

Lepidopteran Genitalia

Volume one: Males

Introduction

Preface

The genitalia of the Order: Lepidoptera show greater variation than in any other animal group. There is an extensive range of modification across Lepidopteran families, and genera within families, through elaboration or obsolescence of structures, and in the degree of sclerotisation of the parts. A wide variety of anatomical terms have been used to describe these parts, often with little consistency in the nomenclature applied. The same term may be applied to one structure in one family and a different structure in another family; and a single structure has had different terms applied to it by different authors. Most terms have been poorly defined.

My overriding aims are to define terms that can be applied across all Lepidopteran families, to demonstrate the variability of the structures so defined and to provide a framework for consistent description of genital features.

An **introduction** illustrates the basic parts of the male genitalia and defines how some terms are used within this work.

The main body of this work analyses the structures in greater detail, initially using examples from Family: Noctuidae. This is a large and familiar family, the genitalia have parts that are relatively easy to see, and the species and their genitalia are of a size that provides an ideal starting point for an introduction to moth dissection - being neither too large nor too small for a standard binocular microscope. The plan is to explore the range of variation of each structure using examples from all the Lepidopteran families.

Formal working definitions are proposed for each structure mentioned.

A series of appendices are intended in order to provide supplementary information and reference where appropriate:

My work has been largely based on my own examination of material from the British Lepidopteran fauna, with little exploration of, or reference to, the work of others.

Families and genera without British representatives are very likely to have variations not covered by this work.

Appendices to the introduction cover:

- 1) Abdominal segmentation
- 2) A simple guide to dissection

An introduction to the anatomy of the male genitalia of the Order: Lepidoptera

The male genitalia of Lepidoptera have 4 major components:

- 1) a supporting framework with anteroventral and posterodorsal parts - the **VINCULUM** and **TEGUMEN** respectively. Together these form a sclerotised ring which I will term the “**VT-RING**”
- 2) the **VALVAE** which function as clasp ing organs during copulation
- 3) the **DIAPHRAGM** which closes off the end of the abdomen, provides support to the aedeagus and is perforated to allow protrusion of the aedeagus.
- 4) the **AEDEAGUS** which functions as a penis

The parts remaining when the aedeagus has been removed are collectively known as the “**armature**”.

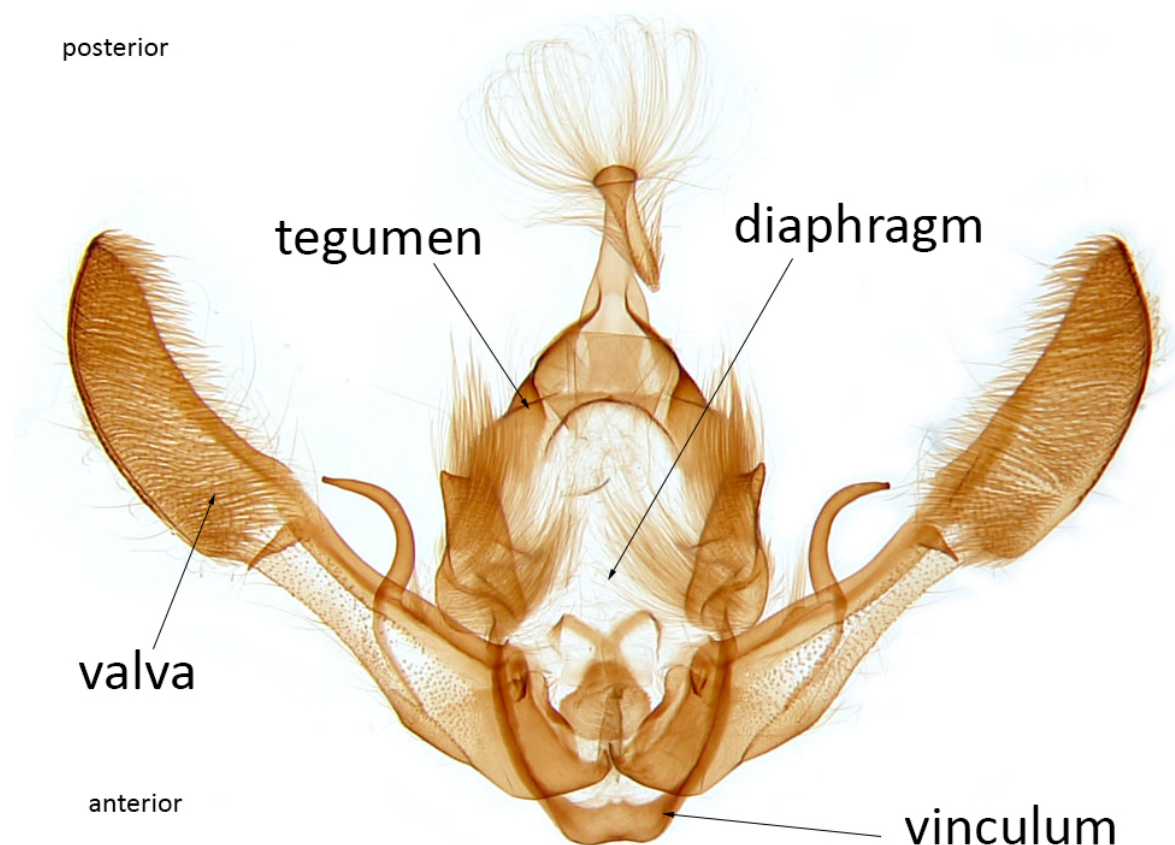


Figure 1: Armature of *Tiliacea aurago* (Barred Sallow)

Each of these major parts has important subdivisions, some of which are illustrated below:

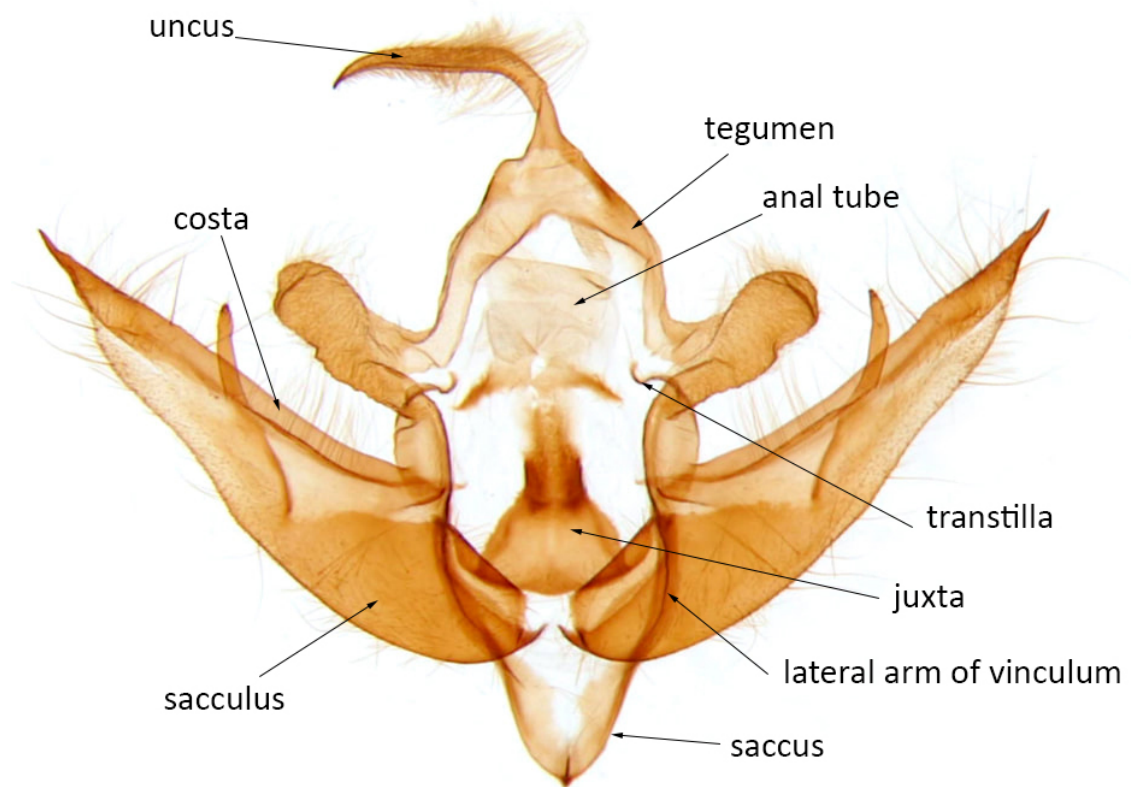


Figure 2: Armature of *Conistra rubiginea* (Dotted Chestnut)

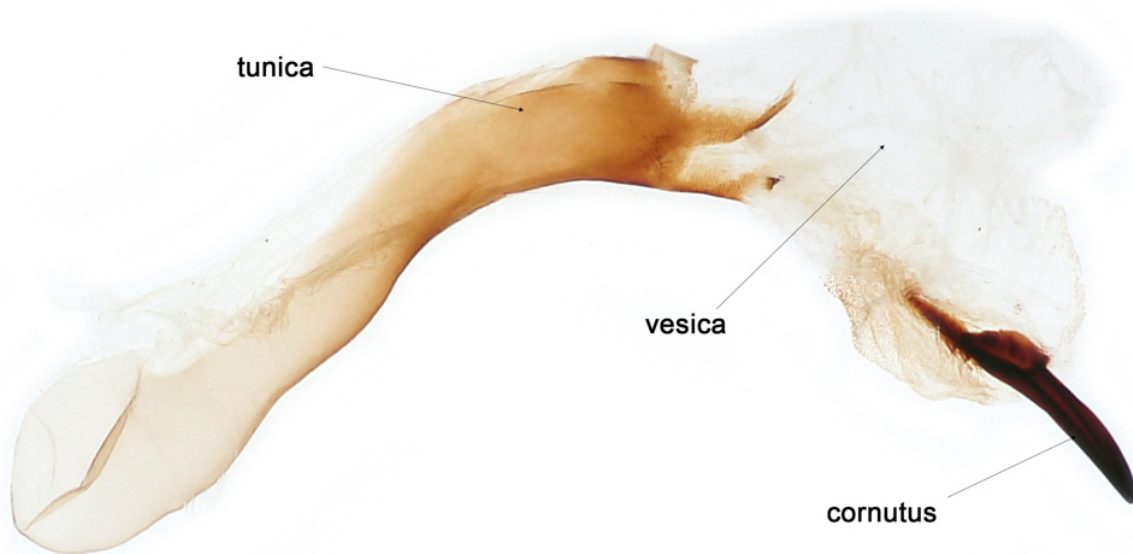


Figure 3: Aedeagus of *Helotropha leucostigma* (Crescent) with vesica everted

Connections

This will be covered in more detail in the main work but, before moving on to a more detailed consideration of the genital parts, it will be helpful to understand how the major parts of the genitalia are connected to each other, and how they are connected to the integument. To understand these connections, it is essential to visualise the vinculum, tegumen and valvae as having internal and external laminae, and a fold on at least one of the margins where these laminae are continuous from one lamina to the other, with a real or apparent space between the laminae.

The major connections are as follows:

- The posterior margin¹ of the intersegmental membrane (ISM) between abdominal segments 8 and 9² is attached to the ventral lamina of the vinculum and to the dorsal lamina of the tegumen.
- The base of the external lamina of a valva is attached to the dorsal lamina of the vinculum.
- The base of the internal lamina of a valva is attached to the diaphragm and often to its partner.
- The diaphragm has a peripheral attachment to the internal laminae of the valvae and to the ventral lamina of the tegumen; and a central attachment to the aedeagus.

¹ The "posterior" margin of the A8/9² ISM is only posterior once the genital capsule has been distracted from the abdomen. In the natural position the membrane is folded anteriorly, and the genital capsule contained within segments A7/8 and sometimes reaching further anteriorly.

² See appendix for more information concerning abdominal segmentation.

Definition of terms

There are some terms used in this work which may be unfamiliar, or which are used in a particular way. These need to be defined before proceeding and may need to be revisited to be properly understood, after reading later sections of this text.

Surfaces:

In considering the structures with internal and external laminae (particularly the valvae, saccus and tegumen), although strictly each lamina possesses an internal and an external surface, nearly all the features of any descriptive value are either on the external surface of the lamina or apply to the whole thickness of the lamina. The term "internal surface" can therefore generally be used to indicate either the internal lamina or the external surface of the internal lamina. Similarly, the term "external surface" can be used to indicate either the external lamina or the external surface of the external lamina. In any situation where a structure arises from the internal surface of a lamina this will be made clear in the text.

Distal vs proximal

These terms are used in anatomy to describe the relative position of structures to each other in relation to the centre of the body. They can be useful in describing the relative position of features of the valvae. "Distal to" means further from the centre of the body; "proximal to" means closer to the centre of the body. Thus, in referring to features of the valva, "distal to" = "apical to" and "proximal to" = "basal to".

Anterior and posterior

I have used to terms “anterior” and “posterior” in preference to “cephal” (closer to the head) and “caudal” (closer to the tail).

Edge vs margin

As far as possible, I have distinguished between an edge as a clearly defined line, and a margin as having some width.

Sclerotised vs hyaline

Chitin is an aminopolysaccharide polymer, it is translucent (=hyaline), pliable, resilient and tough. Sclerotin is a composite material of chitin in a tanned protein matrix. Sclerotised parts are hardened, darkened (brown) and relatively rigid. Hyaline parts are clear and flexible allowing for greater movement between parts. The boundaries between sclerotised and hyaline areas may be sharp edges or diffuse margins.

Natural vs set position

Natural position: The orientation and position of the parts of the genitalia as they appear in the unopened genital capsule.

Set position: The position of the parts of the genitalia as they appear in a standard slide preparation in ventral view with the valvae opened out.

Appendix 1

Abdominal Segmentation

Segmentation of the abdomen is referred to or alluded to in many of the descriptions of Lepidopteran genitalia. To understand these references and allusions it is necessary to provide a brief introduction to segmentation. A simple shorthand is used whenever an abdominal segment is referred to throughout this work: e.g. A8 = abdominal segment 8. Each segment has dorsal and ventral plates (sometimes referred to as tergite/tergum and sternite/sternum respectively). In all Heteroneura, (all British Lepidopteran families except Micropterigidae, Eriocraniidae and Hepialidae), the ventral plate of A1 is redundant. The dorsal plates of A1&2 and the ventral plate of A2 are usually broadly sclerotised. In the Noctuidae, the dorsal plate of A1 bears the tympanic organs.

The segmentation differs somewhat between the sexes.

In the male: dorsal and ventral plates of A8 are present and the genitalia are derived from A9&10. Dorsal A8 varies between species. Paired eversible pouches containing bundles of hairs scales (hair pencils) may be associated with ventral A2 in some species. Similar paired eversible pouches, containing bundles of hair scales (coremata), may be associated with ventral A7,8 or 9, or their inter-segmental membranes, in some species.

In the female: A8 forms part of the "external" genitalia. Dorsal plates of A2-6 are more transverse than in the male. Dorsal A7 is more broadly sclerotised than in the male. Ventral A7 is often strongly sclerotised at least along its posterior margin, where it may be strongly connected to the ostium. Females do not have hair pencils or coremata.

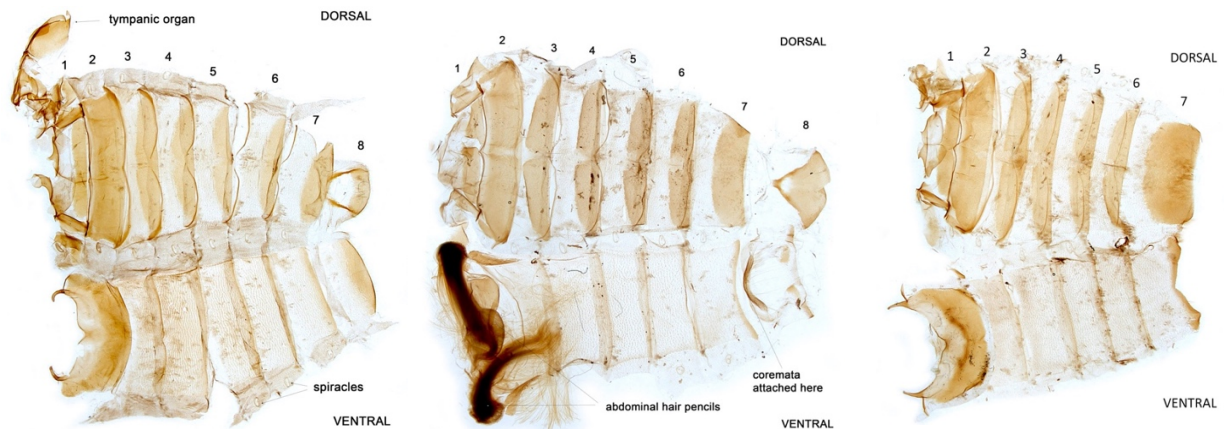


Figure 4: Abdominal segmentation of male *Noctua comes* (left), male *Leucania comma* (centre) and female *Leucania comma* (right)

Appendix 2

A simple guide to dissection

It takes time, practice and patience to master the techniques involved in preparing presentable genital slides. Here is just a guide to the sequence of processes involved.

- 1) Detach the abdomen. For larger abdomens it is helpful to tear the integument from the anterior end to expose the abdominal fat.
- 2) Place in a test tube.
- 3) Add Potassium Hydroxide 10% solution using a pipette – use enough to cover the specimen and a bit more.
- 4) Heat. I use an old anglepoise lamp with the bulb facing up. (Newer lamps with LED bulbs probably won't produce enough heat).
- 5) Set a timer. The length of time you need to heat your specimen varies with the size of the abdomen (longer for larger specimens) but is generally 15 to 40 minutes. It is better to underdo it and then do it more if necessary than to overdo it.
- 6) Pour the contents of the test tube into a suitable container – I use the lid of a specimen pot.
- 7) Remove the abdomen using forceps and place it in water in a petri dish.
- 8) With the aid of a stereo binocular or trinocular microscope carefully dissect out the genitalia. You may be able to take short cuts when you gain experience but its best to start at the anterior end of the abdomen and tear along the full length of the integument to find the genitalia.
- 9) Once the genitalia are located remove the integument at its attachments to the genital capsule (some species have identification features on the ventral plate of A8, which may then need to be preserved). Identify the ductus ejaculatorius, grasp and divide it with fine forceps. Identify the anal tube, grasp and divide it with fine forceps.
- 10) Clean the specimen of adherent gubbins and loose surface hair scales.
- 11) If you are simply interested in identification that may be all you need to do but for photography and slide preparation >
- 12) I stain female preparations with 2% Chlorazol Black at this stage, returning it to rinse in water before proceeding.
- 13) Place the genitalia in Glacial (>99%) Acetic Acid in a Petri dish – this softens the preparation and aids with further cleaning.
- 14) Once satisfied that your preparation is as clean as you are going to get it manipulate it into a flattened position with the valvae opened out using a pair of fine forceps – until you can grasp it in the flattened position with one of the forceps.
- 15) Maintaining your grip on the specimen place it in Isopropyl Alcohol for 5 to 15 seconds depending on the size of the specimen. This will fix it in the flattened position, but if you leave it in the alcohol for too long it will become brittle and disintegrate.
- 16) Place the specimen in Euparal Essence in a Petri dish or watch glass.
- 17) Drop Euparal onto a microscope slide; place your specimen in the Euparal, apply a cover slip.

Note that both Euparal Essence and Euparal are very expensive and hard to obtain.

For good quality photography you will need a trinocular microscope with a microscope camera; Helicon Focus or other image stacking software and Photoshop or other image editing software.