THE BIZARRE WORLD OF MOTH 'NAUGHTY BITS'

A naturalist colleague has a difficult time accepting the legitimate word 'genitalia' for animal reproductive organs (insects are animals!). Just about every moth species has two sexes, males and females; a very few species are parthenogenetic having only females. Moth genitalia are distinctive for each species and thus are useful for identifying an individual moth to a species and for showing phylogenetic relationships, although the latter is being usurped by DNA analysis.

MALE

The genitalia have a basic design and occur at the extreme posterior tip of the abdomen. It is a spherical structure (genital capsule) having a pair of conspicuous valves laterally, a dorsal hook, and a ventral plate. Suspended through the center of the sphere in a anterior-posterior orientation is the phallus (aedeagus) which functionally is equivalent to the mammalian penis; sperm transfer in moths is internal.

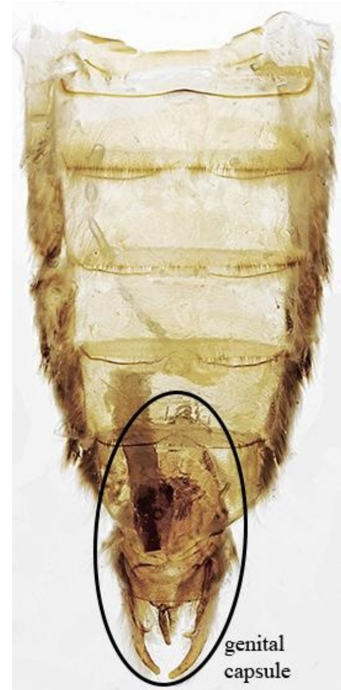
FEMALE

Genitalia are simpler than those of males, a posterior opening leading to a tube which ends in a sac into which the male deposits sperm.

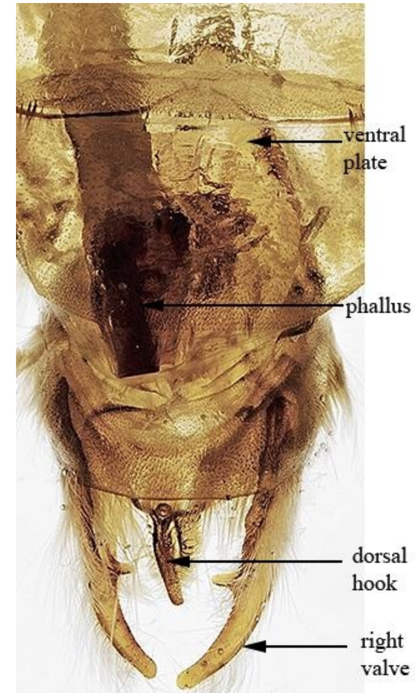
Standard practice is to illustrate the genitalia in a reversed orientation *i.e.*, posterior is shown as anterior and ventral is shown as dorsal; and to move the phallus to the side. Thus, the most posterior hook of the male genital capsule is shown at the top of a genital image, the pair of valves point upwards, and the phallus also points upwards. Such a view bears little resemblance to how the genitalia look in a live moth but as long as every species has the genitalia displayed in this standard orientation comparison between and within species becomes possible.

In females the genital opening is displayed at the top and the sac to hold the sperm displayed at the bottom; in real life the genital opening is posterior and the sac is closest to the head.

'In use' most of the male's genitalia is to hold onto the tip of the female's abdomen. The phallus consists of a somewhat rigid tube with an internal sac that can be everted and greatly expanded by blood pressure; this part of the phallus enters the female's reproductive system and delivers a packet of sperms. From this basic design, evolution has run wild.



Dorsal view of abdomen of male *Noctua pronuba*



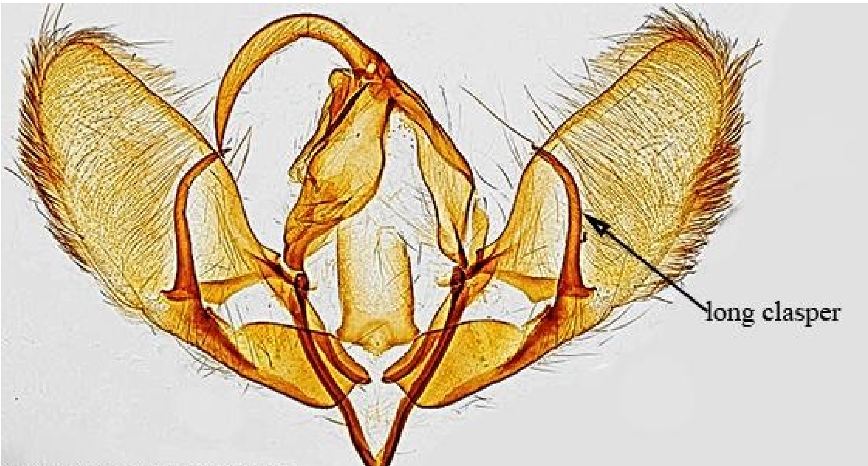
Dorsal view of male genital capsule

Genital capsule of male *Noctua pronuba* mounted (flattened) in the standard reverse upside-down orientation and with the phallus moved from within the capsule

The valves

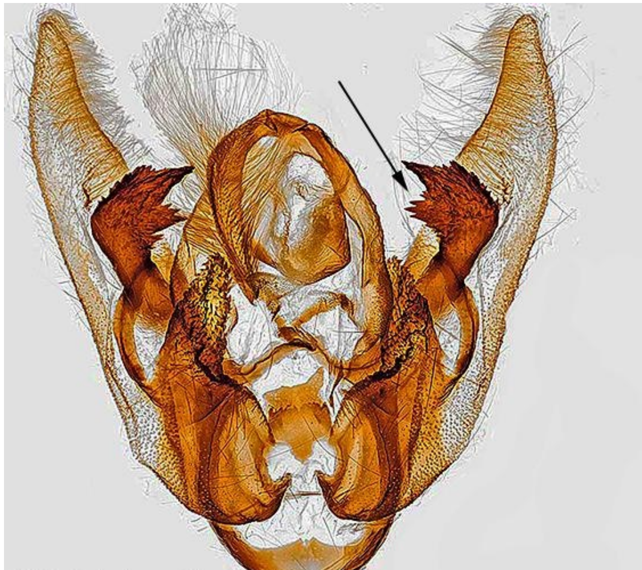
I am assuming that the valves originally were a pair of simple lateral flaps that grabbed the sides of the female's abdomen e.g. *Bomolocha baltimoralis.* The gripping power of the valves could be increased by the development of a spike (clasper), e.g. *Acronicta americana.*

8442 *Bomolocha baltimoralis*

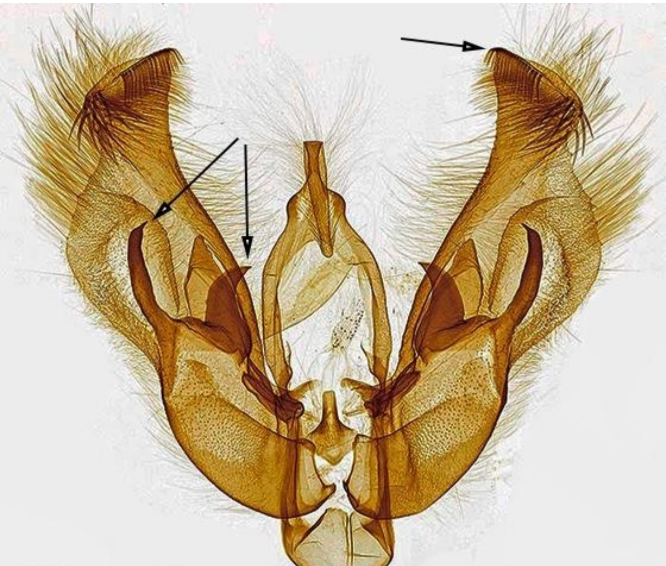


9200 *Acronicta ameriana*

Why stop at a simple one-pointed clasper when a serrated edge, e.g. *Orthodes goodelii* or a double-clasper and some hooks on an expanded tip e.g. *Diasia rubifera* would function better?



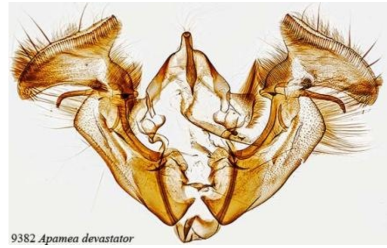
10289 *Orthodes goodelii*



10917 *Diarsia rubifera*

An alternative to a clasper would be to increase the surface area of the tip of the valves, maybe turn then into ‘fingers’ as in *Melanchra pulverulenta* or into a single expanded pad as in *Mthimna oxygala. Apamea devastator* opted for expanded tips to the valves and large hook-tipped spines. *Prodoxus decepiens* fancied a ‘caveman club’, a long shaft expanded at the tip and studded with spikes. *Lacinifolia renigera* turned the apex of the valve into a spike and lengthened the clasper to mate it with the tip of the valve.

10294 *Melanchra pulverulenta*



9382 *Apamea devastator*

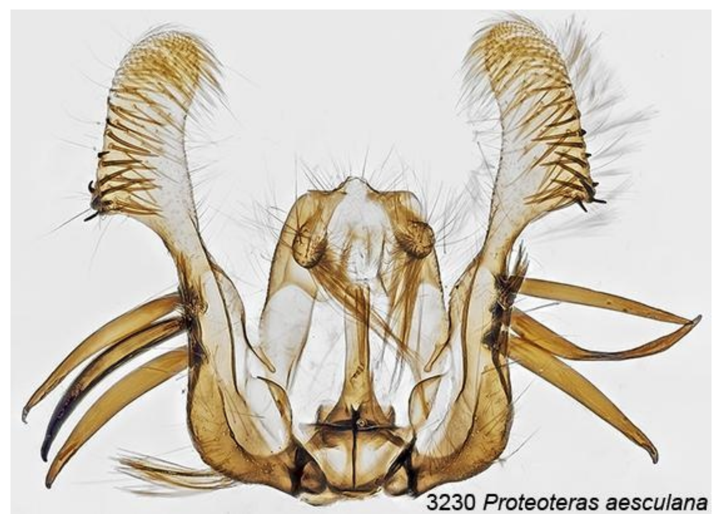
10397 *Lacinipolia renigera*

10436 *Mthimna oxygala*

0200.1 *Prodoxus decepiens*

Some of the small moths (the micros) seem to go to extremes in the structure of the valves, especially as their only function appears to be gripping the female’s abdomen*. Celypha cespitana* arms the tip of the valves with numerous spines and about mid-way on the valves are truly viscous large spines. *Proteoteras aesculana* has indecent-sized spines on the expanded tips of the valves and some massive spines mid-way down.

2859 *Celypha cespitana*

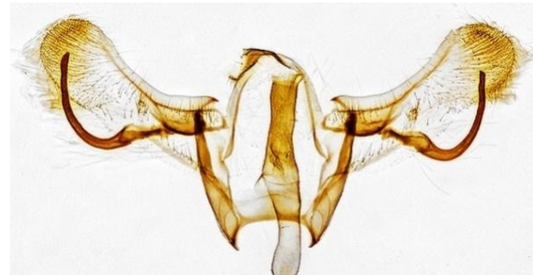


3230 *Proteoteras aesculana*

As there are over 10,000 North American moth species, all of which can be identified by external features (often colour), perhaps it is not surprising that there is an equal number of variations in the structure of the male genitalia. Below is a sampling.


5226 *Palpita magniferalis*


6258 *Alsophila pometaria*


7139 Cyclophora pendulinaria


2827 *Olethreutes ferriferana*


6570 *Aethalura intertexta*

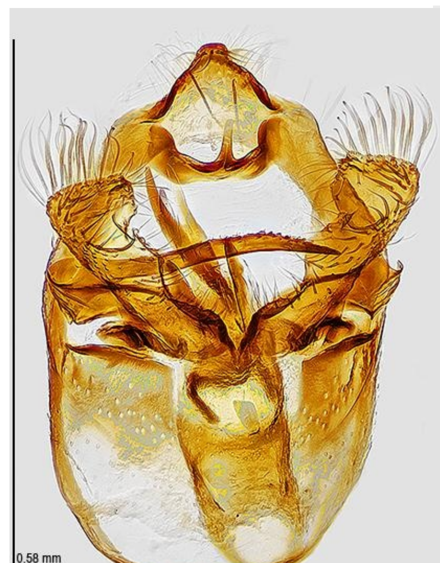

6582 *Iridopsis vellivorata*


1256 *Coleophora tiliaefoliella*


0485 *Bucculatrix solidaginiella*


2747 *Hulda impudens*


0296 *Stenoptinea auriferella*



0037 *Etainia ochrefasciella*


89 *Dichomeris ochripalpella*


0733 *Phyllonorycter argentifimibriella*

The Phallus

The modifications to the valves might be thought of being masochistic towards the females but compared to the 'ornamentations' on the vesica (part of the phallus) they seem benign. Recall that the vesica is the 'organ' that is inserted into the female's genital tract where it is greatly expanded. What more would you need than a simple tube for inserted sperm? Few moths have such a simple tube, many have opted for incorporating one or more spines on the vesica. Moths are relatively small and proportionally the phallus is also small. It is possible to insert a very fine capillary into the base of the phallus and evert the vesica, thus getting a clear view of the 'armaments' (years ago a company offered a "moth phallus-vesica everter" for $4,00.00 – I never did buy it). I have managed to inflate the vesica in one moth *Leucania multilinea*, which has only a minor amount of 'armament'. However, a similar species in the same genus – *Leucania commoides* – has two large spines in its vesica.

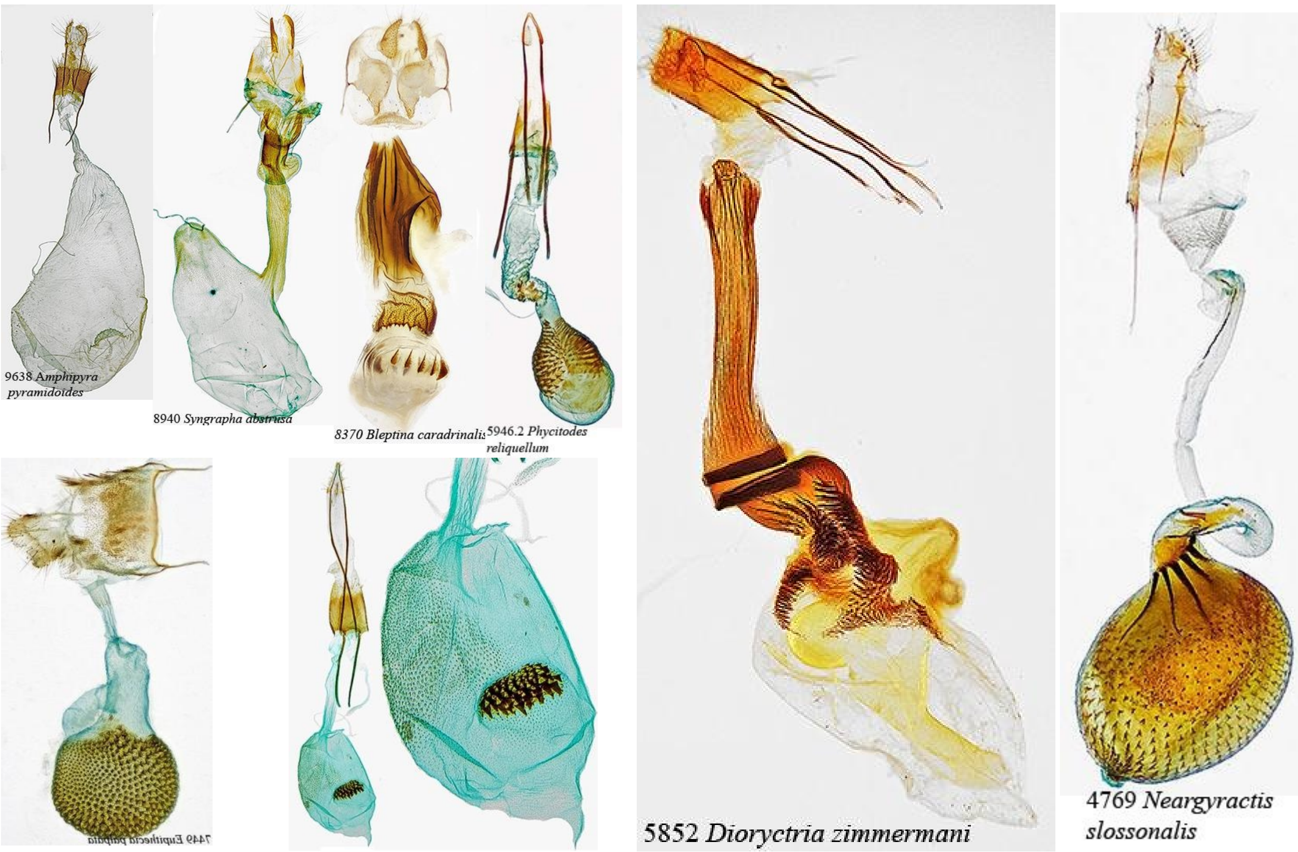
Left: Male genitalia of Leucania multilinea showing complex genital capsule, phallus (moved from within genital capsule), and the everted vesica with an anterior spine and a row of minor lateral spines. This entire everted vesica enters into the female's genitalia. **Right:** larger spikes in the vesica of *Leucania commoides*

There is a limited space in the phallus but some species fill it with spines. Males have taken two routes: have a very few large spines as in some *Leucania* species or have many smaller, and not so small, spines. Sharp-pointed studs is favoured by some species

Females

After seeing all those viscous vesica armaments one could almost feel sorry for female moths. The simplest female genitalia is a posterior opening leading to a thin-walled tube that leads into a thin-walled sac where the male deposits a packet of sperms., eg., *Amphyra pyramidoides.* Perhaps a modification to protect from aggressive males is to thicken the walls of the tube. However, females are not completely inoffensive, many include a battery of spines in the sac; the function of which is most likely to break open the sperm package .

When spines are at the base of the tube their function to break open the sperm package seems unlikely. *Dioryctria zimmermani* has a strengthened tube leading to a battery of spines before to the sac. *Neogyractis slossonalis* has 5 large spines at the end of the tube 'protecting' the opening to the sac. The prize, however, must go to *Horisme intestinalis* females. The bottom of the tube has a chicane curve bordered with an opposing pair of 'jaws' with many teeth, once the male gets past these he is confronted with a sac whose walls are fully spined. It's a miracle that the eggs ever get fertilized!



7445 *Horisme intestinata*

The above essay is one of fact and speculation. The genitalia images are fact; the speculation is just that – conjecture without evidence.

Full-sized images and the associated moth images (North America) can be seen on BugGuide and Moth Photographers Group. Simply enter the species # on the search window.

Genital images of UK and European species here: mothdissection.co.uk

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