

long series of examples. Species are separated, for instance, by the presence of several (six or seven) blunt bristles, or *at least one*, amongst many pointed bristles from those which possess *no* blunt bristle. If, however, they vary in this respect between six and one, there is no reason why they should not vary from six to *none*. So, too, with respect to colour-differences and characters based on the relative length of protarsus i., in connexion at any rate with the distinction of *L. geometricus* from *L. obscurior*, new species. In numerous examples of *L. geometricus* from the Amazons, Table Mountain, Karachi, and Jansenville one finds every variation in coloration from pale whity grey to almost jet-black, while protarsus i. varies in length from three to four times longer than the tarsus. *L. obscurior* is distinguished from *geometricus* by the variation of protarsus i., three and a quarter to three and a half times the tarsus—that of the latter species being *about four* times the tarsus.

The variation of colour in *L. mactans*, too, ranges from the central band and lateral slashes being red (as in the typical North-American form) to almost jet-black, so that one hesitates to separate examples even as *subspecies* on the strength of slight variations in this respect—as, for instance, *L. insularis*, *L. insularis insularis*, and *L. insularis lunulifer*.

The following are Dr. Dahl's new species and subspecies:—*L. obscurior*, sp. n., Madagascar; *L. insularis*, sp. n., Antilles; *L. insularis insularis*, subsp. n., St. Thomas; *L. insularis lunulifer*, subsp. n., Haiti; *L. sagittifer*, sp. n., Porto Alegre; *L. ancorifer*, sp. n., New Guinea; *L. Hahli*, sp. n., Bismarck Archipelago; *L. luzonicus*, sp. n., Philippines; *L. Stuhlmanni*, sp. n., East Africa; *L. renivulvatus*, sp. n., German S.W. Africa.

V.—*Contributions from the New Mexico Biological Station.*

—XIII. *On the Bees of the Family Nomadidæ of Ashmead.*

By T. D. A. COCKERELL and EMERSON ATKINS.

THE Nomadidæ of Ashmead (Trans. Am. Ent. Soc. xxvi. p. 64) are the parasitic bees with three submarginal cells. Ashmead himself says that they have “undoubtedly originated from other bees, through different lines of descent.” He adds:—“It is evident, however, that most of them are descendants from various Anthophorid bees, since they agree more nearly with these bees in venation and the characters of the mouth-parts than with any of the others.” If we admit

that a valid taxonomic group must consist of forms not less related to one another than to forms outside of the group, or, at least, that the group must have a common ancestor exhibiting the group-characters, then the family Nomadidæ, by the admission of its author, is not valid, or else must be restricted to a small portion of the genera now included in it. In other words, convergent evolution must be distinguished from blood-relationship*.

In our studies of these bees we have met with facts which convince us that they are descended from two or three entirely diverse groups, *Nomada* itself coming from the Panurginæ.

NOMADA, Scopoli, 1770.

Mr. E. Saunders (Journ. Linn. Soc., Zool. xxiii. p. 423) says:—"This genus forms a curious transition between the Andrenidæ and Apidæ; it has many of the characteristics of the latter division, such as the long tongue, the acute paraglossæ, and the long basal joint of the labial palpi; on the other hand, however, it has the joints of the labial palpi sub-cylindrical, like the Andrenidæ, without any tendency to the flat or concave sheath-like form of the Apidæ, and its species are also parasitic on the Andrenidæ (with the exception of *N. seafasciata*, which frequents the burrows of *Eucera*). . . . I should feel inclined to treat it as a very abnormal genus of the Andrenidæ."

When we come to compare the mouth-parts of *Nomada* with those of the Panurginæ (which are themselves obviously derived from the Andrenidæ) all the difficulties mentioned by Saunders disappear. In the Panurgine mouth we find the long tongue, the long basal joint of the labial palpus, and paraglossæ of the same type as *Nomada*. Moreover, certain species of *Nomada* (e. g. *N. similis*) are parasitic on *Panurgus*.

Of all the Panurginæ *Panurgus* is most like *Nomada*, having the same slender tapering galea, the same long maxillary palpi, &c. The greatest difference is in the paraglossæ, which in *Nomada* are much more slender; but another Panurgine bee, *Dufourea vulgaris*, has slender paraglossæ, as in *Nomada*, though it differs from *Nomada* in the palpi. *Nomada*, to be sure, has three submarginal cells in

* In the famous paper by De Vries (cf. 'Science,' May 9, 1902, p. 726) new "species" are said to appear repeatedly among the offspring of *Ænothera* or *Onagra Lamarckiana* (apparently it should be *Onagra grandiflora*); thus the "species" *Ænothera oblonga* originated several hundred times independently. Of course the fact is that *Æ. Lamarckiana* is polymorphic, and the various mutations have not yet reached the status of species.—T. D. A. C.

the wings, whereas the Panurginæ have but two; however, *Nomada obliterata*, Cresson, has constantly only two submarginals*, while a form of *Dufourea* (subg. *Trilia*, Vachal) has three. *Andrena* has usually three submarginals, but some species have only two.

As typical examples of *Nomada* we have studied *N. fucata*, Panz. (Mallorca, Balearic Is., from Friese), and *N. xanthophila*, Ckll. (New Mexico). In *Panurgus* we have used *P. calcaratus* and *P. Banksianus*.

Nomada modesta, Cresson (Las Vegas, N. M., collected by A. Garlick), differs from the other species by the very large and long galea (actually larger than in *N. xanthophila*, though the bee is smaller), shorter maxillary palpi (not much over half length of galea), very long paraglossæ, long tongue, and very long basal joint of labial palpi (much exceeding the other three joints together). In these characters (except the paraglossæ) *N. modesta* closely resembles *Calliopsis verbena* (also from Las Vegas, N. M.).

There is a singular resemblance in the mouth-parts between *Nomada* and *Exomalopsis*, but the bees are otherwise entirely different, and are evidently not related.

The following table gives the differential characters of the mouth-parts of several Panurgine bees, placing *Nomada* among them for purposes of comparison:—

- | | |
|--|-----------------------------------|
| A. Maxillary palpi far surpassing the galea †. | |
| a. First joint of labial palpi longer than the other three together; galea broad, not bristly | <i>Halictoides dentiventris</i> , |
| aa. First joint of labial palpi not longer than the other three together. | [Nyl. |
| b. First joint of labial palpi about equal with second; the first two joints very stout | <i>Rhopitoides canus</i> |
| bb. First joint of labial palpi conspicuously longer than second. | [(Eversm.). |
| c. Tongue very narrow, nearly parallel-sided; labial palpi long and slender; galea very slender apically, with bristles along its whole hind | |

* *Nomada obliterata* may stand as the type of a subgenus *Heminomada*.—T. D. A. C.

† The maxillary palpi also surpass the galea in *Spinoliella scitula* (Cresson) and *Hyleosoma atriceps* (Cresson), species formerly referred to *Calliopsis*. In the *Spinoliella* the first joint of the labial palpi is very stout and longer than the other three together; in the *Hyleosoma* it is scarcely as long as the other three together. In both the galea is broad and bristly at the apex.—T. D. A. C.

- margin; third joint of maxillary palpi about $\frac{2}{3}$ length of second . . . *Dufourea vulgaris*,
 cc. Tongue broad and sharply pointed [Schenk.]
 (dagger-like); galea broad, bristly at tip.
- d. Labial palpi stout, first joint very stout; third joint of maxillary palpi hardly half length of second *Parahalicoides Tinsleyi*,
 dd. Labial palpi rather slender; [(Ckll.).
 third joint of maxillary palpi about $\frac{2}{3}$ length of second *Parahalicoides paradoxus*
 [(Moraw.).
- AA. Maxillary palpi shorter than galea.
- a. First joint of labial palpi much shorter than the other three together; maxillary palpi short and rather stout. . . . *Hesperapis rhodocerata*
 aa. First joint of labial palpi about as long as the other three together; maxillary palpi long, often almost as long as galea. [(Ckll.).
- b. Galea short and broad, sepia-brown, its hind margin only bristly on apical portion *Panurginus Boylei* (Ckll.).
- bb. Galea narrow and curved apically, the apical portion mostly hyaline, its hind margin bristly throughout.
- c. Paraglossæ linear *Nomada xanthophila*, Ckll.
- cc. Paraglossæ broad *Panurgus Banksianus*
 (Kirby).
- aaa. First joint of labial palpi decidedly longer than the other three together.
- b. Maxillary palpi about or little over half length of galea.
- c. Paraglossæ long and linear; second joint of labial palpi bristly and longer than the last two joints together *Nomada modesta* (Cresson).
- cc. Paraglossæ shorter and shaped like a knife-blade; second joint of labial palpi short, no longer than third *Calliopsis verbenæ*, C. & P.
- bb. Maxillary palpi not very much shorter than galea.
- c. Galea with the apical portion much elongated, very narrow, and curved *Nomada fucata*, Panz.
- cc. Galea broad, the apical portion not or scarcely elongated.
- d. First joint of labial palpi not nearly twice as long as the other three together; tongue short (about as in *Dasypoda*) . . *Hypomacrotera semirufa*
 dd. First joint of labial palpi at least twice as long as the other three together; tongue longer; paraglossæ quite slender. [(Ckll.).

- e. First joint of labial palpi very long *Calliopsis coloradensis*,
 ee. First joint of labial palpi somewhat shorter; tongue considerably surpassing labial palpi *Calliopsis chlorops*, Ckll. [Cresson.]

The *Nomada* figured by E. Saunders (*l. c.*) has the labial palpi of the type of *N. xanthophila*, but the galea, as figured, is more like that of *Panurginus Boylei*. Saunders does not state the species. The species with the *N. xanthophila* type of palpi may be regarded as typical *Nomada*.

Nomada modesta, with the characters indicated in the table, may be taken as the type of a new subgenus, *Micronomada*.

Calliopsis verbenæ, with its long galea not abruptly narrowed at apex and the extremely long basal joint of labial palpus, may form the type of a new subgenus, *Verbenapis*.

We believe that *Phileremulus*, *Neolarra*, and probably *Allodape* are related to *Nomada*, and are therefore also derived from Panurgine ancestors.

EPEOLUS, Latr., 1802.

This genus is parasitic on *Colletes*, but cannot be derived therefrom. From all the genera discussed in connexion with *Nomada* it differs by its greatly reduced maxillary palpi, which have only two joints. Many species found in North America, formerly referred to *Epeolus*, have three-jointed maxillary palpi, and constitute the genus *Triepeolus* of Robertson (1901). Robertson thinks that *Triepeolus* is probably a parasite (or, rather, inquiline) of the Melissodinæ. Examining *Triepeolus verbesinæ* (Ckll.) as an example of the *Epeolus* type, we find that it has a broad blunt galea, with erect bristles at intervals on the outer margin, such as we find in several of the *Nomada*-Panurgine series. But the whole of the mouth-parts indicate the closest affinity with *Phileremus*. The characters which remove *Epeolus* and *Phileremus* from the *Nomada*-Panurgine series are the reduced maxillary palpi, and the broadened and flattened two basal joints of the labial palpi, with the two terminal joints diverging laterally, as in the ordinary long-tongued bees.

At this point we note that *Calliopsis chlorops* (a veritable Panurgine) has the first joint of the labial palpi broadened and flattened, while its paraglossæ are very like those of *Epeolus*. Furthermore, the series of *Phileremus* &c., while departing very much in many respects from *Phileremus* or the Panurginæ, nevertheless forms in some ways a connecting-link between these groups. *Phileremus* is remarkable for

having a very long tongue, with entirely *Panurgus*-like labial palpi. *Allodape*, on the other hand, has the labial palpi wholly as in the ordinary long-tongued bees.

It would seem, then, that *Epeolus* and *Phileremus*, with their allies, have been derived from the Panurgine series, but from a higher type than *Nomada*. The resemblances we find between *Epeolus* and the Anthophorinæ may be explained by the probable fact that the Anthophorinæ themselves have a Panurgine ancestry, though they have now travelled far along their own special path.

MELECTA, Latr., 1802.

Dalla Torre gives this as the first genus of the Nomadinæ. It is parasitic upon *Anthophora*, as also is *Crocisa*. In *Melecta miranda* we find the maxillary palpi very small, five-jointed, the last joint minute; the galea is very large, with a few short dark spines at the apex; the tongue and the labial palpi are of the type usual in long-tongued bees. In *Anthophora montana* we find the third joint of the labial palpi attached laterally some distance before the end of the second, at about the middle of the terminal narrowed portion of the second joint. The outer side of the two first joints is covered with bristles, which form a brush at the end of the second. In *Epeolus* and *Melecta* the last two joints are attached at the end of the second, as also in *Melissodes* and *Xenoglossa*. In *Epeolus*, however, the second joint is not narrowed apically, whereas in *Melecta miranda* it is greatly narrowed, with the narrowed portion largely hyaline. The galea of *Anthophora montana* has the same general form as that of *Melecta miranda*, but is distinguished by numerous strong bristles scattered over its surface. Much more similar to that of *Melecta*, when one goes into details, is the galea of the series of *Melissodes* &c. Thus in *Xenoglossa pruinosa* we find on the apical part of the galea a longitudinal series of bristles having tubular sockets, while the margin of the galea behind these bristles is abruptly narrowed and hyaline. The same row of bristles appears in the *Melecta*, but it is longer and the long hyaline area is not narrowed. In *Melissodes pallidicincta* the hyaline area is extremely small, but recognizable in comparison with the other genera.

From the above facts we must apparently conclude that *Melecta* is really derived from the Anthophorine series, but not from *Anthophora* itself.

ERICROCIS, Cresson, 1887.

We have examined *Ericrocis lata*, Cresson. Its evident affinity is with *Centris*, to which it is allied by the short paraglossæ and the very peculiar form of the labial palpi and galea. The similarity of the galea even extends to the transverse brown spots, though the maxillary palpi in *Ericrocis* are reduced to two joints. Both *Centris* and *Ericrocis* are no doubt derived from *Exomalopsis* or a similar form.

THALESTRIA, Smith, 1854.

We have studied *Thalestria smaragdina*, Sm., collected by Mr. H. H. Smith at Chapada, Brazil. The maxillary palpi are reduced to two joints. The galea is large and broad, with the series of bristles having tubular sockets, as seen in *Xenoglossa*, while the ill-defined hyaline area is narrowed, though not strongly. The labial palpi are extremely hairy on the inner side, and the third joint is placed at the lateral apex of the second. All this indicates the origin of *Thalestria* from the Anthophorine series, near to the place of origin of *Melecta*.

Thus the "Nomadidæ" are of composite origin and should be divided into groups, somewhat as follows:—

Nomadinae, for *Nomada* and its allies, to follow the Panurginae.

Philereminae, for *Phileremus* and *Epeolus*.

Melectinae, for *Melecta*, *Thalestria*, &c., to follow the groups of *Xenoglossa* &c.

Ericrocinae, for *Ericrocis*, to follow the group of *Centris* &c.

The genus *Bombomelecta* falls in Melectinae, and its affinity with *Xenoglossa* is further indicated by the very long paraglossæ, which, however, are devoid of hairs. The tip of the galea exhibits a number of flattened hairs, and exactly the same, but not so large, are found in *Melissodes*. The *Bombomelecta* studied is *B. thoracica*, var. *fulvida*, Cresson.

It is worth while to remark that the nest-building bees can be recognized by the comb of bristles on the basal part (stipes) of the maxilla. In the parasitic genera this is wholly wanting, the corresponding place presenting at most a series of fine short hairs.

All the slides used in this investigation were prepared by Mrs. W. P. Cockerell.

East Las Vegas, New Mexico, U.S.A.,
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