

## ON THE MALE GENITALIA OF THE MICROLEPIDOPTERA AND THEIR SYSTEMATIC IMPORTANCE.

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In recent papers we have applied certain terms in defining the genitalia structure which it is our intention to use in subsequent treatment of the various Micro families. These are based on careful morphological studies of many forms and a homology of the parts in their various and often puzzling modifications. While we have considered mainly the Microlepidoptera our studies have included the Macro groups also and to them the nomenclature applies equally well. We have not conformed to strict priority in choice of names but have adopted the terms which seemed most appropriate and at the same time most generally accepted by Lepidopterists.<sup>1</sup>

In the structure of the genitalia are involved two segments of the abdomen (the 9th and 10th) aside from occasional modifications of the 8th.<sup>2</sup>

The exact defining limits of these two segments are not determinable; but the general structure, homologized with the locations of corresponding openings in the pupa, clearly indicate that the chitinized structures surrounding the genital opening are developments of sclerites of the 9th abdominal segment and that the chitinizations surrounding the anal opening are developed from the 10th.

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<sup>1</sup>Since John B. Smith has been the first to make extensive systematic use of the genitalia in Lepidoptera we have where possible used his terms in preference to others. For this reason we have not followed the suggestion of Dr. McDunnough in his excellent paper on the terminology of these parts (*Can. Ent.*, vol. 43, 1911, pp. 181-189.)

<sup>2</sup>Different homologies have been suggested by other authors. Some following Berlese have included an eleventh abdominal segment in the genitalia. In a recent paper by Mr. John R. Eyer (*Bul. Brook Ent. Soc.*, vol. 16, 1921, pp. 1-8) certain of the structure we refer to the 9th segment (harpes, vinculum and aedoeagus) are considered as belonging to the 8th and 10th respectively, while others which form their close association with the anal opening (socii) we consider as developments of the 10th segment are considered by him as belonging to the 9th. Such homologies do not seem to harmonize with the position of the genital and anal openings and armature of the pupa. Again we are unable to find any indication of an 11th abdominal segment in any Lepidopterous larva or pupa and the hypothesis of such an additional segment in the adult moth is at least unnecessary to a definition of the various parts of the genitalia structure and their homology within the Lepidoptera.

Our purpose, however, is not primarily the homology of the genital parts with particular sclerites or somites, but a homology of the structures as they are developed within the order Lepidoptera and a definition which will enable satisfactory application to Taxonomy.

In the lepidopterous genitalia all or most of the following nine external structures are present and can be differentiated and definitely homologized in the various groups however modified they may be.

#### **Vinculum (Vm).**

The vinculum is a ventral chitinized band articulating at its dorsal extremities with the tegumen. It is usually a simple narrow band but may be divided in the middle ventrally (ex. *Ellopiia*) or extended into an anteriorly projecting process (ex. many *Gelechiidae* and *Plutellidae*). This and the following four structures are formed from sclerites of the ninth abdominal segment.

#### **Anellus (An).**

The anellus is a small, more or less triangular plate situated within the ventral angle of the vinculum and supporting the aedoeagus. This support may be affected in various ways; the anellus may be a mere plate with a hole (ex. *Hemerophila*) or situation in which the aedoeagus rests (ex. *Xyloricta*); or it may partially surround the aedoeagus as a chitinous cylinder (ex. *Cerostoma*) or semi-cylinder (ex. *Borkhausenia conia*) or from the plate an arm may be developed on which the aedoeagus is supported and pivoted (ex. *Olethreutidae*). In some forms the anellus develops various projections or lobes (ex. *Ethmiidae*, *Stenomiidae*). Sometimes the structures are not differentiated, the aedoeagus passing through the unchitinized membrane (ex. some *Helialidae*).

#### **Aedoeagus (Ae).**

The aedoeagus is normally a tube containing and protecting the penis, sometimes so modified as to be merely a ring with a thin extension (ex. many *Blastobasidae*) or more or less split and occasionally developed into finger or thorn-like projections from a tubular base (ex. *Gelechia natalis*). It articulates on the anellus when the latter is present. Sometimes, however, it is merely supported by the membrane of the 9th segment. It may be simple or prolonged into one or more spines or processes at apex (ex. *Gelechia* and *Stenoma*) or be laterally armed with tooth-like projections (ex. *Hystriophora*). Often the posterior end is produced beyond the entrance hole of the penis into a blind sack (ex. *Tortricidae*, *Plutellidae*, etc.). Some authorities have considered the aedoeagus to be but a chitinized part of the penis proper and therefore strictly speaking an internal structure; but we consider it a part of the external structure. As a chitinized part it has always a definite beginning and ending, is always rigid and serves directly as a protective armature and guide to the membranous penis.

Within and for part of its length connected with the aedoeagus lies the penis (P), a soft flexible tube which can be projected by blood pressure far beyond the mouth of the aedoeagus itself. It is usually armed near its tip by one or more spines or thorns, the so-called *cornuti* (Cn) (of Pierce) or "love thorns" (of Rothchild and Jordan). The number, size and shape of these is constant within the species and of great aid in specific differentiation.

#### **Harpes (Hp).**

The harpes are paired lateral claspings organs attached to the vinculum and frequently also articulated on the anellus, occasionally fusing at their base (ex.

certain *Geometridae*); hollow flattened structures of various and diverse shapes subject to extravagant modification; usually symmetrical but not seldom asymmetrical (ex. many *Gelechiidae*, *Gracilariidae*, some *Oecophoriidae*). In most forms three distinct areas can be differentiated: a costal, an apical and a dorsal. These are sometimes defined by actual sutures (as in *Ethmiidae*) indicating that the harpes are compound organs (modified pedal appendages). More often the areas are only defined by heavier chitinization, or inward folding of the edges, or by peculiarities of armature and hairs. These parts have been named respectively, costa (Ca), cucullus (Cs) and sacculus (Sc) (Pierce) which terms we have adopted. They are each subject to various modifications, and one is often developed at the expense of the others; the sacculus and costa having a tendency to develop into free extended arms. Occasionally one of these is so far separated from the rest of the harpes as to form a double harpe structure (Comp. Fig. 4). The so-called *clasper* of Smith prominently developed in the *Noctuidae* is a similar modification of the *sacculus*, being a free extension from the edge near the base. It takes various shapes in different families, is often forked and otherwise highly modified (ex. *Agrotinae*, *Pyraustinae*), and sometimes is represented by a mere thorn-like projection (ex. *Epiblema*, in *Olethreutidae*). Very often it is entirely absent. Similar clasper-like processes (Anl) may often be found arising from the annellus (ex. *Ethmiidae*, *Stenomidae*) and sometimes fusing into the harpes. These must not be confounded with the clasper of the harpes. All of these characters are constant within the species, and furnish excellent aid in the separation of higher groups. In a few groups the harpes are greatly reduced and hardly capable of functioning as clasping organs.

#### **Transtilla (Ts).**

The transtilla is a more or less band-like bridge connecting the harpes at their inner costal angles. Often merely a plain band. Often lobed or sinuated and ornamented with spine clusters. Sometimes attenuated or broken in the middle (ex. *Adoxophyes*) and appearing as free arms from the harpes. These arms may be reduced to mere knobs or spurs (ex. *Olethreutidae* and a few *Tortricidae*). Sometimes the transtilla is entirely absent (ex. *Oecophoridae*, *Blastobasidae* and *Noctuidae*).

#### **Uncus (U).**

This and the following two structures constitute the armature of the anus and therefore belongs to the 10th segment. The uncus is the posterior dorsal projections of the genitalia above the anal opening. It is normally more or less hook like (ex. *Sparganothis*), but may be broadened out (ex. *Gelechia*), spoon shaped (ex. *Pandemis*), trifid (ex. *Ethmia zelleriella*), bifurcate (ex. *Rhopobota*), or otherwise modified. It may be smoothed or haired. Often it is reduced or absent.

#### **Socii (Si).**

The socii are paired organs, normally soft, membranous and hairy; arising from the base of the uncus, more or less lateral to the anal opening. They are of very varied shape; commonly soft, papilla like and drooping (ex. *Eucosma*), sometimes erect (ex. *Harpyteryx*) or flattened or leaf-like (ex. *Sparganothis*),

rarely strongly chitinized (ex. some species in *Epinotia*). They are occasionally more or less fused with gnathos (ex. some *Olethreutidae*) and are frequently rudimentary or absent (ex. *Laspeyresia*).

#### Gnathos (Gn).

The gnathos is a paired organ, ventral to the anus, arising near the base of the uncus below the soci if the latter are present and consisting in its completeness of two lateral arms and a ventral plate (Vp). The arms may be free, more or less tentile and hairy (ex. *Sparganothis*, *Synnoma*). Much more commonly they are fused at their tips into a strongly chitinized, smooth hook or beak-like structure (ex. *Cacoecia*, *Gelechia*), or into a variously modified and ornamented knob (ex. *Coleophora*, *Depresparia*). Occasionally the joined arms are reduced to a mere band (ex. *Holcocera*). The ventral plate (Figs. 2, 3) if present, is situated in a median line immediately below the anus and is more or less fused with the arms when these are present. It may be a broad shield-like structure (ex. *Peronea*) or a narrow chitinous strip along the under side of the alimentary canal (ex. *Pyrausta*, *Cerostoma*). It is sometimes greatly developed and apparently free lying against and covering much of the anal tube; in which case the arms themselves may be absent. It is often absent or not to be differentiated as a distinct part.

The gnathos is subject to very great modification. Rarely it is entirely absent (ex. *Amorbia*, *Coelostathma*).

#### Tegumen (Tg).

The tegumen is really the entire external covering of the 9th and 10th segments which have not been differentiated in the foregoing 8 parts and from which these 8 parts originate as specialized sclerite structures; but specifically it is recognized as the chitinized dorsal part, articulating at its lower extremities with the vinculum and from which arises the uncus, soci and gnathos, the other parts being normally membranous. This chitinized part of tegumen has been considered by many as the tergite of the 9th segment continued ventrally in the vinculum which is recognized as the sternite of the 9th segment. In certain isolated forms a suture just below the base of uncus would seem to substantiate this view; but the structure is normally so fused that it is impossible to differentiate two distinct parts, and we are inclined to consider the entire chitinized tegumen as part of the 10th segment; the 9th segment being greatly reduced and continued dorsally as membrane only.

In several groups the 8th abdominal segment is more or less modified and apparently a part of the genital apparatus, either as a specially chitinized covering (ex. *Gelechia*) or forming a lobed and strongly haired structure closely associated with the genitalia proper (ex. *Pandemis*).

In his presidential address before this society in 1914 the senior author gave in outline the progress of the classification of the Micro-Lepidoptera up to that time and showed how it had culminated in a comprehensive and natural system based fundamentally on venation as conceived and elaborated by Meyrick, who brilliantly utilized the foundations laid by Heirrich-Schaefer.

It was even then realized that while venation is the funda-

mental character upon which our classification must rest, it does not tell the whole story, nor is it alone always sufficient to determine natural groups. Characters of the pupa and larva and genitalia give an added light and a fuller understanding. In fact the seta arrangement in the larva is as fundamental as the venation. As an independent basis for classification it enables sure and accurate group definition and the results correlate with those obtained by venation.

Genitalia on the other hand are subject to such extreme modifications and the group characters are so subtle that unsupported by other characters in the insect, they would not be a safe guide except for specific differentiation; but as an additional factor in the classification they are of considerable significance, enabling clearer and sharper definition and finer division of families and genera.

For example, while the division between the families *Tortricidae* and *Olethreutidae* has always been clearly recognized and their species properly referred, no exact definition between them has been possible on venation or other hitherto considered adult characters. It is a curious coincidence that an attempt should have been made to employ genitalia in the separation of these very families by Fernald and Meyrick and unfortunate that these authors should have hit upon a superficial character—the presence or absence of uncus—which does not hold.<sup>1</sup>

The long standing confusion regarding the family *Xylorictidae* and its present mistaken lumping with the family *Stenomidae* could have been avoided by a consideration of the genitalia. The two represent distinct geographical entities with but few stragglers outside their respective continents, Australia and America, and their genitalia in gross structure and detail (for example the split hairs on the harpes in *Stenomidae*) at once separate the two.

The genus *Setiostoma* Zeller described as a *Glyphipterygid* and always so considered on pterogostic characters is definitely proven by the genitalia to belong to the family *Stenomidae* (not equal *Xylorictidae* Meyrick). This fact is fully born out by a proper consideration of the venation though the venation alone might be—and has been—otherwise interpreted.

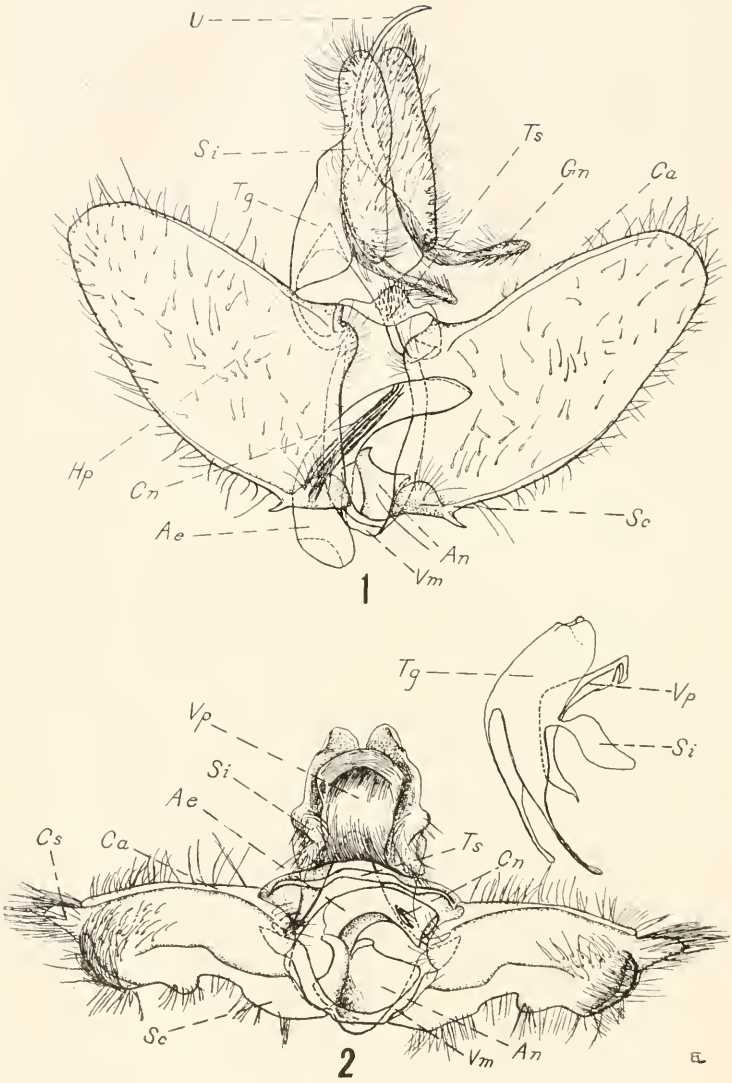
In the separation of genera the genitalia must be used with extreme caution, but here also they throw an additional light on the correlation of species and thereby enable a more natural grouping and a sharper division.

As a character for specific differentiation the genitalia are of

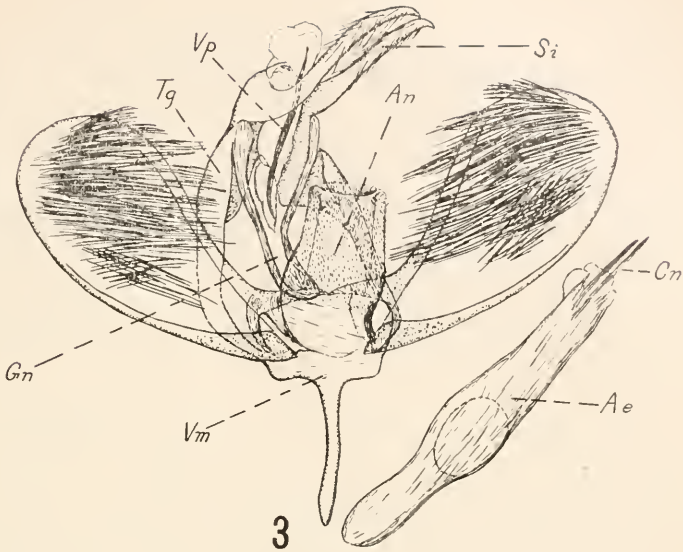
<sup>1</sup>Dampf: "Über den Genitalapparat von *Rhopobota Naevana*," *Iris*, 1908, pp. 304-329.

Heinrich: "A Note on the Tortricid Genitalia," *Proc. Ent. Soc. Wash.*, vol. 19, 1917, pp. 137-138.

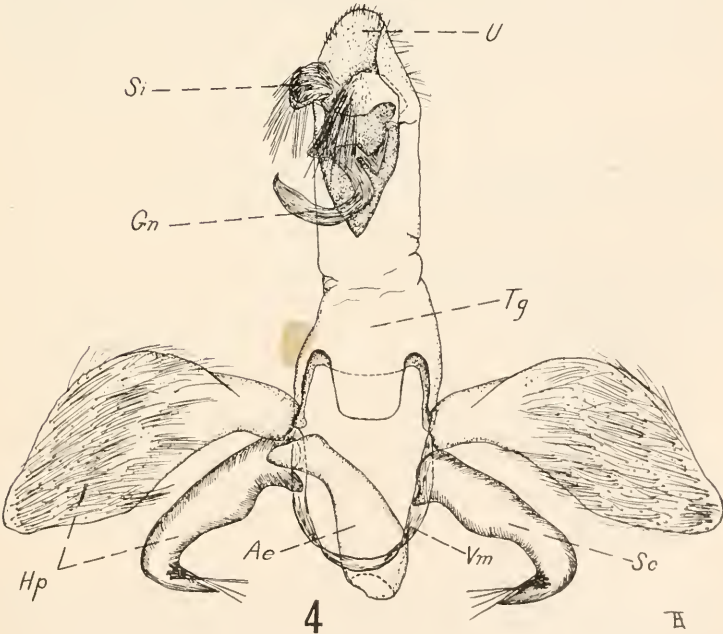




BUSCK AND HEINRICH—GENITALIA OF MICROLEPIDOPTERA



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BUSCK AND HEINRICH—GENITALIA OF MICROLEPIDOPTERA

supreme importance, enabling the separation and definition of closely allied species that otherwise would be difficult or impossible to separate and also proving beyond dispute the specific identity of varieties, the superficial differences of which obscure their specific limits. With the aid of genitalia the identity or non-identity of a supposedly introduced species can be definitely ascertained, and a question of synonymy settled. No longer need it be a matter of personal opinion. It can be proven or disproven. For example, the identity of *Laspeyresia molesta* Busck with the Japanese and Australian Peach Moth is thus established while the hitherto accepted identity of the American and European pea moths (*L. nigricana* Stph. and *L. novimundi* Heinrich) is disproven. Except for the genitalia both of these cases and many similar ones would have remained debatable.

The introduction of the male genitalia into the classification of the Microlepidoptera does not in any way invalidate or revolutionize our present well-founded system. On the contrary, it gives us a better understanding and a surer confidence in this very system, substantiating it, enlarging upon its foundations and giving added light where venation is insufficient. The use of genitalia together with characters of the larva and pupa brings us nearer to that ideal of the systematist, a classification based upon the whole insect.

#### EXPLANATION OF PLATES<sup>1</sup>

##### Plate XII

Fig. 1—Male genitalia of *Sparganothis pilleriana* Schiffermuller.

Fig. 2—Male genitalia of *Peronsa cristana* Fabricius.

##### Plate XIII

Fig. 3—Male genitalia of *Cerostoma vittella* Linn.

Fig. 4—Male genitalia of *Platyedra vilella* Zeller.

Ae —aedeagus.

An —anellus.

Ca —costa.

Cn —cornuti.

Cs —cucullus.

Gn —gnathos.

Hp —harpes.

Sc —sacculus.

Si —socii.

Tg —tegumen.

Ts —transtilla.

U —uncus.

Vm —vinculum.

Vp —ventral plate.

<sup>1</sup>The drawings were made by Miss Eleanor T. Armstrong under the direction of the authors.