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*Results of the Oxford University Sarawak (Borneo) Expedition:  
Bornean Stingless Bees of the Genus Trigona*

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BULLETIN

OF

THE AMERICAN MUSEUM OF NATURAL HISTORY

VOL. LXXIII, ART. III, pp. 281-329

*New York*

*Issued May 3, 1937*

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**Article III.—RESULTS OF THE OXFORD UNIVERSITY  
SARAWAK (BORNEO) EXPEDITION: BORNEAN  
STINGLESS BEES OF THE GENUS *TRIGONA***

**BY HERBERT F. SCHWARZ**

**PLATES II TO VII**

The present paper is primarily a report of the Meliponidae collected in 1932 by the Oxford University Sarawak (Borneo) Expedition, in which Dr. B. M. Hobby and A. W. Moore participated as entomologists. In making the determinations I have had opportunity to study the types of certain of the Indo-Malayan species deposited by Professor Cockerell at the U. S. National Museum, the types of *Trigona* from that region described by Smith, Cameron, and Cockerell that are in the British Museum as well as the Smith types in the Wilson Saunders collection at the Oxford University Museum. With characteristic generosity Professor Cockerell, upon learning that I planned to study the *Trigona* types at the British Museum, undertook to aid my investigation by depositing there all of the types of Indo-Malayan *Trigona* that had not hitherto been distributed from his private collection. For his cordial coöperation as evidenced by this action and throughout his personal correspondence with me regarding the group to be studied I desire to record my hearty thanks. I am deeply appreciative, too, of the courtesies extended to me by Miss Grace Sandhouse and by Mr. Robert Benson, respectively in charge of Hymenoptera at the U. S. National Museum and at the British Museum, during my visits to those institutions, and for equally helpful coöperation received at the Oxford University Museum. In The American Museum of Natural History are paratypes of several of the Indo-Malayan species described by Professor Friese and these, too, have been studied in connection with the collection of Messrs. Hobby and Moore.

I have been especially fortunate in having the coöperation as artist of Mr. Pierre-Noël whose accurate drawings, to scale, should prove of distinct aid in visualizing the characters of the several species considered. To Miss Ethel Olsen, secretary of the department of entomology of the American Museum, I am indebted for having transcribed with faultless accuracy and good judgment my much interlineated longhand manuscript.

A total of sixteen different forms are represented in the catch of the Oxford University Expedition, and of these four are believed to be new. From 1857, when Frederick Smith described *ventralis*, *apicalis*, and *canifrons*—the first *Trigona* to be reported from Borneo—to 1933, when Friese erected his *sericea* and *borneënsis*, a total of thirty-two species have been recorded from the island (see list at end of this paper). Several of these are to be regarded as synonyms while others represent merely phases of variability within a species. It may, therefore, be conservatively stated that the collection of the Oxford University Expedition includes about one-half of the species hitherto reported from Borneo, in addition to certain new forms. This total is the more impressive when it is stated that the specimens, with a minimum of exception, were collected between the foot of Mt. Dulit and an elevation of 4000 feet on that mountain.

In his recent study of 'The Distribution of Mammals and Birds in Sarawak and Adjacent Parts of Borneo' (1933, Proc. of Zool. Soc. of London, I, pp. 273-282, Pl. 1), E. Banks offers, among others, the following conclusions:—

The fauna of Bornean mountains over 3000 feet high differs from that of the lowlands and hills up to that height.

.....  
The highland fauna is most numerous on Mt. Kinabalu, less so on Mts. Murud and Dulit, further reduced on Mts. Penrissen and Poi.

.....  
The highland fauna is composed of two elements, with and without lowland racial or specific representatives.

The latter element is in a majority more marked on Mt. Kinabalu, on Murud, and Dulit than on Mts. Penrissen and Poi.

Unfortunately there are no specimens of *Trigona* available from the mountains mentioned other than Dulit, so that it is impossible to say to what extent generalizations applicable to the mammals and the birds may be applied also to the stingless bees. But it may perhaps not be amiss in this connection to list the species taken at different elevations on Mt. Dulit.

#### I.—LOWLAND SLOPES

##### A.—Foot of Mt. Dulit

*Trigona confusella*

*Trigona haematoptera* variety  
*dulitae*, new variety

*Trigona melanocephala*

*Trigona terminata* variety *lateballeata*

*Trigona iridipennis*  
*Trigona itama*

*Trigona thoracica* variety *lacteifasciata*  
*Trigona ventralis*

B.—Mt. Dulit, R. Lejok

*Trigona iridipennis*  
*Trigona melanocephala*

*Trigona melina*  
*Trigona moorei*, new species  
*Trigona ventralis*

C.—Mt. Dulit Trail

*Trigona fimbriata*  
*Trigona iridipennis*

*Trigona melanocephala*  
*Trigona melina*

II. MT. DULIT, AT AN ELEVATION OF 2500 FEET

*Trigona apicalis*

*Trigona collina*  
*Trigona melina*

III.—MT. DULIT, AT AN ELEVATION OF 4000 FEET

MOSS FOREST

*Trigona collina*  
*Trigona hobbyi*, new species  
*Trigona sarawakensis*, new species

*Trigona melanocephala*  
*Trigona rufibasalis*

IV—R. KAPAH, TRIBUTARY OF R. TINJAR

*Trigona fimbriata*

*Trigona itama*  
*Trigona melanocephala*

V.—MT. KALULONG, AT AN ELEVATION OF 1800 FEET

*Trigona haematoptera* variety *dulitae*, new variety

Eleven forms were collected either at the foot of Mt. Dulit, on the Mt. Dulit Trail, on R. Lejok, or R. Kapah, which represent elevations less than 2000 ft. Of these one (*melina*) was duplicated at 2500 feet, and another (*melanocephala*), rather well represented on the lower slopes, was again secured further upward at 4000 feet. One species (*collina*), secured at 2500 ft., was taken again at 4000 feet. Of the three specimens obtained at 4000 feet that are not duplicated in the catch at lower elevations, two (*hobbyi* and *sarawakensis*) are here recognized as new species. One of the bees, *haematoptera* variety *dulitae*, new variety, obtained in numbers at the foot of Mt. Dulit, is repre-

sented by a single specimen collected at an elevation of 1800 feet on Mt. Kalulong.

The collection made on Mt. Dulit is evidence of the large number of forms obtainable in a relatively small area, especially when such an area presents different levels of altitude. From the Indo-Malayan region in excess of seventy forms have been described or reported, but allowance must be made for the fact that some of these are synonyms or not very clearly separable varieties.<sup>1</sup> The sixteen forms collected in the environment of Mt. Dulit thus may be said roughly to represent one-quarter of the known Meliponid fauna of the Indo-Malayan region. If this proportion seems extraordinarily high, it is to be remembered that similarly limited areas in the New World that have been intensively scoured for specimens have been found to harbor a substantial fraction of the total recorded fauna of a vastly larger embracing area. Thus the successive expeditions to Barro Colorado Island in the Canal Zone have resulted in assembling twenty-six species and subspecies from that speck of land—only about three miles in diameter. This is more than one-third of the known forms of stingless bees (somewhat under seventy in number) listed by Lutz and Cockerell (1920, Bull. Amer. Museum Nat. Hist., XLII, pp. 492-502) from all Central America and Mexico.

It is pertinent, too, to cite the experience of Alfred Russell Wallace at a collecting site "near the Simunjon River, a small branch of the Sádong, a river east of Saráwak and between it and the Batang-Lupar." Wallace states ("The Malay Archipelago," second edition, 1869, Vol. I, p. 37) that "When I arrived at the mines, on the 14th of March, I had collected in the four preceding months, 320 different kinds of beetles. In less than a fortnight I had doubled this number, an average of about 24 new species every day. On one day I collected 76 different kinds, of which 34 were new to me. By the end of April I had more than a thousand species, and they then went on increasing at a slower rate; so that I obtained altogether in Borneo about two thousand distinct kinds, of which all but about a hundred were collected at this place, and on scarcely more than a square mile of ground."

Several of the species here reported upon—*ventralis*, *terminata* variety

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<sup>1</sup> From Professor T. D. A. Cockerell I have recieved the following statement, drawn up by H. M. Pendlebury, offering an explanation for the relatively greater abundance of stingless bees in Malaysia as compared with the areas beyond:

"I suppose that the reason why *Trigona* are so numerous in Siam, Malaya, and Borneo, and so poor outside these limits is possibly due to the greater number of resin-secreting trees belonging to the Dipterocarpaceae found in Malaysia; the stable conditions regarding humidity and temperature may be contributory factors also."

*latebaleata*, *fulvopilosella*, and *trochanterica*—are relatives of such New World species as *lineata*, *opaca*, *prosopiformis*, *haeckeli*, *schrottkyi*, and *impunctata*, having like these the head and thorax dull and opaque due to a microscopic tessellation that is utterly devoid of shiny interspaces and also having the hairs fringing their hind tibiae posteriorly not branched but simple.

The greater number of the species here reported upon, however, belong to *Tetragona*, which I believe to be a valid subgenus of *Trigona*. An abdomen distinctly narrower than the thorax and rather elongate is a character usually associated with *Tetragona* because it applies to the type species, *clavipes*, but the mere possession of a narrow abdomen would admit into the fold of *Tetragona* such an insect as *compressa*, which has a four-toothed mandible and is in my judgment assignable to *Trigona* subgenus *Trigona*. In my estimation the width of the abdomen is not of determining importance for the admission to or exclusion from *Tetragona* of any given Meliponid. Subgenus *Trigona* and subgenus *Tetragona* are, it seems to me, very closely related. Both are characterized by plumose hairs on the posterior fringe of the hind tibiae, usually supplemented by similar hairs on the outer surface of the middle tibiae and on the outer surface of the hind tibiae basally. In the possession of this posterior fringe of plumose hairs these two subgenera, which, in addition, have the chitin smooth or at least devoid of decided sculpturing, differentiate themselves from other subdivisions of the genus *Trigona*. The worker of *Trigona* has the mandible completely toothed along the apex, being either quadridentate or, more often, quinquedentate. The subgenus *Tetragona*, on the other hand, has the outer half or two-thirds of the apex of the mandible edentate. The worker of all species of the subgenus *Trigona* has a well differentiated flat, bristleless although usually sericeous, oval area at the base of the inner surface of the hind metatarsi that contrasts with the metatarsal brush occupying the greater part of the joint. Such a differentiated area characterizes also the males, so far as known, of the several species and subspecies of the subgenus *Trigona*. Among the New World species of *Tetragona* only a few—*jaty*, *buchwaldi*, and *pfeifferi*—share with true *Trigona* this differentiated patch on the hind metatarsus. In the case of *jaty* it is the worker only that has this distinction. The males of *buchwaldi* and *pfeifferi* are unknown. On the other hand, a predominant number of the *Tetragona* from Borneo—and indeed from the Indo-Malayan region generally—are characterized in the worker, at least, by this earmark of relationship (Pl. IV, fig. M<sup>1</sup>).

Another character which has been frequently emphasized in the key is the emphatic development of the two inner teeth of the mandible in a great many of the species (see especially Pl. II, figs. A, B, C, D). Even the first of these two teeth is impressive in size due to a deep and decided cleft between it and the edentate outer one-half to two-thirds of the mandible, but the second and innermost tooth is even more developed and springs from a point on the inner contour almost midway toward the base of the mandible. Among the New World *Tetragona* the species and subspecies of *heideri* share this peculiar dentition. *Trigona heideri* is cited as being particularly combative. Dücke (1925, Zool. Jahr. Syst. Geogr. u. Biol., XLIX, p. 383) called it by far the most aggressive species of those with whose nests he was familiar and added in a footnote that it will attack even though the victim be many meters distant from the nest and even though he has in no wise molested the insects. Dr. Roman (cited by Alfken, 1930, Arkiv för Zoologi, XXI A, No. 28, p. 8) found *heideri* very inclined to bite. The unusually strong teeth on the inner side of the mandible of *heideri* seem a particularly potent weapon to be associated with so aggressive a bee, and one might assume offhand that there is a similar manifestation of aggressiveness on the part of the Bornean bees of comparable armature. Dr. Hobby tells me, however, that he did not experience any unusual molestation even though one of the forms with developed teeth (*haematoptera* variety *dulitae*) was in part collected from a nest.

As the key supplied for the present paper indicates, several of the species are characterized by a sharp color contrast between the dark basal half of the wing and the milky apical half with its bright orange-colored stigma and venation (Pl. VII, fig. Z). Although there are wing patterns in several of the New World *Trigona*, only *dimidiata* Smith among the described Neotropical Meliponidae duplicates the condition that is common to so many Indo-Malayan stingless bees, and *dimidiata* is a member not of the subgenus *Tetragona* but of the subgenus *Trigona*.

In the following key are included all of the forms collected by the Oxford University Sarawak (Borneo) Expedition as well as such other species from Borneo as are known to me from an examination of the type material or which on other grounds I believe can be interpreted with some confidence that the interpretation is correct. In certain cases superficial characters have been relied upon for separation, especially where these superficial characters are pronounced and constant or where the plastic characters tend to be concealed. In the main, however, more reliance has been placed on structural char-

acters, under the impression that these will be of greater aid in distinguishing between bees that are sometimes superficially very similar.

# KEY TO WORKERS OF *Trigona* FROM BORNEO<sup>1</sup>

- 1.—The head and thorax roughened with an exceedingly dense tessellation that is devoid or virtually devoid of shiny interspaces. The mesonotum bordered laterally as well as anteriorly and posteriorly by scalelike hairs that frequently produce a symmetrical, well-defined frame of uniform thickness; in other cases the scalelike hairs are more extensively spread anteriorly and posteriorly than along the sides, with resulting irregularity of the borders and encroachment on the disc, but usually there is a surviving bare area at least medianly. . . . . 2.  
The head and thorax either entirely smooth and polished, or with sculpturing so sparse and delicate that the shininess of the surface is usually dulled only, if at all, by the presence of hairs. . . . . 5.
- 2.—The hind tibiae enormously expanded, at their widest fully half as wide as they are long and twice the width of the also very wide hind metatarsi; a little more than the apical half of the external surface of these tibiae occupied by a very deep and decisive, almost circular depression. Fairly large, about 6 mm. to 7 mm. in length. . . . . 3.  
The hind tibiae about one-third as wide toward the apex as they are long. The first abdominal segment cream-colored or fulvous, with frequently a dark stripe or spot to each side of the basal concavity. Smaller bees, 3 1/4 to 5 mm. . . . . 4.
- 3.—The length of the malar space about half the width of the mandible at its base. The bristles on the vertex black. The trochanters at least beneath and the terminal joints of the tarsi ferruginous; the other joints of the leg black. The abdomen viewed from above for the most part sooty red. . . . .  
. . . . . I. *trochanterica* Cockerell.  
The length of the malar space about one-third the width of the mandible at its base. The bristles on the vertex fulvous. The coxae, trochanters, greater part of the front and middle femora, the hind femora basally and posteriorly, and the terminal joint of the tarsi reddish; the other parts of the leg black. The abdomen viewed from above a clearer red. . . . . II. *fulvopilosella* Cameron.
- 4.—The head, thorax, legs, and tergites 2-6 of the abdomen black; tergite 1 cream-colored. The posterior tibiae fringed with pale hairs, their apex with a tooth anteriorly (Pl. VII, fig. Y). Length 3 1/4 to 3 1/2 mm. . . . .  
. . . . . III. *ventralis* Smith.  
The following parts fulvous:—mandibles except their apical tips and black basal prominences; a transverse stripe along the apex of the clypeus expanded at each of the lateral extremities; base of scape in front; tegulae; the fore legs largely or wholly; middle coxae, trochanters, femora, tibiae more or less,

<sup>1</sup> The reader is also referred to other existing keys in which Bornean *Trigona* or other Indo-Malayan *Trigona* are included, as follows:—

Bingham, 1897, "Fauna of British India—Hymenoptera," I, pp. 560-561.  
Cameron, 1908, *The Entomologist*, XLI, pp. 192-193.  
Cockerell, 1918, *Annals and Mag. Nat. Hist.*, (9), II, p. 387.  
Cockerell, 1919, *Philippine Journal of Science*, XIV, p. 78.  
Cockerell, 1923, *Annals and Mag. Nat. Hist.*, (9), XII, pp. 240-242.

- and tarsal joints beyond the metatarsus; hind coxae and trochanters wholly or beneath, hind femora beneath and within, hind tibiae slightly at the base, the small joints of the hind tarsi; tergites 1, 5, and 6, sometimes also 2. Hind tibiae somewhat spoon-shaped, with nearly as strong a convexity along the anterior margin of the apical half of the joint as there is along the posterior margin of the apical half; the fringe along the posterior margin of the hind tibiae black. Length 4-5 mm...IV. *terminata* variety *lateballeata* (Cameron).
- 5.—The basal half of the forewing to the stigma stained a deep brown, usually verging on black, with the venation in this basal region likewise dark; the apical half of the wing a sharply contrasting milk white; the stigma ferruginous to orange-colored, and similarly colored or paler are the veins of the apical half of the wing. (Pl. VII, fig. Z).....6.
- The forewing without such a sharp contrast between the basal and the apical half, usually rather uniform in clarity or in tint, whether hyaline, yellowish, or fuliginous, although sometimes a more decided yellowish or orange in the median cell. Venation rather uniform in tint basally and apically.....9.
- 6.—The malar space short, the distance between the base of the mandible and the rim of the eye less than the width of the scape. Black, with a ferruginous maculation on the clypeus. [With somewhat reddened thorax, *collina* variety *fuscibasis* (Cockerell)]. Length about 4 1/2 mm.....V. *collina* Smith.
- The malar space well developed, emphatically longer than the scape is wide. Larger, 5 to 7 mm.....7.
- 7.—Wholly black with black hairs. The mandible with two moderately developed teeth inwardly on its apex, the innermost somewhat the larger of the two. Length about 7 mm.....VI. *hobbyi*, new species.
- The clypeus, usually at least the adjoining parts of the sides of the face (and sometimes much more extensively), the supraclypeus, scape, and tegulae fulvous or testaceous yellow. The mandible for the most part deep reddish, with two unusually large black teeth on its inner side toward the apex, the innermost and larger of the two springing from a level nearly one-half the distance toward the base of the mandible, the anterior tooth almost level with the edentate outer part of the apex of the mandible (Pl. II, fig. D). Length from 5 1/2 to 6 mm.....8.
- 8.—The fulvous maculations of the sides of the face not extending upward beyond the base of the clypeus, sometimes even rather obliterated, the entire upper part of the head being black. The thorax black or blackish. The legs with considerable black.....VII. *apicalis* Smith.
- The head almost completely fulvous, with the black usually confined to a subtriangular area the base of which is the supraorbital line and the apex the space between the antennal sockets. The prothorax and mesopleura fulvous. The legs with little or no black...VIII. *apicalis* variety *binghami*, new variety.
- 9.—The hind tibiae (Pl. IV, fig. P) very wide and conspicuous, almost half as wide as the joint is long; the hind metatarsi relatively narrow, about one-half the width of the tibiae and rather parallel-sided, with their inner surface covered completely with bristles, not with a differentiated smooth area without bristles at the base (Pl. IV, fig. P<sup>1</sup>). The malar space moderately developed, the shortest distance between eye and mandible only about one-third of the width of the mandible at the base. The mandible with two unusually large teeth

on its inner side, the innermost of the two springing from a level about one-half the distance toward the base of the mandible (Pl. II, fig. A). The clypeus short and wide; on its lower half, where it is rather abruptly expanded, somewhat more than twice as wide as the clypeus is long. Robust; much of head, especially over its lower half or two-thirds, usually fulvous or rufo-testaceous, but sometimes darker [*fimbriata* variety *melanotricha* (Cockerell)]. Length 7 1/2 mm. to 7 3/4 mm.; length of forewing about 8 3/4 mm. Median cell orange fulvous. . . . . IX. *fimbriata* Smith.

Not having this combination of characters. Hind tibiae frequently wide but not as emphatically so. . . . . 10.

- 10.—Hind basitarsi with light golden bristles over their entire inner surface. Black and very shiny. The basal half of the clypeus somewhat swollen, raised well above the sides of the face and level with the rather prominent supraclypeus; the apical half somewhat downslanting. The flagellum black both above and below in contrast to the scape. The hairs on head, thorax, legs, and abdomen (above and beneath) exceedingly few and, with the exception of the light golden bristles over the entire inner surface of the basitarsi, all pale. Wings clear hyaline. Labrum, mandibles, scape in front, and tarsal joints ferruginous. Very tiny, 2 to 2 1/2 mm. . . . . X. *scintillans* Cockerell.

Inner surface of hind basitarsi with a differentiated, flat, bristleless, although frequently sericeous, more or less oval area at the base. (Pl. IV, fig. M<sup>1</sup>) . . 11.

- 11.—The propodeum covered more or less with hair over its middle region, which is somewhat punctate and of subdued sheen.<sup>1</sup> The malar space about half as long as the mandible is wide at the base. The mandible with two unusually large teeth on its inner side near the apex, the innermost of the two springing from a level nearly one-half the distance toward the base of the mandible, the anterior one almost level with the narrow edentate outer part of the apex of the mandible (Pl. II, fig. C). The thorax, in addition to erect black hairs on mesonotum, scutellum, and mesopleura, has in these areas a dense, woolly, brownish to blackish tomentum. Similar dark, woolly tomentum on tergites 3-6. The venter with black hairs. Length 5-6 mm. . . . XI. *canifrons* Smith.

The propodeum hairless and polished over its middle region. The malar space either exceedingly short or longer than one-half the width of the mandible at the base. . . . . 12.

- 12.—The malar space very short, the inner angle of the mandible almost in contact with the rim of the eye or with only a narrow linear separation, the intervening space where eye and mandible are closest being at most one-quarter of the width of the mandible at the base, usually much less. Only minute appressed hairs on clypeus, which is without erect bristles. Small bees to bees of intermediate size, 2 1/4 mm. to 5 1/2 mm. . . . . 13.

The length of the malar space at least a little more than one-half the width of the mandible at the base and usually not much shorter than, or even as long as, the mandible is wide at the base. . . . . 21.

- 13.—The head, thorax, tegulae, and legs wholly or predominantly black or approximately black (tegulae sometimes rufo-piceous). The abdomen black or sepia brown or banded. . . . . 14.

<sup>1</sup> See comments also under *flaviventris*, p. 320.

- At least the tegulae and legs wholly or predominantly honey-colored to ferruginous; the abdomen usually so but in individual specimens sometimes more or less darkened over the apical and occasionally also the basal segments. The stigma and venation of the wings ferruginous.....18.
- 14.—Very small bees, 2 1/2 to 3 1/4 mm. in length. Ventral surface of abdomen with whitish hairs.....15.
- Larger, fully 4 mm. to 5 mm. in length.....17.
- 15.—Slightly larger, 3 to 3 1/4 mm., and considerably more robust. The hairs on the vertex black. On the mesonotum and scutellum there are usually some black hairs, especially fringing the scutellum posteriorly, although pale hairs predominate. The bristles on the inner surface of the hind basitarsi blackish.....XII. *iridipennis* Smith.
- (See also XII A, *?erythrostoma* Cameron).
- Tiny, length about 2 1/2 to 2 3/4 mm., comparable in size and delicacy of structure to the minute *scintillans* (see *ante*) but clypeus barely, if at all, raised above the level of the sides of the face, so very gradually arched that it seems flat, and without difference of elevation between its basal half and its apical. Clypeus, sides of face, and front covered densely with appressed microscopic, whitish hairs. The frontal suture very deep. The hairs on the mesonotum, scutellum, mesopleura whitish, and a fine fringe of whitish hairs usually framing the mesonotum on each side and especially the scutellum along its posterior margin. The bristles on the inner surface of the hind basitarsi (exclusive of the bristleless area at the base) pale golden.....16.
- 16.—The abdomen viewed from above pallid testaceous; the tergites, exclusive usually of tergite 1, broadly banded with fuscous of varying degrees of distinctness. The abdomen viewed from below pallid testaceous to ivory-colored; the sternites without dark bands....XIII. *fusco-balteata* Cameron.
- The abdomen rather dilute sepia brown, the hind margin of segment 1 broadly pellucid whitish.....XIV. *atomella* Cockerell.
- 17.—The wings somewhat milky, due to the presence of rather dense, ultramicroscopic hairs, but suffused with orange, more deeply so in the median cell; the veins and stigma bright fulvous. The short tomentum on the clypeus and sides of face dense and dark grayish brown. The mesopleura with the longer hairs predominantly black. Tegulae fairly shiny. The hairs on the under side of the abdomen and on the apical tergites black. Length 5 mm. ....XV. *rufibasalis* Cockerell.
- Wings rather uniformly hyaline to yellowish. Clypeus, sides of face, and front with silvery gray, short, tomentum that is rather dense. The mesopleura with silvery gray hairs and silvery gray tomentum. The hairs on the under side of the abdomen silvery gray. Length 4 to 4 1/2 mm.....XVI. *confusella* Cockerell.
- 18.—The thorax predominantly black. Some of the joints of the leg somewhat darkened, the middle and hind basitarsi usually so. Length 3 1/2 to 4 mm. ....XVII. *sarawakensis*, new species.
- The thorax honey-colored to ferruginous.....19.
- 19.—The head black except for the clypeus, labrum, mandibles, scape, and flagellum beneath. Length 3 1/2 to 4 1/4 mm.....XVIII. *melanocephala* Gribodo.

- The head usually wholly honey-colored to ferruginous, except that the flagellum is usually dark above; the upper part of the head sometimes a little darkened. ....20.
- 20.—Very small, 2 1/2 to 3 mm. in length. ....XIX. *pallidistigma* Cameron.  
Conspicuously larger and more robust, 4 1/2 to 5 mm. ....XX. *melina* Gribodo.
- 21.—The wings lightly suffused with orange, sometimes more or less milky toward the apex, their stigma and venation bright fulvous. The abdomen usually more or less castaneous, or partly reddish or testaceous and partly black, or wholly red, rarely wholly black. Relatively large *Trigona*, upward of 6 mm. ....22.
- The wings hyaline to more or less dilute fuliginous, with the stigma and venation dull brownish to dark. Abdomen black, or sometimes with a pale stripe on tergites 1 and 6. Smaller, 3 1/4 to 6 mm. ....25.
- 22.—The head black, with clypeus, supraclypeus, and basal half to two-thirds of scape fulvous to rufous. The thorax likewise fulvous to rufous and densely tomentose ("mosslike pubescence," Cockerell). The malar space fully as long as the mandible is wide at the base. Inner one-third of apex of mandible with two teeth, one of which constitutes the inner angle (Pl. III, fig. J). The hind metatarsi very broad, nearly as broad as their tibiae (Pl. VII, fig. W). Length 8 to 9 mm. ....XXI. *thoracica* variety *lacteifasciata* (Cameron) and associated forms.  
The head, thorax, and legs black. The malar space subequal in length to the width of the mandible at the base. Length 6 to 7 mm. ....23.
- 23.—The largely or wholly dark mandible with only a single, moderately developed tooth on the inner edge of its apex (Pl. III, fig. K). No erect black bristle-like hairs on the clypeus, merely grayish down or tomentum like that of the sides of the face. ....XXII. *erythrogastra* Cameron.  
The deep red mandible with two unusually large teeth on its inner side, the innermost and larger of the two springing from a level nearly one-half of the distance toward the base of the mandible (Pl. II, fig. B). The clypeus with conspicuous erect black bristles. ....24.
- 24.—Scape dark castaneous in back, rather bright ferruginous in front. Tergites of abdomen black. Trochanters with a red stripe above. ....XXIII. *haematoptera* variety *haematoptera* Cockerell.  
Scape black, with merely the extreme base and antennal sockets reddened. Tergites of abdomen more or less castaneous basally with fragmentary to sometimes complete bands of usually a deeper brown to blackish along the apex of each. In addition to the blackish bands at the apex, there is frequently a very narrow curvilinear blackish band extending transversely across the middle of, particularly, tergites 2-3. ....XXIV. *haematoptera* variety *dulitae*, new variety.
- 25.—Smaller, 3 1/4 to 3 1/2 mm. long. The mandibles except for their black apical edge and basal prominences, deep red as is also the apical one-third to one-half of the clypeus. The mandibles with two denticles—the innermost slightly the larger—on the inner two-fifths of apex. The erect hairs on the mesopleura whitish like the tomentum, contrasting with the erect black hairs anteriorly on the mesonotum and with the denser and longer black hairs on the scutellum. Tergite 1 with an ivory-colored, somewhat membranous

- transverse stripe at the apex, and tergite 6 with its apical tip ivory-colored.  
 .....XXV. *moorei*, new species.  
 Larger, 5 mm. to 6 mm. long. The mandibles wholly or for the most part, the clypeus, the scape (except at its extreme base) are black. The mandible with only a single tooth toward the inner edge of the otherwise edentate apex (Pl. III, fig. L). The erect hairs (as distinguished from the feathery dull gray tomentum) on the mesopleura black.....26.  
 26.—Malar space about two-thirds as long as the mandible is wide at the base....  
 .....XXVI. *itama* Cockerell.  
 Malar space a little more than half as long as the mandible is wide at the base.  
 .....XXVII. *breviceps* Cockerell.

#### I.—*Trigona trochanterica* Cockerell

*Trigona trochanterica* COCKERELL, 1920, *Annals and Mag. Nat. Hist.*, (9), V, p. 115.

*Trigona trochanterica* Cockerell, the type of which I have examined, was described from Borneo. It belongs to the group with densely tessellated head and thorax but is especially distinguished by its enormously expanded hind tibiae—See key. Structurally it would seem to be identical with *nitidiventris* Smith, from Mt. Ophir, which I have seen in the Saunders collection at Oxford. This specimen of *nitidiventris* is labeled "M. Ophir 79" and is assumed—and I think correctly—to have been part of the material on which Smith's description was based.

Although Smith says nothing in his description regarding the sculpturing of the head and thorax of *nitidiventris*, the contrast between their condition and that of the abdomen is perhaps implied in the name Smith gave the insect and in his emphasis on the fact that the abdomen is shining black. Smith speaks of the "margins of the thorax and scutellum" of *nitidiventris* as having ochraceous pubescence; but as a matter of fact, while there is a thin border of hairs in the Oxford specimen along the lateral margins of the mesonotum, by far the greater abundance and extent of such hairs is anteriorly and posteriorly (especially posteriorly) on the mesonotum, conforming with the condition specified by Cockerell for *trochanterica* and revealed by his type specimen. Smith's description of the wings of *nitidiventris* as "subhyaline and iridescent, slightly fuscous toward their base" does not seem to me to fit the Oxford specimen of *nitidiventris* as accurately as the description Cockerell gives of the wings of *trochanterica*: "wings yellowish, nervures and stigma ferruginous." The wings are a little more yellowish in the median cell of *nitidiventris* than in the apical region. The impressively widened hind tibiae are characteristic of both the Oxford specimen of *nitidiventris* and *trochanterica*, and other minor points of agreement

are the "greyish-olivaceous pruinosity" of the face, the dull reddish tegulae, the more or less reddish trochanters and claw-joints of the tarsi, and the pale red of the ventral aspect of the abdomen.

The following differences should be noted:—Although in both insects the scape is mainly black with only the extreme base ferruginous, the flagellum in *nitidiventris* is black, in *trochanterica* "dark reddish, with the first joint black, and the very short second one pale reddish beneath;" the stiff bristles on the vertex are fulvous in *nitidiventris* but black in *trochanterica*. Also, *nitidiventris* has the abdomen black rather than dark reddish, as specified for *trochanterica*; *nitidiventris* is not "more distinctly reddened at the sides of the second segment," as specified for *trochanterica*, although it shares with *trochanterica* the red patch on each side of the fifth tergite and has the sixth tergite red. In size *nitidiventris* slightly exceeds *trochanterica*.

In the British Museum is a specimen from the Smith collection which was obtained at Mt. Ophir, the type locality of *nitidiventris*. It, too, is designated *nitidiventris* and has the word "type" written on the accession label. It is utterly different from the Oxford University Museum specimen of *nitidiventris* and departs widely, also, from the description of *nitidiventris*. I regard it as very close to what Cockerell described as *itama*, but it cannot possibly be the type of *nitidiventris*.

An insect that is a very near relative of *nitidiventris* as represented by the specimen at Oxford is *fulvopilosella* Cameron.

*Trigona trochanterica* is not represented in the collection of the Oxford University Sarawak (Borneo) Expedition.

## II.—*Trigona fulvopilosella* Cameron

*Trigona fulvopilosella* CAMERON, 1908, The Entomologist, XLI, pp. 192–193, 194.

The type material of *fulvopilosella* in the British Museum consists of two specimens, both from Kuching, Borneo, with dates Oct., 1906 and May, 1907, thus corresponding as to place and month with the record connected with the description. Also on the labels are the initials J. H., undoubtedly standing for the name of the collector, John Hewitt. There can be little doubt that these specimens are the authentic types of *fulvopilosella*.

This species is very close to *trochanterica* Cockerell but differs by the slightly shorter malar space. Differences of coloration between *fulvopilosella* and *trochanterica* are noted in the key.

An even closer relative is *Trigona latipes* Friese, described from Singapore. I have seen a metatype from this locality which seems to

differ from *fulvopilosella* mainly in the still greater predominance of red, such areas as the upper half of the mesopleura, the metapleura, and the entire abdomen, not to mention the coxae, trochanters, and femora, being a clear bright red.

*Trigona fulvopilosella* is not represented among the specimens collected by the Oxford University Sarawak (Borneo) Expedition.

### III.—*Trigona ventralis* Smith

(Pl. III, fig. I; Pl. VII, fig. Y)

*Trigona ventralis* SMITH, 1857, Journ. of Proc. Linn. Soc. Zool., II, p. 50. (Specimens from Sarawak only.)

*Melipona ventralis* DALLA TORRE, 1896, 'Catalogus Hymenopterorum,' X, p. 584.

*Melipona ventralis* BINGHAM, 1897, 'Fauna of British India—Hymenoptera,' I, pp. 561, 562–563.

*Trigona ventralis* COCKERELL, 1923, Annals and Mag. Nat. Hist., (9), XII, p. 241.

*Trigona ventralis* COCKERELL, 1929, Annals and Mag. Nat. Hist., (10), IV, pp. 139, 591–592.

*Trigona ventralis* FRIESE, 1933, Naturh. Maandblad, XXII, p. 147.

Smith's *ventralis* was described on the basis of specimens obtained from Sarawak, Borneo, and Mount Ophir, Malacca. It seems almost certain that the material was composite, and that the Borneo specimens were *ventralis*; the Mount Ophir specimens, on the other hand, *latebalteata*. The ground for this suspicion is the fact that the Smith specimen at Oxford, bearing on the label the wording "M. Ophir 77," departs from Smith's description of *ventralis* by its larger size, by having the various maculations associated with *latebalteata* (see key in present paper) and by having the hairs that fringe the hind tibiae black—the condition in *latebalteata*—not pale, as called for in the description of *ventralis* and as exemplified in the Bornean specimens here assigned to *ventralis*. Fortunately there is among the specimens in the British Museum a specimen labeled *ventralis* from the Smith collection that has the legend "Sar.," standing for Sarawak, with "Borneo" on the under side of the label. This specimen, which is *ventralis* as usually interpreted, is, it seems reasonable to suppose, probably one of the specimens from Sarawak that Smith had before him when describing the species. Cockerell (1929, Annals and Mag. Nat. Hist., (10), IV, p. 591) has previously taken the stand that Sarawak must be held to be the typical locality.

The specimens here assigned to *ventralis* have a black spot on each side of the pale segment 1 of the abdomen, as noted by Bingham (1897, p. 563) and in Cockerell's key to the *Trigona* of the Malay region (1923,

Annals and Mag. Nat. Hist., (9), XII, pp. 240-241). These black spots are present also, according to the description of Gribodo (1891, Bullet. Soc. Entomol. Italiana, XXIII, p. 109) in his *Trigona javanica*, and they occur likewise on the first abdominal segment of Smith's *terminata* and Cockerell's *fulvomarginata*, the type of which I have seen. They are also faintly present on the specimen here determined as *latebalteata*. In *Trigona arcifera* Cockerell from Testa Bridge, Himalayas, India, which is closely related to *ventralis*, there is instead of these spots a semi-circular dark brown band bordering the basal concavity of the first segment. The length of *ventralis* is given by Smith as  $1 \frac{2}{3}$  lines, approximating the size of the specimens here reported upon, which measure  $3 \frac{1}{4}$  to  $3 \frac{1}{2}$  mm. A specimen of *fulvomarginata* from Pat Meeung Mts., Siam, Jan. 18, 1928, is larger and more robust, measuring about  $4 \frac{1}{2}$  mm., which approximates the measurement, 4-5 mm., that Gribodo gives for *javanica*. Smith's *terminata* was  $2 \frac{1}{2}$  lines in length. Cockerell (1929, Annals and Mag. Nat. Hist., (10), IV, p. 591) well discusses the differences between these several rather closely related insects. The flagellum in three out of the four specimens here assigned to *ventralis* is almost uniformly black (except for the sometimes lighter colored joint 2) rather than rufo-fuscous as described by Smith.

Specimens of *ventralis* collected by the Oxford University Sarawak (Borneo) Expedition:

Sarawak: foot of Mt. Dulit, junction of rivers Tinjar and Lejok, on "Dulit Trail," Aug. 16, 1932, two workers; Mt. Dulit, R. Lejok, "near sweat and water," Oct. 5, 1932, two workers.

#### IV.—*Trigona terminata* variety *latebalteata* (Cameron)

*Trigona ventralis* SMITH, 1857, Journ. of Proc. Linn. Soc. Zool., II, p. 50. (Specimens from Mt. Ophir but not those from Sarawak.)

*Trigona latebalteata* CAMERON, 1902, Journal Straits Asiatic Soc., XXXVII, pp. 130-131.

*Trigona latibalteata* CAMERON, 1908, Entomologist, XLI, p. 193.

This species shares with *ventralis*, *fulvopilosella*, and *trochanterica* the condition of having head and thorax densely tessellated without shiny interspaces. The mesonotum is enclosed by a square formed by minute, rather scalelike hairs in the case of *ventralis* and *latebalteata*; in *trochanterica* such hairs are present anteriorly and posteriorly on the mesonotum but do not border or only very thinly border the sides. *Trigona javanica* Gribodo would seem to be a very close relative, distinguishable from *latebalteata* possibly mainly by the maculation of the legs, which in *javanica* are described as being rufo-fuscous or rufo-

ochraceous whereas in *latebalteata* the hind tibiae and metatarsi are black. *Trigona latebalteata* is also approached by *fulvomarginata* Cockerell. In *fulvomarginata*, the type of which I have seen, "the coxae, trochanters, and middle femora are light ferruginous," also the front femora, whereas in *latebalteata* the ferruginous areas on the leg are more extensive (see the specifications in the key under 4). Thus *latebalteata* with respect to the maculation of the legs stands about midway between *javanica*, with its mainly reddish legs, and *fulvomarginata*, with its mainly black legs. The hind tibiae of *latebalteata*, *fulvomarginata*, and also to some extent *javanica* are fringed posteriorly with black hairs. This is also the case in *terminata* Smith (1878, Journ. Asiat. Soc. Bengal, XLVII, Pt. 2, p. 169), the otherwise much mutilated type of which fortunately still retains the hind legs. In *ventralis*, on the other hand, as Cockerell has pointed out (1929, Annals and Mag. Nat. Hist., (10), IV, p. 591), the fringe is pale. Furthermore, *ventralis* is distinguished from all the related insects mentioned by its smaller size. *Trigona nitidiventris* from Mt. Ophir and *fulvopilosella* and *trochanterica* from Borneo are easily distinguished from their near relatives, including *latebalteata*, by their unusually large hind tibiae—see key.

*Trigona latebalteata* is represented in the British Museum by two specimens marked "type." Both of these bear on the label the designation "Kuching, Sarawak," which is the type locality. One of the specimens, dated July 17, 1900, and further labeled "P. Cameron Coll. 1914-110" is much mutilated, with merely the thorax and some of the joints of the leg surviving. The other specimen, dated July 18, 1900, with the number 1903.249, is nearly perfect and agrees with the specimen from the foot of Mt. Dulit collected by the Oxford University Sarawak (Borneo) Expedition.

The type specimen of *terminata* (79.22) in the British Museum lacks a locality label. Its head, one pair of wings, and hind legs are in perfect preservation; the thorax is much mutilated; the fore and middle legs and the abdomen are lacking. The parts present justify one, I think, in believing that *terminata* is structurally an insect of the same pattern as *latebalteata*. The hind leg of the type of *terminata* has the coxa, trochanter, and small joints of tarsi ferruginous, and the inner surface of the tibiae dusky ferruginous. Smith's description mentions only the tarsi as ferruginous, with the implication that the other joints of the legs are darker.

The following specimen of *latebalteata* was collected by the Oxford University Sarawak (Borneo) Expedition:

Sarawak: foot of Mt. Dulit, junction of rivers Tinjar and Lejok, Dulit Trail, primitive forest, Aug. 16, 1932, one worker.

V.—*Trigona collina* Smith

(Pl. II, fig. F; Pl. V, fig. S)

*Trigona collina* SMITH, 1857, Journ. of Proc. Linn. Soc. Zool., II, pp. 51–52.

*Melipona collina* DALLA TORRE, 1896, 'Catalogus Hymenopterorum,' X, p. 577.

?*Melipona collina* BINGHAM, 1897, 'Fauna of British India—Hymenoptera,' I, pp. 560, 562.

*Trigona collina* CAMERON, 1908, Entomologist, XLI, p. 192.

*Trigona collina* COCKERELL, 1920, Annals and Mag. Nat. Hist., (9), V, p. 116.

*Trigona collina* COCKERELL, 1923, Annals and Mag. Nat. Hist., (9), XII, p. 241.

*Trigona collina*, the type of which I have seen, has the head and thorax polished, not opaque as indicated by Bingham ('Fauna of British India—Hymenoptera,' I, p. 562). The hind legs of the type are missing but the characters present give confidence in assigning the specimens collected by the Oxford University Sarawak (Borneo) Expedition to this species. Especial significance should be ascribed, in my estimation, to the much reduced malar space evidenced by the type of *collina* and the specimens here placed in that species. One discrepancy should be noted. The almost complete absence of hair on the mesonotum of the type specimen as against the presence of hair on the others. However, an aggregation of hairs of normal density on a small area of the mesonotum prompts the suspicion that their absence over the greater part of the disc is due to wear and represents an abnormal condition. Indeed Smith in his description indicates "the disk of the thorax with a cinereous pile."

As *collina* Smith as I interpret it on the basis of the type and the description has been frequently confused with *apicalis* Smith, it is worth emphasizing its distinctive characters—smaller size,  $2\frac{1}{4}$  lines as against  $2\frac{1}{2}$  (actually still larger) specified for *apicalis*; the clypeus with "a pale spot in the middle," not as in *apicalis* with "the clypeus, the lower parts of the face, testaceous yellow," and finally, most important of all, although not mentioned by Smith, the much shorter malar space of *collina*.

Very close to *collina* is Cockerell's *cambodiensis*, the type of which I have seen. In *cambodiensis* the malar space is much reduced, wings with a sharp contrast between the dark basal half and milky apical half, mainly black hair on thorax, legs, and abdomen, in all of these respects resembling *collina*. From *collina*, however, *cambodiensis* may be differentiated by having a median longitudinal keel on the clypeus,

more distinctly ferruginous mandibles, "sordid white" instead of mouse-colored to blackish tomentum to each side of the median polished area on propodeum.

Cockerell separates his *fuscibasis* from *collina* by its shiny head and thorax, thus following Bingham in regarding these parts as dull in *collina*. The insect here interpreted as *collina* is structurally essentially the same as *fuscibasis*, and *fuscibasis*, it seems to me, is separable from it at most as a variety that has the mesothorax dark chestnut red instead of black and that has the tegulae clear red.

The nest which Waterhouse ascribed to *collina* (1903, Trans. Ent. Soc. London, pp. 133-134) is, on the basis of the associated insects, which I have examined in the British Museum, a nest not of *collina* but of *apicalis*.

Cockerell, who examined specimens of Cameron in the collection at Cambridge University, found one labeled Patalung, Malay Peninsula (Skeat), with the designation *collina*. This interpretation Cockerell did not accept (1923, Annals and Mag. Nat. Hist., (9), XII, p. 242). I have not seen the specimen at Cambridge but a specimen in the British Museum with identical data as to collecting site and collector and with, in addition, a label reading P. Cameron Coll. 1914-110, seems to me correctly identified as *collina*.

Specimens of *collina* collected by the Oxford University Sarawak (Borneo) Expedition:

Sarawak: Mt. Dulit, 4000 ft., "waterfall, moss forest," Oct. 22, 1932, one worker; Mt. Dulit, R. Koyan, 2500 ft., "primitive forest," Nov. 17, 1932, one worker.

#### VI.—*Trigona hobbyi*, new species

WORKER.—Entirely black except for the ferruginous antennal sockets, basal half of tarsal claws, veins of apical half of wing, and a faintly dull reddish, narrow area near the apex of the mandible. The erect hairs uniformly black except that the metatarsal brushes, especially those of the anterior legs, have a coppery tinge. For the most part shiny and sculptureless.

Head broader than long and extending slightly beyond the outer rims of the tegulae; eyes barely convergent below; malar space very long, nearly as long as the mandible is wide at the base; apex of mandibles curvilinear in profile, its outer two-thirds edentate, its inner one-third with two distinct teeth, of which the innermost is somewhat the larger; apico-lateral corners of rather flat, six-sided clypeus exceedingly remote from eye; the genae somewhat broader than the eye. The head mostly smooth and shiny, the clypeus, sides of face, front, genae, and scape with fine, appressed, black, ultramicroscopic hairs; the upper part of front, vertex, labrum, inferior margin of mandibles and lower part of genae with black bristles, those on the

vertex coarse. The clypeus with a very few scattered, shallow but fairly large punctures laterally on its anterior half that contrast with the inconspicuous and almost negligible, ultrafine punctation over the entire face that apparently corresponds with the points of emergence of the fine hairs.

The thorax smooth and fairly shiny although abundantly covered with black bristles on mesonotum (especially anteriorly), scutellum, mesopleura, tubercles, and tegulae anteriorly. In addition, there is darkish tomentum over these areas; the tomentum to each side of the shiny bare median area of the propodeum a little more grayish brown in some lights.

Rather long, erect, black hairs on the coxae and trochanters beneath, contrasting with the rather inconspicuous hairs beneath on the otherwise largely bare femora; the outer side of the front tibiae with very short, stiff, downsloping, black hairs, much shorter than the erect black hairs on the outer side of the front and middle basitarsi, and contrasting strongly with the conspicuously hairy outer side of the middle tibiae with its dense growth of erect, plumose hairs. The hind tibiae gradually broadened from base to apex, their posterior margin convex, their anterior margin a little concave on the basal half, more convex toward the apex, which is subtruncate; the anterior margin with a thin fringe of simple, black hairs, the posterior margin with a much denser fringe of black, plumose hairs; such plumose hairs cover densely also the basal half of the exterior surface, with stray simple hairs scattered over the somewhat depressed apical half.

The basal half of the wing dark brownish, with its venation dark; the apical half of the wing of a sharply contrasting milk white, the stigma, marginal vein, and that part of the costal vein apicad to the stigma a bright ferruginous to orange color. Tegulae black.

The abdomen about the width of the thorax, the first four tergites (which in the specimen on which this description is based are fully exposed) polished and shiny, without sculpturing except for faint fine tessellation at the extreme sides of the apex of tergites 2-4, corresponding with the presence of minute, black hairs which, in the case of tergites 3-4, extend also narrowly along the entire apical margin. Tergites 5-6 more telescoped, their entire exposed surface covered with such minute hairs rather densely and, in addition, with some longer black hairs. The sternites with longish black hairs down the middle that grade into darkish sericeous patches to each side.

Length 7 mm.; width of thorax about 2 mm.; length of forewing 7 1/2 mm.

The key will assist in separating *hobbyi* from several other species from Borneo characterized by similarly colored wings.

Its prevailingly black appearance associates *hobbyi* with the brief description that Lepeletier (1836, 'Histoire naturelle des Insectes—Hyménoptères,' I, p. 429) gives of *vidua* from the Island of Timor. The description is so brief, however, that reliance cannot be placed upon it. In Bingham's key (1897, 'Fauna of British India—Hymenoptera,' I, pp. 560-561) *hobbyi* runs to *vidua* but Bingham's brief redescription of *vidua*, supplied in the same work (p. 585), does not tally with *hobbyi*, such statements as "head and thorax dull and opaque," "face in front

with a thin cinereous pile," "antennae and the anterior tarsi brownish" being inapplicable. Indeed the single specimen from the Bingham collection labeled *vidua* in the British Museum is structurally like *apicalis*.

Cockerell (1926, *Annals and Mag. Nat. Hist.*, (9), XVIII, p. 224) expresses the opinion that Bingham may have included in his conception of *vidua* what Cockerell described as a new species (*cambodiensis*) from Angkor, Cambodia. The "clear red scape" "the pale yellowish red" under-surface of the antennae, its smaller size, etc., are superficial characters that separate *cambodiensis* from *hobbyi*, while structurally it differs notably from *hobbyi* by having a much reduced malar space—only a little more than linear (see account of *cambodiensis* under *collina*).

The description of *melanoleuca* Cockerell (1929, *Annals and Mag. Nat. Hist.*, (10), IV, pp. 140–141) applies rather well to *hobbyi* in many respects although *melanoleuca* has "very fine pale pruinose pubescence" over its face whereas *hobbyi* has this pubescence black. However, the malar space of *melanoleuca* is ever so much smaller than is the case in *hobbyi*.

Description based on a single specimen from Sarawak: Mt. Dulit, 4000 feet, moss forest, Oct. 18, 1932, collected by the Oxford University Sarawak (Borneo) Expedition.

#### VII.—*Trigona apicalis* Smith

*Trigona apicalis* SMITH, 1857, *Journ. of Proc. Linn. Soc. Zool.*, II, p. 51.

*Melipona apicalis* DALLA TORRE, 1896, 'Catalogus Hymenopterorum,' X, p. 575.

*Melipona apicalis* BINGHAM, 1897, 'Fauna of British India—Hymenoptera,' I, pp. 560 and 562. (In part only, the majority of the specimens of the Bingham collection in the British Museum being assignable to the variety *binghami*.)

*Trigona collina* WATERHOUSE, 1903, *Trans. Entom. Soc. of London*, pp. 133–134, Pl. VI (nest and male).

*Trigona apicalis* COCKERELL, 1918, *Annals and Mag. Nat. Hist.*, (9), II, p. 387 (in part).

*Trigona apicalis* COCKERELL, 1920, *Annals and Mag. Nat. Hist.*, (9), V, p. 116.

*Trigona apicalis* COCKERELL, 1923, *Annals and Mag. Nat. Hist.*, (9), XII, p. 241.

*Trigona hemileuca* COCKERELL, 1929, *Annals and Mag. Nat. Hist.*, (10), IV, p. 140.

*Trigona hemileuca* COCKERELL, 1929, *Annals and Mag. Nat. Hist.*, (10), IV, p. 591.

?*Trigona apicalis* FRIESE, 1933, *Naturh. Maandblad*, XXII, pp. 45, 46.

*Trigona sericea* FRIESE, 1933, *Naturh. Maandblad*, XXII, pp. 45–46.

Bingham (1897, 'Fauna of British India—Hymenoptera,' I, p. 562)

noted that *apicalis* varies considerably in different localities. "Specimens from South Tenasserim very closely approach the typical form from Borneo, but are not quite so dark." Many of the specimens that Bingham thus merged with typical *apicalis* have here been placed in the variety *binghami*.

The specimens collected by the Oxford University Sarawak (Borneo) Expedition have rather well-defined black and red areas. Black are: apical half to all of fore femora, apex of fore tibiae briefly, middle coxae, middle femora entirely beneath and at apex also above, middle tibiae briefly at apex and often also extensively anteriorly, middle metatarsus, hind coxae, hind femora entirely beneath and extensively (sometimes entirely) also above, hind tibiae at base and anteriorly at apex (but with red area between black maculations and with red posteriorly at apex). Smith described the legs of *apicalis*, the type of which I have seen, as dark rufo-piceous; the posterior tibiae pale.

Cockerell (1920, *Annals and Mag. Nat. Hist.*, (9), V, p. 116) differentiated his *fuscibasis* from *apicalis* "by the black legs," although the description indicates that in *fuscibasis*, too, parts of the legs ("anterior femora and basitarsi in front, small joints of their tarsi and of the others more or less") are ferruginous. However, *apicalis* and *fuscibasis*, the types of which I have examined, differ fundamentally in respect to the length of the malar space, which is well developed in *apicalis* and merely linear in *fuscibasis*. See discussion of *fuscibasis* under *collina* (p. 298).

The abdomen of the type of *apicalis*, described by Smith as nigropiceous, has the three apical segments suffused with red. The apical segments of the specimens taken by the Oxford University Sarawak (Borneo) Expedition are similarly reddish, and the basal segments, notwithstanding their darker appearance, are inclined to be red at least on their apical rims, a condition observable also in the type specimen.

Before me are paratypes of Friese's *Trigona sericea*, from Sauggau, Borneo, July 24, 1932. Friese (1933, *Naturh. Maandblad*, XXII, pp. 45-46) differentiates *sericea* from *apicalis* as follows:—

WORKER.—Like *Trigona apicalis* Smith, but somewhat larger, segments 4-6 yellowish brown with short silklike felting. Corbiculum differently shaped, widened toward the end abruptly and spoonlike.

Friese seems to have been misled by the size assigned by Smith to *apicalis*. It is 6 mm., rather than 2 1/2 lines, and thus approximates the dimensions Friese gives for *sericea*, 6-6 1/2 mm. The wing measurement is the same in both insects. I am unable to detect a difference

in the shape of the tibiae of *apicalis* and *sericea*. The term "spoonlike," (löffelartig) applicable to such New World forms as *testacea* and *cupira*, seems here misapplied. The presence of hairs on the apical rims and the lighter, more reddish or yellowish brown coloration of the apical tergites of the abdomen, are characters shared by both the type of *apicalis* and the paratypes of *sericea*.

I am unable to separate structurally *Trigona hemileuca* Cockerell (1929, Annals and Mag. Nat. Hist., (10), IV, p. 140), collected in Siam, a type and cotype of which I have examined, from *Trigona apicalis* Smith as here interpreted. The length recorded for *hemileuca* is greater than that noted by Smith for *apicalis* and greater, too, than that of the present specimens, but the disparity is explained by the distention of the segments of the abdomen in the type. The wing length—a more trustworthy criterion—is approximately the same in *hemileuca* and in the present specimens. The posterior tibiae of the type, at least, of *hemileuca* are red on their external surface (Smith describes the corresponding tibiae of *apicalis* as "pale").

Closely related to but, in my estimation specifically distinct from *apicalis* is *melanoleuca* Cockerell, (1929, Annals and Mag. Nat. Hist., (10), IV, pp. 140–141), the type of which, collected at Nan, Siam, I have examined. It is separable from *apicalis* not only on the grounds of its darker color, lacking the maculations on the clypeus, adjacent parts of sides of face, and tegulae that characterize *apicalis*, but its malar space is less developed, being only about half the width of the mandible at the base, and its hind metatarsi have their posterior edge more nearly straight instead of slanting obliquely to form a rather pronounced apical angle.

Differentiated from the typical variety of *apicalis* by its orange-ferruginous abdomen and almost wholly reddish legs, with the hind tibiae and hind basitarsi fulvous, is *Trigona apicalis peninsularis* from the Malay Peninsula, the type of which I have seen.

The nest described by Waterhouse (1903, Trans. Ent. Soc. London, pp. 133–134) as that of *collina* should be assigned to *apicalis*. I have seen specimens from this nest in the British Museum and, while several of them are callows, they are, I think, indubitably *apicalis*.

Specimens of *apicalis* collected by the Oxford University Sarawak (Borneo) Expedition:

Sarawak: Mt. Dulit, R. Koyan, 2500 ft., in "primitive forest," Nov. 17, 1932, four workers, one of them "collecting resin on tree trunk" and two of them "on tree trunk."

VIII.—*Trigona apicalis* variety *binghami*, new variety(Pl. II, figs. D and D<sup>1</sup>; Pl. V, figs. R and R<sup>1</sup>; Pl. VII, fig. Z)

*Trigona apicalis* BINGHAM, 1897, 'Fauna of British India—Hymenoptera,' I, pp. 560–562 (in part, especially specimens from Tenasserim).

*Trigona apicalis* COCKERELL, 1918, *Annals and Mag. Nat. Hist.*, (9), II, p. 387 (in part).

WORKER.—The variety *binghami* differs from typical *apicalis* by its more extensively testaceous yellow appearance. Especially does the contrast in coloration between the two varieties apply to the head. As Smith's description indicates, typical *apicalis* has the head black, with the clypeus and lower parts of the face (the region up to the level of the base of the clypeus and the supraclypeus) testaceous yellow. In contrast, in the variety *binghami* virtually the whole head is testaceous yellow with the exception of usually the malar space and a black triangular area on the front that extends from the supraorbital line to the space between the antennal sockets (and even this triangle may in rare cases be absent or obscure). In typical *apicalis* the entire thorax with the exception of the red tegulae is black. In the variety *binghami*, instead, not merely the tegulae but the prothorax, mesopleura, and sometimes the scutellum and axillae are testaceous yellow. The mesonotum of *binghami* is sometimes darker than the mesopleura, occasionally brownish black to black (this condition is more prevalent in the specimens from Tenasserim than in those from Sandakan). The three pairs of legs are almost wholly testaceous yellow although sometimes the middle and hind metatarsi are more or less darkened. The abdomen is more extensively blackish than any other part of the body, in the Tenasserim specimens wholly so; in the Borneo specimens usually black on the apical rims of at least the three or four basal tergites, sometimes more extensively black but frequently more or less suffused or replaced by castaneous, especially on the apical tergites.

MALE.—Very similar in its coloration to the worker, with the head testaceous except for the large black triangle on the front, the blackish malar space, and, in addition, an ill-defined blackish area in back of the summit of the eye. The erect hairs of the head for the most part black as in the worker and with a somewhat similar distribution (apical region of clypeus, mandibles—especially basal half of their inferior margin—front, vertex, and lower part of genae) but longer than the corresponding hairs of the worker. In addition to the more conspicuous black hairs there is in the male a tomentum-like felting of paler hairs on the front and vertex and similar minute pale hairs occur anteriorly on the scape. The eyes broader by about one-fourth than in the worker and a little more convergent below, but the face itself narrower. The malar space distinct but much more reduced than in the worker, in length about one-half the width of the flagellum. The mandibles broad at the base, with their basal half triangular, their apical half narrow and parallel-sided, their apex obliquely slanting inward with a single, emphatic denticle (not two) at the inner extremity (Pl. II, fig. D<sup>1</sup>).

The thorax dull reddish with the mesopleura invaded by black on their lower half (a condition sometimes found also in the worker). The erect black hairs on the mesonotum finer, less coarsely bristle-like, than in the worker.

The wings as in the typical variety.

The legs testaceous like those of the worker. The hind tibiae (Pl. V, fig. R<sup>1</sup>)

about four-fifths as wide as those of the worker (Pl. V, fig. R) and more rounded apically, fringed along their posterior margin, as in the worker, densely with plumose hairs that overlie a very much thinner fringe of simple bristle-like hairs. The hind metatarsi more elongate and a little narrower than in the worker; their inner surface without a differentiated, oval area at the base, covered rather uniformly both basally and apically with blackish bristles.

The abdomen blackish, with invasions of red in the basal depression on tergite 1 and basally on tergites 3-6. The venter rather concave beyond sternite 1, devoid of longer hairs except for a few black ones along the sides of the last three visible sternites, which are bilobed and felted over with short, grayish, sericeous pile. Similar sericeous hairs but darker cover the apical rims of tergites 2-4. On the apical tergites the hairs are long and black.

The description of the male is based on a single specimen from Sandakan, Borneo (Baker) in the collection of the U. S. National Museum.

Bingham himself called attention (1897, 'Fauna of British India—Hymenoptera,' I, p. 562) to the variability of *apicalis* and noted that "Specimens from South Tenasserim very closely approach the typical form from Borneo, but are not quite so dark." Bingham even described a melanistic variety of *apicalis*, but it is impossible, due to the brevity of his description, to decide whether he had before him an insect similar to Cockerell's *melanoleuca* or not.

The specimens here assigned to the new variety *binghami* come from the following localities:

Tenasserim: Salween Valley, October, 1889; Ataran Valley, June and December, 1890; Dawnat Range, Jan., 1891 (type); Thaungyin Valley, Jan., 1891; Alaran Valley, June, 1891; Maulmain, Feb., 1894. (All collected by Col. C. T. Bingham.)

Upper Burma: Nanpandet, Nov. 21, 1899. (Col. C. T. Bingham)

Borneo: Sandakan (Baker), including the male allotype.

#### IX.—*Trigona fimbriata* Smith

(Pl. II, fig. A; Pl. IV, figs. P and P<sup>1</sup>)

*Trigona fimbriata* SMITH, 1857, Journ. of Proc. Linn. Soc. Zool., II, p. 52.

*Melipona fimbriata* DALLA TORRE, 1896, 'Catalogus Hymenopterorum,' X, p. 578.

*Trigona flavistigma* CAMERON, 1902, Journal Straits Asiatic Society, XXXVII, p. 130 (variety).

*Trigona flavistigma* CAMERON, 1908, Entomologist, XLI, p. 192 (variety).

*Trigona versicolor* FRIESE, 1908, 'Nova Guinea' (l'Expéd. scient. néerlandaise sous A. Wichmann), V, Zoologie, p. 358, Pl. xv, fig 1 (variety).

*Trigona anamitica* FRIESE, 1917, 'Nova Guinea' (Expéd. sci. néerlandaise sous A. Wichmann), V, Zoologie, pp. 358-359 (variety).

*Trigona melanotricha* COCKERELL, 1918, Annals and Mag. Nat. Hist., (9), II, pp. 386, 387 (variety).

*Trigona fimbriata* COCKERELL, 1919, Philippine Journal of Science, XIV, p. 79.

*Trigona fimbriata* COCKERELL, 1923, Annals and Mag. Nat. Hist., (9), XII, p. 241.

*Trigona flavistigma* COCKERELL, 1923, Annals and Mag. Nat. Hist., (9), XII, p. 241 (variety).

*Trigona aliciae* COCKERELL, 1929, Annals and Mag. Nat. Hist., (10), IV, pp. 139, 140 (variety).

*Trigona ferrea* COCKERELL, 1929, Annals and Mag. Nat. Hist., (10), IV, pp. 139-140 (variety).

*Trigona fimbriata*, which Smith described from Singapore, and *flavistigma*, which Cameron described from Kuching, Sarawak, are very closely related. Their principal difference resides in the coloration of the legs and of the abdomen. In *fimbriata*, the type of which I have seen, both middle and hind tibiae are deep reddish brown to black, as well as their respective metatarsi; in *flavistigma* merely the middle metatarsi and the hind tibiae and metatarsi are of this dark coloration, as I have had a chance to confirm through an examination of what seems to be the authentic type of *flavistigma*, bearing as it does the legend "Sarawak 1903.249" and "Kuching, Apl. 29, 1899." The specimens collected by Messrs. Hobby and Moore while on the Oxford University Sarawak (Borneo) Expedition more nearly approximate *fimbriata* than *flavistigma* in the coloration of the legs although the parts mentioned as deep reddish brown to black in *fimbriata* are more nearly completely black in these specimens. Moreover, they have the hind femora black and one of them has also the middle femora more or less black, a degree of melanism not shared by the type of *fimbriata*.

The abdomen of *fimbriata* is described as follows: "The two basal segments rufo-testaceous, their apical margins, as well as the whole of the following segments, nigrofuscos." Cockerell's key to the *Trigona* of the Malay region (1923, Annals and Mag. Nat. Hist., (9), XII, pp. 240-241) specifies that the first THREE abdominal segments are fulvous, with broad black margin, and this condition is suggested by the partly revealed third tergite of the type of *fimbriata*. Cameron's *flavistigma*, on the other hand, is rufo-testaceous with the base of the abdomen of lighter tint, and this condition is somewhat approximated by the specimens collected by Messrs. Hobby and Moore, which are for the most part dark red, with, in the case of one of them, darker rims.

These specimens thus occupy in some ways a middle ground between *fimbriata* and *flavistigma*, and it seems from these comments that we

are dealing in *fimbriata* with a species that is rather variable and that *flavistigma* is at most a not very clearly separable race of it.

This impression is further confirmed by the description of Friese's *versicolor* (1908, Nova Guinea, V, Zoologie, p. 358) part of the type material of which came from Borneo. The structure of the hind tibiae and hind metatarsi as described for *versicolor*, and for the most part the other characters given, apply so well to the specimens here interpreted as *fimbriata* as to leave little doubt that Friese's insect and the insects collected by Hobby and Moore are essentially the same, and the structural identity of the two is confirmed by a paratype of *versicolor* I have seen from Perak, Malacca, 1902 (Pl. IV, figs. P and P<sup>1</sup>). Friese's description of *versicolor* as respects the coloration of the abdomen reads: "Segments 1-4 mostly reddish yellow, 5-6 more blackish brown." This is the condition of the Perak paratype except that one might add that the apex, at least, of tergites 1-4 is likewise blackish brown. The legs of *versicolor* are described as "nearly black," but as regards the paratype from Perak this seems to me an overstatement, the legs being more extensively red than in the specimens here reported upon from Borneo.

Differentiating itself from *fimbriata*, *flavistigma*, and *versicolor* by its prevailingly black appearance is *melanotricha* Cockerell (1918, Annals and Mag. Nat. Hist., (9), II, p. 386), the type of which I have seen, but structurally this insect seems to me to ally itself with the others.

The opposite extreme to *melanotricha* is represented by *ferrea* from Mekami River, Siam. It is structurally like *fimbriata*, according with the plastic characters set down in the key to this paper, but it is even more extensively clear ferruginous than the other light-colored forms of the *fimbriata* complex. The middle basitarsi, as well as the hind tibiae and hind basitarsi are ferruginous, not black as in *flavistigma*, with the type of which I have compared the type of *ferrea*.

*Trigona alicae* is in my estimation also to be considered a variety of *fimbriata*. It has been stated that the mandible of *aliceae* is different from that of *flavistigma*, which I believe to be structurally like *fimbriata*. I have compared the type of *aliceae* with the type of *flavistigma*. Both have a ferruginous mandible with "a broad rounded apical dusky cutting edge" but, in addition, each insect has two large black teeth of, it seems to me, identical shape and size, placed in the same relative position along the inner margin of the mandible (Pl. II, fig. A). The abdomen of *aliceae* has tergites 1-5 traversed, each near the middle, by a blackish

band that gives the otherwise largely reddish abdomen a distinctive appearance.

*Trigona anamitica* Friese, judging from the description, appears also to be a close relative.

Specimens of the *fimbriata* complex collected by the Oxford University Sarawak (Borneo) Expedition:

Sarawak: Mt. Dulit, Dulit Trail, in "primitive forest," Aug. 16, 1932, one worker; R. Kapah, trib. of R. Tinjar, on "clearing," Oct. 6, 1932, one worker.

In the British Museum are other specimens from Sarawak that approximate the condition of *flavistigma*. These were collected at Lundu, Jan. 6, 1914, and at Mt. Matang, Jan. 25, 1914, by G. E. Bryant.

#### X.—*Trigona scintillans* Cockerell

(Pl. VII, fig. X)

*Trigona scintillans* COCKERELL, 1920, Annals and Mag. Nat. Hist., (9), V, p. 116.

*Trigona scintillans* COCKERELL, 1929, Annals and Mag. Nat. Hist., (10), IV, p. 590.

This distinctive little insect, originally described from Borneo and subsequently reported by Cockerell also from northern Siam, "where they were a great nuisance in camp, settling on one's hands and face," is not represented in the collection of the Oxford University Sarawak (Borneo) Expedition.

#### XI.—*Trigona canifrons* Smith

(Pl. II, fig. C; Pl. V, fig. Q)

*Trigona canifrons* SMITH, 1857, Journ. of Proc. Linn. Soc. Zool., II, p. 51.

*Melipona canifrons* DALLA TORRE, 1896, 'Catalogus Hymenopterorum,' X, p. 576.

?*Melipona canifrons* BINGHAM, 1897, 'Fauna of British India—Hymenoptera,' I, pp. 560, 562.

?*Trigona canifrons* COCKERELL, 1905, Annals and Mag. Nat. Hist., (7), XVI, p. 220.

?*Trigona laeviceps* SCHULZ, 1907, Zeitschr. wiss. Insektenbiol., III, pp. 65-73 (nest from Java). (See Zeitschr. wiss. Insektenbiol., 1909, V, p. 341.)

*Trigona canifrons* CAMERON, 1908, Entomologist, XLI, pp. 192, 194.

?*Trigona canifrons* SCHULZ, 1909, Zeitschr. wiss. Insektenbiol., V, pp. 338-341 (nest from Java).

?*Trigona canifrons* COCKERELL, 1918, Annals and Mag. Nat. Hist., (9), II, p. 385.

*Trigona busara* COCKERELL, 1918, Annals and Mag. Nat. Hist., (9), II, p. 387.

?*Trigona canifrons* COCKERELL, 1919, Annals and Mag. Nat. Hist., (9), III, p. 244.

*Trigona busara* COCKERELL, 1919, Philippine Journal of Science, XIV, pp. 78, 79.

*Trigona canifrons* COCKERELL, 1923, Annals and Mag. Nat. Hist. (9), XII, pp. 241, 242.

*Trigona canifrons* FRIESE, 1933, Naturh. Maandblad, XXII, p. 46.

Some of the more salient characters of *canifrons*, based on the specimen in the Wilson Saunders collection at Oxford, are set down in the key. Smith in his original description recorded the length as 2 1/2 lines but remeasurement of the specimen at Oxford reveals the length as slightly more than 7 mm. I have not seen the type of *busara* Cockerell but a specimen from Singapore, collected by Baker and designated *busara* by Cockerell,<sup>1</sup> is in my estimation scarcely separable from *canifrons*. Smith's type of *canifrons* keys out to *busara* in Cockerell's keys (1918, Annals and Mag. Nat. Hist., (9), II, p. 387; 1919, Philippine Journal of Science, XIV, p. 78).

*Trigona canifrons* is not represented in the catch of the Oxford University Sarawak (Borneo) Expedition.

## XII.—*Trigona iridipennis* Smith

(Pl. III, fig. H; Pl. IV, fig. O)

*Trigona iridipennis* SMITH, 1854, Catal. Hymen. Brit. Mus., II, p. 413.

*Trigona praeterita* WALKER, 1860, Annals and Mag. Nat. Hist., (3), V, p. 305.

*Melipona iridipennis* DALLA TORRE, 1896, 'Catalogus Hymenopterorum,' X, p. 579.

*Melipona praeterita* WALKER, 1896, 'Catalogus Hymenopterorum,' X, p. 582.

*Melipona iridipennis* BINGHAM, 1897, 'Fauna of British India—Hymenoptera,' I, pp. 560–561, 563–564.

?*Melipona praeterita* BINGHAM, 1897, 'Fauna of British India—Hymenoptera,' I, pp. 560–561, 564.

*Trigona bengalensis* CAMERON, 1896, Memoirs and Proc. Manchester Lit. and Phil. Soc., XLI, pp. 143–144.

*Trigona iridipennis* COCKERELL, 1919, Philippine Journal of Science, XIV, p. 79.

*Trigona iridipennis* COCKERELL, 1919, Annals and Mag. Nat. Hist., (9), III, p. 242.

?*Trigona laeviceps* COCKERELL, 1923, Annals and Mag. Nat. Hist., (9), XII, p. 241.

*Trigona iridipennis* COCKERELL, 1929, Annals and Mag. Nat. Hist., (10), IV, pp. 590, 592.

*Trigona iridipennis* FRIESE, 1933, Naturh. Maandblad, XXII, p. 46.

*Melipona irridipennis* GEORGE, 1933, Journal of University of Bombay, I, Pt. 5, pp. 58–61 (bionomics, morphology, and metamorphosis).

*Melipona irridipennis* GEORGE, 1934, Journal of University of Bombay, II, Pt. 5, pp. 1–16 (excretion during metamorphosis).

<sup>1</sup> Very possibly this is the specimen of *busara* collected by Baker at Singapore which figures in Cockerell's key (1919, Philippine Journal of Science, XIV, p. 78).

A series in the U. S. National Museum from Buitenzorg, Java, identified by Crawford as *iridipennis*, has the hairs on vertex pale and those on mesonotum and scutellum likewise exclusively pale, in these respects differing from the type of *iridipennis* and from the Borneo specimens here considered (see specifications in key under 15).

Cockerell differentiated *valdezi* and *penangensis* from *iridipennis* by the dusky wings, but the type of *valdezi* seems to me to have wings of approximately the same clarity as those in the Bornean specimens here referred to *iridipennis*. *Trigona valdezi* as represented by the type is a slightly larger insect than what I interpret as *iridipennis*, but shares with *iridipennis* the merely vestigial malar space, approximately flat clypeus, black hairs on vertex and a few dark hairs intermixed with the light on the mesonotum and scutellum.

Walker's *praeterita* (1860, Annals and Mag. Nat. Hist., (3), V, p. 305) is represented by a type in the British Museum to which Walker's description applies except as to size, his type being only about 3 mm. whereas the description calls for a larger insect, 2 1/2 lines in length. If the type be authentic, *praeterita* is, in my estimation, a synonym of *iridipennis*, with the type of which I have compared it. Both insects were described from Ceylon and the distinctions that Bingham draws in his key (1897, 'Fauna of British India—Hymenoptera,' I, pp. 560–561) are not sustained by the types of *iridipennis* and *praeterita*, both of which have the smaller joints of the tarsi of all the legs ferruginous. Bingham said of *praeterita* (p. 564): "I am not quite certain whether I have rightly identified this species."

Cockerell (1929, Annals and Mag. Nat. Hist., (10), IV, p. 590) found *iridipennis* "common at flowers of *Helianthus annuus*" in Rangoon, Burma, on Dec. 15. More recently I have received specimens obtained in Malaya by Mr. James A. Baker, who reports their "frequent attendance on the inflorescences of the aroid *Homalomena sagittifolia*."

Specimens of *iridipennis* collected by the Oxford University Sarawak (Borneo) Expedition:

Sarawak: Mt. Dulit, Dulit Trail, "primitive forest," Aug. 16, 1932, three workers; foot of Mt. Dulit, junction of rivers Tinjar and Lejok, "cultivated land now waste," Aug. 22, 1932, one worker; Mt. Dulit, R. Lejok, "near sweat and water," Oct. 5, 1932, three workers.

The specimens collected by Messrs. Hobby and Moore that are here assigned to *iridipennis* have the flagellum rather dark above and cloudy even below in contrast to the ferruginous scape, which is tipped with black only at the apex behind. According to Smith's description the

antennae are "pale testaceous" but his type specimen is testaceous only below, being black above, and this is the condition of another specimen from the type locality (Ceylon) identified by Friese as *iridipennis*. Friese (1933, Naturh. Maandblad, XXII, p. 46) has reported *iridipennis* from Borneo.

#### XII A.—? *Trigona erythrostoma* Cameron

*Trigona erythrostoma* CAMERON, 1908, The Entomologist, XLI, pp. 192-193.

*Trigona erythrostoma* COCKERELL, 1918, Annals and Mag. Nat. Hist., (9), II, p. 386.

*Trigona erythrostoma* COCKERELL, 1920, Annals and Mag. Nat. Hist., (9), V, p. 116.

The specimens that have been assigned to the type material of *erythrostoma* in the British Museum, although all from Kuching, the type locality, are, in my estimation, probably not the specimens on which Cameron based his description. Two of them are *fusco-balteata* and depart rather decidedly from the specifications for *erythrostoma*. On the other hand, even the third specimen does not fit Cameron's description by any means perfectly. The nervures and stigma of *erythrostoma* are described by Cameron as black and Cockerell in his paper of 1920 refers to the stigma as black, but the specimen labeled type has both the venation and the stigma dull brown, and does not fully correspond in respect to the distribution of the dark hairs and the light hairs with Cameron's specifications. The specimen in any event comes very close to *iridipennis* Smith, the type of which I have seen. It runs to that species in the key prepared for this paper.

#### XIII.—*Trigona fusco-balteata* Cameron

*Trigona fusco-balteata* CAMERON, 1908, The Entomologist, XLI, pp. 192-193, 194, 195.

*Trigona pygmaea* FRIESE, 1933, Naturh. Maandblad, XXII, p. 147.

There are two specimens of *fusco-balteata* in the British Museum, both with type labels and bearing the legend, "Medang, July 1902." Medang, in Sarawak, Borneo, is the type locality specified in Cameron's description. Friese's *pygmaea* from Sumatra, of which I have seen paratypes, is scarcely to be differentiated from *fusco-balteata* and I am inclined to regard it as a synonym. Friese (1933, Naturh. Maandblad, XXII, p. 147) like Cameron mentions the variability in the depth of the abdominal coloration, raising the question in connection with the specimens of more faded banding whether they do not represent a callow condition. The type of *atomella* Cockerell is in the U. S. National

Museum and the type of *fusco-balteata* is in the British Museum. An actual comparison of the types was, therefore, not feasible, but a specimen from Siam identified by Cockerell as *atomella* is exceedingly like *fusco-balteata*, differing mainly in the darker coloration of the abdomen, although even *atomella* has the venter of the abdomen more or less pale.

There are no specimens assignable to *fusco-balteata* among the specimens obtained by the Oxford University Sarawak (Borneo) Expedition.

#### XIV.—*Trigona atomella* Cockerell

*Trigona atomella* COCKERELL, 1919, *Annals and Mag. Nat. Hist.*, (9), III, pp. 243–244.

*Trigona atomella* COCKERELL, 1920, *Annals and Mag. Nat. Hist.*, (9), V, p. 116.

*Trigona atomella* COCKERELL, 1929, *Annals and Mag. Nat. Hist.*, (10), IV, p. 590.

*Trigona atomella*, which is possibly rather to be considered a variety of *fusco-balteata* than an independent species, was described from the Island of Penang and subsequently recorded from various localities in Siam. A series in the U. S. National Museum from Sandakan, Borneo (Baker) is, in my estimation, also ascribable to *atomella*.

#### XV.—*Trigona rufibasalis* Cockerell

*Trigona rufibasalis* COCKERELL, 1918, *Annals and Mag. Nat. Hist.*, (9), II, p. 387.

*Trigona rufibasalis* COCKERELL variety *a*, 1920, *Annals and Mag. Nat. Hist.*, (9), V, p. 116.

This species, the type of which I have seen, is represented by a single specimen in the collection of the Oxford University Sarawak (Borneo) Expedition:

Sarawak: Mt. Dulit, 4000 ft., moss forest, Oct. 18, 1932, one worker.

#### XVI.—*Trigona confusella* Cockerell

*Trigona geissleri* FRIESE (specimens from Sintang, Borneo, thus named by Friese but presumably never described).

*Trigona geissleri* COCKERELL, 1918, *Annals and Mag. Nat. Hist.*, (9), II, pp. 385–386, 387.

?*Trigona geissleri* var. *a*, COCKERELL, 1919, *Annals and Mag. Nat. Hist.*, (9), III, p. 242.

*Trigona confusella* COCKERELL, 1919, *Annals and Mag. Nat. Hist.*, (9), III, p. 242.

In 1918 Cockerell examined a male from Sintang, north Borneo, and a couple of workers from Singapore. The Bornean male had the flagellum black; in the Singapore workers the flagellum was "ferruginous, more or less dusky above." Cockerell assigned the specimens from both localities to *geissleri* Friese, commenting, however, to the effect that "the Singapore insect should perhaps be separated but we should first see Bornean workers." In 1919, Cockerell erected his *confusella* on the basis of these Singapore workers previously assigned to *geissleri*. A paratype (worker) of *geissleri* Friese, bearing the label "Sintang 1909," has been compared with *confusella* and the slight differences noted by Cockerell between the male from Sintang and the workers from Singapore does not obtain, judging from this paratype, between workers from Sintang and workers from Singapore. It is true there is some difference in the depth of tone of the tomentum on the scutellum: that of the Sintang worker (*geissleri*) being fulvous, while that of the Singapore worker (*confusella*) is blackish (in both the Sintang worker and the Singapore worker the erect hairs, as distinguished from the tomentum, on the scutellum are black). However, as the specimens collected by the Oxford University Expedition to Borneo have this tomentum blackish, it is evidently a very unstable character and one on which a separation of the insects cannot well be based. I also note some variability in the coloration of the erect hairs on the outer side of the middle tibiae. In the specimens taken by the Oxford University Expedition to Borneo these seem to be pure black, in the paratype of *geissleri* silvery gray, in *confusella* gray apically and more blackish basally. However, the middle tibiae in these several specimens (exclusive of the paratype of *geissleri*) are rather clogged with foreign material and this may have contributed to the dark appearance of their hairs. One character that seemed to me at first to separate the Oxford University Expedition specimens from the type material of Cockerell and of Friese was the more heavily punctate tegulae of the specimens of the Oxford University Expedition. However, I have come to the conclusion that the roughened character of the surface of the tegulae is illusory rather than real, due, I believe, to the fact that the dense hairs covering the tegulae in these specimens are sticky and massed, producing a rugose appearance. To some extent this is the condition on one of the tegulae also of the paratype of *geissleri* while the other tegula, on which the hairs are less massed, has at least a dull sheen.

Cockerell could not locate a description of *geissleri* and I, too, have failed to trace a description of it by Friese. If such a description exists,

the specimens taken by the Oxford University Expedition to Borneo should be designated *geissleri* Friese but in the absence of such a description they bear the name *confusella* Cockerell.

Specimens of *confusella* collected by the Oxford University Sarawak (Borneo) Expedition:

Sarawak: foot of Mt. Dulit, junction of rivers Tinjar and Lejok, on "cultivated land now waste," Aug. 22, 1932.

#### XVII.—*Trigona sarawakensis*, new species

(Pl. II, fig. E; Pl. IV, fig. M and M<sup>1</sup>)

WORKER.—Smooth and sculptureless. Head and thorax predominantly black, the tegulae clear ferruginous, the legs almost wholly ferruginous, the abdomen usually rather uniformly ferruginous, sometimes darkened on the apical segments.

The head smooth and polished, broader than long and extending somewhat beyond the outer rims of the tegulae; eyes slightly convergent below; malar space vestigial, the base of the mandible almost in contact with the rim of the eye, separated from it by only a hair's width; mandibles with their apex curvilinear in profile, the outer three-fifths edentate, the inner two-fifths with two teeth, of which the first and much the smaller tooth is in close proximity to the edentate part, the second and notably larger tooth is emphatically separated and springs from a somewhat lower level than its companion (Pl. II, fig. E); apico-lateral corners of rather flat clypeus in close approximation to the eye; the anterior ocellus rather more sunken than the lateral ocelli, which, placed somewhat slantwise, seem slightly protuberant in contrast. The clypeus, sides of face, and front covered with minute appressed silvery hairs; no erect bristles on clypeus, sides of face, or scape; a very few fine erect hairs on the front just below the ocelli and on the vertex, labrum, and fringing the mandibles below. The head black but the clypeus more or less suffused with red and the supraclypeus dull red; the mandibles, except for their black basal prominences and dull red to black apical edge and teeth, ferruginous as are the labrum, scape (except for a little sootiness posteriorly at the apex) and flagellum below.

The thorax semi-shiny and predominantly black, with the tubercles and prothorax somewhat invaded by ferruginous and the tegulae bright ferruginous. Erect, pale hairs on mesonotum, scutellum, and mesopleura in addition to silvery tomentum, which is especially dense on the sides of the metathorax and somewhat less dense on the mesopleura. A very deep fossa separating the mesonotum from the scutellum; the latter extended backward, somewhat over-roofing the bare and highly shiny propodeum.

The legs predominantly ferruginous, the front and middle tibiae briefly tipped with black at the apex, the femora sometimes similarly blackened at the apex, and the middle and hind metatarsi usually darkened. The hairs of the legs pale to ferruginous, those on the under side of the coxae and trochanters relatively long and pale in contrast to the much shorter and sparser hairs of the femora; the middle tibiae more conspicuously hairy, especially on their under surface, than the fore tibiae, on which the hairs are for the most part minute; the hind tibiae fringed anteriorly with

pale bristles and posteriorly with rather short, finely plumose pale hairs that overlie a much thinner fringe of simple pale hairs; over the basal half of the external face of the hind tibiae are erect pale to yellowish hairs. The anterior contour of the hind tibiae slightly concave at the base but approximately straight beyond; the posterior contour convex with the result that the joint is widened gradually toward the apex, which is rounded behind at the tip and subtruncate to very slightly emarginate along its apical edge (Pl. IV, fig. M). The hind metatarsi narrowed very slightly toward the base, their under side with a suboval, bristleless, differentiated area at the base (Pl. IV, fig. M<sup>1</sup>).

The wings are hyaline, slightly tinged with yellow, their venation and stigma rather bright ferruginous like the tegulae.

The abdomen about as wide as the thorax, rather plump, not in the least flattened, as a rule rather uniformly ferruginous (but in one specimen decidedly darkened on the three apical segments), and the three basal tergites virtually hairless (a few inconspicuous hairs apically on tergites 2 and 3) and very shiny, the three apical tergites with a few pale to ferruginous erect hairs, somewhat denser on tergite 6 than on either tergites 5 or 4, and appressed pale hairs also on tergite 6. The venter with pale hairs down the middle grading into silvery sericeous patches to each side.

Length 3 1/2 to 4 mm.; width of thorax 1 1/2 mm.; length of forewing, 4 1/2 to 5 mm.

This species is possibly close to Smith's *laeviceps*, the abdomen of which is described as "castaneorufus" in the abbreviated description in Latin and as "ferruginous" in the more expanded description in English (Smith, 1857, Journ. Proc. Linn. Soc. Zool., II, p. 51). There is no mention in Smith's description of the color of the tegulae and of the legs but, in view of the fact that in the brief summary in Latin the insect is described as "nigra," it is likely that the legs and tegulae were black in *laeviceps* in contrast to the condition in *sarawakensis*, which has mainly ferruginous legs and tegulae. A dark condition of the legs characterizes a specimen in the U. S. National Museum collected by Fea in May, 1885, at Rangoon, which Cockerell (1929, Annals and Mag. Nat. Hist., (10), IV, p. 590) interpreted as identical with *laeviceps* as described by Smith. This Rangoon specimen identified as *laeviceps* is identical in such measurements as the width of the head and the length of the hind tibiae with specimens of *iridipennis* from various localities, including those collected on Mt. Dulit. The specimens designated *sarawakensis* are, on the other hand, larger than *iridipennis* in respect to these parts as well as having somewhat greater body length.

Smith's type of *laeviceps* is no longer in existence. As Cockerell has pointed out (1929, Annals and Mag. Nat. Hist., (10), IV, p. 590), what is designated the type of *laeviceps* in the Oxford University Museum has the locality label "Aru," not "Singapore" from which *laeviceps* was described, and it is an insect of dark abdomen. It is, I think, un-

doubtedly the specimen that Smith recorded from Aru two years after describing *laeviceps* (Smith, 1859, Journ. Linn. Soc. Zool., III, p. 135).

Specimens of *sarawakensis* collected by the Oxford University Sarawak (Borneo) Expedition:

Sarawak: Mt. Dulit, 4000 ft., in "moss forest," Oct. 18, 1932, two workers; Oct. 19, 1932, two workers; Oct. 22, 1932, one worker (the specimen with darker apical segments of abdomen), and with the additional field note "at waterfall."

#### XVIII.—*Trigona melanocephala* Gribodo

*Trigona melanocephala* GRIBODO, 1893, Bullet. Soc. Entom. Italiana, XXV, p. 264.

*Trigona testaceinerva* CAMERON, 1908, The Entomologist, XLI, p. 195.

*Trigona melanocephala* COCKERELL, 1919, Annals and Mag. Nat. Hist., (9), III, p. 242.

In some of the specimens of the rather large series before me the mesonotum is more or less darkened in addition to the head (exclusive of the honey-colored clypeus, supraclypeal triangle, labrum, scape, and flagellum beneath). The legs, too, sometimes have a few somewhat darkened areas, especially the posterior half of the hind tibiae and hind basitarsi; even the abdomen is in rare cases more or less brownish.

Gribodo regarded *melanocephala*, the type of which I have not seen, as perhaps only a conspicuous variety of his *melina*. The malar space seems just a trifle less obsolete in what is here interpreted as *melina* than in *melanocephala*, but perhaps the insignificant difference is relatively no greater than that between the sizes of the two insects. Due to the fact that it has black areas on the head, *melanocephala* bears about the same relation to *melina* that, among the New World species, *pallida* variety *ferricauda* bears to typical *pallida*.

The type of *testaceinerva* Cameron from Kuching in the British Museum unfortunately lacks a head, in which the characters most diagnostic for this species reside, but in other respects the insect seems to be in accord with what I have interpreted as *melanocephala*.

Specimens of *melanocephala* collected by the Oxford University Sarawak (Borneo) Expedition:

Sarawak: Mt. Dulit, Dulit Trail, primitive forest, Aug. 16, 1932, two workers; foot of Mt. Dulit, junction of rivers Tinjar and Lejok, "light traps 5," Sept. 24, 1932, seven workers; Mt. Dulit, R. Lejok, "near sweat and water," Oct. 5, 1932, five workers; Mt. Dulit, 4000 ft., moss forest, Oct. 19, 1932, one worker.

XIX.—*Trigona pallidistigma* Cameron

*Trigona pallidistigma* CAMERON, 1908, The Entomologist, XLI, pp. 192-193, 195.

This little bee, the type of which I have seen, is a dwarf among the other bees of mainly ferruginous coloration such as *melina* and *melanocephala*, and on this basis alone is readily separable from them. The relationship, however, of not merely *melina*, *melanocephala*, *sarawakensis*, and *pallidistigma* but also of *iridipennis*, *fusco-balteata*, and *atomella* is structurally very close. In fact, the present insect is possibly merely a pale variety of *fusco-balteata*, with which it agrees in size.

The type of *pallidistigma* seems to be authentic. The label gives the locality as Borneo and the collector as "147 Shelf," which undoubtedly stands for R. Shelford; both of these designations are in accord with the corresponding data given in the description.

XX.—*Trigona melina* Gribodo

*Trigona melina* GRIBODO, 1893, Bullet. Soc. Entom. Italiana, XXV, pp. 262-263.

*Trigona melina* FRIESE, 1908, 'Nova Guinea' (Expéd. sci. néerlandaise sous A. Wichmann), V, Zoologie, p. 357.

Although I have not seen the type of *melina*, which Gribodo described from Borneo, the specimens collected by Messrs. Hobby and Moore correspond so well with Gribodo's specifications that there can be little doubt that they belong to that species. They are slightly smaller (about 4 1/2 mm.) than the measurement (5 mm.) recorded by Gribodo, thus tending to bridge the contrast in size which Gribodo reported to exist between his *melina* and his *melanocephala*; but this trifling disparity may be accounted for by the degree of telescoping of the abdomen in individual specimens. The extent of the darkening of the apical segments of the abdomen to which Gribodo called attention is somewhat variable even in the little series before me, ranging from a condition where there is hardly any deepening of tint to one where not merely the apical segments but the basal as well are deep brownish.

Specimens of *melina* collected by the Oxford University Sarawak (Borneo) Expedition:

Sarawak: Mt. Dulit, Dulit Trail, primitive forest, Aug. 16, 1932, one worker; Mt. Dulit, R. Lejok, "near sweat and water," Oct. 5, 1932, two workers (including the specimen with dark abdomen); Mt. Dulit, R. Koyan, 2500 feet, undergrowth, primitive forest, Nov. 17, 1932, one worker.

XXI.—*Trigona thoracica* variety *lacteifasciata* (Cameron)

(Pl. III, fig. J; Pl. VII, fig. W)

*Trigona lacteifasciata* CAMERON, 1902, Journal Straits Asiatic Soc., XXXVII, p. 131.

*Trigona lacteifasciata* CAMERON, 1908, Entomologist, XLI, pp. 192–193.

*Trigona lacteifasciata* COCKERELL, 1919, Philippine Journal of Science, XIV, p. 78.

*Trigona lacteifasciata* COCKERELL, 1923, Annals and Mag. Nat. Hist., (9), XII, p. 242.

In *thoracica* Smith (1857, Journ. Proc. Linn. Soc. Zool., II, p. 50), *lacteifasciata* Cameron (1902, Journal Straits Asiatic Soc., XXXVII, p. 131), *ambusta* Cockerell (1919, Philippine Journal of Science, XIV, p. 78), and *borneënsis* Friese (1933, Naturh. Maandblad, XXII, p. 46) we have four insects that are structurally alike. The resemblances and differences are tabulated (p. 318) on basis of the several descriptions and an examination of the types of *thoracica*, *lacteifasciata*, and *ambusta*, and of paratypes of *borneënsis*; also there have been tabulated the corresponding characters of the single representative of this complex collected by the Oxford University Sarawak (Borneo) Expedition. The comments in parenthesis are based on an examination of the type material.

*Trigona thoracica*, according to Bingham's key (1897, 'Fauna of British India—Hymenoptera I,' pp. 560–561) has "Head, thorax and abdomen black, a square mark on mesonotum rufo-testaceous," but Smith indicated that the thorax is "obscurely ferruginous," which I have substantiated by an examination of the type. Nevertheless, *thoracica* is a darker form, with mainly blackish abdomen, than the variants from Borneo. Its measurement, 7 mm., is deceptive, its small size compared with the insular variants being ascribable to the telescoping of the apical tergites, not to lack of robustness.

*Trigona ambusta*, like *thoracica* described from Singapore, is also of darker appearance than the Borneo forms, for it has mainly black legs and a mainly blackish abdomen, which is the condition also in a specimen from Kuala Kubu, Malacca, collected in March, 1912, by Buttel-Reepen.

The members of this complex extend also into Sumatra, represented in the British Museum by a specimen collected at Deli by Dr. Martin. It is possibly a callow, having rather pale hind tibiae.

The following specimen collected by the Oxford University Sarawak (Borneo) Expedition:

<i>thoracica</i> Smith (from Singapore)	<i>lactefasciata</i> Cameron (from Borneo)	<i>ambusta</i> Cockerell (from Singapore)	<i>bornensis</i> Friese (from Borneo)	<i>Oxford Exped. specimen</i> (from Borneo)
Scape red at base (approximately the basal half)	Scape rufous on basal two-thirds	Basal third of scape bright ferruginous	(In paratypes scape is fulvous in front on basal half to two-thirds)	Scape fulvous on basal two-thirds
Clypeus red (with a wide frame of black. Supraclypeus also red)	Clypeus broadly rufous in center (almost completely so, being dusky only near edges). Supraclypeus also rufous	Clypeus ferruginous broadly suffused with dusky above and at sides. (Supraclypeus ferruginous)	Clypeus yellowish brown (also supraclypeus in all paratypes examined)	Clypeus and supraclypeus largely fulvous, blackish around edges
Mandibles red at base	Mandibles black	Mandibles blackish	Mandibles yellowish brown at base (the mandibles range in paratypes from deep red to black)	Mandibles black
Thorax obscurely ferruginous	Thorax dark rufous	Mesothorax and scutellum ferruginous, the latter with two dark marks and mesothorax with dusky lines	Thorax reddish brown	Thorax fulvous
Legs ferruginous at base. (More or less reddish also on femora, tibiae, and tarsi)	Coxae, trochanters, and femora dark rufous. (In the specimen designated type they seem rather to be bright red)	Like <i>lactefasciata</i> but femora black (more especially the middle and hind pair, the fore pair being red beneath)	Legs reddish brown but tibiae and tarsi of II and III black. (Also black in the paratypes are front basitarsi, and there are black stripes on under side of femora III and more feebly on under side of femora II)	Legs fulvous but tibiae and tarsi (except apical joint) of II and III black, and black stripes on under side of middle and hind femora
Abdomen pale testaceous at base (in basal concavity)	(The first two tergites a rather bright red; the others dull, clouded red)	Abdomen black, extreme base of first segment red	Abdomen reddish brown; segments 5-6 yellowish brown. (Apical rims of tergites of paratypes, especially tergites 2-4, paler than base)	Abdomen fulvous to reddish; the apical half of the tergites somewhat darkened
Length 3 1/2 lines	Length 8-9 mm.	Length 8.5 mm.	Length 8-9 mm.	Length 8-9 mm.

Sarawak: foot of Mt. Dulit, junction of rivers Tinjar and Lejok, on "cultivated land now waste," Aug. 22, 1932.

XXII.—*Trigona erythrogastra* Cameron

(Pl. III, fig. K; Pl. VI, fig. V)

*Trigona erythrogastra* CAMERON, 1902, Journal Straits Asiatic Soc., XXXVII pp. 129–130.

*Trigona erythrogaster* CAMERON, 1908, Entomologist, XLI, pp. 193, 194.

*Trigona luteiventris* FRIESE, 1917, 'Nova Guinea' (Expéd. sci. néerlandaise sous A. Wichmann), Zoologie, V, p. 358 (variety).

*Trigona sandacana* COCKERELL, 1919, Annals and Mag. Nat. Hist., (9), III, pp. 242–243 (synonym of *luteiventris*).

*Trigona erythrogaster* COCKERELL, 1920, Annals and Mag. Nat. Hist., (9), V, p. 115.

*Trigona erythrogastra* COCKERELL, 1923, Annals and Mag. Nat. Hist., (9), XII, p. 242.

*Trigona erythrogastra*, the type of which I have examined,<sup>1</sup> has the three apical tergites of the abdomen black and black areas even on tergites 2–3 whereas *luteiventris* Friese, of which I have seen a metatype from Gap Selang., Malacca, collected by Buttet-Reepen in March, 1912, has all of the tergites of the abdomen, and the sternites as well, red. Nevertheless, I am inclined to believe *luteiventris* at most a variety of *erythrogastra*, for the two insects agree structurally in all essential respects. I have also seen the type of Cockerell's *sandacana* and believe this, too, cannot well be separated. It approximates *luteiventris* in the coloration of the abdomen, and it is likely that a completely red abdomen is the more usual condition in this species rather than one partly black. The clypeus of both *erythrogastra* and *luteiventris* is covered with a fine down or pile that at first glance seems to be absent from the clypeus of *sandacana*, but, when *sandacana* is viewed from the side, such hairs are also traceable on its clypeus although in less abundance, possibly due to wear.

Friese has called attention to the superficial resemblance between his *luteiventris* and the Neotropical *fulviventris*, but fundamentally the insects are very different, *fulviventris* having a quadridentate mandible, whereas *erythrogastra*, *luteiventris*, and *sandacana* are unusual in having only a single, merely moderately developed tooth toward the inner edge of the apex of the mandible (Pl. III, fig. K). This rather unusual type of mandible is approximated also by *itama* (Pl. III, fig. L). The unidentate mandible of the New World *Trigona capitata* and

<sup>1</sup> The specimen marked type is undoubtedly authentic, both the collecting site (Sarawak and the collector's name (Shelford) being in agreement on the label and in the description.

its varieties has, in contrast, the tooth at its inner extremity very prominent.

*Trigona flaviventris* Friese, described from New Guinea, is superficially much like *luteiventris*, having a reddish abdomen that contrasts with the black head and thorax, but *flaviventris* is readily separable by the presence of two teeth on the inner one-third of the mandible and by its somewhat shorter malar space. If one may judge from a metatype of *flaviventris*, this species shares with *canifrons* the distinction of having the middle region of the propodeum hairy.

XXIII.—*Trigona haematoptera* variety *haematoptera* Cockerell

*Trigona haematoptera* COCKERELL, 1919, *Annals and Mag. Nat. Hist.*, (9), III, p. 243.

*Trigona haematoptera*, the type of which I have seen, resembles *fimbriata* and its varieties in the peculiarly strong dentition of the mandible. At first glance it might perhaps be mistaken for *fimbriata* variety *melanotricha*, the black bristles on the clypeus and the black hairs on the thorax and legs—common to both insects—intensifying the resemblance due to similar size and coloration, but *haematoptera* is structurally distinct by having a malar space almost twice as great as that of *melanotricha*, a less expanded hind tibia than *melanotricha*, and a differentiated bristleless area at the base of the inner surface of the hind metatarsi, which does not find place in *melanotricha* (see characters given for *fimbriata* in the key to this paper).

The typical variety of *haematoptera* is not represented among the specimens collected by the Oxford University Sandakan (Borneo) Expedition.

XXIV.—*Trigona haematoptera* variety *dulitae*, new variety

(Pl. II, fig. B; Pl. VI, fig. T)

Among the specimens collected by Messrs. Hobby and Moore is a large series identical in structure with *haematoptera*, which was described from Sandakan, Borneo (Cockerell, 1919, *Annals and Mag. Nat. Hist.*, (9), III, p. 243). The specimens of this series differ from the type of *haematoptera*, which I have seen, by the color of the abdomen and by other characters noted under 24 in the key published in this paper.

It is not likely that the specimens with castaneous abdomen, here erected as the variety *dulitae*, are callows, for they do not evidence any other earmarks of a callow condition, and even the specimen collected at 1800 ft. in primitive forest on Mt. Kalulong by Mr. A. W. Moore

shares the castaneous abdomen and other characters with the specimens obtained at the foot of Mt. Dulit.

Variability as to the color of the abdomen has been pointed out in connection with other species discussed in this paper. It seems not improbable that a partly or wholly castaneous abdomen rather than a purely black abdomen is the more usual condition in *haematoptera*.

Specimens of *haematoptera* variety *dulitae* collected by the Oxford University Sarawak (Borneo) Expedition:

Sarawak: Foot of Mt. Dulit, junction of rivers Tinjar and Lejok, "nesting in dead tree," Aug. 2, 1932, two workers, and "flying round nest on large tree," Aug. 3, 1932, ten workers; Mt. Kalulong, 1800 ft., "undergrowth in primitive forest," Nov. 4, 1932, one worker.

#### XXV.—*Trigona moorei*, new species

(Pl. III, fig. G; Pl. IV, fig. N)

WORKER.—Small, shiny, almost wholly black (whitish maculation at apex of tergites 1 and 6) with partly black, partly silvery gray hairs.

The head somewhat broader than long, extending a little beyond the outer rims of the tegulae; the eyes somewhat convergent below; the malar space long, only a little shorter than the mandible is wide at the base; the apical contour of the mandible somewhat curvilinear, its outer three-fifths edentate, its inner two-fifths with two denticles (Pl. III, fig. G); the clypeus distinctly flat, about twice as broad as it is long, broadly truncate along its apex, with only a very slight recession toward the eye at each end of the apex, the apico-lateral angles of the clypeus separated from the rim of the eye by more than the width of the flagellum; the ocelli almost in a straight line, the lateral ones oblique in position and raised a little above the level of the area intervening between their outer rims and the compound eyes. Dull reddish are: approximately the apical one-third of the clypeus in the form of a not very clearly outlined transverse stripe, the labrum, the mandibles except for the black apex and black basal prominences; ferruginous are: the antennal sockets and the adjoining area at the base of the scape, the rest of the scape and the flagellum, even below, being black. The head smooth and shining, that part of it extending downward from the ocelli to the apex of the clypeus being devoid of erect hairs but covered, rather more densely and conspicuously on its lower half than on its upper half, with appressed, rather scalelike, ultramicroscopic silvery gray hairs; similar hairs on the genae; especially fine, stunted down on the scape—much finer even than the microscopic tomentum on the face; the vertex with rather coarse black bristles; pale hairs fringe the inferior margin of the mandibles, the labrum, and the lower part of the genae.

A few short black bristles along the anterior margin of the otherwise rather bare and distinctly shiny black mesonotum; scutellum also very shiny but with considerably longer black bristles, especially posteriorly. The mesopleura with silvery gray tomentum and concolorous erect hairs, the area to each side of the bare shiny middle portion of the propodeum with dense silvery gray tomentum.

The legs black except for the more or less ferruginous to deeper red tarsal joints.

The hair on at least the under side of the coxae and trochanters and on the fore femora beneath silvery gray, the hairs on the tarsal joints more or less yellowish, metatarsal brushes copper-colored to darker. With these exceptions the hairs are black: very minute and downslanting on the outer surface of the front tibiae; denser, somewhat longer and erect, with some plumose hairs intermixed, on the outer side of the middle tibiae; a thin fringe of simple hairs along the anterior contour of the hind tibiae and a much denser fringe of mainly plumose hairs along the posterior contour, both simple and plumose hairs on the basal half of the outer surface of the joint. The hind tibiae gradually widened from base to apex, their anterior contour concave, their posterior contour convex, the outer face of the joint depressed on its apical half, the apex itself rounded on its anterior half (but with a cleft where the comb is attached), subemarginate on its posterior half (Pl. IV, fig N). The hind basitarsi one-half to two-thirds the width of the hind tibiae, slightly contracted toward the base, their inner face with a differentiated, flat, bristleless area at the base contrasting with the rather brush-like arrangement of the bristles on the more apical part of the inner face.

Wings hyaline, iridescent, with darkish venation and stigma. The tegulae black.

The abdomen comparable in breadth with the thorax, its tergites rather fully revealed (not telescoped), shiny black, with a narrow ivory-colored to faintly yellowish, transverse stripe at the apex of tergite 1 and the apical tip of tergite 6 likewise ivory-colored. Tergites 3-4 (to a slight extent also 2) very delicately and narrowly tessellated along their apical rims, with ultramicroscopic appressed hairs in the tessellated areas; at each of the lateral extremities of these tergites a few rather large punctures basad to the tessellation; tergite 5 with not merely appressed but minute erect black hairs narrowly along the apex; tergite 6 with such erect black hairs over most of its exposed surface. The venter with silvery gray erect hairs down the middle that grade into concolorous sericeous patches to each side.

Length  $3\frac{1}{4}$  to  $3\frac{1}{2}$  mm.; width of thorax about  $1\frac{1}{4}$  mm.; length of forewing about  $3\frac{3}{4}$  mm.

By its well-developed malar space *Trigona moorei* is readily differentiated from other very small species referred to in this paper, its distinctiveness being further indicated by the characters of separation noted in the key.

The description of *moorei* is based on two workers obtained by the Oxford University Sarawak (Borneo) Expedition, with the following data:

Sarawak: Mt. Dulit, R. Lejok, "near sweat and water," Oct. 5, 1932.

XXVI.—*Trigona itama* Cockerell and XXVII.—*Trigona breviceps*  
Cockerell

(Pl. III, fig. L; Pl. VI, fig. U)

*Trigona itama* COCKERELL, 1918, Annals and Mag. Nat. Hist., (9), II, p. 387.

*Trigona itama* COCKERELL, 1919, Philippine Journal of Science, XIV, pp. 78, 79.

*Trigona itama* variety *a* COCKERELL, 1919, Annals and Mag. Nat. Hist., (9), III, p. 241.

*Trigona itama* COCKERELL, 1919, Annals and Mag. Nat. Hist., (9), III, p. 244.

*Trigona itama* COCKERELL, 1927, Annals and Mag. Nat. Hist., (9), XX, p. 541.

*Trigona bakeri* COCKERELL, 1919, Philippine Journal of Science, XIV, pp. 67, 71.

*Trigona itama* was described by Cockerell from Singapore and subsequently Cockerell identified as a variety of *itama* a specimen from Sandakan, Borneo, (Baker, 23120). The present specimens agree with the specimen so identified except that the microscopic, silvery white, appressed hairs over the clypeus, sides of face, and front are more abundant on the present specimens than on Cockerell's Bornean specimen.

*Trigona itama* has a well-developed malar space, in length about two-thirds of the width of the mandible at the base. The face in front is silvered over with minute pale hairs, contrasting with the long erect black bristles on the vertex. The erect bristles of mesonotum, scutellum, and mesopleura are likewise black but the feathery tomentum on the mesopleura and to each side of the shiny median area on the propodeum is silvery white. The hair of the legs, except for the golden-hued brushes on the inner side of the fore basitarsi, is exclusively or nearly exclusively black, and that is the color, too, of the hairs on the abdomen both ventrally and dorsally, those on the tergites being confined largely to the apical segments.

*Trigona itama* shares with *Trigona erythrogastra* the rather unusual distinction of having only a single tooth near the inner end of the apex of its otherwise edentate mandible (Pl. III, fig. L). In certain other structural respects, too, *itama* is closely related to *erythrogastra*, but the latter is a somewhat larger insect and is readily separated from *itama* by its mainly or wholly ferruginous abdomen and the light orange tint (rather more so basally than apically, where it becomes somewhat milky) of its wings and by their bright ferruginous venation and stigma; the abdomen of *itama*, in contrast, is black and its wings "dilute fuliginous."

*Trigona bakeri*, which Cockerell separated from *itama*, on the basis of its bare scutellum and smoother and more polished mesothorax, is in my estimation hardly to be distinguished structurally from *itama*. The greater shininess of the mesonotum of *bakeri* seems to be due not to a more polished condition of the chitin but to the absence of the fine, appressed down that covers this area in *itama*. *Trigona bakeri* is a little less hirsute not only on its mesothorax but also over the head in front. These distinctions are bridged, however, by yet a third specimen—an example from the type locality of *bakeri*, Island of Penang, that bears the identical field data. This specimen, which was withheld by

Baker when the specimen on which Cockerell erected *bakeri* was submitted to Cockerell and which was acquired subsequently by the U. S. National Museum, shares with *itama* the downy appressed hairs on the mesonotum and hence the more subdued sheen; its scutellum is hairy like that of *itama*, not largely bare like that of the type of *bakeri*. It would seem doubtful, therefore, whether *bakeri* represents more than an individual variation from *itama*.

The type of *itama*, like the type of *bakeri*, is in the U. S. National Museum; the type of *breviceps* is in the British Museum. I have not had a chance, therefore, to compare the former with the last mentioned. The homotypes I had made of *itama*, however, seem hardly separable from *breviceps*, both the length and width of head and the malar space measured on a micrometer scale being substantially in accord with the corresponding parts of *breviceps*. I have tried to indicate in the key the hair's breadth difference that may exist, using in this connection specimens of *itama* from Singapore, the type locality of *itama*, that are in the British Museum collection, but it is difficult to evaluate the difference with accuracy.

A single male collected by the Oxford University Expedition is with some hesitation assigned to *itama*. It is about the same size as the worker, black, with dilute fuliginous wings, and erect black hairs on: vertex, mesonotum, mesopleura, legs for the most part (metatarsal brush on fore legs golden), and tergites of abdomen, the hairs being rather appressed and confined largely to the apex on tergites 2-3, longer, erect, and more conspicuous on the apical tergites, resembling in all of these respects the condition of the worker. The tomentum—as distinguished from the erect hairs—on the head in front, on the mesonotum, and flanking the bare space on the propodeum, though pale, is a little duller than in the worker. The hairs of the male, however, are not so coarse as those of the worker, particularly those of the vertex and mesonotum, being less thickly bristlelike.

Structurally the male differs from the worker in having the facial quadrangle narrower, the eyes rather more convergent below, the clypeus not so arched, very nearly flat, the apico-lateral extremities of the clypeus separated only briefly (by not more than half the diameter of the flagellum) from the rim of the eye, whereas in the worker the antero-lateral extremity of the clypeus is separated from the eye by a space nearly equivalent to that of the width of the mandible at its base. Especially is the malar space much reduced in the male, only a narrow linear separation intervening between the rim of the eye and the base of

the mandibles. The mandibles are elongate and well overlapping, black on their basal half, ferruginous on their apical half, twice as broad at the base as at the apex, which is diagonally truncate with a slight notch just before its inner extremity.

The hind tibiae are of a breadth and shape comparable with those of the worker, but the bare oval area at the base of the inner surface of the hind metatarsi of the worker is poorly developed to absent in the male. (While in *Trigona* subgenus *Trigona*, in which I include the species with quinquedentate or quadridentate mandibles and with branched hairs fringing the hind tibiae posteriorly, all of the males—so far as known—have, like the workers, this differentiated bristleless area on the hind metatarsi, the condition is not shared by the male of the few species of New World *Tetragona* in which the worker is thus characterized. For instance, the widely distributed *Trigona* (*Tetragona*) *jaty* shows, like the present species, a divergence between the male and the worker in this respect.

Specimens of *itama* collected by the Oxford University Sarawak (Borneo) Expedition:—

Sarawak: foot of Mt. Dulit, junction of rivers Tinjar and Lejok, "cultivated land now waste," Aug. 22, 1932, one worker and in "old secondary forest," Sept. 14, 1932, one male; R. Kapah, tributary of R. Tinjar, Oct. 8, 1932, "undergrowth," Oct. 8, 1932, one worker.

LIST OF *TRIGONA* REPORTED FROM BORNEO, IN CHRONOLOGICAL ORDER, WITH BIBLIOGRAPHIC REFERENCE TO THEIR FIRST MENTION AND LOCATION OF THE TYPE MATERIAL

*Trigona ventralis* SMITH, 1857, Journ. of Proc. Linn. Soc. Zool., II, p. 50.

Type material composite:

Sarawak specimen, believed to be part of the type material but not bearing a type label, is in the British Museum.

Mount Ophir specimen, which is not *ventralis* but *lateballeata*, is in the Wilson Saunders collection at Oxford University Museum.

*Trigona apicalis* SMITH, 1857, Journ. of Proc. Linn. Soc. Zool., II, p. 51.

A specimen is in the Wilson Saunders collection at Oxford University Museum.<sup>1</sup>

*Trigona canifrons* SMITH, 1857, Journ. of Proc. Linn. Soc. Zool., p. 51.

A specimen is in the Wilson Saunders collection at Oxford University Museum.

*Trigona melina* GRIBODO, 1893, Bull. Soc. Entom. Ital., XXV, pp. 262-263.

*Trigona melanocephala* GRIBODO, 1893, Bull. Soc. Entom. Ital., XXV, p. 264.

*Trigona erythrogastra* CAMERON, 1902, Journal Straits Asiatic Soc., XXXVII, p. 129.

The type and a cotype (from Matang) are in the British Museum.

*Trigona flavistigma* CAMERON, 1902, Journal Straits Asiatic Soc., XXXVII, p. 130.

(A variety of *fimbriata*.)

The type is in the British Museum.

*Trigona lateballeata* CAMERON, 1902, Journal Straits Asiatic Soc., XXXVII, pp. 130-131.

(A variety of *terminata*.)

Two type specimens in the British Museum.

*Trigona lacteifasciata* CAMERON, 1902, Journal Straits Asiatic Soc., XXXVII, p. 131.

(A variety of *thoracica*.)

The type is in the British Museum.

*Trigona collina* SMITH, reported by Cameron, 1908, Entomologist, XLI, p. 192.

A specimen is in the Wilson Saunders collection at Oxford University Museum.

*Trigona erythrostoma* CAMERON, 1908, Entomologist, XLI, p. 193.

"Type" material, in British Museum, is composite—part of it identical with *fuscoballeata*, part of it very close to *iridipennis*. But neither representative seems to be the authentic type.

*Trigona fulvopilosella* CAMERON, 1908, Entomologist, XLI, pp. 192, 194.

Two type specimens in the British Museum.

*Trigona fusco-balleata* CAMERON, 1908, Entomologist, XLI, pp. 193, 194.

Two type specimens in the British Museum.

*Trigona testaceinerva* CAMERON, 1908, Entomologist, XLI, pp. 193, 195.

(Probably synonym of *melanocephala*.)

The type is in the British Museum.

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<sup>1</sup> The specimens in the Wilson Saunders collection, while not labeled as types, are believed to be of the material on which Smith's descriptions were based.

*Trigona pallidistigma* CAMERON, 1908, Entomologist, XLI, pp. 193, 195.

The type is in the British Museum.

*Trigona versicolor* FRIESE, 1908, 'Nova Guinea' (l'Expéd. sci. néerlandaise sous A. Wichmann, V. Zoologie, p. 358, Pl. XV, fig. 1.

(Variety of *fimbriata*.)

Paratype in the American Museum of Natural History.

*Trigona geissleri* FRIESE, reported by Cockerell, 1918, Annals and Mag. Nat. Hist., (9), II, pp. 385-386.

*Trigona melanotricha* COCKERELL, 1918, Annals and Mag. Nat. Hist., (9), II, pp. 386-387.

(Variety of *fimbriata*.)

The type is in the British Museum.

*Trigona rufibasalis* COCKERELL, 1918, Annals and Mag. Nat. Hist., (9), II, p. 387.

The type is in the British Museum.

*Trigona ambusta* COCKERELL, 1918, Annals and Mag. Nat. Hist., (9), II, p. 387.

(Variety of *thoracica*.)

The type is in the British Museum.

*Trigona busara* COCKERELL, 1918, Annals and Mag. Nat. Hist., (9), II, p. 387.

(Synonym of *canifrons*.)

*Trigona itama* variety *a* COCKERELL, 1919, Annals and Mag. Nat. Hist., (9), III, p. 241.

*Trigona geissleri* FRIESE, variety *a* COCKERELL, 1919, Annals and Mag. Nat. Hist., (9), III, p. 242.

*Trigona sandacana* COCKERELL, 1919, Annals and Mag. Nat. Hist., (9), III, pp. 242-243.

(Synonym of *luteiventris* FRIESE, which itself is a variety of *erythrogastra* Cameron.)

The type is in the British Museum.

*Trigona haematoptera* COCKERELL, 1919, Annals and Mag. Nat. Hist., (9), III, p. 243.

The type is in the British Museum.

*Trigona breviceps* COCKERELL, 1919, Annals and Mag. Nat. Hist., (9), III, p. 244.

(Exceedingly close to, if not identical with, *itama* Cockerell.)

The type is in the British Museum.

*Trigona trochanterica* COCKERELL, 1920, Annals and Mag. Nat. Hist., (9), V, p. 115.

(Very closely related to *nitidiventris* Smith, possibly only a variety of it.)

The type is in the British Museum.

*Trigona fuscibasis* COCKERELL, 1920, Annals and Mag. Nat. Hist., (9), V, pp. 115-116.

(A variety of *collina* Smith.)

The type is in the British Museum.

*Trigona rufibasalis* COCKERELL, var. *a* COCKERELL, 1920, Annals and Mag. Nat. Hist., (9), V, p. 116.

*Trigona scintillans* COCKERELL, 1920, Annals and Mag. Nat. Hist., (9), V, p. 116.

The type is in the British Museum.

*Trigona sericea* FRIESE, 1933, Naturh. Maandblad, XXII, pp. 45-46.

(Synonym of *apicalis* Smith.)

Two paratypes in The American Museum of Natural History.

*Trigona borneënsis* FRIESE, 1933, Naturh. Maandblad, XXII, p. 46.

(Variety of *thoracica* Smith.)

Four paratypes in American Museum of Natural History.

*Trigona iridipennis* Smith, reported by FRIESE, 1933, Naturh. Maandblad, XXII, p. 46.

The type is in the British Museum.

Species and varieties of *Trigona*, not hitherto reported from Borneo, that have been added in the present paper:—

*Trigona hobbyi*, new species, p. 298.

The type is in the British Museum.

*Trigona apicalis* variety *binghami*, new variety, p. 303.

The type is in the British Museum. Allotype in the U. S. National Museum. Paratypes in the British Museum, the U. S. National Museum, and The American Museum of Natural History.

*Trigona fimbriata* Smith, p. 304.

A specimen of *fimbriata* is in the Wilson Saunders collection at Oxford University Museum.

*Trigona atomella* Cockerell, p. 311.

The type is in the U. S. National Museum.

*Trigona sarawakensis*, new species, p. 313.

The type is in the British Museum. Paratypes in the British Museum and in The American Museum of Natural History.

*Trigona haematoptera* variety *dulitae*, new variety, p. 320.

The type is in the British Museum. Paratypes in the British Museum and in The American Museum of Natural History.

*Trigona moorei*, new species, p. 321.

The type is in the British Museum. A paratype is in The American Museum of Natural History.

PLATES II TO VII

PLATE II

A—*fimbriata* Smith, ♀. B—*haematoptera* variety *dulitae*, new variety, ♀ (paratype). C—*canifrons* Smith, ♀. D—*apicalis* variety *binghami*, new variety, ♀ (paratype). D<sup>1</sup>—*apicalis* variety *binghami*, new variety, ♂ (allotype). E—*sarawakensis*, new species, ♀ (paratype). F—*collina* Smith, ♀.

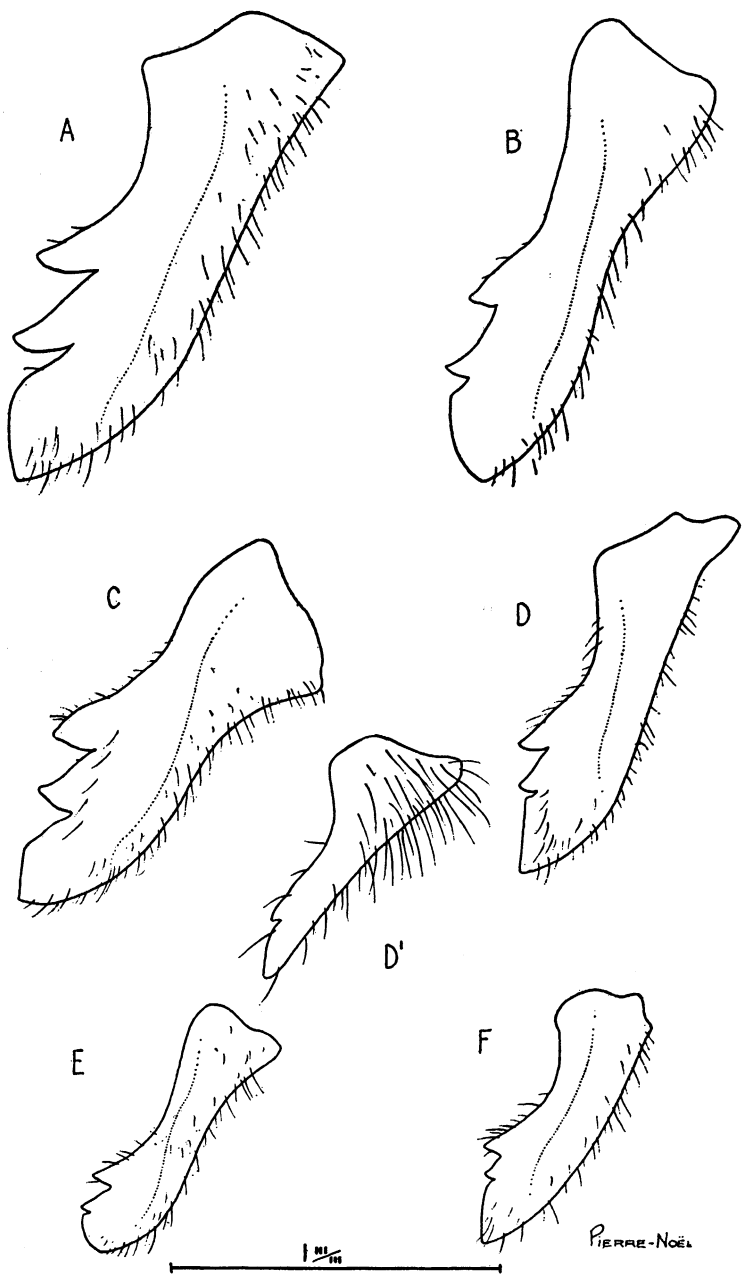


PLATE III

G—*moorei*, new species, ♀ (paratype). H—*iridipennis* Smith, ♀. I—*ventralis* Smith, ♀. J—*thoracica* variety *borneënsis* (Friese), ♀ (paratype). K—*erythrogastra* variety *luteiventris* (Friese), ♀ (metatype). L—*itama* Cockerell, ♀.

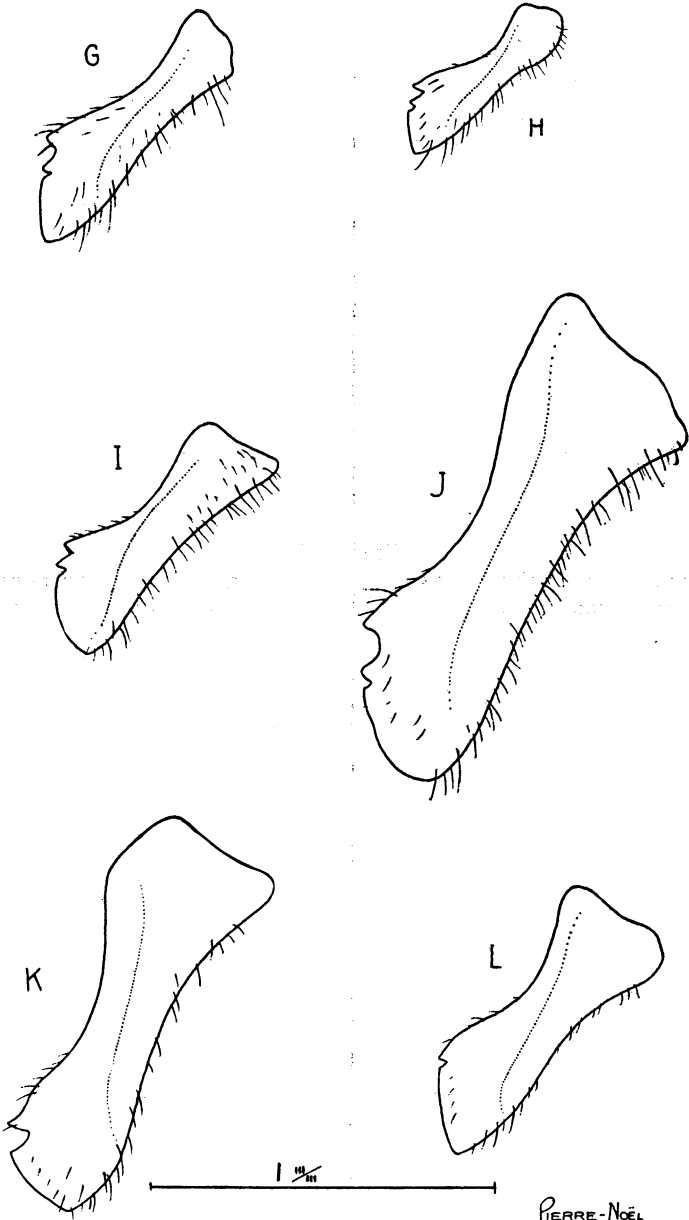


PLATE IV

M and M<sup>1</sup>—*sarawakensis*, new species, ♀ (paratype). N—*moorei*, new species, ♀. O—*iridipennis* Smith, ♀. P and P<sup>1</sup>—*fimbriata* variety *versicolor* (Fries), ♀ (paratype).

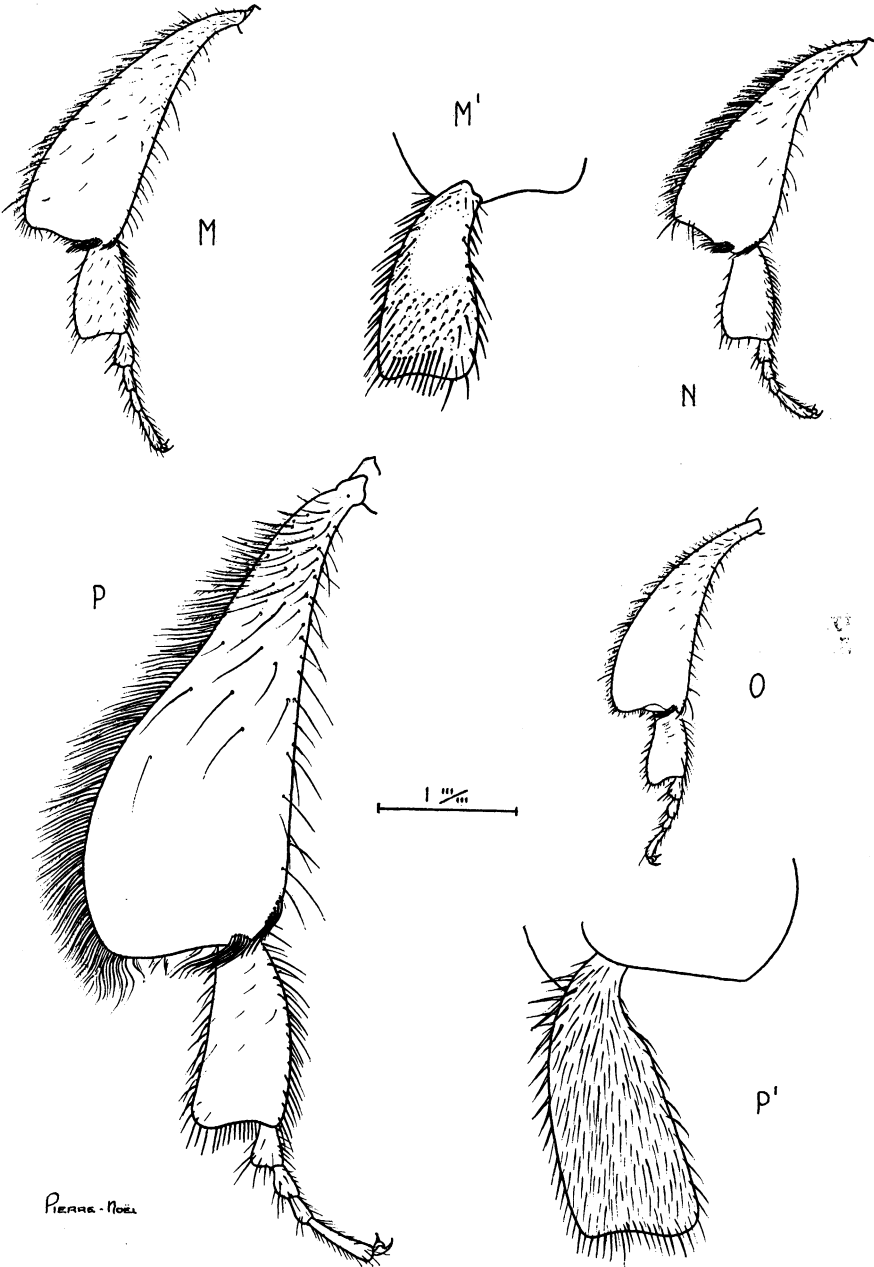


PLATE V

Q—*canifrons* Smith, ♀. R—*apicalis* variety *binghami*, new variety, ♀ (paratype). R<sup>1</sup>—*apicalis* variety *binghami*, new variety, ♂ (allotype). S—*collina* Smith, ♀.

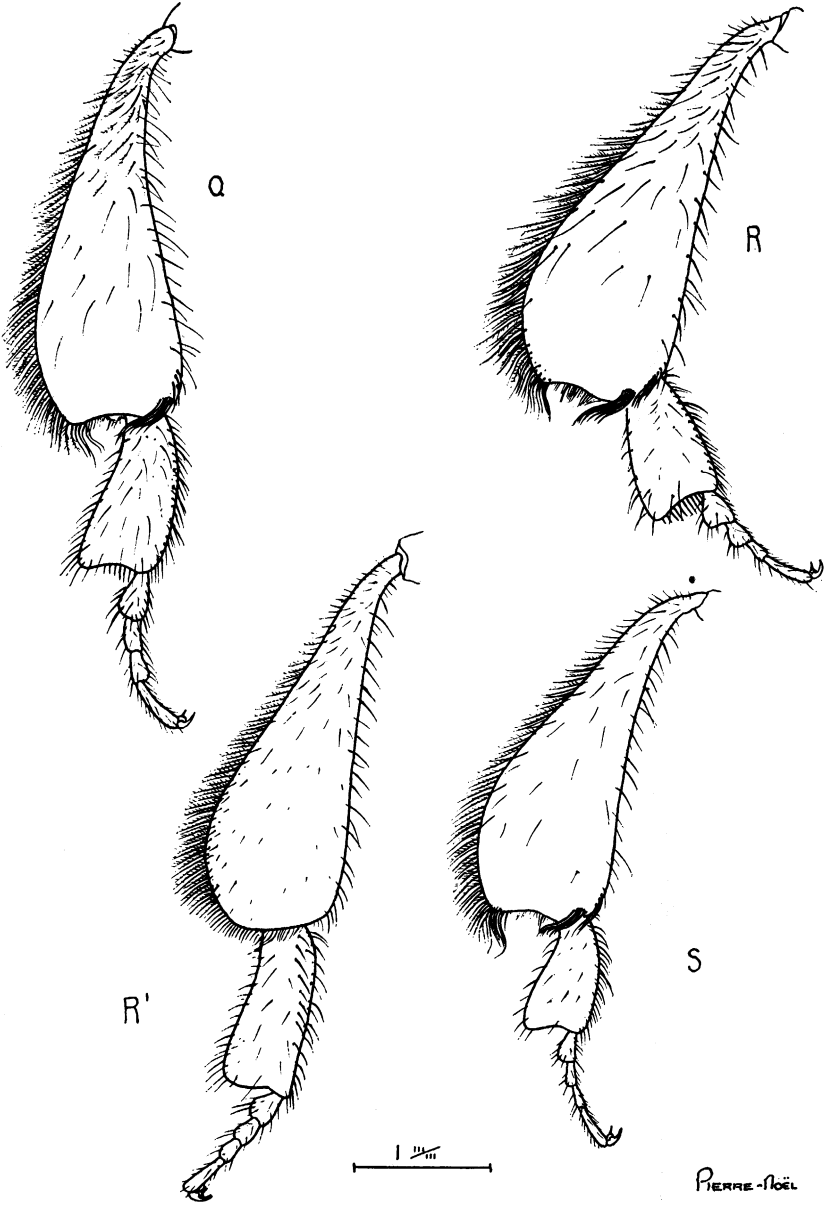


PLATE VI

T—*haemuloptera* variety *dubilai*, new variety, ♀ (paratype). U—*itama*  
Cockerell, ♀. V—*erythrogastra* variety *luteiventris* (Fries), ♀ (metatype).

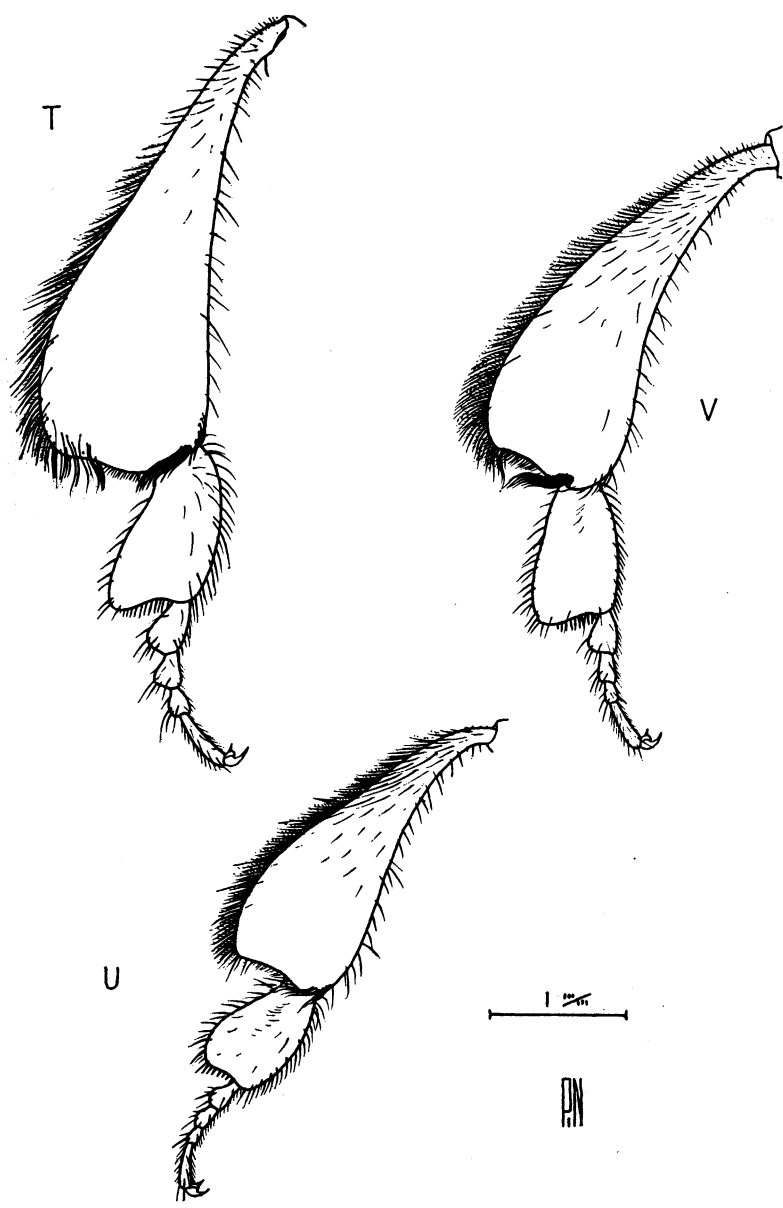
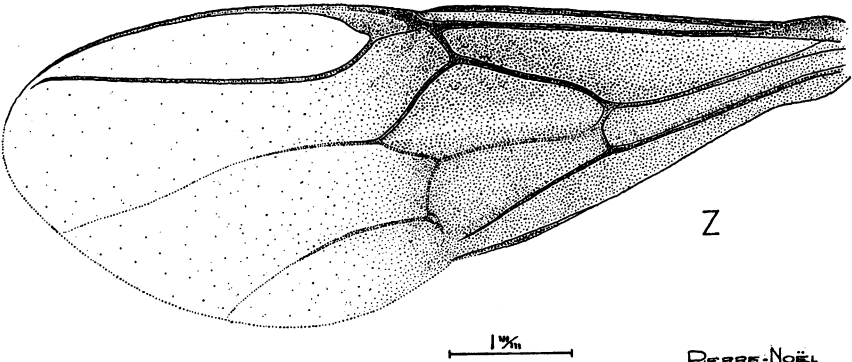
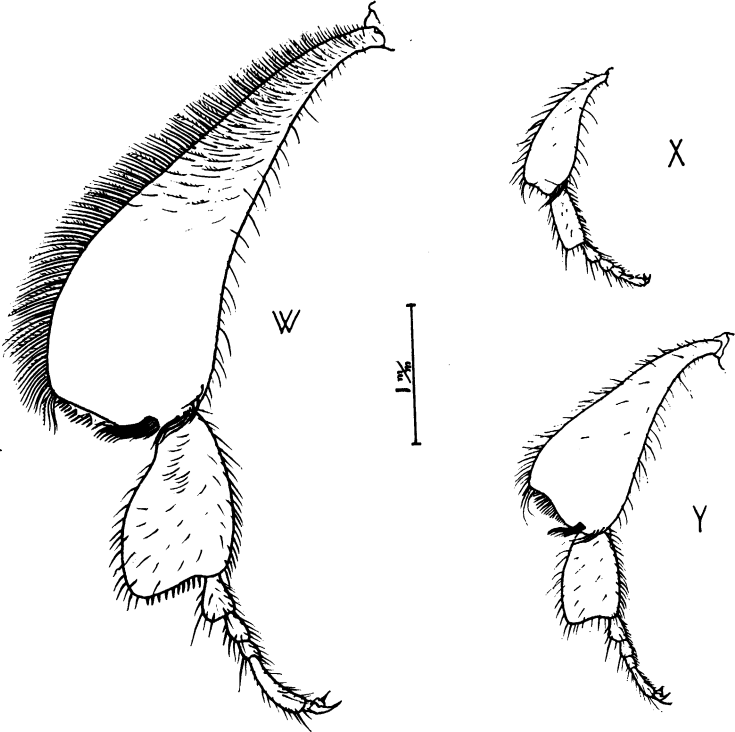


PLATE VII

W—*thoracica* variety *borneënsis* (Fries), ♀ (paratype). X—*scintillans* Cockerell, ♀ (metatype). Y—*ventralis* Smith, ♀. Z—*apicalis* variety *binghami*, new variety, ♀ (paratype).



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