

Penis straight. Cornuti present.

Species examined. *Tyndaris erycinata* Wlk. ; *Cleosiris erycinoides* Wlk. (Text-fig. 69).

Family Drepanidae.

Valvae short and broad (e.g., *Drepana falcataria* Linn.), or narrow long and with terminal process (e.g., *Rondotia lineata* Leech.).

Uncus elongate, well developed. Bifurcate with long arms (e.g., *Cilix glaucata* Scop.), or reduced (e.g., *Rondotia lineata* Leech.). Socii present, lobiform. Gnathos distinct with broad heavily scobinated central lip (e.g., *Drepana falcataria* Linn.), or long free arms (e.g., *Cilix glaucata* Scop.). Vinculum ' U ' shaped, sometimes a short saccus present (e.g., *Cilix glaucata* Scop. ; *Rondotia lineata* Leech.).

Penis short and stumpy or long and slightly arcuate. Anellus lobes often well developed.

Species examined. *Drepana falcataria* Linn. ; *Cilix glaucata* Scop. ; *Rondotia lineata* Leech.

Concluding remarks on the genitalia of Lasiocampina.

The family Lasiocampidae in this group sometimes shows a peculiar development of the eighth sternite. The ninth sternite is a ' U ' shaped chitinous band and saccus is rarely present. The valvae are short and broad except in some of the Lasiocampidae (e.g., *Chondrostega powelli* Oberth ; *Trichiura crataegi* Linn.), in which the distinction into sacculus and cucullus portions is maintained. The tegumen develops small terminal lobes, the uncus in such cases being reduced or hood-shaped (*e.g.*, Lasiocampidae). The gnathos may be with free arms or fused into a prominent central lip. The penis is usually long, armed with cornuti and supported by the anellus or juxta.

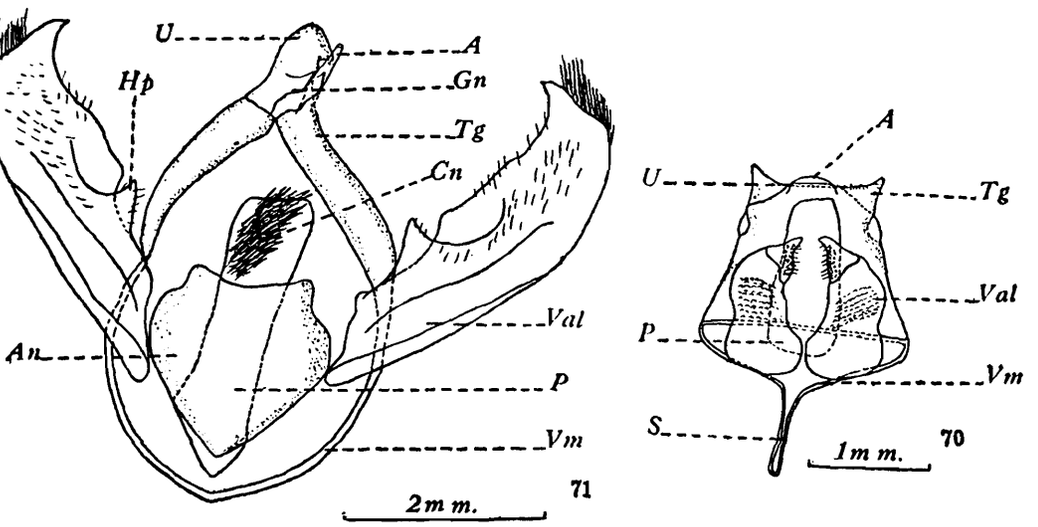
Superfamily Notodontina.

Family Eupterotidae.

Valvae simple, broad and reduced, apex usually narrow and acuminate, sometimes scobinated (e.g., *Nisaga simplex* Wlk.), or emarginate with a depression on the anal margin (e.g., *Phiala marshalli* Auriv.).

Tegumen usually broad with pair of short lateral processes which may be reduced to peg-like projections. Uncus reduced, hood-shaped. Vinculum broad. Saccus long.

Penis short. Cornuti when present represented by small denticles.



TEXT-FIG. 70.—*Nisaga simplex* Wlk.
TEXT-FIG. 71.—*Notodonta carmelita* Esp.

Species examined. *Tagora postica* Wlk. ; *Eupterote flavicollis* Guerin ; *Nisaga simplex* Wlk. (Text-fig. 70) ; *Phiala marshalli* Auriv. ; *Sangatissa subcurvifera* Wlk.

Family NOTODONTIDAE.

The genitalia are usually enveloped within the eighth abdominal somite.

Valvae long with clavate arm on the costal margin (e.g., *Stauropus pallidifascia* Hmpsn.). Apex pointed. Harpe large (*e.g.*, *Notodonta carmelita* Esp.).

Tegumen broad. Uncus long or short and pointed at the tip, sometimes divided (e.g., *Pterostoma palpina* Linn.). Gnathos well developed often with arms free distally (e.g., *Notodonta carmelita* Esp.). Vinculum ' U ' or 'V ' shaped. Saccus absent.

Penis usually long, broad at the base or slightly arcuate on the apex (e.g., *Stauropus pallidifascia* Hmpsn.). It may be short and stout with numerous spines (e.g., *Notodonta carmelita* Esp.). Anellus broad.

Species examined. *Stauropus pallidifascia* Hmpsn. ; *Nystalea ebalea* Cram. ; *Notodonta carmelita* Esp. (Text-fig. 71) ; *Pterostoma palpina* Linn.

Family BOMBYCIDAE.

Valvae comparatively short, or long and narrow. Sacculi broad, fused or free. Apex usually narrow, acuminate or curved.

Tegumen elongated. Uncus stout and divided. Gnathos usually well developed, curved (e.g., *Bombyx mori* Linn.). Vinculum broad sometimes shaped into a long ' U '

Penis long and straight or slightly arcuate. Anellus lobes often large e.g., *Bombyx mori* Linn.).

Species examined. Bombyx mori Linn. (Text-fig. 72); *Trilocha varians* Wlk.

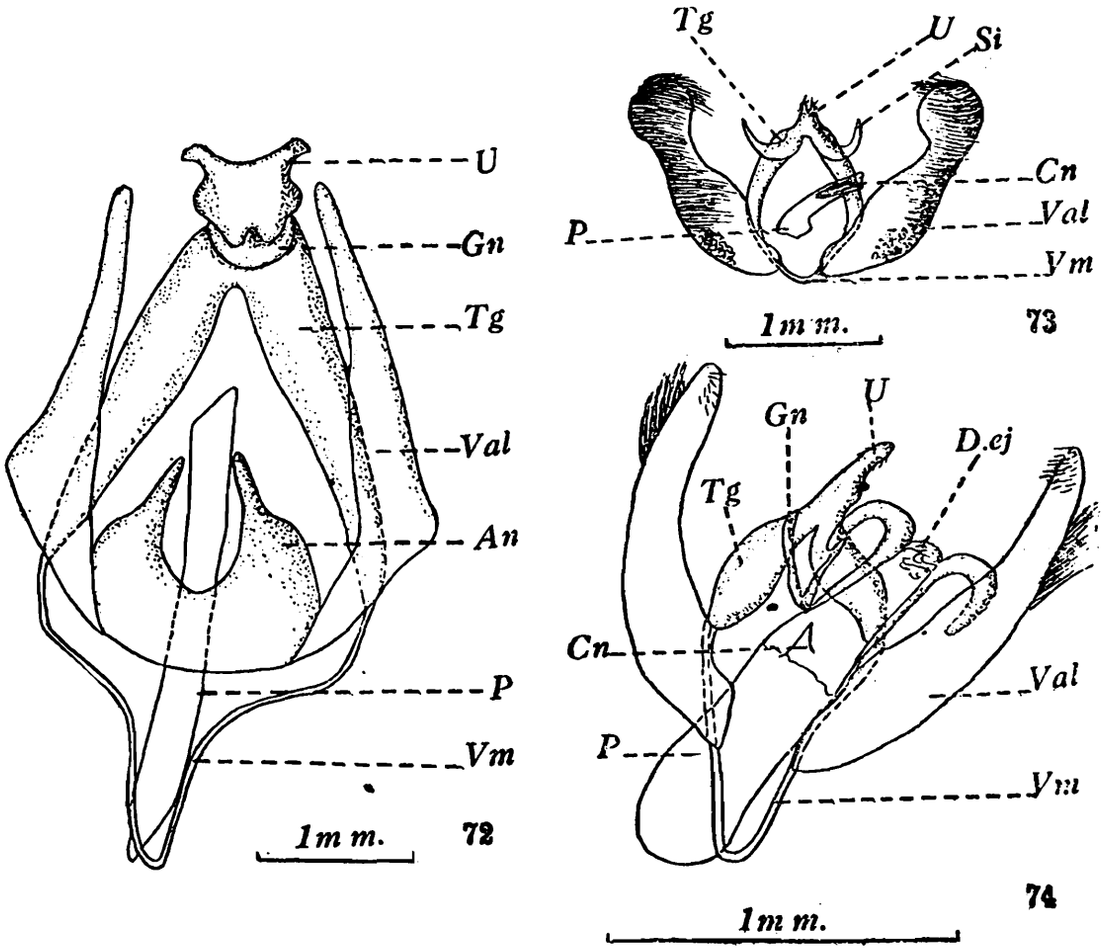
Family SELIDOSEMIDAE.

Valvae simple and long.

Tegumen broad. Uncus distinctly bifid. Socii curved. Vinculum broadly ' V ' shaped.

Penis short. Cornuti present.

Species examined. Selenia bilunaria Esp. (Text-fig. 73).



TEXT-FIG. 72.—*Bombyx mori* Linn.
TEXT-FIG. 73.—*Salenia bilunaria* Esp.
TEXT-FIG. 74.—*Eois circuitaria* Hubn.

Family STERRHIDAE.

Valvae simple and long.

Tegumen with straight uncus. Gnathos large. Vinculum ' V ' shaped.

Penis long and stout with curved heavily chitinized terminal processes. Vesica distinct.

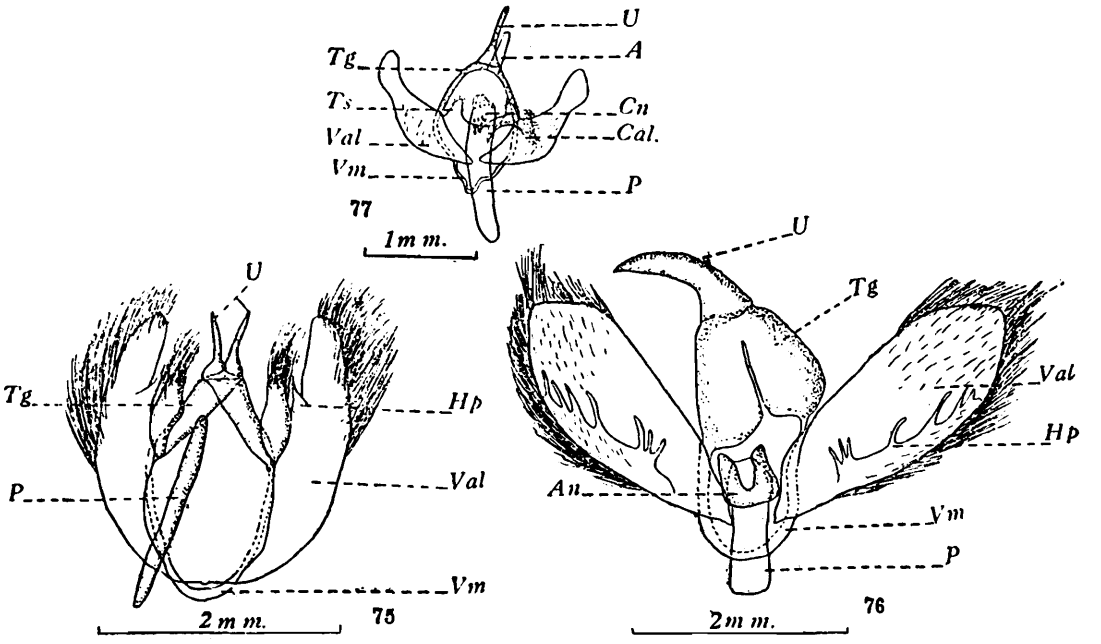
Species examined. Eois circuitaria Hubn. (Text-fig. 74).

Family URANIADAE.

Valvae large, usually broad. Costal margin often sinuate and produced into hairy lobe. (e.g., *Chrisiridia rhipheus* Drury). Anal fold sometimes produced into several (eight) finger-like processes (e.g., *Sematura lunus* Linn.). Harpe often present, hooked (e.g., *Acropteris parvidentata* Warr.).

Uncus usually long, tapered. Apex acuminate, sometimes bifid (e.g., *Acropteris parvidentata* Warr. ; *Epicopia hainesi* Holl.). Vinculum 'U' shaped. Saccus when present usually short (e.g., *Urania leilus* Linn.)

Penis long, arcuate and stout. Cornuti often well developed.



TEXT-FIG. 75.—*Acropteria parvidentata* Warr.
TEXT-FIG. 76.—*Sematura lunus* Linn.
TEXT-FIG. 77.—*Xanthorhoe fluctuata* Linn.

Species examined. *Acropteris parvidentata* Warr. (Text-fig. 75) ; *Urania leilus* Linn. ; *Sematura lunus* Linn. (Text-fig. 76) ; *Erosia birostrata* Guen. ; *Chrisiridia rhiphens* Drury. ; *Epicopia hainesi* Holl. ; *Urania fulgens* Wlk. ; *Lyssidia achillari* Hubn. ; *Alcidis aruns* Feld.

Family GEOMETRIDAE.

The male genitalia in this family are characterized by the presence or absence of gnathos. Pierce (1914) found it convenient to divide the family into Agnathoi and Gnathoi according to the presence or absence of this organ. I have adopted his arrangement which is reproduced below.

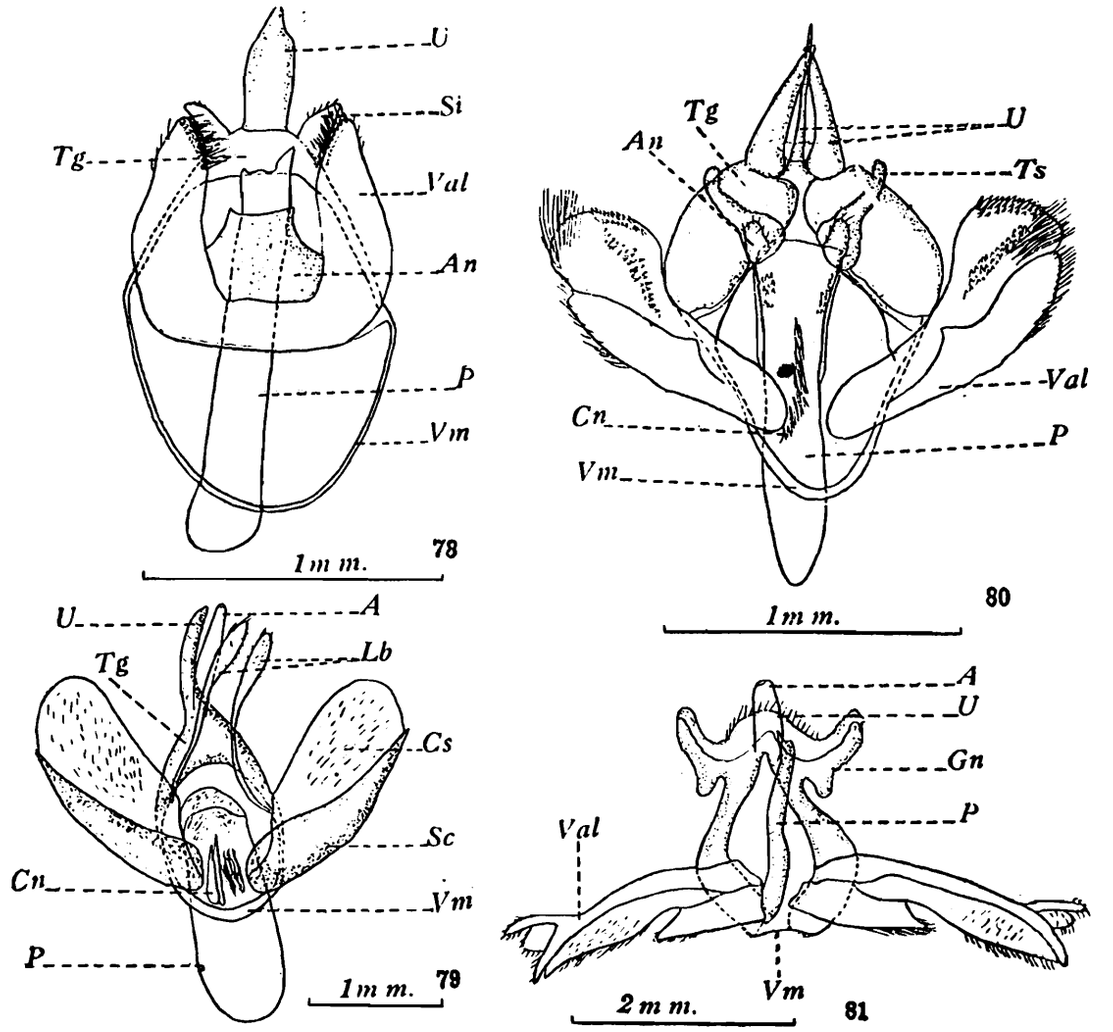
Agnathoi.

The eighth sternite broad and produced into long curved lateral arms or the " Rami " (Poljanec, 1902) (e.g., *Leptomeris imitaria* Hubn.).

Valvae apically emarginate, with single or more processes (e.g., *Leptomeris imitaria* Hubn. ; *Euphanessa mendica* Wlk. ; *Cosmorhoe subangulata* Koll. ; *Alsophila aescularia* Schiff.). Harpe well developed (e.g., *Alsophila aescularia* Schiff. ; *Sarcinodes debitaria* Wlk. ; *Aspilates virgata* Rott. ; *Hypenophora perlimbata* Guen.). Sacculus produced into a fold along the anal margin (e. g., *Acidalia dubiosata* Wlk. ; *Collix hyperythras* Hmpsn.). Costal margin sometimes thickened, highly spinose. Transtilla raised, hairy (e.g., *Xanthorhoe fluctuata* Linn.), or lobed with margin dentate (e.g., *Cataclysme bilineata* Linn. ; *Pelurga comitata* Schiff. ; *Larentia limitata* Scop.), or produced into curved

dentate arms (e.g., *Aspilates virgata* Rott.). In *Heterusia quadriplicaria* Hubn.; Valvae are broad, costal margin minutely serrate and the cucullus bears a brush of sensory hairs with curious terminal papillae. Labides long and erect (e.g., *Eulype hastata* Linn.; *Poilocambogia pluristrigata* Moore.

Tegumen usually broad. Uncus long and tapered or short and coniform and sometimes spatulate (e.g., *Acidalia dubiosata* Wlk.). In *Leptomeris imitaria* Hubn.; the tegumen is sometimes rounded on the apex and the uncus is divided into lateral processes or lobes. In *Aspilates virgata* Moore., the uncus consists of paired lateral lobes and an elongated median arm. Uncus may be reduced (e.g., *Collix hyperythras* Hampsn.). Socii present (e.g., *Tanaorhinus vittata* Moore.; *Sauris hirudinata* Guen.; *Lythia purpuraria* Linn.). Vinculum 'U' or 'V' shaped. Saccus absent except in *Calostigia aptata* Hubn.; in which the vinculum is basally involuted and a median saccus is present.



TEXT-FIG. 78.—*Rhodometra sacraria* Linn.
TEXT-FIG. 79.—*Eulype hastata* Linn.
TEXT-FIG. 80.—*Aspilates virgata* Rott.
TEXT-FIG. 81.—*Calothysanis amata* Linn.

Penis usually long, curved (e.g., *Traminda obversata* Wlk.), sometimes straight or stout with terminal cluster of thick-set long spines. Anellus lobes invariably present often long and broad, or fused to form a long arm—the "Calcar" (e.g., *Xanthorhoe fluctuata* Linn.; *Mesoleuca ruficillata* Guen.; *Cataclysme bilineata* Linn.).

Species examined. Cosmorhoe subangulata Koll.; *Alsophila aescularia* Schiff.; *Sarcinodes debitaria* Wlk.; *Tanaorhinus vittata* Moore.; *Leptomeris imitaria* Hubn.; *Organopoda carnearia* Wlk.; *Dindica polyphaenaria* Guen.; *Lygris pyropata* Hubn.; *Xanthorhoe fluctuata* Linn. (Text-fig. 77); *Ephyaxa rosearia* Dbld.; *Calostigia aptata* Hubn.; *Scopula imitaria* Hubn.; *Cleta pygmocaria* Hubn.; *Euphia miata* Linn.; *Emmiltis rubiginata* Hubn.; *Traminda obversata* Wlk.; *Perizoma albulata* Schiff.; *Mesoleuca ruficillata* Guen.; *Cataclysme bilineata* Linn.; *Euphanessa mendica* Wlk.; *Pelurga comitata* Schiff.; *Sauris hirudinata* Guen.; *Hydrelia sylvata* Schiff.; *Poilocambogia pluristrigata* Moore; *Rhodometra sacraria* Linn. (Text-fig. 78); *Lythia purpuraria* Linn.; *Eulype hastata* Linn. (Text-fig. 79); *Heterusia quadriplicaria* Hubn.; *Calostigia molata* Feld.; *Acidalia dubiosata* Wlk.; *Collix hyperythras* Hmpsn.; *Aspilates virgata* Rott. (Text-fig. 80); *Larentia limitata* Scop.; *Hypenophora perlimbata* Guen.; *Anisogomia carnea* Butl.; *Patelia medardaria* H-Sch.

Gnathoi.

This group, according to Pierce (1914), is marked by the presence of a distinct gnathos.

The eighth abdominal segment sometimes completely encloses the genital armature (e.g., *Oenospila flavifusata* Wlk.). Coremata present in connection with the eighth sternite. (e.g., *Pithea continua* Wlk.; *Hylemera circumcincta* Prout.).

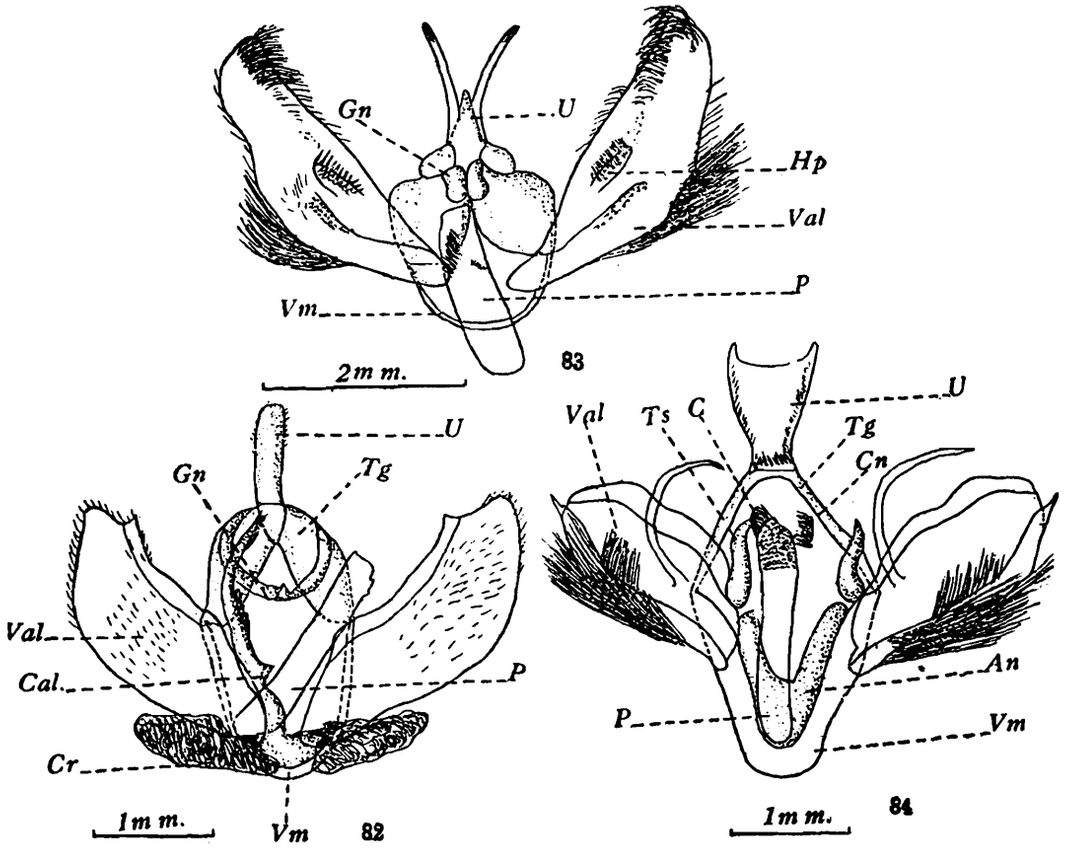
Valvae simple, elongate or broad or slightly curved (e.g., *Cosmostola subtiliaria* Brem.). Valvae sometimes with margin irregular, incised (e. g., *Agathia lyceanaria* Koll.), or produced into long, narrow, finger-like processes or cucullus forked (e.g., *Calothysania amata* Linn.). A chitinous fold runs along the anal margin and terminates in a small process (e.g., *Dilophodes elegans* Butl.; *Nothabraxas irregularis* Prout; *Cleora leucophaea* Snell.; *Paradarisa comparataria* Wlk.; *Pseudocoremia productata* Wlk.; *Amraica divisaria* Wlk.). Costal margin usually thickened and in many cases heavily spinose. Harpe small or hooked (e.g., *Zerene procellata* Schiff.), or elongate (e.g., *Hirasa scripturaria* Wlk.), rounded or clavate (e.g., *Pseudocoremia productata* Wlk.; *Phigalia pedaria* Fabr.) heavily spined (e.g., *Hemerophila seperata* Wlk.). In *Codonia punctata* Stoll., the membranous cucullus is distinct from the sacculus which has a raised prominence on the costal margin. This in turn, bears a curved process.

Uncus may be long and straight, sometimes lobulate (e.g., *Codonia punctata* Stoll.), or tip of the uncus divided and produced into two or three prominences (e.g., *Pradarisa comparataria* Wlk.; *Pseudocoremia productata* Wlk.; *Arachanna ramosa* Wlk.; *Phigalia pedaria* Fabr.; *Cusiala decursaria* Wlk.). It may be small, coniform and pointed (e.g., *Pingasa tephrosiaria* Guen.; *Dilophodes elegans* Butl.). Socci long and lobiform (e.g., *Eretmopus dissita* Wlk.; *Nephodia exularia* Wlk.), or broad and drooping (e.g., *Codonia punctata* Stoll.; *Crocallis tusciaria* Borkh.). Tegumen sometimes produced into terminal arms one on either side of the uncus (e.g., *Cabera punctaria* Linn.; *Hemerophila seperata* Wlk.; *Boarmia castaria* Guen.). In *Cosmostola subtiliaria*

Brem., these are long, curved and with peculiar terminal bulbs. Gnathos usually curved and central lip elongated or broad. The arms sometimes form a wide ventral loop and the central lip in such cases remains broad and rounded (e.g., *Hylemera circumcincta* Prout.; *Obeidia gigantearia* Leech.; *Nothabraxas irregularis* Prout.; *Boarmia castaria* Guen.; *Nephodia exularia* Wlk.; *Paradarisa comparataria* Wlk.; *Arachanna ramosa* Wlk.). Gnathos compact rounded lobes (e.g., *Pythea continua* Wlk.; *Hemerophila seperata* Wlk.), entirely reduced (e.g., *Cabera punctaria* Linn.). Vinculum rounded or ' U ' shaped.

Penis usually long, straight or short and stout. Cornuti often well developed spines. Anellus lobes distinct and fused to form the calcar (e.g., *Hylemera circumcincta* Prout.; *Pythea continua* Wlk.).

Species examined. Pingasa tephrosiaria Guen.; *Petovia dichroaria* H-Sch.; *Agathia lyceanaria* Koll.; *Eretmopus dissita* Wlk.; *Oenospila flavifusata* Wlk.; *Calothysanis amata* Linn. (Text-fig. 81).; *Codonia punctata* Stoll.; *Cabera punctaria* Linn.; *Cosmostola subtiliaria* Brem.; *Zerene procellata* Schiff.; *Obeidia gigantearia* Leech.; *Hylemera circum-*



Text-fig. 82.—*Hylemera circumcincta* Prout.
Text-fig. 83.—*Hemerophila seperata* Wlk.
Text-fig. 84.—*Hydriomena sordidata* Fabr.

cincta Prout. (Text-fig. 82); *Dilophodes elegans* Butl.; *Nothabraxas irregularis* Prout.; *Ectropis crepuscularia* Hubn.; *Hemerophila seperata* Wlk. (Text-fig. 83); *Cleora leucophaea* Snell.; *Boarmia castaria* Guen.; *Pythea continua* Wlk.; *Nephodia exularia* Wlk.; *Cingilea catenaria* Cram.; *Leucula ablinearia* Guen.; *Paradarisa comparataria* Wlk.; *Hirasa scripturaria* Wlk.; *Pseudocoremia productata* Wlk.; *Arachanna ramosa* Wlk.; *Percnia ductaria* Wlk.; *Lycia hirtaria* Clerck.; *Phigalia pedaria* Fabr.; *Polla vesulia* Cram.; *Therapsis evonymaria* Schiff.;

Compaea margeritata Linn. ; *Amraica divisaria* Wlk. ; *Cusiala decursaria* Wlk. ; *Crocallis tusciaria* Borkh.

Family HYDRIOMENIDAE.

Valvae simple and broad. Sacculus with long, curved basal process. Transtilla horn-shaped, stout (e.g., *Hydriomena sordidata* Fabr.). Gnathos absent. Vinculum ' U ' or ' V ' shaped.

Penis with strong cornuti. Anellus distinct.

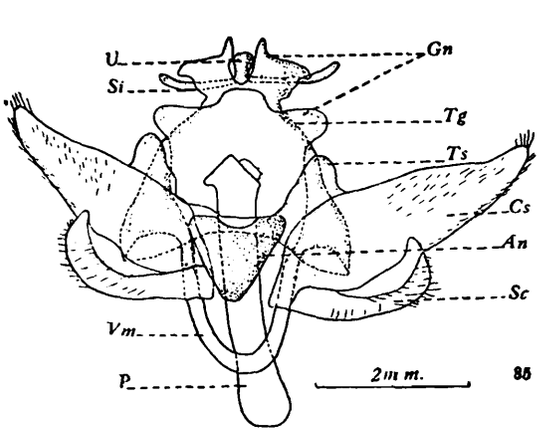
Species examined. Hydriomena sordidata Fabr. (Text-fig. 84) ; *Eucymatoge scabiosata* Borkh.

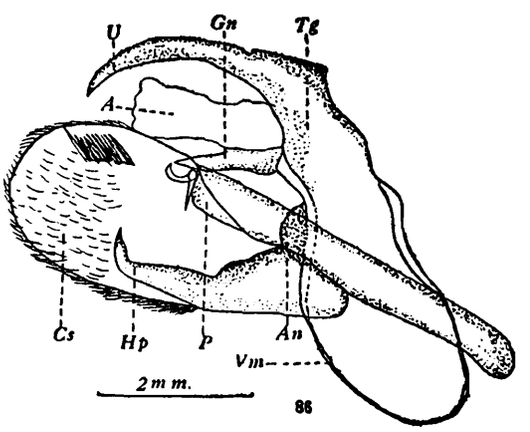
Family POLYPLOCIDAE.

Valvae simple, elongate or broad. Sacculus broad and slightly angulate (e.g., *Gaurena florens* Wlk.), or sometimes free (e.g., *Polyploca orbicularis* Moore.). Transtilla lobed (e.g., *Polyploca orbicularis* Moore.).

Tegumen broad. Uncus long and short, straight or curved. Socii long, erect or curved (e.g., *Palimpsestis or* Gmelin.). In *Polyploca orbicularis* Moore., the gnathos is a complicated structure and forms a thick chitinous piece with margin produced into three pairs of processes —two lateral and a single distal, median pair. Gnathos sometimes completely wanting (e.g., *Thyatira batis* Linn. ; *Gaurena florens* Wlk. ; *Palimpsestis or* Gmelin. ; *Apha subdives* Wlk.). Vinculum broadly ' U ' shaped.

Penis long or broad near the orifice. Anellus prominent. Juxta often well developed plate.





TEXT-FIG. 85.—*Polyploca orbicularis* Moore.
TEXT-FIG. 86.—*Nephele didyma* Fabr.

Species examined. Thyatira batis Linn. ; *Gaurena florens* Wlk. ; *Palimpsestis or* Gmelin. ; *Polyploca orbicularis* Moore. (Text-fig. 85) ; *Apha subdives* Wlk. ; *Polyploca flavicornis* Esp.

Family SPHINGIDAE.

Valvae simple, long or broad. Harpe often well developed (e.g., *Temnora iapygoides* Holl. ; *Basiothis laticornis* Butl. ; *Clerio euphorbiae* Linn. ; *Nephele didyma* Fabr. ; *Pholus fasciatus* Sulzer. ; *Pseudoclanis postica* Wlk. ; *Sphinx ligustri* Linn.). Sacculus sometimes with an anal fold which terminates into curved process. Valvae may be thickly

clothed with hair and long spines (e.g., *Nephele didyma* Fabr. ; *Pachylia ficus* Linn.). Apex notched (e.g., *Mimas tiliae* Linn.).

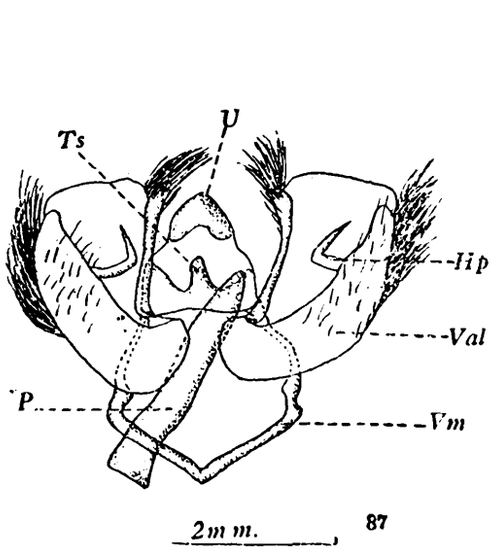
Uncus usually well developed, simple, elongated or short, curved and bifid (e.g., *Hippotion boerhaviae* Fabr. ; *Pseudoclanis postica* Wlk.) the divisions may be long, erect lobiform processes (e.g., *Erinnyis ello* Linn. ; *Pachylia ficus* Linn.). Tip of the uncus often acuminate or divided (e.g., *Sphinx ligustri* Linn.). Gnathos large, heavily chitinized, usually long, curved or pointed, sometimes forms a complete ring on base of the uncus (e.g., *Cephonodes hylas* Linn.). The tip often pointed dentate (e.g., *Celerio euphorbiae* Linn.), forked (e.g., *Sphinx ligustri* Linn.). In *Erinnys ello* Linn., and *Pseudosphinx tetrio* Linn. ; the gnathos arms are long and free distally arising from base of the uncus. Anal tube long and lies between the uncus and the gnathos. Vinculum round, ' U ' or ' V ' shaped. A short saccus present in *Pholus fasciatus* Sulzer. ; *Pachylia ficus* Linn. and *Pseudosphinx tetrio* Linn.

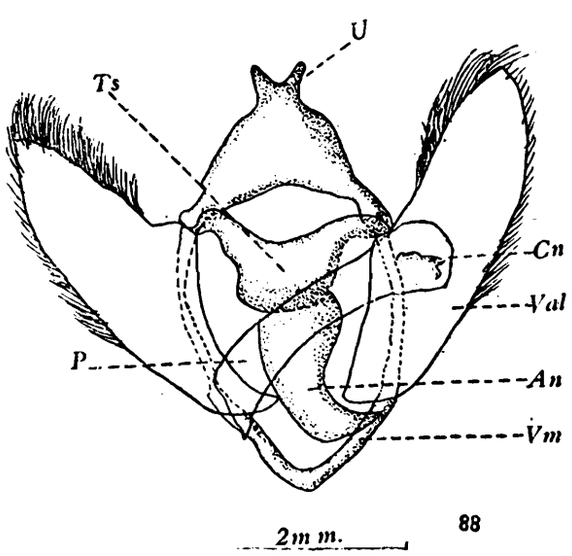
Penis usually very long and narrowed at the orifice. Cornuti variable number of long spines, sometimes short, stout and dentate (e.g.,*Temnora iapygoides* Holl.). Juxta often present, elongate or broad. Anellus lobes broad and well developed (e.g., *Cephonodes hylas* Linn.) or fused basally and raised on either side of the penis (e.g., *Pseudosphinx tetrio* Linn. ; *Pseudoclanis postica* Wlk.).

Species examined. *Theretra latreillei* Macleay. ; *Hippotion boerhaviae* Fabr. ; *Macroglossum gyrans* Wlk. ; *Leucostrophus nirundo* Grestaecker ; *Temnora iapygoides* Holl. ; *Basiothia laticornis* Butl. ; *Celerio euphorbiae* Linn. ; *Nephele didyma* Fabr. (Text-fig. 86) ; *Deilephila hypothus* Cram. ; *Epistor lugubris* Linn. ; *Erinnys ello* Linn. ; *Cephonodes hylas* Linn. ; *Mimas tiliae* Linn. ; *Protoparce quinquemaculatus* Haw. ; *Pseudosphinx tetrio* Linn. ; *Pseudoclanis postica* Wlk. ; *Sphinx ligustri* Linn. ; *Pholus fasciatus* Sulzer. ; *Pachylia ficus* Linn.

Family SATURNIDAE.

Eighth segment produced into terminal process (e.g., *Cyrtogone nenia* Westw.).





TEXT-FIG. 87.—*Catocephala nigrosignata* Pholisant.

TEXT-FIG. 88.—*Cricula trifenestrata* Helf.

Valvae usually large, complex and costal margin thickened. Anal margin sometimes flap-like and produced into central process. Valvae sometimes heavily denticulated (e.g., *Urota sinope* Westw.). Harpe often present. Transtilla sometimes large, broad or apically produced.

Uncus usually simple, heavily chitinized sometimes bifid (e.g., *Attacus atlas* Linn.). Vinculum ' U ' shaped, saccus often present.

Penis long, straight and thick-set. Anellus conspicuously large and broad or elongate.

Species examined. Heliconisa pagenstecheri Gerer.; *Catocephala nigrosignata* Pholisant. (Text-fig. 87); *Urota sinope* Westw.; *Cricula trifenestrata* Helfer. (Text-fig. 88); *Ludia smithi* Holl.; *Cyrtogone nenia* Westw.: *Gonimbrasia nictitatus* Fabr.; *Attacus atlas* Linn.

Concluding remarks on the genitalia of Notodontina.

The genitalia on the whole are of a specialized character. The ninth sternite is ' U ' or ' V ' shaped and saccus is short and often absent. The valvae may be simple, short and fused (*e.g.*, Eupterotidae) or emarginate, divided and develop accessory structures such as the harpe, furca, and labides (*e.g.*, Geometridae and Hydriomenidae). A large uncus and gnathos are present, the latter structure usually attains considerable size (*e.g.*, Polyplocidae). The socii may be present. The penis is short or long, heavily chitinized and armed with strong denticles or cornuti. The anellus lobes are prominent or fused to form a large juxta which is sometimes produced into a long arm called the ' calcar ' (*e.g.*, Geometridae).

Superfamily NOCTUINA. (Caradrinina).

Family HYPSIDAE.

Valvae usually long, narrow or broad with an apical process (e.g., *Caryatis phileta* Drury.). Sacculus often produced into basal process (harpe) and in *Sommeria cribraria* Fab., it reaches the cucullus.

Tegumen sometimes produced into lateral lobes (e.g., *Sommeria cribraria* Fabr.). Uncus long, straight or curved and pointed at the tip. Vinculum ' U ' or ' V' shaped.

Penis usually straight sometimes arcuate (e.g., *Caryatis phileta* Drury.). Juxta, when present, is a large plate.

Species examined. Sommeria cribraria Fabr.; *Asota versicolor* Don. (Text-fig. 89); *Amphicallia bellatrix* Dalm.; *Argina syringa* Cram.; *Caryatis phileta* Drury.

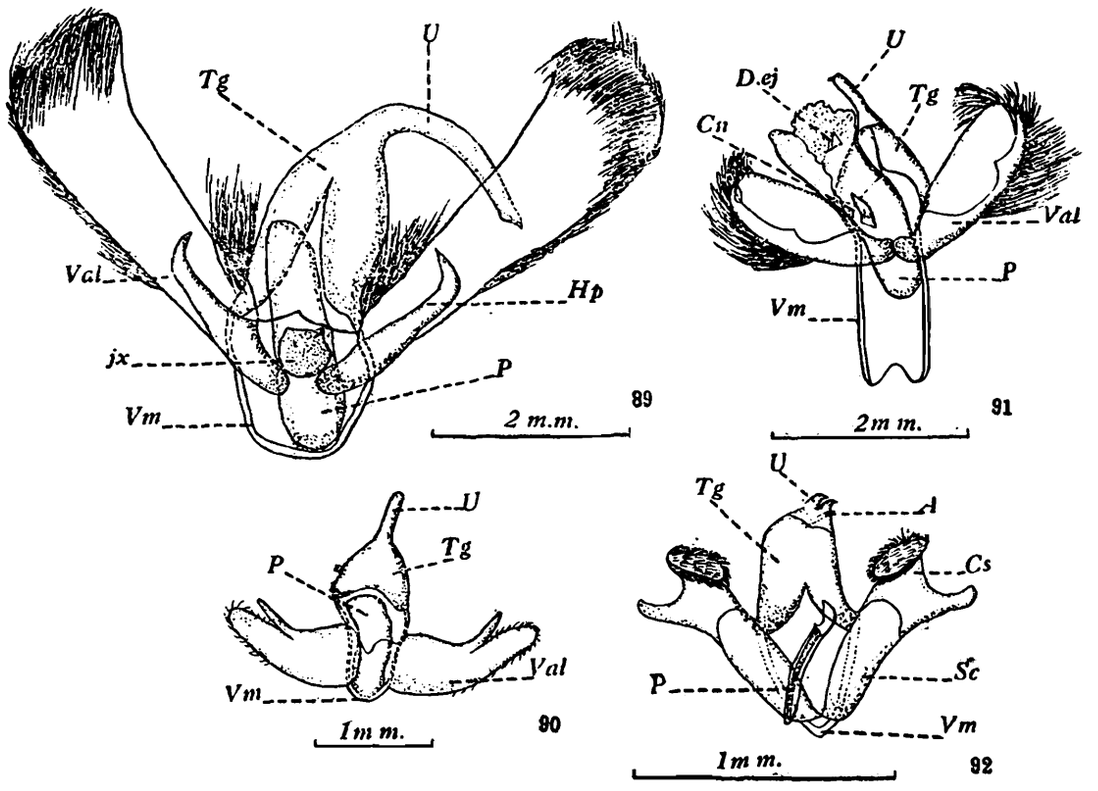
Family OCNERIADAE (Lymantridae).

Valvae simple, sacculus usually broad and produced into a process on the costal margin (e.g., *Orgyia antiqua* Linn.).

Uncus simple, linear or slightly curved. Vinculum ' U ' shaped. Saccus present in *Lymantria dispar* Linn.

Penis short or long, narrowed terminally (e.g., *Lymantria dispar* Linn.).

Species examined. *Orgyia antiqua* Linn. (Text-fig. 90); *Lymantria dispar* Linn.



TEXT-FIG. 89.—*Asota versicolor* Don.
TEXT-FIG. 90.—*Orgyia antiqua* Linn.
TEXT-FIG. 91.—*Lithosia complanata* Costa.
TEXT-FIG. 92.—*Earias fabia* Stoll.

Family ARCTIADAE.

Valvae simple, broad, sometimes produced into short apical process.

Uncus usually simple, straight or shaped like a beak (e.g., *Utetheisa pulchella* Linn.); sometimes bifurcate (e.g., *Secusio mania* Druce.), or with four processes (e.g., *Estigmene tenuistrigata* Hmpsn.). Gnathos absent. Anal tube projects below the uncus. Vinculum 'U' shaped, more or less rounded sometimes long (e.g., *Lithosia complanata* Costa).

Penis usually long with vesica (*D. ej.*) well developed.

Species examined. *Secusio mania* Druce.; *Utetheisa pulchella* Linn.; *Perricallia ricini* Fabr.; *Teracotona submacula* Wlk.; *Estigmene tenuistrigata* Hmpsn.; *Ilema vagesa* Moore.; *Lithosia complanata* Costa (Text-fig. 91).

Family HYLOPHILIDAE.

Pencils of hair present (e.g., *Hylophila prasinana* Linn.). Valvae simple, broad, apically notched and produced into lateral lobes, inner lobe disciform hairy pad.

Uncus simple, straight or bifid (e.g., *Earias fabia* Stoll.). Vinculum 'V' shaped.

Penis short with a single bulbed cornutus (e.g., *Hylophila prasinana* Linn.).

Species examined. *Hylophila prasinana* Linn.; *Earias fabia* Stoll. (Text-fig. 92).

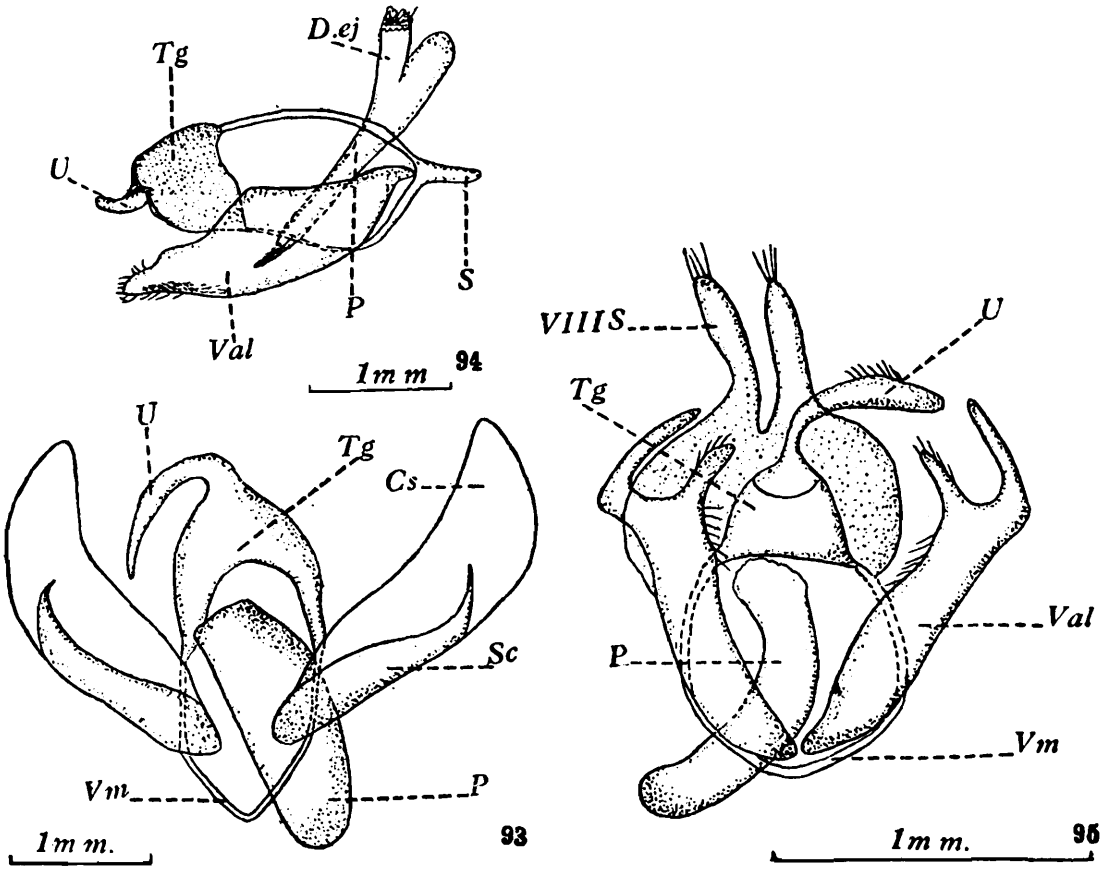
Family AGARISTIDAE.

Valvae simple, broad, often with well developed apically curved harpe arising from base of the sacculus.

Uncus long, tapering and curved, sometimes short. Gnathos absent. Vinculum broadly ' V ' shaped.

Penis short or long, vesica sometimes everted. Juxta elongate when present.

Species examined. Agarista agricola Donov. ; *Hespagarista rendalli* Roths. ; *Tuerta trimeni* Feld. ; *Crameria amabilis* Drury. ; *Aegocera rectilinea* Boisd. (Text-fig. 93).



TEXT-FIG. 93.—*Aegocera rectilinea* Boisd.
TEXT-FIG. 94.—*Amata cerbera* Linn.
TEXT-FIG. 95.—*Holocryptis melanosticta* Hmpsn.

Family SYNTOMIDAE (Amatidae).

Valvae usually simple, with an apical scobinated bulb (e.g., *Epitoxis amazoula* Boisd.), lobiform process (e.g., *Amata cerbera* Linn.), or notched and produced into lateral lobes (e. g., *Psichotoe duvauceli* Boisd.).

Tegumen of characteristic shape, often long. Uncus coniform. Vinculum long, broadly ' V ' shaped. Saccus sometimes present. (e.g., *Amata cerbera* Linn.).

Penis long. Cornuti sharp spines.

Species examined. Epitoxis amazoula Boisd. ; *Amata cerbera* Linn. (Text-fig. 94) ; *Psichotoe duvauceli* Boisd.

Family NOCTUIDAE.

Pencils of hair as they are termed by Pierce (1909), or anal brushes (Eltringham, 1925) are found in connection with the eighth or ninth

sternite in many of the Noctuidae. They appear to have no taxonomic value.

The eighth abdominal sternite distally produced into elongate lobiform processes or rami (e.g., *Holocryptis melanosticta* Hmpsn.).

The genitalia exhibit considerable variation and are here grouped from the apparently simpler to more complex types.

(i) Valvae simple, short or long, broad or narrow often with marginal spines sometimes apex slightly produced (e.g., *Brachionycha nubeculosa* Esp.; *Cloantha solidaginis* Hubn.; *Ercheia cyllaria* Cram.). Apical margin sinuate (e.g., *Lithocodia vialis* Moore.), or emarginate (e.g., *Holocryptis melanosticta* Hmpsn.).

Tegumen usually broad. Uncus long, tongue-shaped (e.g., *Azeta versicolor* Fabr.), tapered, straight or curved, cygnate, often with terminal spines (e.g., *Ercheia cyllaria* Cram.; *Cyclodes omma* Van der Hoev.; *Phytometra albostriata* Brem.; *Bendis formularis* Hubn.). Uncus short and broad (e.g., *Othreis materna* Linn.; *Brachionycha nubeculosa* Esp.), or pointed (e.g., *Odontodes aleuca* Guen.), sometimes bulbous—ending with a terminal spine (e.g., *Carea vexilla* Swinh.). Supra-anal process present (e.g., *Maurelia iconice* Wlk.; *Anomis erosa* Hubn.). Vinculum 'U' or 'V' -shaped. Saccus rarely present, long in *Phytometra albostriata* Brem.

Penis short and thick, basally broad (e.g., *Azeta versicolor* Fabr.), long and straight or curved (e.g., *Ommatophora fulvastra* Guen.). Cornuti variable, a single large cornutus present in *Odontodes aleuca* Guen.

Species examined. *Raghuva multiradiata* Hmpsn.; *Chloridea dipsacea* Linn.; *Adisura atkinsoni* Moore.; *Timora decorata* Moore.; *Brachionycha nubeculosa* Esp.; *Cloantha solidaginis* Hubn.; *Ozarba perplexa* Saalm.; *Lithocodia vialis* Moore.; *Tathothripa continua* Wlk.; *Odontodes aleuca* Guen.; *Carea vexilla* Swinh.; *Enmonodia capensis* H-Schaff.; *Ercheia cyllaria* Cram.; *Cyclodes omma* Van der Hoev.; *Phytometra albostriata* Brem.; *Azeta versicolor* Fabr.; *Othreis materna* Linn.; *Anomis erosa* Hubn.; *Bendis formularis* Hubn.; *Holocryptis melanosticta* Hmpsn. (Text-fig. 95); *Maurelia iconica* Wlk.; *Ommatophora fulvastra* Guen.

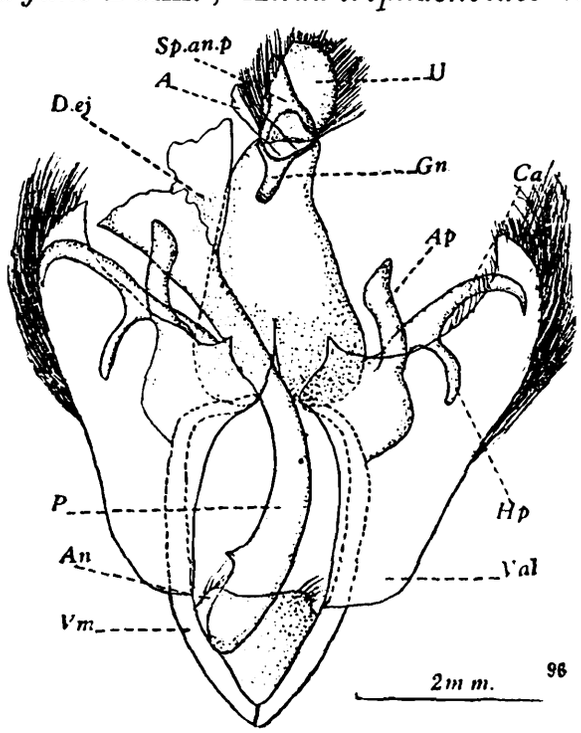
Valvae usually long, cucullus with characteristic apical spines. Sacculus sometimes distally emarginate and produced into lateral arms (e.g., *Coenurgia crassiuscula* Haw.). Harpe sometimes small and rudimentary often well developed, curved and arise from base of the sacculus and may extend and terminate on the cucullus into hook-shaped process. It may be bifurcate (e.g., *Gonospileia glyphica* Linn.; *Oxyodes scrobiculata* Fabr.). Ampulla of varied form, usually long process. Sacculus sometimes develops a fold on the anal margin which often extends almost to the apex (e.g., *Barathra brassicae* Linn.; *Mania maura* Linn.; *Trachea stoliczkae* Feld.; *Erygia* apicalis Guen.).

Tegumen usually broad sometimes develops latero-basal hairy pads, *i.e.*," Peniculus" of Pierce (1909). Uncus short, broad and bulbous or long usually cygnate, tongue-shaped, diamond-tipped, sometimes disciform (e.g., *Perigea* sp.), or long and sinuate with terminal spines (e.g., *Labanda fasciatus* Wlk.). A supra-anal process arises from base of the uncus (e.g., *Erebus hierogyphica* Drury.; *Calliodes pratiosissima* Holl.; *Heliophisma klugii* Boisd.; *Isadelphina cheilosema* Hmpsn.;

Plusiodonta metalensis Wlk.). Gnathos present in *Heliophisma klugii* Boisd. Vinculum 'U' or 'V' shaped. Saccus rudimentary or absent.

Penis short and stumpy (e.g., *Oxicesta geographica* Fabr.), usually long, well developed, basally broad or flask-shaped. Cornuti variable—long spines or small denticles. Anellus broad or rounded. Juxta large cup-shaped and scobinated (e.g., *Eumichtis roboris* Hubn.), or disciform (e.g., *Ancara obliterans* Wlk.).

Species examined. Rhizogramma comma Schiff.; *Actinotia radiosa* Esp.; *Euxoa porphricollis* Guen.; *Feltia subgothica* Haw.; *Hermonassa consignata* Wlk.; *Pachnobia carnea* Thumb.; *Agrotis spina* Guen.; *Episilia festiva* Schiff.; *Lycophotia margaritosa* Haw.; *Mythimna rubricosa* Schiff.; *Eurois prasina* Schiff.; *Neurois atrovirens* Wlk.; *Barathra brassicae* Linn.; *Scotogramma trifolii* Rott.; *Polytela gloriosae* Fabr.; *Eriopyga puerilis* Grote.; *Oxicesta geographica* Fabr.; *Cucullia umbratica* Linn.; *Euscotia inextricata* Moore.; *Epunda nigra* Steph.; *Miselia bimaculosa* Linn.; *Psylla celsia* Linn.; *Agriopis aeruginea* Hubn.; *Antitype polymita* Linn.; *Eumichtis roboris* Hubn.; *Polia olivacea* Steph.; *Amathes lota* Clerck.; *Amphipyra tragopogonis* Linn.; *Trachea stoliczkae* Feld.; *Ancara obliterans* Wlk.; *Acronycta psi* Linn.; *Simyra venosa* Borkh.; *Spodoptera mauritia* Boisd.; *Prodenia litura* Fabr.; *Perigea* sp.; *Hydroecia petasitis* Doubl.; *Nonagria despecta* Treits.; *Laphygma exigua* Hubn.; *Proxenus pectinifera* Auriv.; *Eublemma admota* Feld.; *Cerynea thermesialis* Wlk.; *Oruza latifera* Wlk.; *Lophoptera xista* Swinh.; *Chamyris cerintha* Treits.; *Eustrotia erectia* Moore.; *Eulocastra argentifrons* Butl.; *Marathyssa cuneata* Saalm.; *Tarachidia condefacta* Hubn.; *Paectes subapicalis* Wlk.; *Gyrtona proximalis* Wlk.; *Labanda fasciatus* Wlk.; *Corgatha costinotalis* Moore.; *Negeta albigrisea* Hmpsn.; *Leocyma appolinis* Guen.; *Catocala concubens* Wlk.; *Erebus hieroglyphica* Drury.; *Entomogramma torsa* Guen.; *Calliodes pratiosissima* Holl.; *Speiredonia retorta* Linn.; *Ischyja eyndhovii* Voll.; *Dermaleipa juno* Dalm.; *Anua triphaenoides* Wlk.; *Heilophisma*



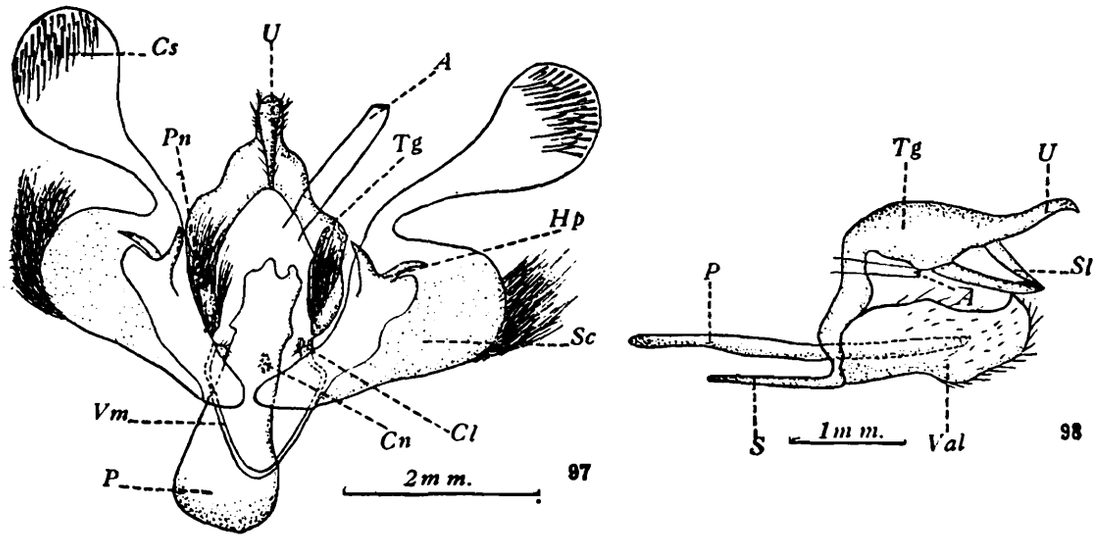
TEXT-FI[illegible]—*Helophisma klugii* Boisd.

klugii Boisd. (Text-fig. 96); *Gonospileia glyphica* Linn.; *Coenurgia crassiuscula* Haw.; *Pericyma glaucinans* Guen.; *Erygia apicalis* Guen.; *Polydesma umbricola* Boisd.; *Calophasia hochenwarthi* Hochenw.; *Syngrapha circumflexa* Linn.; *Tathorhynchus exsiceata* Zell.; *Apopestis spectrum* Esp.; *Antophila dilucida* Hubn.; *Athyrma adjutrix* Cram.; *Deinopa aspila* Hmpsn.; *Baniana culminifera* Hmpsn.; *Fodina pallula* Guen.; *Isadelphina cheilosoma* Hmpsn.; *Oxyodes scrobiculata* Fabr.; *Micragrotis puncticostata* Hmpsn.; *Plusiodonta metalensis* Wlk.

Valvae complex, division into cucullus and sacculus almost complete. Anal margin usually notched near the apex so that the cucullus is separated into a trigonate heavily spined corona and a broad sacculus. In such cases the cucullus may be 'battledore', 'trigonate', or 'C' shaped. Sometimes reduced and raised on a narrow stalk (e.g., *Leucania pudorina* Schiff.). Sacculus sometimes free and produced into a long arm (e.g., *Amyna leucostriga* Hmpsn.; *Achaea ezea* Cram.; *Bareia sp.*). Harpe well developed, form varied. Ampulla often present. Clavus small, rounded and toothed or large, lobiform (e.g., *Nephelodes emmedonia* Cram.).

Tegumen usually broad, sometimes with large lateral expansions (e.g., *Eremobia ochroleuca* Schiff.; *Miana arcuosa* Haw.). Peniculus well developed in *Lasiplexia chalybeata* Wlk.; and *Amyna leucostriga* Hmpsn. Uncus long curved, heavily spinose, cygnate or tongue-shaped. Sometimes short broad and drooping (e.g., *Senta albilinea* Hmpsn.), or spatulate (e.g., *Nephelodes emmedonia* Cram.). Gnathos long, central lip pointed (e.g., *Parallelia proxima* Hmpsn.; *Achaea ezea* Cram.). Vinculum 'U' or 'V' shaped. Saccus absent.

Penis long and stout or basally broad. Cornuti variable, sometimes rows of several long spines present (e.g., *Borolia amens* Guen.). Juxta often present as an elongate plate.



TEXT-FIG. 97.—*Chabuata conigera* Schiff.
TEXT-FIG. 98.—*Adopaea thaumas* Hubn.

Species examined. Craterestra media Wlk.; *Hadena reticulata* Vill.; *Chabuata conigera* Schiff. (Text-fig. 97); *Senta albilinea* Hubn.; *Tricochlea albicolon* Sepp.; *Nephelodes emmedonia* Cram.; *Persectania ewingi* Westw.; *Miselia persicariae* Linn.; *Cirphis L-album* Linn.;

Borolia amens Guen.; *Leucania pudorina* Schiff.; *Sideridis lithargyrea* Esp.; *Euplexia lucipara* Linn.; *Miana rufuncula* Haw.; *Eremobia ochroleuca* Schiff.; *Amyna leucostriga* Hmpsn.; *Lasiplexia chalybeata* Wlk.; *Beara dichromella* Wlk.; *Parallelia proxima* Hmpsn.; *Achaea exea* Cram.; *Bareia sp.*; *Miana arcuosa* Haw.

Concluding remarks on the genitalia of Noctuina.

The copulatory organs have attained considerable specialization in this group and this is specially evident in the family Noctuidae. The vinculum is 'U' or 'V' shaped. The valvae are usually very complicated and show a division into distinct cucullus and sacculus. Accessory prehensile structures like the harpe and the ampulla are also borne on them. The tegumen is usually broad and develops a broad peniculus on each side (*e.g.*, Noctuidae). The uncus is prominent structure and assumes variable shape—a character very useful in taxomomy. A gnathos may be present or absent. The penis is usually long and the cornuti may be in the form of long spines or sharp denticles.

Superfamily PAPILIONINA.

Family HESPERIIDAE.

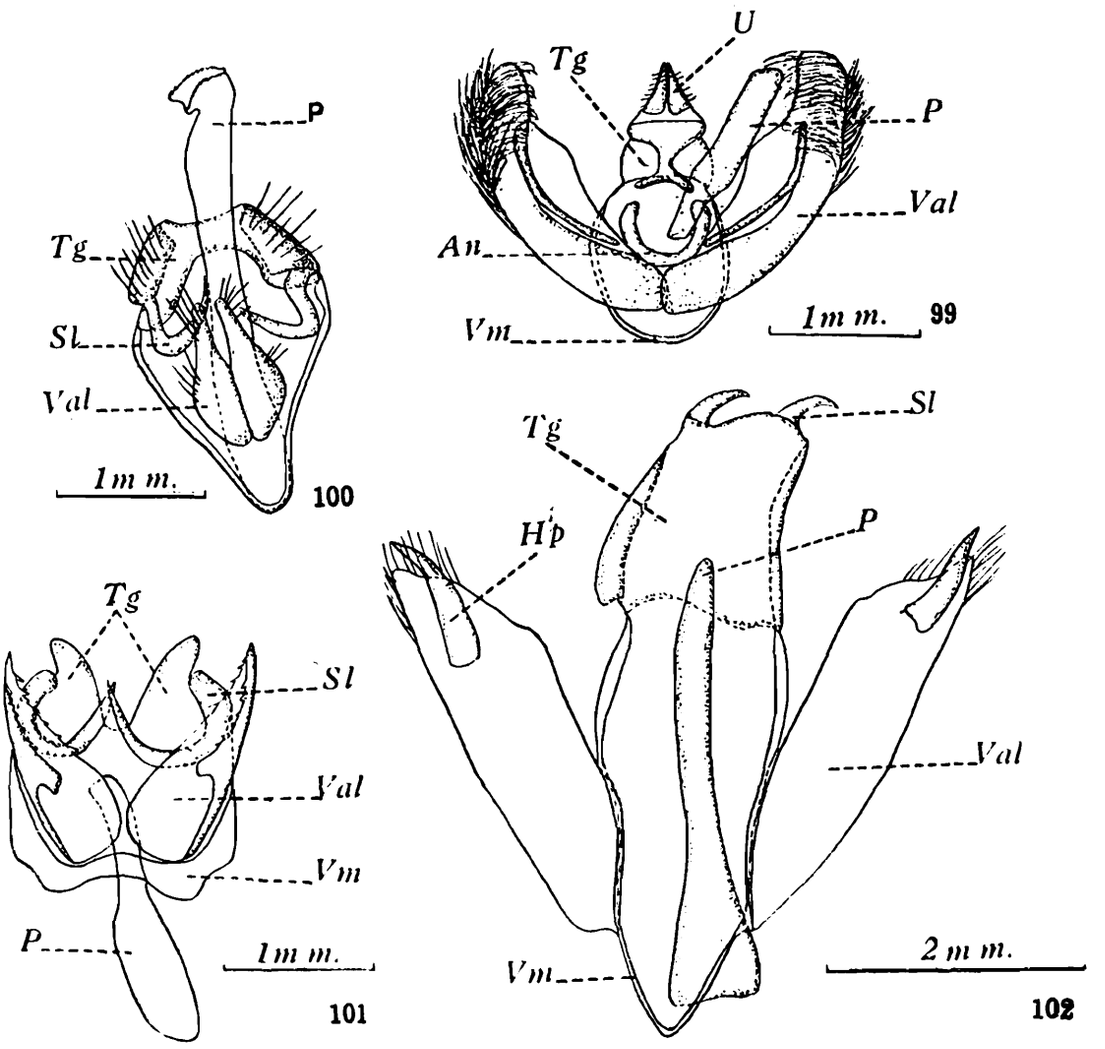
Valvae simple, usually broad (e.g., *Pamphila sylvanoides* Edw. *Pamphila agricola* Bdv.; *Hylephila phyleus* Drury.), costal margin produced into curved, peg-like process, apical margin dentate (e.g., *Catia otho* Sm. & Abbot.).

Valvae complex (e.g., *Hesperia notata* Plotz.) with an inner membranous and outer (anal), more heavily chitinized part. A basally directed process hangs freely from the costal margin. A costal fold sometimes runs along the inner, mesial surface of the valvae ending in spine-like processes near the apex (e.g., *Atalopedes mesogramma* Latr.; *Atrytone melane* Edw.; *Systasea erosus* Hubn.). Tegumen broad, more or less saddle-shaped with pair of terminal lobes which may be small (e.g., *Atalopedes mesogramma* Latr.; *Cogia calchas* Herr-Sch.), or long, erect (e.g., *Atrytone melane* Edw.; *Pamphila sylvanoides* Edw.; *Eudamus proteus* Linn.; *Systasea erosus* Hubn.; *Pamphila agricola* Bdv.; *Hesperia notata* Plotz.). The lobes coalesce into a single, median lobe in *Atalopedes mesogramma* Latr. Sometimes it is long and straight, apparently homologous with the uncus (Gosse) (e.g., *Ceratrichia flava* Murr.; *Thymelicus athenion* Hubn.; *Limochares baracoa* Lucas; *Adopaea christi* Rbl.). Side lobes usually present, long or curved and very prominent. Vinculum 'U' or 'V' shaped. Saccus usually present, very long (e.g., *Adopaea thaumas* Hubn.; *Adopaea christi* Rbl.); absent in *Cogia calchas* Herr-Sch.; *Systasea erosus* Hubn.; *Hesperia notata* Plotz.

Penis long, usually straight with apical cluster of cornuti. Juxta sometimes present. Anellus distinct.

Species examined. Polites vibex Hubn.; *Thymelicus vibex* Hubn.; *Ceratrichia flava* Murr.; *Thymelicus athenion* Hubn.; *Pamphila sylvanoides* Edw.; *Pamphila agricola* Bdv.; *Hylephila phyleus* Drury.;

Hesperia Sp.; *Adopaea thaumas* Hubn. (Text-fig. 98); *Limochares boracoa* Lucas.; *Catia otho* Sm. & Abbot.; *Atalopedes mesogramma* Latr.; *Atrytone hobomok* Harr.; *Choranthus radians* Luc.; *Eudamus proteus* Linn.; *Adopaea christi* Rbl.; *Hesperia syrichthus* Fabr.; *Cogia*



TEXT-FIG. 99.—*Hesperia notata* Plotz.
TEXT-FIG. 100.—*Rapala lazulina* Moore.
TEXT-FIG. 101.—*Loxura atymnus* Cram.
TEXT-FIG. 102.—*Parnassius epaphus* Bdv.

calchas Herr-Sch.; *Systasea erosus* Hubn.; *Hesperia notata* Plotz. (Text-fig. 99); *Atrytone melane* Edw.

Family LYCAENIDAE.

The genitalia are withdrawn into the abdomen, and in *Rapala melampus* Cram.; extend as far as the IV abdominal sternite, sometimes deeply notched medially, partly enclosing the genitalia.

Valvae simple, usually broad, costal margin sometimes notched near apex or raised into a prominence. Apical process curved, apical margin dentate in *Lampides boeticus* Linn.; *Zizera lysinion* Hubn.; *Horsfieldia anita* Hew.; *Chrysophanus alciphron* Rott. Valvae sometimes reduced (e.g., *Rapala lazulina* Moore.; *Hypolycaena erylus* Godt.; *Surendra quercetorum* Moore; *Virachola isocrates* Fabr.; *Eumaeus minyas* Hubn.). Sacculii in such cases fused on costal margin, cucullus free, narrow and straight.

Tegumen broad, usually developed into lateral lobes (terminal) by a deep distal convexity. No well defined uncus present. At the base of these lobes, more on latero-ventral line arise paired long, curved spine-like processes called the " Side lobes " (B. White, 1876). These may be homologized with processes similarly situated on the tegumen in Heterocera and called " Socii " (Pierce, 1914). Vinculum ' U ' shaped usually broad. Saccus usually absent.

Penis usually long, cornuti present on the orifice. Anellus distinct.

Species examined. Horsfieldia anita Hew.; *Rapala melampus* Cram.; *Virachola isocrates* Fabr.; *Chrysophanus alciphron* Rott.; *Thecla pholus* Cram.; *Eumaeus minyas* Hub.; *Chilades trochilus* Frey.; *Lycaena acmon* Westw. & Hew.; *Cupido sagittigera* Fel.; *Uranothauma falkensteini* Dew.; *Tarucus telicanus* Lang.; *Lampides boeticus* Linn.; *Lycaenesthes larydas* Cram.; *Axiocerses harpax* Fabr.; *Zizera lysinion* Hubn.; *Zeltus etolus* Fabr.; *Rapala lazulina* Moore (Text-fig. 100); *Spindasis lohita* Horsf.; *Catochrysops cnejus* Fabr.; *Amblypodia amantes* Hew.; *Hypolycaena erylus* Godt.; *Surendra quercetorum* Moore; *Loxura atymnus* Cram. (Text-fig. 101); *Spindasis ictis* Hew.; *Zesius chrysomallus* Hubn.; *Iraota timoleon* Stoll.

Family PAPILIONIDAE.

Valvae simple, broad or elongated, usually with well developed heavily chitinized harpe.

Tegumen broad, uncus slender, acuminate (e.g., *Papilio demoleus* Linn.), slightly curved (e.g., *Eurycus cressida* Fabr.). A pair of side lobes present in *Parnassius epaphus* Bdv., and *Eurycus cressida* Fabr. Scaphium of Gosse (Supra-anal process) well developed in the Papilionidae, central lip divided (e.g., *Papilio demoleus* Linn.). Vinculum ' U '-shaped.

Penis long and stout. Anellus lobes often present, absent in *Parnassius epaphus* Bdv.

Species examined. Parnassius epaphus Bdv. (Text-fig. 102); *Papilio demoleus* Linn.; *Eurycus cressida* Fabr.

Family NYMPHALIDAE.

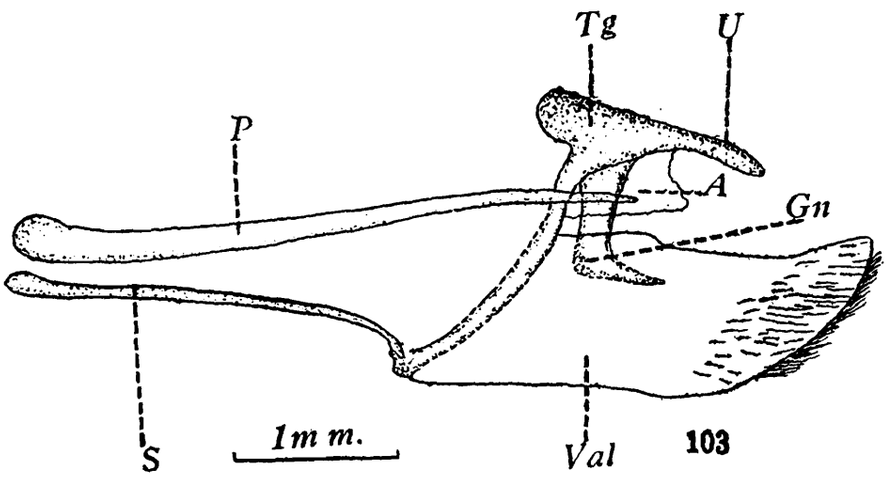
Valvae usually simple, broad and elongate, sometimes with broad sacculus and narrow curved cucullus (e.g., *Symbrenthia niphanda* Moore). Costal margin sinuate in valvae of *Argynnis pales* Schiff.; and produced into tall, curved process in *Cynthia erota* Fabr.; *Cupha erymanthis* Drury. Apex sometimes with lateral and terminal processes (e.g., *Pyrameis cardui* Linn.; *Parhestina persimilis* Westw.; *Araschnia levana* Linn.). Harpe often well developed (e.g., *Antanartia hippomene* Hubn.), club-shaped (e.g., *Callinaga lhatso* Oberth.).

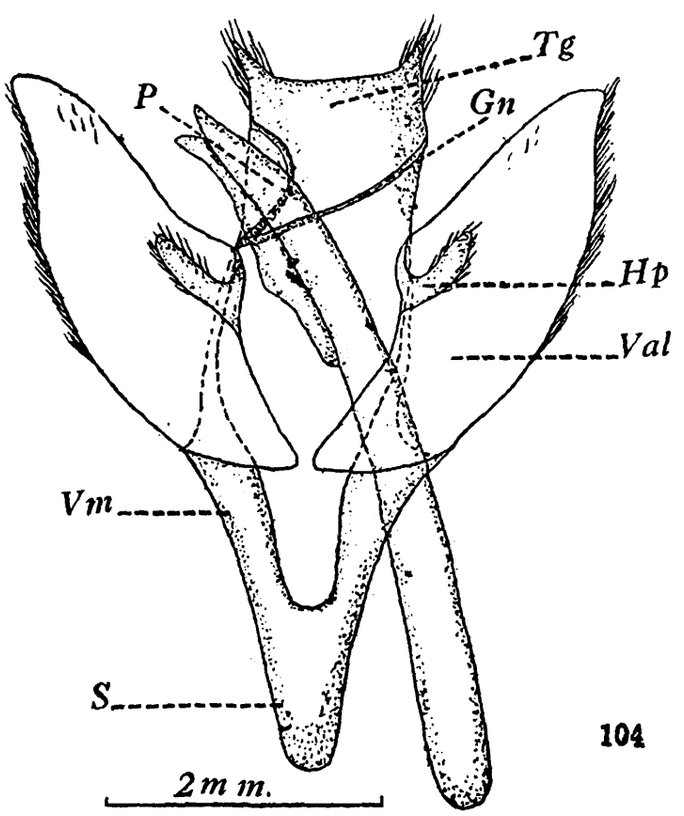
Tegumen broad, sometimes it develops terminal lobes by a distal convexity as in the Lycaenidae (e.g., *Charaxes polyxena* Cram.; *Charaxes etheocles* Cram.). Uncus long, tapered or reduced (e.g., *Eulepis athamas* Drury.). Gnathos usually present. Central lip curved, the arms arising from the base of the uncus. Saccus often present and very long. In such cases it extends to the VI abdominal somite (e.g., *Rohana parisatis* Westw.; *Apatura ilia* Linn.; *Dilipa morgiana* Westw.;

Helchyra hemina Hew.). Absent in *Vanessa polychloros* Linn. and *Cupha erymanthis* Drury.

Penis usually of moderate length but sometimes it is very long and runs almost parallel to the saccus and extends as far as the fifth abdominal segment. Cornuti variable. Anellus usually distinct.

Species examined. Rohana parisatis Westw. (Text-fig. 103); *Neptis vermona* Moore; *Vanessa polychloros* Linn.; *Euthalia lepidea* Butl.; *Euthalia magnolia* Stgr.; *Symbrenthia niphanda* Moore; *Pyrameis cardui* Linn.; *Antanartia hippomene* Hubn.; *Argynnis pales* Schiff.;



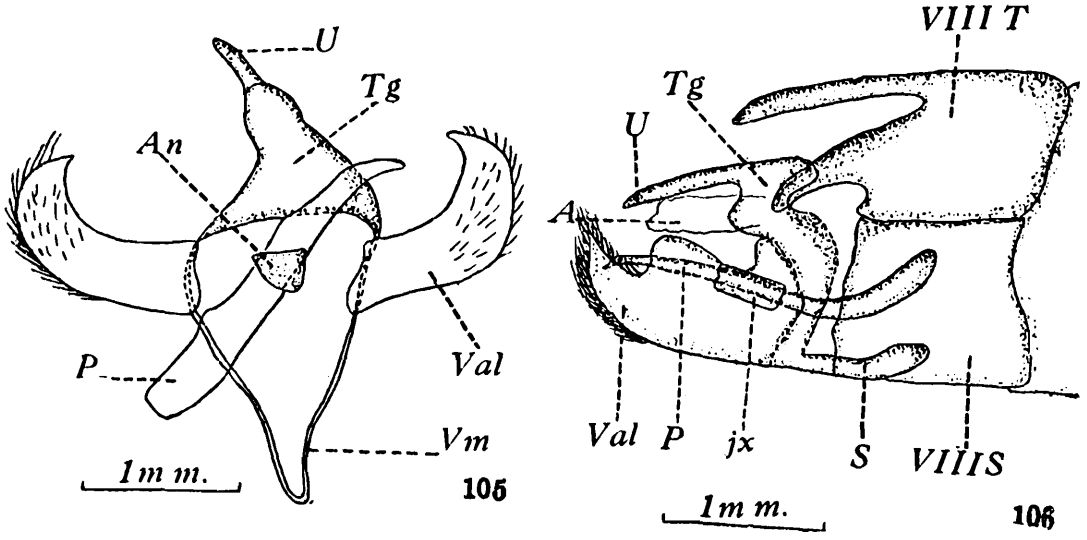


Text-fig. 103.—*Rohana parisatis* Westw.

Text-fig. 104.—*Charaxes polyxena* Cram.

Eulepis athamas Drury.; *Charaxes polyxena* Cram. (Text-fig. 104); *Charaxes etheocles* Cram.; *Cynthia erota* Fabr.; *Apatura ambica* Koll.; *Apatura ilia* Linn.; *Dilipa morgiana* Westw.; *Helcyra hemina* Hew.; *Parhestina persimilis* Westw.; *Cupha erymanthis* Drury.; *Precis almana* Linn.; *Araschnia levana* Linn.; *Actinote hylonome* Dbl.; *Acraea uvui*

Gr.-Sm. ; *Acraea perenna* Dbl. ; *Acraea encedon* Linn. ; *Acraea bonasia* Fab. (Text-fig. 105) ; *Pseudergolis wedah* Kott. ; *Calinaga lhatso* Oberth.



TEXT-FIG. 105.—*Acraea bonasia* Feb.
TEXT-FIG. 106.—*Libythea myrrha* Godt.

Family LIBYTHEIDAE.

Eighth abdominal tergite emarginate and produced into lateral processes.

Valvae broad, usually with a costal bulb and pointed apex.

Tegumen with long acuminate and depressed uncus. Saccus long.

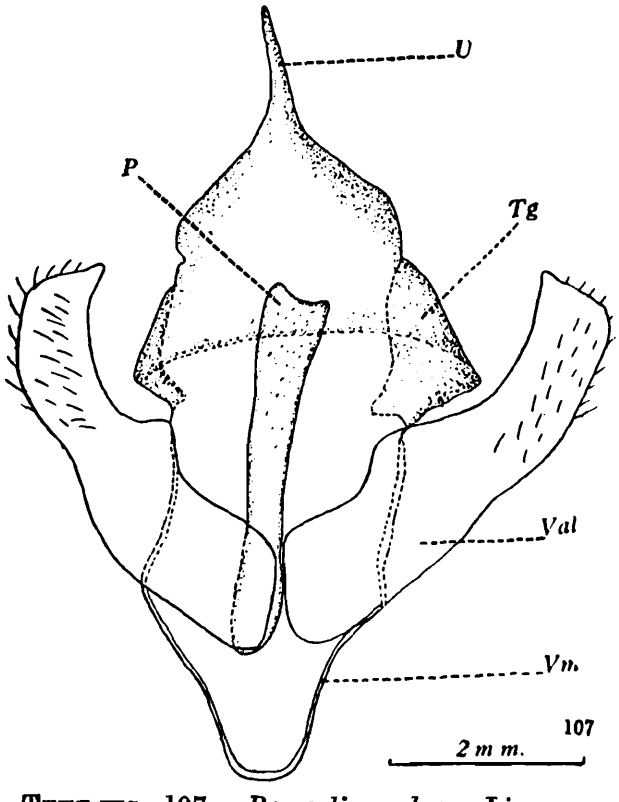
Penis long, curved. Cornuti absent.

Species examined. *Libythea myrrha* Godt. (Text-fig. 106) ; *Libythea celtis* Esp. ; *Libythea lepita* Moore.

Family BRASSOLIDAE.

Valvae simple, long, apex curved.

Tegumen broad. Uncus straight. Vinculum broadly ' V ' shaped.



TEXT-FIG. 107.—*Brassolis sophorae* Linn.

Penis long and straight.

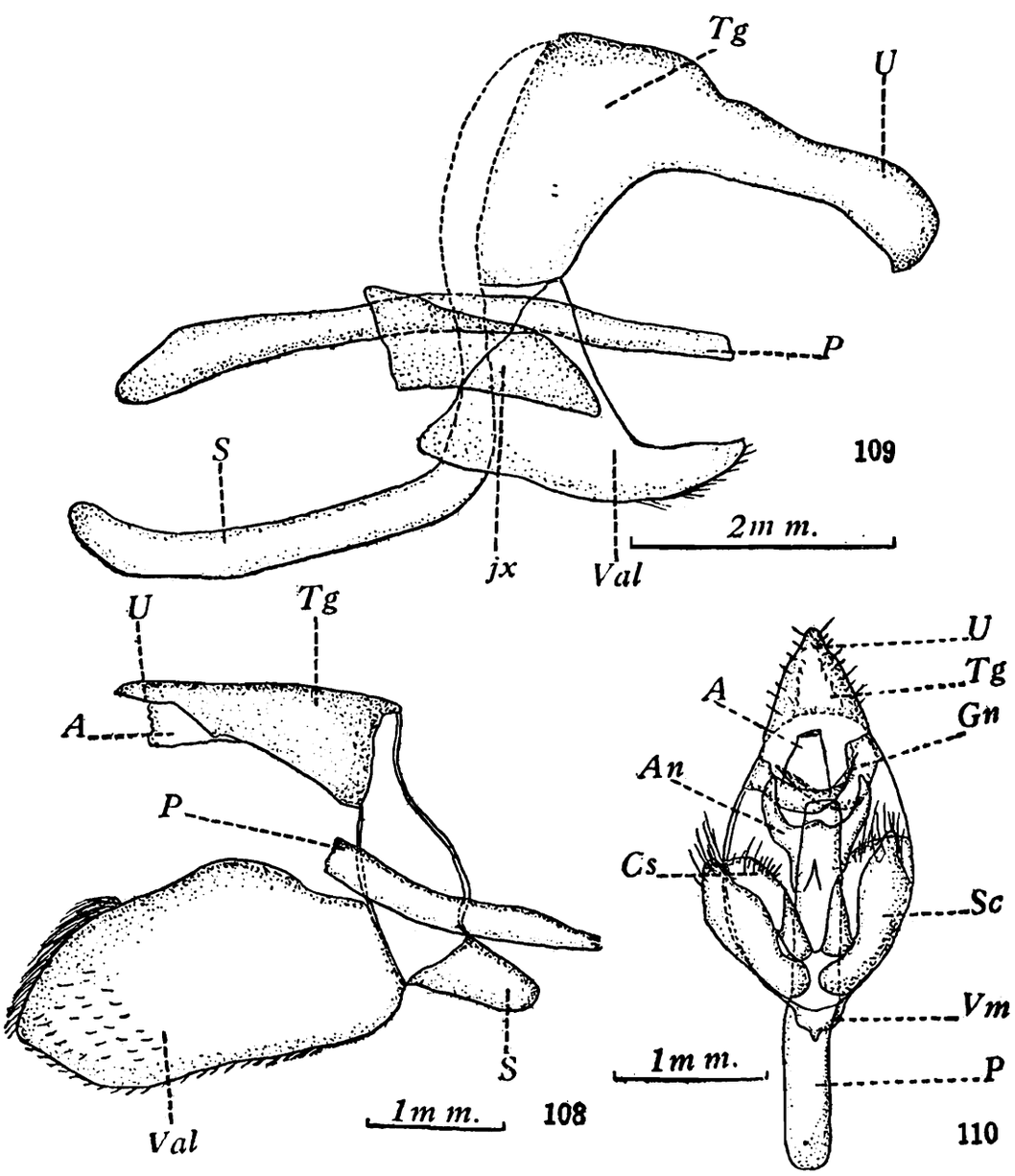
Species examined. *Brassolis sophorae* Linn. (Text-fig. 107).

Family PIERIDAE.

Valvae simple, very broad, harpe well developed, digitate (e.g., *Terias hecabe* Linn.); costal margin fused. Cucullus narrow (e.g., *Delias* sp.).

Tegumen broad. Uncus acuminate. Saccus short.

Penis long, slightly bent or with basal digitate processes (e.g., *Appias nero* Fabr.). Cornuti variable.



TEXT-FIG. 108.—*Pieris rapae* Linn.

TEXT-FIG. 109.—*Enispe cycnus* D. W. & H.

TEXT-FIG. 110.—*Abisara fylla* Moore.

Species examined. *Terias hecabe* Linn.; *Delias* sp.; *Delias caenius* Linn.; *Teracolus halimede* Klug.; *Appias nero* Fabr.; *Delias belladona* Fab.; *Nychitona nina* Fabr.; *Pieris rapae* Linn. (Text-fig. 108).

Family AMATHUSIIDAE.

Valvae simple, broad. Apical process long. Costal margin irregular, produced into an inner process. Apex spinose (e.g., *Tenaris honrathi* Stgr.).

Tegumen broad, usually with a long beak-like uncus. A pair of lateral processes sometimes arise from the tegumen. Saccus long.

Penis very long and in *Enispe cycnus* D. W & H. ; reaches the VI abdominal segment. Juxta plate well developed.

Species examined. Discophora tullia Moore ; *Enispe cycnus* D. W & H. (Text-fig. 109) ; *Tenaris honrathi* Stgr.

Family NEMEOBIIDAE.

Valvae simple, short and broad. Sometimes with chitinous fold on anal margin which is terminally produced into lobiform process (e.g., *Abisara fylla* Moore).

Tegumen broad. Uncus distinct. Gnathos with free curved arms. Saccus reduced.

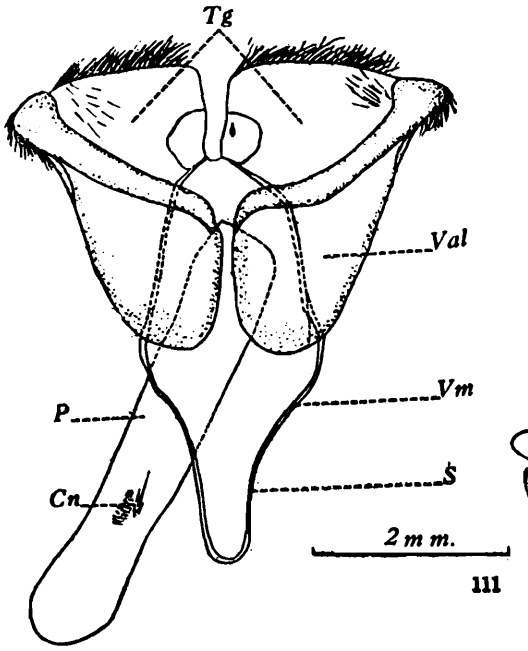
Penis long and straight. Cornuti present. Anellus lobes well developed.

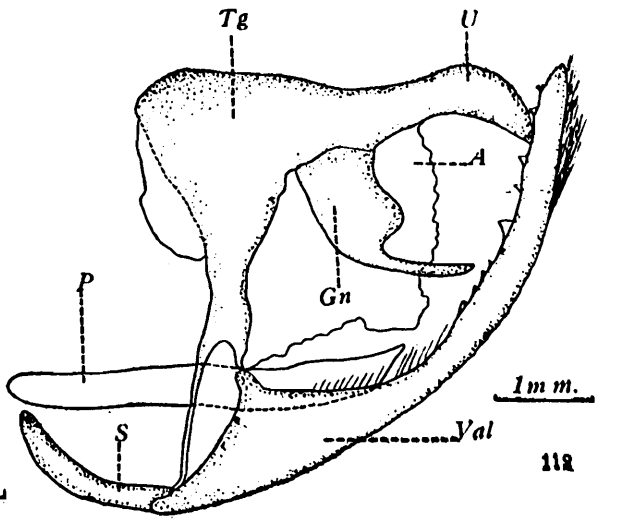
Species examined. Abisara fylla Moore (Text-fig. 110) ; *Dodona durga* Koll. ; *Dodona ouida* Moore.

Family DANAIDAE.

Pencils of hair characteristically present.

Valvae simple, very broad, sacculus angulate (e.g., *Radena similis* Linn.). Apex produced (e.g., *Danais archippus* Fabr.). Harpe thick set with dentate process (e.g., *Lycorea ceres* Cram.).





TEXT-FIG. 111.—*Euploea mulciber* Cram.
TEXT-FIG. 112.—*Caligo oileus* Feld.

Tegumen broad. Uncus usually hood-shaped, reduced or absent. Vinculum ' V '-shaped. Saccus long.

Penis well developed, usually long. Cornuti present.

Species examined. *Danais archippus* Fabr.; *Euploea mulciber* Cram. (Text-fig. 111); *Lycorea ceres* Cram.; *Radena similis* Linn.

Family Morphidae.

Valvae long, narrow, costal margin sparsely dentate.

Tegumen broad. Uncus depressed. Gnathos with two curved free processes. Saccus curved.

Penis long and stout.

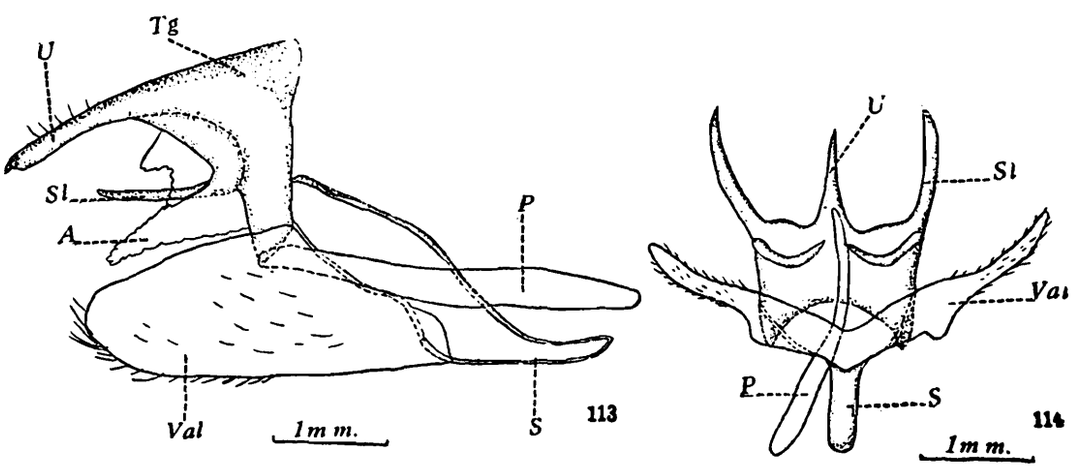
Species examined. *Caligo oileus* Feld. (Text-fig. 112).

Family Satyridae.

Valvae simple, usually elongate or broad.

Tegumen broad. Uncus long, pointed at the apex, or curved (e.g., *Lethe diana* Butl.). A pair of long processes arise from the tegumen and have been termed 'Side lobes' by White (1876) in *Caenonympha*, but as these are ventral to the anal tube, the homology does not stand. Also in *Mycalesis anapita* Moore, besides similarly placed processes, there exists another pair of such organs arising from the tegumen dorsal to the anal tube. These are the 'side lobes'. Saccus present and usually long.

Penis long and slightly bent.



Text-fig. 113.—*Elymnias singhala* Moore.
Text-fig. 114.—*Mycalesis anapita* Moore.

Species examined. *Elymnias singhala* Moore (Text-fig. 113); *Elymnias hypermnestra* Linn.; *Melanitis leda* Linn.; *Ypthima argus* Butl., *Lethe diana* Butl.; *Mycalsis anapita* Moore (Text-fig. 114).

Concluding remarks on the genitalia of Papilionina.

This group possesses genitalia of a character which differs from the Heterocera in the form of the tegumen and its appendages. The ninth sternite is a chitinized band, more or less 'U' or 'V' shaped, and a long saccus is often developed. The valvae are simple and develop a harpe. The tegumen often bears a pair of side lobes which are charac-

teristic of this superfamily. The uncus and the gnathos are well developed. The penis is long and develops several cornuti which may be in the form of long spines or sharp denticles. A large anellus or juxta is often present.

Conclusions in Phylogeny.

It is now generally agreed that the Order Lepidoptera is naturally divisible into two Sub-orders, *e.g.*, Homoneura and Heteroneura, separable by important anatomical characters. In the Homoneura or Jugatae (Comstock), the neuration of both wings is substantially the same, a jugum is developed at the base of the dorsum of the forewing and a spiral proboscis is absent. The Heteroneura are characterized by a reduction of the redial sector to a single vein in the hind wing, presence of a frenulum, and a usually spiral proboscis.

The Homoneura present considerable similarity to the Trichoptera, particularly in the head capsule, character of the mouth parts, the nature of the thoracic sclerites, the wing venation and the presence of a coupling apparatus of the primitive jugo-frenate type, the general character of the terminal abdominal structures and the occurrence of moss-inhabiting larvae. (Crampton, 1920, Braun, 1919). The nature of this alliance is controversial and it is believed that, either the Lepidoptera have descended by way of the Micropterygides directly from the Trichoptera or that Trichoptera and Lepidoptera have arisen from a common ancestor. Recent researches seem to favour the latter idea and Tillyard (1918) has shown that Lepidoptera could be traced back to the Protomecopterous or some similar extinct type.

By common consent the family Micropterygidae is regarded as the most primitive of the Lepidoptera and *Sabatinca* is generally admitted to be the most archaic genus of the family. The evidence accumulated in this direction has been chiefly derived from study of the characters of the egg (Chapman, 1896), caterpillar (Dyar, 1895, and Fracker, 1915), pupa (Chapman, 1896 and Mosher, 1916) and the imago. The most reliable conclusions have been arrived at by working out the wing-venation (Meyrick, 1895, 1927, Hampson, 1898-1920, Tillyard, 1918, 1919 and others) while the scales or aculeae (Kellog, 1895, Comstock, 1925), the wing-coupling apparatus (Comstock) and mouth parts (Packard, 1895) have afforded more or less confirmatory evidence. Quite recently Eyer (1924) and Philpott (1924, 1926) have also held that the Micropterygidae possess a primitive type of male genitalia comparable to that in Mnesarchaeidae, Eriocraniidae, Prototheoridae and the Hepialidae. Eyer (1924) has shown that the male genitalia of the Prototheoridae resemble those of the Hepialidae while the Mnesarchaeidae are intermediate in their structure between the Hepialidae and the Micropterygidae, Eriocraniidae and the Aculeate Tineoidea.

In the possession of a hooded tegumen, the large and broad vinculum, the membranous penis with lightly chitinized juxta and almost general absence of the uncus, gnathos and saccus, I regard the Homoneura as primitive because these organs are here presented in their simplest

form, being very similar to the corresponding organs in the Trichoptera, Mecoptera and Neuroptera. The Micropterygidae appear to be the earliest members of this group and the genitalia in *Sabatinca* (Philpott, 1923) are of the most generalized type as is shown by the presence of the greatly enlarged ninth sternite, hood-shaped tegumen, simple valvae and lightly chitinized penis. The Mnesarchaeidae, according to Eyer (1924) possess the usual characters found in the Micropterygidae, and in the absence of a tube-like aedeagus and the form of the vinculum they resemble the Hepialidae. The genitalia in the family Prototheoridae are comparable to those in the Hepialidae and they together differ from the genitalia of the other Homoneura in the valvae being divided ; a short saccus is sometimes provided to the vinculum, the trulleum is present and the penis is not tubular. This line of specialization in the copulatory organs may be correlated with the more active habits of the males in these families. The Eriocraniidae, though more specialized in the mouth parts and wing venation, present no genitalic features specially marking them from other Homoneura.

The Superfamily Tineina has been divided by Comstock (1925) into two groups which are distinguished by the presence or absence of aculeae. In the Aculeate category are included the families Lamproniadae (Incurvariidae), Adelidae and the Nepticulidae. The genitalia in this group are typically primitive and resemble the similar organs in the Eriocraniidae. This does not, however, necessarily suggest that the Aculeate Tineina are directly derived from this family, but certainly it does emphasize their close relationship. Possibly both have followed a similar line of descent. Amongst the Non-Aculeate families of Tineina there is evident a slow though marked differentiation and development of parts in the male genitalia, yet the organs can hardly be called specialized. The Heliozelidae have retained a primitive type of genital armature very similar to the Aculeate Tineina. The Plutellidae in the possession of a large gnathos come next, while the other families exhibit a greater development of these organs. In the rest of Tineina the uncus is marked, socii and gnathos are present and saccus is well developed. This group forms the base from which the superfamilies Tortricina, Pyralidina and Psychina are probably derived.

The Tortricina are a compact group with Tineid affinities. Thus members of the family Carposinidae in the latter group possess genitalia more or less identical with those in the tortricid family Phaloniadae. The tegumen is broad with a short uncus, socii are well developed, and the valvae are simple with an erect transtilla. The families Eucosmidae and Tortricidae also exhibit these features, though they are more advanced in some respects, *viz.*, in the development of uncus and gnathos and complex valvae.

In the male genitalia, the superfamily Pyralidina resembles the Tineina. The moths of the family Pyralidae typically possess a long uncus, and a large gnathos with elongated central lip ; the valvae simple and harpe sometimes present. The penis bears a variable number of cornuti. Minor deviations from this type are noticed in the different sub-families. The Galleriinae possess a hood-shaped uncus recalling the Tineid condition and the gnathos is absent. In this respect they

are widely separated from the rest of the Pyralidae. In the Anerastiinae the uncus is divided into lateral horns and a large gnathos is present.

The Pterophoridae have a comparatively simple type of male genitalia similar to that in the Pyralidae.

The Thyrididae, though related to the Pyralidae, possess a very advanced type of male genitalia with a well developed uncus which is often broad and produced into paired lateral and terminal lobes or processes. Besides this another supra-anal process arises from the base of the uncus. The gnathos is large, with the two brachia joined to form a loop, the central lip being poorly developed. Meyrick (1927) believes that the " Pyralidina has for its earliest existing form the Thyrididae " The extreme specialization of the genital armature does not support this, nor can one reasonably derive the four segmented palp in the maxillae of the Pyralidae from the Thyrididae with at most a two segmented organ. (Philpott, 1927 ; also refer to ' Meyrick's Law ', 1895).

The Psychina are an ancient group and the family Psychidae exhibits some primitive features in the male genitalia and in this respect is related to the Tineina. The uncus is reduced and the tegumen more or less hood-shaped. The vinculum is large and the valvae remain simple. The penis is often very long with well developed anellus lobes. The possession of these characters by the Zygaenidae and the Psychidae points to the close relationship of these families. The Lacosomidae, however, are of uncertain affinity. The Megalopygidae, on account of a simple tegumen, short uncus, and a prominent gnathos are probably related to the family Limacodidae. The Cossidae possess a simple type of male genital armature. The tegumen is triangular and the uncus is well developed. They resemble the Castniidae in this respect. The Cossidae, notably in the venation, are one of the most primitive families of Lepidoptera. Forbes (1923) believed that they form the base of a series leading directly to the butterflies, yet the only definite butterfly character in this family is the upright egg of the Cossinae. The genitalia, however, lend support to Forbes' theory, for in the Castniidae the tegumen has the triangular shape with hind margin more or less concave, the uncus is tapered and a long penis is present ; all these features are in common with several of the Papilionina.

The Lasiocampina are probably derived from the Psychina, though little evidence is afforded by genitalia in the forms studied. The Lasiocampidae possess genitalia very similar to those of the family Eupterotidae (Notodontina) especially in the form of the valvae, a hood-shaped or reduced uncus and presence of terminal lobes on the tegumen. The resemblance in the larvae of Lasiocampidae and Eupterotidae has been previously described by Dyar in 1895.

The Notodontina perhaps originate from the Lasiocampina as has been indicated by the similarity in copulatory organs between the Lasiocampidae and some of the Geometridae and Eupterotidae. Extreme specialization of these organs is emphasized in the Geometridae Gnathoi and the family Hydriomenidae. Meyrick (1927) held that

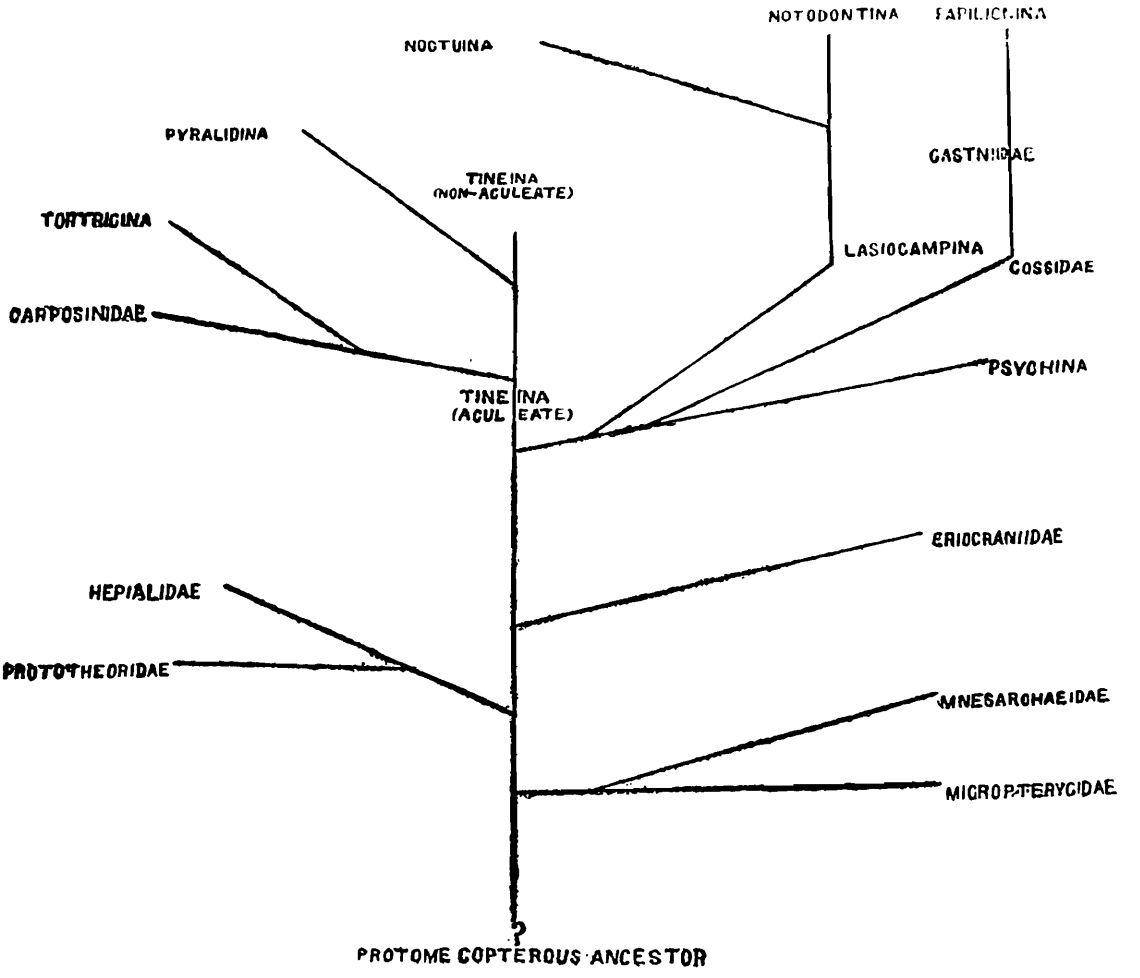
" The Notodontidae and Sphingidae are correlated offshoots from an early form of the line and the Polyplocidae are derived from near the same point " Apparently the copulatory organs in these families are similar and of an advanced type as is indicated by the massive development of the uncus and the gnathos, the transtillae and the valvae.

The genital armature in the Noctuina follows similar lines of specialization, *e.g.*, presence of harpe, ampulla and such other prehensile processes corresponding to the harpe, labides, etc., as in the Notodontid family Geometridae. It is very difficult to say whether they are derived from the latter group (Hampson, 1898) or (as according to Meyrick, 1927), " whether they form another great branch of equally fixed type developing parallel with the Notodontina " The families Hypsidae, Ocneriadae, Arctiadae, Agaristidae, Hylophilidae and Syntomidae have relatively simple genitalia, and the gnathos as a rule is wanting. As we pass on to the family Noctuidae gradually specialization is attained, and the genitalia become complex. In this connection, the valvae show complexity of form, and division into sacculus and cucullus is evident. The peculiar prehensile organs like the harpe, ampulla, clavus, etc., are present. The uncus is large and assumes variable form. The tegumen is often provided with a large hairy peniculus on either side.

Opinions vary as to the probable line of descent of the Papilionina. Packard (1895), Forbes (1923) and others derive them from the family Castniidae. Hampson (1898) traces them from the Zygaenidae and Meyrick (1927) states that " They are referable in origin to the neighbourhood of Callidulidae " The relationship between the general plan of the male genitalia in the families Cossidae, Castniidae and Papilionina is fairly evident. The form of the tegumen and the uncus is characteristically similar while a large gnathos and a relatively long penis also emphasize their close affinity. Besides this, Forbes (1923) has suggested " That in the Castniidae the tongue which is lost in the Cossidae is preserved, the habits have become butterfly-like, the upper fork of Media is lost, the wings have become ample and the cell is relatively small, and the antennae are clubbed ".

The genitalia in the families Hesperiidae and Lycaenidae resemble one another, and are characterized by the presence of side lobes or socii, and a long penis with terminal cornuti. The latter appears to be connected with the Papilionidae through the species *Parnassius epaphus*, a Papilionid which possesses the side lobes characteristic of the Lycaenid type. In the same way the relationship between the Lycaenidae and Nymphalidae is substantiated through the intermedium of the species *Charaxes polyxena* which also possesses a similar set of these organs. The Pieridae possess simple valvae, and a long uncus, and in this respect they resemble the Brassolidae. The Libytheidae, in the presence of a long penis and saccus resemble the Nymphalidae. The other families of Papilionina are also interrelated as is indicated by an almost similar plan of the genital armature. In all such cases the uncus is usually long, a large gnathos is present, the valvae are simple flap-like expansions, and in the family Satyridae a pair of side lobes is also present on the tegumen.

The interrelationships between the various groups of Lepidoptera, as based on a study of the male genitalia, are expressed, in the form of a phylogenetic tree which is reproduced below.



SUMMARY.

In the absence of any sound system of nomenclature for the description of male genitalia in Lepidoptera, a scheme on a priority basis is presented in this memoir.

A comparative account dealing with the morphology of male genitalia is given and the various families in the Systematic part are grouped chiefly on the basis of specialization.

It has long been recognised that the male genitalia offer useful characters for the discrimination of genera and species but hitherto there has been considerable scepticism regarding their value for establishing phylogenetic relationships. It has been possible to show in this study that the male copulatory organs in the superfamilies of Lepidoptera, present definite structural homologies prominent enough to bring out their mutual affinities.

The Homoneura possess a decidedly primitive type of male genitalia and the families in this group are interrelated on these characters.

The Aculeate Tineina with the genitalia similar to the family Eriocraniidae are perhaps related to them. From the Non-aculeate stem of the Tineina are derived the superfamilies Tortricina, Pyralidina and Psychina.

The Lasiocampina are referable in origin to the Psychina. The Notodontina present certain close affinities with the family Lasiocampidae, and are probably derived from this group.

The extreme specialization of corresponding parts in the male genitalia of the superfamilies Notodontina and Noctuina are very suggestive of their close relationship.

The Papilionina present certain peculiarities in the genital armature which are much in common with those of the Castniidae and the Cossidae. Since the other butterfly characters are also indicated in these two families of Psychina, their affinities with Papilionina are all the more emphasized.

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