PECTINATE ANTENNÆ IN THE GEOMETRIDÆ (LEPIDOPTERA).

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The present note is the summary of an analysis of antennal characters in the Ennomid Geometridæ, for which there seems to be no present hope of publication.

The Geometridæ and especially the Ennomid (Boarmine) series, have always been notorious for the plasticity of their characters and the difficulty of their classification. The present study of antennal characters has developed out of Bodine's work (Trans. Am. Ent. Soc. 23, 1, 1896) on the Lepidopterous antenna, and has, I believe brought some significant and useful characters to light.

This discussion includes only the genera with pectinate male antennæ. In the Geometridæ the simple antenna is not primitive, but has been several times produced by reduction. For the present it is not possible to place all these genera, but pupal and other characters will throw light on their relationships.

Bodine recognizes five types of antennal organs: three lengths of setæ, cones, and pit-organs. In the Ennomids the pit-organs seem of little use in classification, and the two types of generally distributed setæ (his types 1 and 3) are not easily distinguished; the presence and arrangement of the long single setæ which he calls type 2, and the thin-walled sensory cones—type 5,—give good characters.

The following grouping may be made:

Series I: Pectinations naked; cones on shaft.

There are three subdivisions of this type, corresponding to two natural groups, and a somewhat heterogeneous remainder.

1. Pectinations each with a single distinct seta of type 2, not obscured by long setæ of type 3; pupa with two strong spines on the cremaster, with dorsal groove (between abdominal segments 9 and 10) well developed; moth slender, wing normally with fovea. Antenna usually with a long simple apex.

Protoboarmia (indicataria), Parexcelsa (inconspicuaria), Eufidonia, Neoalcis (californiaria), Melanolophia, Vinemina (opacaria), Paraphia, Epimecis, Elphos, Boarmia, (e. g. rhomboidaria), Amraica. In Amraica the antenna is unipectinate, with a superficial likeness to Arichanna. The others form a homogeneous group.

2. Pectinations very short, gradually running out to base and apex, slender, central on segments, not clubbed, with long sparse bristles, the apical one not distinct; segments lightly chitinized, with fine striations, transverse on outer part of segments, as in Melanolophia.

Bapta (?) *virginalis.* The remaining Baptas have simple antennæ, and resemble Cabera (Deilinea). This species has no likeness to Cabera and has no visible connection with any other.

3. Pectinations more or less clubbed, with a terminal tuft of long curved setæ, burying the single short apical or sub-apical seta of type 2. Body stout, mouth parts normally reduced; sculpture normally not unlike group 1, which also has a similar pupa.

Biston (ursaria), Amphidasys (cognataria, robusta), Erannis (segments sometimes 4-pectinate, sometimes merely serrate), *Artiora (Therapis), Coniodes, Cochisea.* This is a homogeneous group. Artiora has usually been widely separated from Erannis but hardly differs save in wing-form.

4. Pectinations with at least two strong setæ of type 2, which are typically apical and strongly divergent; and are frequently supplemented by one or more such setæ on the outer sides of the pectinations. A miscellaneous group, held together mainly by the survival of a primitive condition.

A. THREE NEARLY APICAL SETAE OF TYPE 2.

Prosopolopha.

B. A DORSAL SETA (OR MORE) ON PECTINATIONS.

Euchlœna (including *irraria*), *Lytrosis, Stenotrachelys, Angerona (prunaria, œxaria), Xanthotype, Metarrhanthis, Cepphis (Priocycla).*

c. Only two setae of type 2.

Gonodontis (*bidentata, formosa, ocellaria*), *Abbotana, Himera, Campœa* (*Metrocampa*), *Ellopia* (not *Therina*), *Selenia, Hygrochroa, Stenaspilates, Hypoplectis, Scodiona, Hulstina, Amblychia* (*angeronaria*), *Xandrames* (*dholiaria*), *Arichanna* (transitional to Melanolophia group), *Sarcinodes* (unipectinate), *Achlora* (4-pectinate).

Series II: Pectinations naked, cones at their apex.

This series like the first is composed of three main groups, of which two are more like each other than to the third, and has some anomalous genera of uncertain position. Nacophora makes a group by itself, much like the Biston group, but differing in egg-type as well as antenna.

1. Basal segment of antennal shaft with well-marked pectinations; posterior series of longer pectinations than anterior, especially toward apex; cones very few, sometimes irregular in position and deformed. Apical setæ of pectinations strong, strictly apical, and not obscured by setæ of type 3; sub-apical seta strong, often arising well back from apex. Pectinations stout and long, tapering, with tips turned distad; strongly chitinized, especially at base, and longitudinally striate; shaft smooth or slightly granular.

Nacophora (including "*Amphidasys*" *arnobia*), *Phœoura.*

2. Cones numerous, normally on both series of pectinations; apical setæ usually two, and well-marked. Tropical species frequently very heavily chitinized. American genera.

Therina (including *quercivoraria* and *læta*), *Nepytia, Zerene, Sicya, Philtræa, Philedia, Nipteria* (in part), *Lissochares* (*nigrovenata*), *Deutophlebia* (*radiata*), *Emplocia* (*bupaloides*), *Leucula* (*cillenaria*), *Carpella* (*districta*), *Sangalopsis* (*beata*),—also "*Dioptis*" *hesperioides*, for which I have not happened to see a valid generic name,—*Metanema* (*inatomaria* and *determinata*, transitional to group IIc).

3. Cones numerous on one series of pectinations, normally the posterior, usually absent on the other series, but present

on both series on Bupalus, Crocallis and Euctenurapteryx. Old-world genera.

Chemerina, Cleogene, Dasydia, Epione, Bupalus, Euctenurapteryx (maculicaudaria), Crocallis. The last genus on most characters is an outlier of series I.

Series III. Pectinations scaled, cones apical.

This is far the smallest, and in antennal structure the most homogeneous of the four series, but the genitalic structure as well as the appearance seems to indicate it is not homogeneous. Gnophos is particularly troublesome, as with a great variety of antennal type the genitalia are homogeneous, while Platæa, which has practically the antenna of G. dilucidaria, has wholly different genitalia.

Bases of pectinations conspicuously transversely rugose, and often swollen.

Pectinations basal on segments.

Over 40 segments. . . . . *Gnophos, Patœa, Pherne*

Under 40 segments. . . . . *Glaucina, Cœnocharis*

Pectinations subapical.

Segments under 40, pectinations short. *Carphoides, Barnesia*

Segments over 40, pectinations long. . . . . *Pterotœa*

Bases of pectinations smooth or nearly so.

Antenna pectinate to apex.

Lightly chitinized; segments stout. . . . . *Ennomos*

Heavily chitinized; segments very slender. . . . . *Aspilates*

Antenna with a long simple apex. . . . (a few aberrant Nipterias)

Series IV: Pectinations scaled, cones basal.

There are two main types involved in this group, one represented by Cabera and Apicia (Caberodes), in which the cremaster of the pupa has eight hooks, and the other by the Cleora group with a bifid cremaster. There is a corresponding difference in the appearance of the moth and of the antennæ, and the groups are no doubt natural, although at present impossible to define. Ametris, commonly put with the Œnochrominæ, seems to belong

here, while the true Œnochromids fall in series I; Cleora and Ripula have doubly pectinate antennæ, the pectinations alternately scaled and naked. Cleora may be ancestral both to the Cleora group of this series and the Melanolophia group of the first, the inner pectinations having disappeared in one case and the outer in the other. Ripula has no obvious affinities. The diurnal forms Epelis and Ematurga seem to be separately derived from something near Itame, and should not be combined in a single genus, as has been commonly done, following Hulst in Dyar's list. The following grouping is largely artificial and for the convenient tabulating of some characters only.

Synopsis of groups.

Pectinations basal

Sculpture strong on pectinations, setæ of type 2 apical, not strong. . . . . Group *A*

Sculpture weak on pectinations; setæ subapical and obsolescent, lost among the setæ of type 3. . . . . Group *B*

Pectinations central or apical

Strongest seta of type 2 subapical, short and weak as a rule, when near the apex lost among a mass of longer setæ of type 3.

Subapical seta strong, comparable with the apical. Group *C*

Subapical seta less than half as long as the apical and weak, but distinct. . . . . Group *D*

Subapical seta not recognizable, lost in the setæ of type 3 or (more probably) absent. . . . . Group *E*

Pectinations ending in a strong and conspicuous apical seta

No subapical or dorsal seta, only the apical type-2 seta present. . . . . Group *F*

Subapical seta well-marked, no dorsal seta

Pectinations apical. . . . . Group *G*

Pectinations central. . . . . Group *H*

Subapical seta strong; a few, at least, of anterior pectinations with a third dorsal seta at about a third their length. . . . . Group *I*

Pectinations with apical seta more or less distinct, but not fully apical, at least on some segments; subapical strong; sculpture of shaft weaker than in group D
Group *J*

A: *Selidosema (ericetaria, ambustaria* but not the American species sometimes included).

B: *Lychnosea (helviolaria* only), *L.* (?"*Hyperitis*") *triangulifera ria, Stegania (trimaculata), Ripula.*

C: *Caripeta, Hemerophila (abruptaria).* A wholly artificial pairing, I suspect. Caripeta has a pupa similar to Cabera and Apicia, Hemerophila is much more suggestive in all ways of Lytrosis in series I.

D: *Vitrinella (pampinaria).*

E: *Itame (Diastichtis, Cymatophora), Physostegania, Elpiste, Macaria* (species with more or less pectinate antennæ), *Mericisca, Buzura (suppressaria), Eubolia, Enconista, Epelis, Exelis, Eumacaria, Parapheromia (lichenaria), Tracheops, Merisme (spododea), Fidonia (limbaria), Euaspilates,* The South American "*Alcis*" *salmonearia,* and "*Ectropis*" *anaisaria* also belong to this group, but not the genera in which they now stand.

F: *Glena (insaria, quinquelinearia), Anacamptodes, Emmaturga (faxonii, atomaria), Hyposidra (talara), Gynopteryx (seriaria), Hymenomima (tharpa), Ametris.*

G: *Pseudoboarmia (umbrosaria, punctinalis), Stenoporpia (polygrammaria), Tornos, Hesperumia, Chloraspilates, Somatolophia, Halesa (œnitusalis), Erebomorpha, Aplogompha (riofrio), Molybdogompha (biseriata,)* "*Lychnosea*" *intermicata, Neoterpes, Epiplatymetra.*

H: *Ixala, Pterospoda, Enemera.*

I: *Cabera, Drepanulatrix, Catopyrrha, Apicia (Caberodes,* without C. irraria).

J: *Plagodis, Anagoga, Hyperitis.* This is a homogeneous group on venation as well as antenna.

In the following genera I have been unable to find any trace of cones, or at most a few on the simple terminal segments, so that it is impossible to group them unambiguously. I divide them into artificial groups to call attention to some of their characters.

GROUP I: PECTINATIONS NAKED, BASAL ON SEGMENTS, APICAL SETAE NORMALLY DISTINCT

Heliothea, Egea (no terminal setæ), *Nychiodes, Eurrhanthis,*

GROUP II: PECTINATIONS NAKED, APICAL, NO SETAE OF TYPE 2.

Acalia, Brephos

GROUP III: PECTINATIONS SCALED.

Nepterotæa (compare *Cœnocharis* and *Gnophos*), *Eucaterva* (compare IV B or IV G) *Narraga* (compare *Epelis*), *Fernaldella* (very near Narraga), *Melanchroia* (Compare IV F).

STERRHINÆ and HYDRIOMENINÆ

Pectinations slender, basal, naked with stiff, sparse and rather evenly distributed setæ, and a minute apical seta of type 2 or none. Cones rare on the pectinate segments; on the shaft in *Xanthorhoe ferrugata,* rudimentary on apices of pectinations in the *Sterrhinæ.*

HEMITHEINÆ

Pectinations naked, with cones usually on the simple apical segments only, but sometimes also on the apices of some pectinations.