

NOTES ON THE STRUCTURE OF BEES.

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I. CERATINIDAE AND XYLOCOPIDAE.

These families are strikingly diverse in their mouth-parts as follows:

Maxillary comb of closely set long spine-like bristles, on a strongly concave margin; at apical end of comb, next to base of maxillary palpi, a long finger-like lobe; maxillary blade very broad; third joint of labial palpi strictly terminal on second.....XYLOCOPIDAE.

Maxillary comb of less closely set bristles, on a gently concave long margin; no lobe at apex of comb; maxillary blade elongate, or not very broad (slender and tapering at end in *C. binghami* (Ckll.)); third joint of labial palpi attached to side of second near end.....CERATINIDAE (*Ceratina*)

In *Xylocopa* the second joint of labial palpi is not half the length of first; in *Ceratina* it is considerably over half the length.

Minor differences within the Xylocopidae are such as the following:

Second joint of labial palpi stout and strictly cylindrical, with few (about 7) bristles on each side.....*Lestis bombylans* (Fabr.)

Second joint of labial palpi slender, narrowed in middle.....*Xylocopa*.

Second joint of labial palpi with very many bristles, on both sides.....*X. frontalis nitens* (Lepeletier).

Second joint of labial palpi with few bristles (7 or 8), on one side only, except a few minute ones at apex on the other side.

Second joint of maxillary palpi stout, the following ones slender.....*X. barbata* (Fabr.).

Second and third joints of maxillary palpi stout, the following ones slender.....*X. arizonensis* Cress.

Ceratina shows marked differences, thus:

Subgenus CERATINA Latr.

Type *cucurbitina* Rossi. Black species with 5-jointed maxillary palpi; apex of ♂ abdomen truncate; second joint of labial palpi broad and not especially long; last joint of maxillary palpi not or not squarely truncate. An American species differs from the European thus:

Maxillary palpi fully half length of blade.....*C. arizonensis* Ckll.

Maxillary palpi considerably less than half length of blade; apical joint of labial palpi slender, very obliquely subtruncate apically.....*C. cucurbitina* Rossi.

CALLOCERATINA, new subgenus.

Type *Ceratina amabilis* Ckll. Metallic species with 5-jointed maxillary palpi; tongue hardly surpassing labial palpi (far surpassing it in *C. cucurbitina*); second joint of labial palpi very long and slender; apical joint of labial palpi broadly and abruptly truncate at end.

In *C. cucurbitina* and *C. lepida* Smith the second joint of labial palpi is considerably shorter than the first; in *C. cyanea* (Kirby) the second joint is slightly longer than the first. *C. lepida* and *C. cyanea* have 6-jointed maxillary palpi.

Subgenus **CREWELLA** Ckll.

Type *C. titusi* Ckll. Maxillary palpi 6-jointed; mouth-parts greatly elongated; mandibles peculiar. South America.

Subgenus **CERATINIDIA** Ckll. and Porter.

Type designated *C. hieroglyphica* Sm., but specimen studied was *C. lepida* Sm.; they are very closely related. Black species, with 6-jointed maxillary palpi. A distinct and compact subgenus of the Oriental and Palearctic Regions.

Subgenus **PITHITIS** Klug.

Type *smaragdula* Fabr. Bright green species of Oriental and Ethiopian Regions, with 6-jointed maxillary palpi (*C. binghami* Ckll. studied).

Subgenus **ZAODONTOMERUS** Ashmead.

Type designated *tejonensis* Cresson. Dark green species with 6-jointed maxillary palpi (although Ashmead said 4-jointed). Widely distributed in both hemispheres.

II. THE MAXILLAE.

The structure of the maxillae, including the palpi, has for many years been regarded as furnishing important characters for classification. There are however additional features which have received scant attention, and some of these may serve our purpose in establishing a better taxonomic system. Maxillae of insects are often characterized by the possession of combs, consisting of specialized bristles, and stiff more or less broadened, inclined to be curved apically. Thus in termites a well-developed comb may be seen on the lacinia. Among the bees, I find two combs, situated in different positions.

(A) *The inner comb*, placed mesad of the palpus, on the basal part of the galea. This is particularly well developed in *Caupolicana yarrowi* Cresson.

(B) *The outer comb*, placed basad of the palpus, on a more or less concave margin of the stipes, or more properly I suppose the united palpifers. This is very highly developed in *Xylocopa*.

The presence of the inner comb distinguishes those bees which are considered less advanced, and the presence of the outer those which are very highly modified. *Hylaeus*, *Meroglossa*, *Palaeorhiza*, *Colletes* and *Caupolicana* all have the inner comb very well developed. The lacinia in these genera is reduced to a small finger-like structure, beset with bristles.

In *Andrena* the inner comb is very well developed, but the lacinia is shorter and stouter, sometimes (*A. mellea* Cresson) broader than long.

Melitta (*M. leporina* Panzer) has no inner comb, and the lacinia is cylindrical. The outer margin of the stipes is hairy all along, the basal half having excessively long hairs. In *Andrena* there is usually much less hair in this situation, but it may be long and abundant, (as in *A. porterae* Ckll. and *A. flavipes* Panzer), though even then not excessively elongated toward the base as in *Melitta*. There is no trace of any apical division of the galea in *Melitta*.

Nomia has a well-developed inner comb, and narrow lacinia.

Sphecodes has no inner comb; it has a primitive feature in the galea, the apical part being distinctly separated, a condition more strongly emphasized in *Vespa*. *Temnosoma* resembles *Sphecodes*, but the maxillary palpi are stouter.

Halictus has no inner comb, and the terminal portion of the galea is separated by a line or suture as in *Sphecodes*. Thus *Halictus* and *Sphecodes* stand apart from *Nomia*, which has no apical division of the galea. In the Colletids there is no transverse division of the galea, but *Colletes* shows a longitudinal division, the separation between the heavily chitinized outer and the hyaline, hairless, inner division being unusually distinct. In the Hylaeids there is also no trace of an apical division. Thus it appears probable, contrary to expectations, that the Halictines have an origin apart from the Andrenines, and not from any Colletid or Hylaeid stem.

In *Augochlora* and *Agapostemon* the division of the galea becomes extremely oblique, but is still quite distinct from the longitudinal line between the darker and lighter parts. In all these Halictine bees the lacinia has disappeared.

In *Protandrena* (*P. mexicanorum* Ckll., *P. bancrofti* Dunning) there is a well-developed inner comb, the lacinia is present and there is no trace of a transverse division of the galea. (The labial palpi of *P. bancrofti* have the first joint much longer and more slender than in *P. mexicanorum*).

Halictoides has no transverse division of galea and no inner comb. The lacinia is well developed and long, but very delicate, and easily lost in the preparations. (The labrum of *H. tinsleyi* Ckll. is markedly different from *H. campanulae* Ckll.; probably the labra in this group are significant for subgeneric division).

Rhophites (*R. quinquespinosus* Spinola) has the galea long and tapering, of course without transverse division. There is no inner comb. The same may be said of *Panurgus*. In *P. banksianus* (Kirby) the rudimentary lacinia is beset with numerous very long stout dark plumose hairs.

Calliopsis (e. g. *C. coloradensis* Cresson, *C. verbenae* Ckll. and Porter) has a very well developed inner comb, its upper end a moderate (*coloradensis*) or great (*verbenae*) distance basad of the palpi. The galea has of course no transverse division. The rudimentary lacinia bears quite simple bristles. *Spinoliella* (*S. scitula* Cresson) has a well developed inner comb, as in

Calliopsis. *Panurginus* also has a well developed inner comb, and simple bristles on the lacinia.

Perdita has no inner comb. The bristles on the very rudimentary and basad lacinia are sometimes (*P. albipennis* Cresson) briefly plumose.

Has the inner comb been lost in two or more series of Panurgids independently? The Panurgids as a whole must be derived from the Andrenine series, not from the Halictine. If the evolutionary sequence has been Colletoids, Andrenoids, Panurgoids, with the Halictines coming independently from some different, unknown ancestor, it becomes necessary to accept the family Halictidae, which will include *Sphecodes*, but not *Nomia* or *Melitta*.

In none of the bees considered above is there any trace of an outer comb.

Nomada has no inner comb. The margin below the palpi for a considerable distance is gently concave, and beset with small hairs, but these are irregular and do not constitute any sort of comb. In *Triepeolus* there is no inner comb; there is a slightly concave area below the palpus much as in *Nomada*, only it is quite abruptly terminated basad, and here some of the bristles become broadened, and we have the first distinct indication of an outer comb. On the other hand *Pseudomelecta* presents in this region merely a straight edge, without any bristles projecting from the margin. *Crocisa* in this agrees with *Melecta*, except that there are a very few minute hairs. *Phileremus mesillae* Ckll. has the margin gently concave in the style of *Triepeolus* but it is less pronounced, and there are no distinct hairs. *P. americanus* Cresson is nearly identical with *mesillae* in these features. *Phileremulus nanus* Ckll. has the margin below the palpus very faintly evenly concave, with a very few minute hairs. *Neolarra pruinosa* Ashm. has more though irregular hairs. *Oreopasites scituli* Ckll. has this region as in *Phileremulus*.

All these parasitic bees lack the inner comb. They may possibly be derived from bees which had the outer comb, but this can not be shown to be the case, so far as the characters now considered are concerned. *Triepeolus* only has a distinct vestige of an outer comb, but *Phileremus* may be derived from it by degeneration.

The Anthophorid genera, *Anthophora*, *Anthophoroides*, *Emphoropsis*, *Diadesia*, *Centris*, *Melissodes*, *Tetraloniella*, *Tetralonia*, *Melissina*, *Xenoglossa* and *Exomalopsis* all have a very well developed outer comb. This character, together with the absence of the inner comb, indicates their distinctness from the Andrenine series. I find, however, two exceptional forms within the Anthophoridae. The margin on which the comb is set is less concave than usual in the species of *Exomalopsis*, and in *Dasiapis* (*D. ochracea* Ckll.) it is very little concave, and although there is a true comb, there are also many long hairs.

Melitoma (*M. grisella* Ckll. and Porter), which has an extraordinary long and whip-like galea, has no comb. The margin is merely beset with stiff hairs, placed irregularly, and many of them branched. Thus *Melitoma* stands quite apart from the other Anthophoridae.

Xylocopa has an extremely strong outer comb, on a very concave margin. In *Ceratina* the margin is much less concave, but there is a good comb. *Eulaema* has a dense comb of stout curved spiniform bristles on a practically straight base. *Bombus* has a good comb on a gently concave surface (not at all the specialized structures of *Xylocopa*), but the basad end grades into simple hairs. *Psithyrus* has a comb resembling that of *Bombus*. In *Apis* there is a pronounced, rather short concavity, but the comb-like structures exist only on the basad part. Thus the Xylocopidae, Ceratinidae, Bombidae, Euglossidae and Apidae agree with Anthophoridae in possessing an outer comb, as well as lacking an inner one. Such partial exceptions as *Apis*, or complete exceptions like *Melitoma*, indicate secondary specialization.

The Megachilidae still remain to be considered.

Megachile has no inner or outer comb. The margin below the palpus is strongly convex, but presents a certain number of bristles, which in some species are thickened and spiniform. I think these represent the vestiges of an outer comb. The remarkable feature in *Megachile* is the comb often present on the elongate laciniae. In some species (e. g. *M. fidelis* Cress.) the lacinia merely presents some stout bristles at the end. In others there may be also large lateral bristles; but in *M. apicalis* Spinola there is fringe or comb of very long bristle-like hairs. In *Coelioxys* the convex margin below the palpus presents only a very few minute hairs, not at all suggesting a comb. The lacinia may have the hairs practically confined to the end, or may be hairy down the side.

Chalicodoma (*C. caementaria* Meinecke) has merely minute hairs on the convex margin below the palpus. The very stout lacinia has hairs down the side.

Trachusa (*T. serratulae* Panzer) is very remarkable. The galea, palpus and outer face of stipes are excessively bristly, but there is no comb. The basad part of the stipes bears very long finely plumose hairs, recalling the condition common in Anthophoridae.

Anthidium (*A. manicatum* of Europe, and related American species) has a very well-developed outer comb, set on a moderately concave surface. The lower (basad) teeth are very stout, long and curved; they gradually decrease in size apicad, becoming minute at the end of the concavity. The lacinia is broad, and thickly beset with long hairs on the outer edge.

After seeing these, it was astonishing to find the comb totally

absent in other Anthidiines. In *Protanthidium* (*P. steloides* Bingham) the margin below the palpus is nearly straight, and has a good many minute hairs, but no sort of comb. In *Dianthidium* (*perpictum* Ckll., *interruptum* Say, *gilense* Ckll., *parvum* Cresson, *strigatum* Panzer) the margin below the palpus is convex, with a few fine hairs, and no trace of a comb, except that in *D. perpictum* and *D. interruptum* I see a few small scattered spines. The lacinia of *Dianthidium* is just like that of *Anthidium*.

The Osmiines are after the fashion of *Dianthidium*, and have no comb, but in *Osmia brevis* Cresson I find the margin of the stipes with a gentle double curve and all along a series of small dagger-shaped spines, not uniform in size. Other species of *Osmia* show this more or less. *Hoplitis mescalerium* Ckll. has the double curve, but the bristles are not distinctly spiniform. In *H. graceae* Ckll. there are merely small hairs of different sizes on a gently convex margin. *Osmia lignaria* Say has bristles on the margin, and a lacinia just like that of *Anthidium*. *Formicapis* has minute bristles of different sizes on a gently convex margin.

The following key may help to summarize the more essential points:

- Apical segment of galea remaining more or less distinct; lacinia evanescent;
no inner or outer comb.....HALICTINAE.
- Apical segment of galea entirely united with that before.....1.
1. Outer comb absent (in *Triepeolus* apparently vestigial).....2.
- Outer comb present.....ANTHOPHORIDAE (except *Melitoma*),
XYLOCOPIDAE, CERATINIDAE, *Anthidium*. BOMBIDAE, EUGLOSSIDAE,
APIDAE.
2. Inner comb well developed.....HYLAEIDAE,
COLLETIDAE, ANDRENINAE, *Nomia*, *Protandrena*, *Calliopsis*, *Spinoliella*,
Panurginus.
- Inner comb absent.....*Melitta*,
Halictoides, *Rhophites*, *Perdita*, *Nomada*, EPEOLINES, MELECTINES,
PHILEREMINES, MEGACHILIDAE (except *Anthidium*), *Melitoma*. (The
Megachilidae and *Melitoma*, and presumably some of the parasitic bees,
outer comb losers; the others without any outer comb ancestry.)

III. PANURGIDAE OR PANURGINAE OF AUTHORS.

Tribe CALLIOPSINI. (Calliopinae Robertson, Psyche, 1922.)

Panurgine bees with well developed inner comb; nearly always with light face-markings, at least in the males. Related to Protandrenini (Protandreninae, Robertson), but with only two cubital cells. For other character see Robertson.

The following key brings out some of the characters within the group:

- Maxillary palpi less than half length of galea; palpus to tip of galea a greater
distance than to base of stipes.....*Verbenapis verbenae* (Ckll. and Porter).
- Maxillary palpi shorter than galea, but considerably over half its length.

End of galea sharply pointed, with no terminal brush of hair; palpus not so far from tip of galea as from base of stipes.....

Hypomacrotera subalpina (Ckll.), and *H. semirufa* (Ckll.)
(believed to be sexes of one species.)

End of galea rounded, with a strong terminal brush of hairs; palpus about midway between tip of galea and base of stipes.....

Calliopsis coloradensis Cresson.

Maxillary palpi longer than galea; tip of galea with hairs; stipes longer than galea beyond palpus.

Galea broad and short, its inner margin strongly convex; second and third joints of labial palpi short and broad.....

Hypomacrotera callops Ckll. and Porter.

Galea ordinary; second and third joints of labial palpi long and rather slender.....

Calliopsis rhodophilus Ckll.

There appears to have been more or less parallel evolution in *Calliopsis* and *Hypomacrotera*, but the latter genus always has a shorter tongue than *Calliopsis*. *Hypomacrotera subalpina* further differs from *H. callops* in having the second and third joints of labial palpi long and cylindrical.

Spinoliella (*S. scitula* Cresson) falls in the third division above, having the maxillary palpi considerably surpassing end of galea. The tip of galea is hairy, and the inner margin is straight; second and third joints of labial palpi cylindrical. The tongue is not very long, but narrow as in *Calliopsis*.

Pseudopanurgus aethiops (Cresson) is remarkable for the very long (fully 1 mm.) first joint of labial palpi; this joint is not thus elongated in *Panurginus*. *P. aethiops* has the tongue moderate, maxillary palpi not reaching end of galea, end of galea with bristles. In *Panurginus* (*P. boylei* Ckll.) the maxillary palpus does not reach end of galea; the palpus is distinctly nearer tip of galea than base of stipes; the inner comb has ten rather widely spaced teeth or spines.

Tribe PERDITINI—(Perditinae Robertson, l. c.)

See Robertson for characters; the inner comb is lost. The maxillary palpus goes well beyond middle of galea, but does not reach its tip. In the subgenus *Cockerellia* (*P. albipennis* Cress., *P. lacteipennis* Swenk and Ckll., *P. albovittata* Ckll.) the maxillary palpus does not nearly reach half-way to the end of the tapering galea. Thus the development parallels that of *Verbenapis*, but the latter has the first joint of labial palpi much more elongated.

Tribe RHOPHITINI, new.

Type *Rhophites* Spinola. The inner comb is lost, and there is no trace of the outer comb. The remarkable feature is seen in the labial palpi. The first two joints are broadened, clearly prophetic of the normal condition in the higher bees. In the less specialized genus, *Rhophitoides* Schenck (*R. canus* Eversmann) the labial palpi go a little beyond the tongue; the two broad joints are of about equal length, and only moderately long, the third is much shorter and claviform,

while the fourth is about as long as the third, but very slender. All these joints are in the same straight line. In *Rhophites* (*R. quinquespinosus* Spinola) the first two joints are long and broad, much longer than in *Rhophitoides*; the third is short, but broad like the one before, and continuous with its suture being indistinct; the fourth is slender and cylindrical (slightly claviform) and diverges from the side of the tip of the third as do the small joints of the higher bees from the tip of the second.

In *Rhophitoides* the maxillary palpi extend far beyond the galea, but in *Rhophites* they do not nearly reach its end. Thus the two genera are very distinct, although Friese combines them. Friese remarks that *Rhophites* stands nearest to *Halicoides* and *Dufourea*; but these genera (in which the maxillary palpi far exceed the galea) have ordinary labial palpi, and form a separate tribe DUFOUREINI (part of Dufoureae Robertson).

IV. THE GENUS MELITTURGA LATREILLE.

The name is usually spelled *Meliturga*, but Alfken states that Latreille wrote *Melitturga*. I have seen Latreille's type in the Oxford (Hope) Museum. Fourteen species are at present known, ranging from South Africa (*M. capensis* Brauns) to Algeria (*M. rubricata* Morice, *M. algeriensis* Friese), and from western Europe to Persia (*M. caucasica* Morawitz), Transcaspia (*M. pictipes* Morawitz) and the Altai region (*M. clavicornis* Latreille). The apparently discontinuous distribution of *M. pictipes* (Transcaspia and Algeria) was due to a distinct Algerian form (*M. algeriensis*) being taken for *pictipes*.

The position of this genus has long been in doubt. Friese placed it in the Anthophoridae, after *Eucera*. In Ashmead's key it falls between *Melissodes* and *Melitoma*. A study of *M. clavicornis* shows that this is not its true position.

The maxillae have the following characters:

Palpi fairly long, but not nearly reaching end of galea, with six sub-equal joints, the fifth shortest, the first two conspicuously stouter than the others; galea nearly parallel sided, heavily chitinized, the very obtuse end with many strong bristles; margin of stipes basad of palpus straight, with many outstanding hairs, but no trace of a comb; inner comb very well developed, with about fifteen stout red teeth. The tongue is of the long parallel-sided type, but not extremely long; the labial palpi have the first joint longer than the others together, but not flattened, though about the last three-fifths are thickened, and very hairy on one side. The second joint is longer than the last two together; the latter are about equal, and diverge from the straight line of the basal joints.

Both sexes have the clypeus brownish-white; the male has large eyes and a narrow vertex, with the ocelli just above the antennae, and the flagellum is strongly clavate; the labrum is transverse, quadrate, with a longitudinal median groove but no process. The apex of the male abdomen is bispinose. The basal

nervure falls far short of the nervulus; stigma small; three cubital cells, the second receiving first recurrent nervure at its end; marginal cell very broadly obliquely truncate at end.

This bee has nothing to do with the Anthophoridae. It shows a good many points in common with the Neotropical Oxaeinae, which however have no inner or outer comb, and differ conspicuously in other respects. *Melitturga* must stand as the type of a subfamily MELITTURGINAE which will have to be placed for the present under the Panurgidae, a family with uncertain limits. It is to be regarded as a member of the Andrenid-Panurgid series.

A NEW GENUS AND SPECIES OF PIESMIDAE (HEMIP.).¹

BY CARL J. DRAKE.

The family Piesmidae, although widely distributed in the holarctic region, has been heretofore represented by only a single described genus, *Piesma* of Lepeletier de Saint-Fargeau et Serville. Through the kindness of Mr. W. L. McAtee the writer has been permitted to study some undetermined Tingitoidea in the National Museum. Among this material there are four specimens of an apparently undescribed genus and species of Piesmidae from Australia.

MCATEELLA, new genus.

Head broad, nearly truncate in front, the jugae and tylus equal or slightly subequal in length. Ocelli present, inconspicuous, placed near the anterior margin of the pronotum. Antenniferous tubercles large, prominent, slightly curved inwardly. Antennae rather long, moderately stout; first and second segments short, the former greatly swollen; third segment slenderest, considerably longer than either the first or second, but a little shorter than the fourth; fourth segment swollen towards the apex, fusiform, longer than the third. Rostral sulcus deep on the head, the bucculae thin, rather high, moderately incurved; rather deep and narrow on the prosternum, shallow and narrow on the mesosternum and disappearing on the metasternum. All coxae placed rather close together. Metasternal orifice present, with a distinct, latero-projecting plate beneath. Pronotum above very coarsely punctate, the median carina not very distinct, the lateral carinae wanting; lateral margins of the pronotum dilated in front. Scutellum exposed, granular, with a small calloused tubercle at the apex. Elytra (macropterous form) coarsely punctate, a little longer than the abdomen with a distinct clavus as well as costal, subcostal, discoidal and sutural areas. Wings present. The brachypterous form is unknown. In the long-winged forms the elytra are entirely coriaceous and the discoidal area is not divided by a longitudinal vein.

¹Contribution from the department of Zoology and Entomology, Iowa State College, Ames, Iowa.



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