Pacific Insects 11 (3-4): 649-669 10 December 1969

SYNOPSIS OF THE GENUS *PITHITIS* KLUG OF THE WORLD (Hymenoptera: Anthophoridae)[1]

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Abstract: This paper presents a new interpretation of the genus *Pithitis* Klug, 1807, and a preliminary revision of the species of the world. A few species are revealed for the first time from Africa. Two new taxa are *Protopithitis* n. subg. from Africa and *Pithitis indica* n. sp. from India.

When I dealt with the genus *Pithitis* Klug in 1966, I could not study any of the African species. At that time, only a single species of *Pithitis-fastigiata* Fox-was known to occur in Africa (Michener 1965), although the genus was considered as one of the subgenera of the genus *Ceratina*. During my trip in 1967 to the European museums, I realized that there are more species of *Pithitis* in Africa than in Asia. Thus, this paper is a result of my recent study on the world species of *Pithitis*, upon which a new interpretation is made.

Acknowledgement: Material upon which this paper is based is from Bishop Museum, Honolulu, through Dr J. L. Gressitt; Wild Bee Pollination Investigations, Utah State University, Logan, through Dr G. E. Bohart; University of Kansas, Lawrence, through Prof. C. D. Michener; Smithsonian Institution, Washington, D. C., through Dr K. V. Krombein and Dr G. I. Stage; Rijksmuseum van Natuurlijke Historie, Leiden, through Dr M. A. Lieftink and Dr J. van der Vecht; Museum National d'Histoire Naturelle, Paris, through Dr S. Kelner-Pillault; Zoologische Sammlung des Bayerischen Staates, München, through Dr F. Bachmaier; and Hokkaido University, Sapporo, through Dr S. F. Sakagami, in addition to our own. Funds for my trip were provided for in part by Bishop Museum (Dr J. L. Gressitt). Prof. K. Yasumatsu has given much encouragement during the course of the present study. This paper could not have been completed without the help and privileges extended to me from the above mentioned entomologists and institutions. My thanks are also due to Dr G. E. Bohart of the Wild Bee Pollination Investigations, Utah State University, Logan, Mr Yasuo Maeta of the Tohoku Agricultural Experiment Station, Morioka, and Dr A. S. Atwal of the Punjab Agricultural University, Punjab, for interesting information on *Pithitis smaragdula* or "*Ceratina binghami*" which is a useful pollinator of alfalfa in Punjab, India.

Abbreviations: The following abbreviations for institutions are used in this paper. BISHOP (Bishop Museum, Honolulu), HU (Hokkaido University, Sapporo), KU (Kyushu University, Fukuoka), LEIDEN (Rijksmuseum van Natuurlijke Historie, Leiden), WBPI (Wild Bee Pollination Investigations, Utah State University, Logan), MP (Museum Na-

1. Contribution Ser. 2, No. 309, Entomological Laboratory, Kyushu University.

tional d'Histoire Naturelle, Paris), SNOW (Snow Entomological Insect Collection, University of Kansas, Lawrence), STAATSSLG (Zoologische Sammlung des Bayerischen Staates, München), and USNM (Smithsonian Institution or U. S. National Museum, Washington, D. C.)

Genus **Pithitis** Klug, 1807

Species of *Pithitis* are usually bright metallic and more cylindrical than those of *Ceratina*. They can be distinguished at first sight by the students who are familiar with these groups of bees. One of the most interesting characters of the genus is that, as I pointed out in 1966, the axillae are usually strongly spined like *Coelioxys*, a genus of the parasitic bees of the family Megachilidae (it is also interesting to note that *Heriades*, the genus of non-parasitic bees of the Megachilidae, has the axillae pointed). So far as the Oriental fauna is concerned, species of *Pithitis* are very easily distinguished by this character from those of *Ceratina*. This is not true, however, for the African species. I have seen a number of African species of *Ceratina*[2] whose axillae are spined like *Pithitis*. Now, an important new finding for the genus *Pithitis* is that the *graduli are absent on the metasomal terga while the distinct transverse graduli are present on the metasomal sterna except for the 1st segment alone.* First segment of the metasoma, both tergum and sternum, is provided with a longitudinal gradulus at each side as usual for the bees. In the genus *Ceratina*, on the contrary, the distribution of the graduli on the metasomal segments is variable, so far as my study goes, according to the subgenera or species groups but the *transverse graduli are present at least on the 2nd and 3rd terga.* This is a strong gap between *Ceratina* and *Pithitis*.

Description: Medium-sized to rather small, robust, cylindrical species. Usually brilliantly metallic, with a few pale markings on head, thorax and legs. Body densely and strongly punctate; punctures on lower paraocular areas large and flat-bottomed for most species. Hairs scanty like *Ceratina*; metasoma without hair band; pollen collecting hairs of ♀ on tibiae of hind legs.

Maxillary palpi 6-segmented; hypostomal carinae weak to very strong; mandibles tridentate in ♀, bidentate in ♂; clypeus and supraclypeal area flat; supraclypeal area with a ∧-shaped carina on upper portion; preoccipital carina present. Posterior margin (collar) of pronotum convex, only slightly below level of mesoscutum for most species; mesoscutum with longitudinal lines between median mesoscutal and parapsidal lines; axillae strongly spined, apical portions well separated from scutellum for *Pithitis* s. str., not spined and hardly separated from scutellum for *Protopithitis* n. subg.; basal area of propodeum short, horizontal, longitudinally carinate; basal area also sharply separated from vertical posterior face of propodeum by a projecting edge of the latter for *Pithitis* s. str. Venation similar to *Ceratina;* jugal lobe of hind wing at least 1/2 as long as vannal lobe. Tibiae of hind legs without projection on outer face. Metasoma with 2nd and following segments distinctly constricted at each base when seen from above; *metasomal terga without gradulus except for 1st tergum only; 2nd to 5th sterna of* ♀ *and*

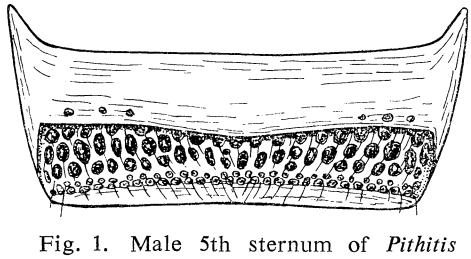

Fig. 1. Male 5th sternum of *Pithitis smaragdula*. (Note the broad, smooth pregradular area between gradulus and basal margin of the sternum).

2. These *Pithitis*-like species of the African *Ceratina* will be revised in a separate paper.

2nd to 6th sterna of ♂ each with a distinct transverse gradulus which is represented by an apical edge of pregradular area; the latter elevated, broad, often exposed, black; apical margins of 1st to 5th sterna sharply indicated, rather broad, rather uniform in width, impunctate, often black; area of wax glands of ♀ either on 2nd and 3rd sterna or on 2nd sternum alone; pygidial plate absent; 6th sternum of ♂ with a small projection at each side of apical portion; gonostyli of ♂ genitalia without comb of hairs.

Key to subgenera of Pithitis

Axillae not spined, not separated from scutellum; vertical posterior face of propodeum not separated from dorsal area by projecting edge; 7th tergum of ♂ bidentate at apex; intermediate sterna of male, especially 4th and 5th, each with a special decoration of hairs in middle (*lateral face of pronotum with longitudinal plicae;* area of wax glands of ♀ on 2nd and 3rd sterna) ..... **Protopithitis** n. subg.

Axillae spined, separated from scutellum; vertical posterior face of propodeum separated from dorsal area (basal area) by projecting edge; 7th tergum of ♂ not bidentate, either rounded or pointed at apex; sterna of ♂ without special decoration of hairs (lateral face of pronotum punctate or coarsely sculptured; area of wax glands of ♀ on 2nd sternum only for most African species, both on 2nd and 3rd for most Oriental species) ... . **Pithitis** s. str.

Subgenus **Protopithitis** Hirashima, n. subg.

Type-species: *Ceratina aereola* Vachal, 1903.

Protopithitis is separable from *Pithitis* s. str. by the characters listed in the key. This subgenus is composed of but 1 African species. According to the literature, however, it is probable that *Ceratina pallidipes* Cockerell, 1937, from Mozambique, might be included in this subgenus.

Distribution: Ethiopian Region.

Pithitis (**Protopithitis**) **aereola** (Vachal), n. comb.

Ceratina aereola Vachal, 1903, *Ann. Soc. Ent. Fr.* **72**: 383, ♀♂.

In addition to the type series (2♀♀, 2♂♂) which is in the Paris Museum, I have seen 4♀♀, 2♂♂ from Ogooué, French Equatorial Africa (R. Ellenberger 1911), also in the collection of the same museum. Ogooué is not far from the type locality, N'Doro. The type of this species is the male.

Redescription of ♀. Length ca 8 mm.

Head and thorax dark blue-green, partly with slight purple reflection; mesoscutum broadly blackened in middle; metasoma dark blue, with slight greenish tint. Clypeus blackish with a round yellow mark in middle; tubercles without pale marking; legs piceous with subapical spots on outer faces of fore femora and basal spots on fore and hind tibiae pale yellow; spots on hind tibiae sometimes absent. Wings brownish distally.

Hypostomal carinae very strong; inner margins of eyes very slightly converging below; preoccipital carina sharp. *Lateral face of pronotum longitudinally plicate;* axillae as stated above; dorsal face of propodeum except for basal area smooth, shining, not separated from vertical posterior face of propodeum by a projecting edge. Sixth tergum with a weak longitudinal carina in middle; graduli on 2nd and 3rd sterna triangularly produced posteriorly in middle; 6th *sternum* with a shining longitudinal ridge in middle.

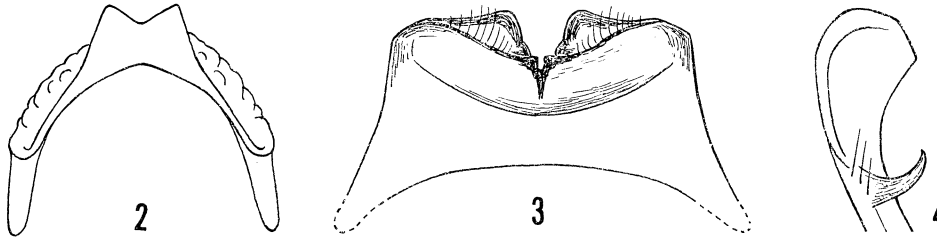

Fig. 2-4. Male structures of *Pithitis aereola*: 2, 7th tergum, seen from behind; 3, 6th sternum; 4, gonostylus, dorsal view.

Head very strongly punctate; punctures on genal areas well separated from each other; genal areas finely shagreened; median and medio-apical portions of clypeus impunctate; this impunctate area separated from lateral portions of clypeus by weak carinae. Thorax also very strongly punctate; lateral faces of propodeum rather finely sculptured. Metasoma densely punctate as usual for *Pithitis*, but punctures not specially strong.

Redescription of ♂. Differs from ♀ as follows: Length ca 7.5 mm; yellow marking on clypeus slightly larger, sometimes hat-shaped; tibiae and femora of fore legs with yellow stripes; inner faces of fore tibiae reddened. Inner margins of eyes slightly more diverging below; scape short, about equal to distance between antennal sockets; 7th tergum, when seen from above, triangular with apex bidentate; 2nd and 3rd sterna with hairs long in middle; 4th and 5th sterna with decorations of white appressed hairs; 6th sternum with apical portion well sclerotized, medio-apical emargination deep and triangular. Gonostylus of genitalia rather robust, apical portion broad, with an incurved spine subapically. Ventral sides of hind femora with a comb of not long, curved, silvery hairs on basal halves; similar hairs on hind trochanters. Punctures on genal areas stronger and denser than in ♀.

Subgenus **Pithitis** s. str.

Pithitis Klug, 1807, *Linn. J. Mag. Insek.* **6**: 198.—Vecht, 1952, *Zool. Verhand.* **16**: 15.—Michener, 1965, *Bull. Amer. Mus. Nat. Hist.* **130**: 221.—Hirashima, 1966, *Kontyû* **34**: 315.—Shiokawa & Sakagami, 1969, *Nature and Life in Southeast Asia* **6**: 140.

Type-species: *Apis smaragdula* Fabricius, 1787.

This is now interpreted as the nominate subgenus of the genus *Pithitis*, which has been treated as one of the subgenera of the genus *Ceratina* until Hirashima (1966) raised it to the generic rank. Species of this subgenus are now understood to be widely distributed in the Ethiopian and Oriental Regions. They are easily separable from *Protopithitis* in having the axillae spined and the basal area of the propodeum separated from the posterior face by the elevating edge of the latter.

African and Oriental species of this subgenus will be discussed below under separate headings because they seem to have their own traits of evolution.

(A). African species of *Pithitis* s. str.

Friese (1909), in his monograph of the African bees, enumerated five species in the *Ceratina viridis* group which is "blau oder grün gefärbt." They are *viridis* Guérin, 1845, *congoensis* Meunier, 1890, *caesia* Vachal, 1903, *nasalis* Friese, 1905, and *inermis* Friese,

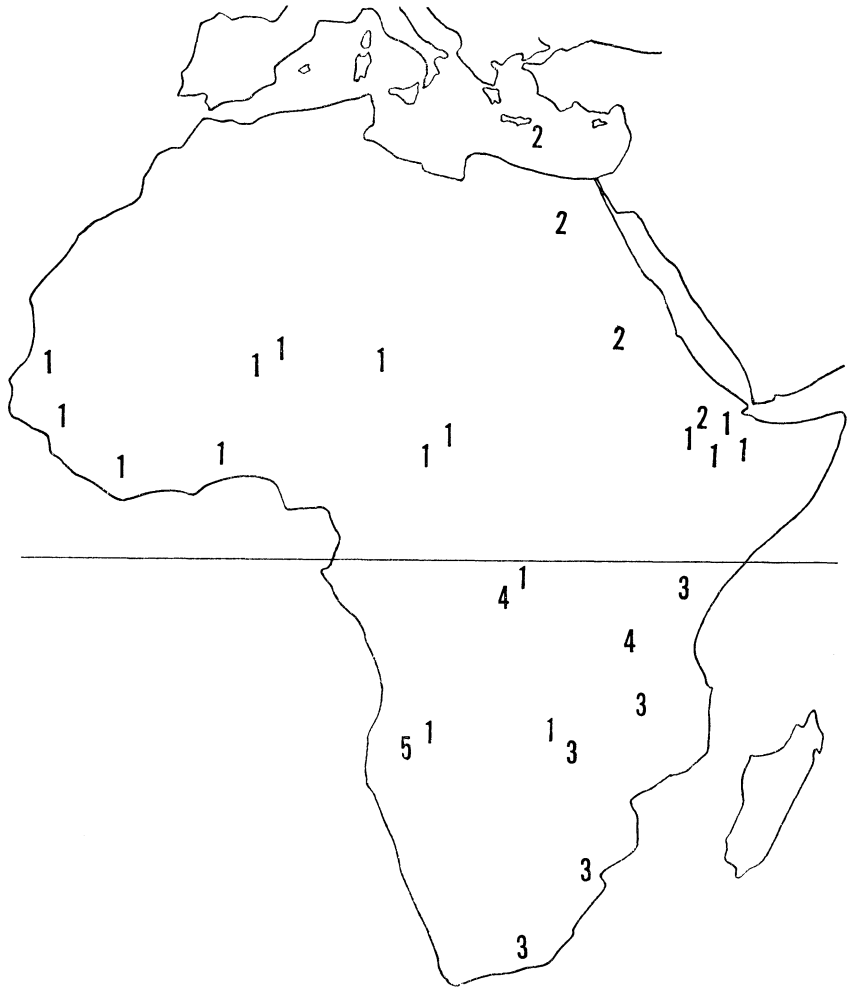

Fig. 5. Distribution of *Pithitis* s. str. in Africa. Numeral denotes the species group (see text).

1905. The first 4 species are now transferred to the present subgenus of *Pithitis*. I have not seen *inermis*, but according to the literature, it is likely that it also belongs to *Pithitis* s. str.

Friese did not list *Ceratina savignyi* Radoszkowski, 1876, of Egypt, in his 1909 monograph. He included it, however, in the *loewii* group in his 1896 synopsis of the Palaearctic species. So far as I know, *Ceratina loewii* Gerstaecker does not belong to *Pithitis*, although it has the metallic integument like the latter. Cockerell (1937: 13, lines 7–8) says that *savignyi* Rad. is the Egyptian form of *Ceratina tarsata* Morawitz, 1872, which was originally described from Crete. I am uncertain whether Cockerell is correct. I have seen a ♂ specimen of *savignyi*, as stated below, which is a good representative of *Pithitis*.

Ceratina tarsata Morawitz is also transferred to *Pithitis* in this paper.

Ceratina fastigiata Fox, 1896, from Somaliland, is a *Pithitis* according to Michener (1965: 221, spelled as *fastigata*). I have not seen this species, but Cockerell's (1937) note on *fastigiata* also implies that this species belongs to *Pithitis*.

Hedicke (1931) says that *Ceratina nasiinsignita* Strand, 1912, from Spanish Guinea, is identical with *Ceratina viridis* Guérin, which belongs to *Pithitis* as stated above.

Cockerell described a large number of *Ceratina* from Africa. According to his work on African bees published in 1937, the following species described by him under the genus *Ceratina* seem to belong to *Pithitis* s. str.: *albopicta*, *atopura*, *liberica*, *nilotica*, *pembana*, *pileifera*, *roseoviridis*, *turneri* and *viridifrons*.

In addition, some species described by Strand such as *daressalamica*, *viriditincta*, *langenburgiae*, *defeminata*, *toborae*, *acutipyga* and *furcilinea* may be also included in this subgenus of *Pithitis*.

Many species of *Pithitis* are thus known to occur in Africa, but there is some doubt regarding their validity. I have seen the following African species of *Pithitis* s. str. which are separable into 5 groups, which may eventually be recognizable as the species groups, chiefly based on the ♂ characters. Females of these species are very similar to each other and often very difficult to distinguish. The same is true of the Oriental species.

Group 1. (Group of *viridis*)

Small to rather large, blue, blue-green, or green species; tubercles with or without an ivory marking; apical margin of 5th sternum of ♂ entire or indistinctly notched in middle; *6th sternum of ♂ with a pair of small teeth at base of medio-apical emargination like Oriental species* (fig. 6); shape of these teeth specific to species, although differences are slight; gonostyli of ♂ genitalia strongly bifid at apices.

Pithitis congoensis (Meunier 1890) is undoubtedly very close to *Pithitis viridis* (Guérin 1845). Detailed study of them is necessary. One ♂ from French Equatorial Africa (Point Noire, 12/13.VI.1957, in SNOW), which seems to be *viridis*, slightly differs from the ♂ of *congoensis* (Mt Coffee, Liberia, in USNM) in the shape of the apical teeth on the 6th sternum only. I have seen 10 African specimens (7♀♀, 3♂♂) of *viridis* and *congoensis* from Guinea, Liberia, French Equatorial Africa (Point Noire, Lastoursville), Ethiopia (Harar), Congo and Angola (Cacolo, 1400 m), in MP, SNOW and USNM.

One ♂ from the Gold Coast (IX.1956, N. L. H. Krauss, in SNOW) has the preoccipital carinae slightly reflected and the spines on the axillae exceedingly long. Dark blue green, mesoscutum largely blackened in middle. This is probably a distinct species although very close to *congoensis*.

Pithitis caesia (Vachal 1903) is a medium-sized, blue species. This is easily separable from the *viridis*-complex in having the tubercles and basitarsi of hind legs ivory in both sexes, *mandibles of ♀ strongly curved*, and *hypostomal carinae, especially in ♀, strongly elevating on their posterior portions*. Medio-apical teeth of the 6th sternum of ♂ are larger than in the *viridis*-complex. One ♂ from N. Rhodesia (Silverlock Coll. 1912-20, in USNM), which was erroneously determined as *aereola* Vachal, seems to be *caesia* (Vachal), although the hind basitarsus (the left hind leg is missing) is entirely piceous,

I have seen 4 more specimens (2♀♀, 2♂♂) of *caesia* from French Somaliland (Djibouti and Obok) in MP. Obok is the type locality of this species

Pithitis savignyi (Radoszkowski 1876), so far as the ♂ (1♂ from Abyssinia, USNM) is concerned, is very close to *caesia* (Vachal), although the integument of *savignyi* is blue-green, not blue like *caesia*. I am not sure whether these are independent species. Cockerell (1937) says, as stated above, that *Ceratina savignyi* Rad. is the Egyptian form of *Ceratina tarsata* Morawitz. The latter does not belong to the present group, however (see the next one).

Another species (undetermined) from Senegal (9♀♀, 1♂), French West Africa (Goundan, 2♀♀, 1♂, Niafunké, 1♀, 2♂♂) and French Equatorial Africa (Bas Chari, Fort Lamy, 70♀♀, 52♂♂), all in MP, is also very close to *caesia* (Vachal), but slightly smaller, blue-green, and the 6th sternum of ♂ delicately different.

Thus, the present group is composed of at least 5 or 6 species.

Group 2. (Group of *tarsata*)

Medium-sized or more or less small, blue species; tubercles of ♂ often without pale marking; basitarsi of hind legs usually ivory; *apical margin of 5th sternum of ♂ with a pair of triangular projections; 6th sternum of ♂ with a broad projection in middle of subapical portion* (fig. 7), gonostyli of ♂ genitalia distinctly curved inward and bifid at apices.

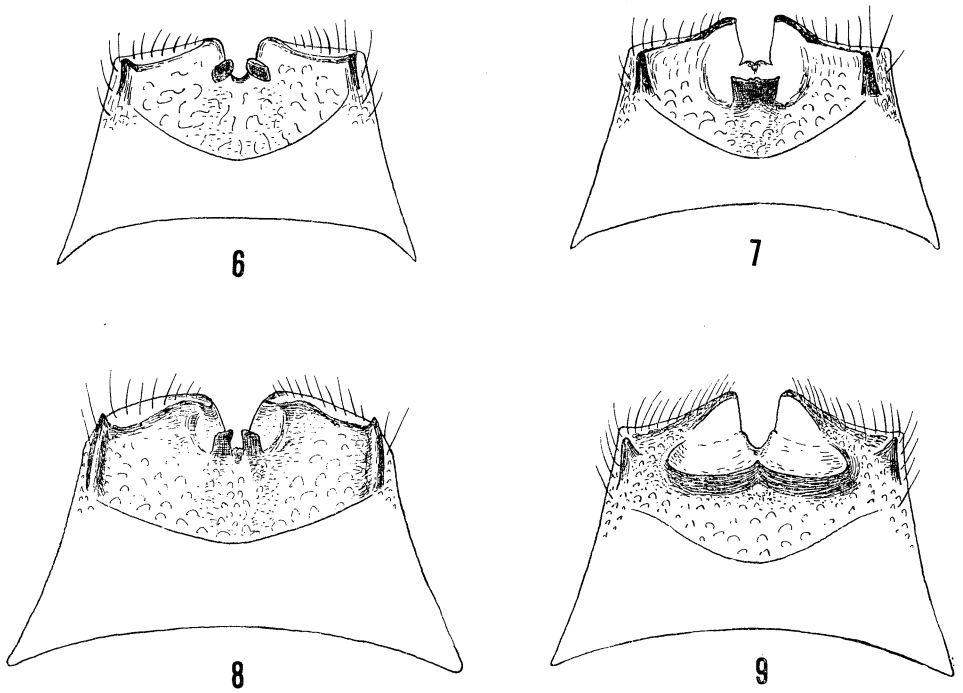

Fig. 6–9. Male 6th sternum of African *Pithitis*: 6, *congoensis*; 7, *tarsata*; 8, *nasalis*; 9, sp. of group 4.

Pithitis tarsata (Morawitz 1872) was described from Crete, and also known to occur in Africa. I have seen 4 specimens from Egypt (2♀♀ in USNM, 1♀, 1♂ in MP), 2 from Sudan (Erkowit, 1000-1300 m, R. Remane, in STAATSSLG), and 8 from Eritrea (=Ethiopia)(1♀ in USNM, 1♂ in SNOW, 4♀♀, 1♂ in MP, 1♀ in WBPI).

This group is composed of but 1 species.

Group 3. (Group of *nasalis*)

Large, blue species; apical margin of 5th sternum of ♂ slightly produced posteriorly in middle; 6th sternum of ♂ as in Fig. 8; *gonostyli of ♂ genitalia large, robust, with 1 or 2 spines at each apex.*

Pithitis nasalis (Friese 1905) was originally described from Algoa Bay (Cape Province), Delagoa Bay (Mozambique) and Lake Nyasa. I have seen 6 authentic specimens from Algoa Bay and other localities in Capland taken by Brauns (2♂♂, 1♀ in MP, 2♀♀, 1♂ in STAATSSLG). Legs black with pale markings restricted to bases of tibiae only, and tubercles without ivory marking. One ♀ from Rhodesia (in USNM) has the ivory markings on the fore and hind tibiae well developed, however.

Friese recorded *nasalis* from Kilimanjaro in 1909. I have seen 1♂ from Kilimanjaro, in MP, which seems to be one of the specimens treated by Friese. This specimen is very close to that from Algoa Bay and hardly separable from the latter in superficial appearance, but is different in having the *gonostyli with only 1 spine at each apex.* It seems probable that the specimen from Kilimandjaro represents a separate species.

Thus, this group seems to be represented by 2 species at present.

Group 4.

Medium-sized, blue species; tubercles with an ivory marking sometimes evanescent; basitarsi of hind legs ivory like the group 2 (group of *tarsata*); apical margin of 5th sternum of ♂ entire; *6th sternum of ♂ with apical portion strongly excavated; this area bounded basally by a strong transverse carina* (fig. 9); gonostyli of ♂ genitalia similar to the group 2 (group of *tarsata*).

This is composed of but 1 undetermined species. I have seen 1♂ from Congo (Fort-Crampel, Coll. J. DeGaulle, 1919, in MP) and 6 specimens (2♀♀, 4♂♂) from Tanganyika (Tabora, X.1956, W. H. Keer, in SNOW).

Group 5.

This group is known by the ♀ of an undetermined species only. I have seen 1♀ from Angola (Catolo, 1400 m, 13-12.I.1958, no collector's name, in SNOW). This is unusual for the African species in having the following characters: clypeus impunctate, with a very large silk hat-shaped pale yellow marking; preoccipital carina not very sharp; collar of pronotum distinctly below level of mesoscutum; 6th tergum with a longitudinal median keel (although weak); areas of wax glands present on 2nd and 3rd sterna.

KEY TO GROUPS OF AFRICAN SPECIES OF PITHITIS S. STR.

1. Collar of pronotum far below level of mesoscutum; ♀ with areas of wax glands on 2nd and 3rd sterna, clypeus impunctate and 6th tergum with a longitudinal keel in middle ..... **Group 5**
   Collar of pronotum distinctly convex, *not* far below level of mesoscutum; ♀ with area of wax glands on 2nd sternum only; clypeus punctate, and 6th tergum without a long keel in middle (♀♀ are scarcely separable unless the ♂♂ are associated) 2
2. Apical margin of 5th sternum of ♂ with a pair of triangular projections ..... **Group 2** (Group of *tarsata*)
   Apical margin of ♂ 5th sternum without triangular projections 3
3. Apical portion of 6th sternum of ♂ strongly excavated with a strong transverse keel which is weakly interrupted in middle ..... **Group 4**
   Apical portion of ♂ 6th sternum not excavated, with a pair of small tubercles at base of median emargination 4
4. Apical margin of ♂ 5th sternum slightly produced posteriorly in middle; gonostyli of ♂ genitalia robust with 1 or 2 spines ..... **Group 3** (Group of *nasalis*)
   Apical margin of ♂ 5th sternum not produced posteriorly in middle; gonostyli of ♂ genitalia strongly bifid ..... **Group 1** (Group of *viridis*)

(B). Oriental species of *Pithitis* s. str., with description of a new species

Vecht (1952) presented a fine synopsis of the Oriental species of *Pithitis*, although it was treated as one of the subgenera of the genus *Ceratina*. In his paper, *Pithitis smaragdula* (Fabricius) and *P. unimaculata* (Smith) were revised very well; both are common species of the genus in that region. He also gave the detailed description (excellent key also) of *Pithitis binghami* (Cockerell), but left 3 species, *aenea* (Fabricius), *comberi* (Cockerell) and *siamensis* (Cockerell), not studied adequately.

Very recently Shiokawa & Sakagami (1969) published a paper on the Oriental *Pithitis*, and recognized 5 species in all. They are *smaragdula*, *unimaculata*, *binghami*, and 2 new Indian species, *waini* and *sympatrica*. I have seen all the specimens of the latter 3 species studied by them through the courtesy of Dr Sakagami, and found that (1) what was determined as *binghami* is to be known as *comberi*, (2) *sympatrica* is a synonym of *binghami*, and (3) *waini* is a distinct species, although it is not unlikely that the ♀ of that species had previously been described as *nanensis* or other names. It is obvious that Shiokawa & Sakagami misunderstood *binghami*, and this was probably a result of a hurried study of the alien species of very complicated group.

I think the Oriental species of *Pithitis* are still insufficiently known. So far as my investigation goes, I recognize 6 species which may be grouped in the following system. In addition, I have seen more species from India which require further study.

Group 1. (Group of *binghami*)

This group is composed of but 1 species, *binghami* (Cockerell 1908), which might be a synonym of *Apis aenea* Fabricius, 1798 (see also Vecht 1952). Female of *binghami* shows an affinity to the African species.

Green species, often with brassy reflection in ♀ and strong blue-purple reflections in ♂ (see also description given below); ivory marking on clypeus of ♀ well developed, usually with

apical transverse bar; tubercles with ivory markings; *area of wax glands of ♀ restricted to 2nd sternum only*; 7th tergum of ♂ well produced posteriorly with narrow apex slightly rounded or nearly straight; apical area of ♂ 6th sternum short (much shorter than distance between gradulus and apex of medio-apical tooth), with well sclerotized, polished portions; *ventral sides of hind femora of ♂ with a triangular swelling near base, almost free of hairs.*

Pithitis (Pithitis) binghami (Cockerell)

? *Apis aenea* Fabricius, 1798, *Suppl. Ent. Syst.*: 277.

Ceratina binghami Cockerell, 1908, *Ann. Mag. Nat. Hist.* ser. 8, **1**: 340.—Vecht, 1952, *Zool. Verhandl.* **16**: 21.

Pithitis sympatrica Shiokawa & Sakagami, 1969, *Nature and Life in Southeast Asia* **6**: 149. **New Synonymy.**

I have seen both sexes of this species determined by Vecht in Leiden and USNM. It is apparent that he overlooked the absence of the area of wax glands on the 3rd sternum of the ♀. The ♂ has a distinct triangular swelling near the base of each hind femur (Fig. 10). This is specially important in comparison with the ♂ of *comberi.*

I have seen the types of *sympatrica* described by Shiokawa & Sakagami, and found it is identical with *binghami.*

Paris Museum possesses specimens of this species taken in India long ago. Most of them were taken in the 19th century. One ♀ from Pondicherry taken in 1828 is labeled as *M. aenea* Fab. *M* means *Megilla.* Upon seeing these specimens, I am rather convinced that *binghami* might be a synonym of *aenea.* This is proved only by a study of the type of *Apis aenea*, however.

Color of the integument of *binghami* is fairly variable. This is not mentioned by the previous authors. This species is usually shining green like *smaragdula*, but more often and more distinctly brassy or golden-brassy on the head and thorax, and, in lesser extent, on the metasomal terga. Female is rarely slightly bluish. Male is often strongly blue-purple on the head, thorax and metasoma, and this is well recognizable without lenses. Only rarely the ♂ has a distinct brassy reflection like the ♀.

I think Shiokawa & Sakagami succeeded in illustrating the ivory marking of the ♀ clypeus of this species (*sympatrica*). Clypeal marking of the ♀ is one of the diagnostic characters of this species, but in the ♀ specimens from Ceylon the apical transverse bar is much reduced or sometimes absent, then the clypeal marking becomes very similar to that of *smaragdula.*

In addition to the specimens from Bombay, India (J. C. Bridwell), determined by Vecht in USNM and Leiden, and types of *sympatrica* in HU, I have seen the following specimens.

BISHOP: 4♀♀, 2♂♂, Karikal, Pondicherry State, South India, X.1962; 2♀♀, Kallar, 360 m, Nilgiri Hills, S. India, XI.1955; and 1♂, Coimbatore, S. India, XI.1955, Nathan.

MP: 1♀, 1♂, Pondicherry, Maindron 1882; 2♀♀, 2♂♂, 1867, Coll. O. Sichel 1867; 1♀, Pondicherry (Coll. Bosc, 1828), labeled as *M. aenea* Fab., as stated above; 1♀, Bengale, Diard & Duvaucel, 1815; 1♂, Kandy, Ceylon (M. Maindron, 1902); 2♀♀, Ceylon (Coll. J. DeGaulle, 1919), labeled as *Ceratina viridissima*; and 3 more ♀♀ from India.

SNOW: 2♀♀, 1♂, Nettapackam, Pondicherry State, S. India, X.1963, P. S. Nathan; 1 ♂, same locality as above, XI.1963, Nathan; 1♂, X.1962, 1♂, XII.1963, 450 m, 1♀, I.1964,

1♀, 2♂♂, II.1964, 1♂, II.1965, all from Karikal, Pondicherry State, S. India, Nathan; 1♀, 2♂♂, XII.1963, 5♀♀, 6♂♂, VIII.1964, 9♀♀, 13♂♂, IX.1964, 2♀♀, 2♂♂, VI.1965, all from Coimbatore, 420 m, Madras State, S. India, Nathan; 1♀, Wayalar Forests, 210 m, Kerala State, S. India, X.1963, Nathan; 2♀♀, Poona, India, XI.1957, F. L. Wain; 2♀♀, 2♂♂, Colombo, Ceylon, III.1957, Perera; 2♀♀, 2♂♂, Laxapathiya, 21 km S. of Colombo, Ceylon, 15-30.I.1959, R. L. A. Perera.

Group 2. (Group of *comberi*)

This group and the next group of *smaragdula*, are undoubtedly very close to each other, although the ♂♂ of the latter group have a different appearance due to the large, excavated, velvety black areas on the 4th to 6th metasomal terga. I think these 2 groups are subjects of interesting speciation, as discussed below.

Green or dark blue species; base of 3rd sternum (area of wax glands) of ♀ black and finely sculptured like that of 2nd sternum, although not always very distinct in the dark blue species; 7th tergum of ♂ well produced posteriorly with apex either narrowly pointed or broad and rounded; 6th sternum of ♂ with apical area usually well sclerotized, nearly triangular or at most only slightly rounded at apex; ventral sides of hind femora of ♂ hairy at base, neither distinctly convex nor with a comb of hairs.

This group includes two species, *comberi* (Cockerell) and *indica* n. sp.

Pithitis (Pithitis) comberi (Cockerell)

Ceratina comberi Cockerell, 1911, *Ann. Mag. Nat. Hist.* ser. 8, **8**: 185, ♀.—Vecht, 1952, *Zool. Verhand.* **16**: 22.

Pithitis binghami: Shiokawa & Sakagami, 1969, *Nature and Life in Southeast Asia* **6**: 148.

Vecht suspected that *comberi* will eventually prove to be identical with *smaragdula*. I have not seen the type of *comberi*, which is said to be in the British Museum, but I am rather impressed, according to the description of *comberi*, that it is a good species. I think what was described as *binghami* by Shiokawa & Sakagami (1969) is to be known as *comberi*. If it is not the case, the present species I am discussing will require a new name.

♀. Rather small, length 6-7 mm.

Color only slightly darker than in *smaragdula*, and slightly variable, usually dark green with brassy reflection, but sometimes green with blue reflection; ivory markings on clypeus, tubercles and legs very like *smaragdula*.

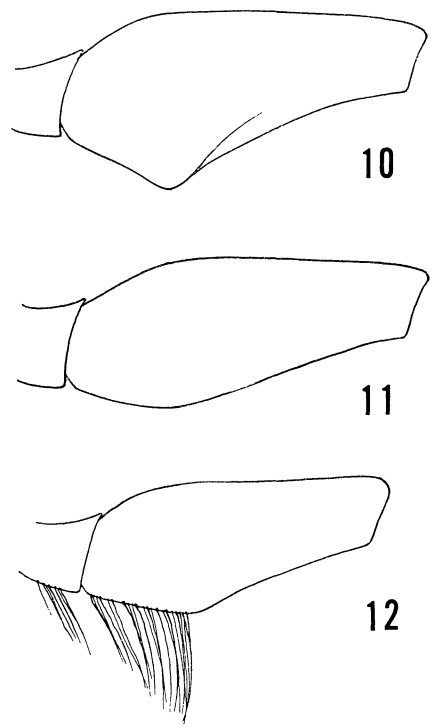

Fig. 10-12. Male hind femur of Oriental *Pithitis*: 10, *binghami*; 11, *smaragdula*; 12, *unimaculata*.

Structurally very close to *smaragdula* also, and sometimes hardly separable from the latter, but often *punctures on median portions of genal areas, median portion of mesoscutum and mesopleura slightly weaker, and hypostomal carinae strong-*

er, more distinctly elevated.

♂. Slightly smaller than ♀.

Very easily separable from *binghami* by hind femora which are not distinctly convex ventrally near base and from *smaragdula* by metasoma which is not provided with a pair of black velvety areas on 4th to 6th terga; 7th tergum, which is strongly narrowed to more or less pointed apex, is one of the good diagnostic characters.

I have seen all the specimens of this species which were erroneously determined as *binghami* by Shiokawa & Sakagami (1969). In addition, I have seen 3 more ♀♀ in SNOW as follows: 2 ♀♀, Lonavla, 600 m, Bombay, India, 16.IV.1959, F. L. Wain; 1♀, Karachi, Pakistan, VII. 1957, N. L. H. Krauss. The last mentioned specimen from Karachi, the type locality of *comberi*, could either be determined as *comberi*, or *smaragdula*, but more likely it is *comberi*.

Pithitis (Pithitis) indica Hirashima, new species

Female of this species is very close to that of *waini* Shiokawa & Sakagami, and also to the blue form of *smaragdula*, so that I am not very convinced, as in the case of *waini*, that this species has not been named previously. Male of *indica* is easily separable from *waini* by the absence of the velvety black areas on the metasomal segments.

♀. Length 7.5-10 mm.

Very close to *waini* but color of integument slightly more bright and shining; hypostomal carinae weaker and not distinctly elevated like *waini*.

♂. Slightly smaller than ♀, 7-9 mm.

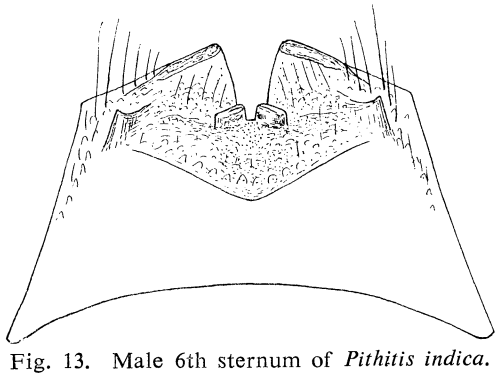

Fig. 13. Male 6th sternum of *Pithitis indica*.

Color slightly darker than ♀, then very similar to *waini*; hypostomal carinae not strong like ♀, and therefore weaker than in *waini*; unlike the latter, 4th to 6th terga without excavated velvety areas; 7th tergum with apex slightly broader than in *waini*.

Type material: Holotype ♂, Cinchona, 1050 m, Anaimalai Hills, S. India, V.1964, P. S. Nathan; 5 paratopotype ♀♀ and 8 paratopotype ♂♂, 1964-5, Nathan; 1 paratopotype ♂, 1050 m, IV. 1956, Nathan.

Type depositories: Holotype and most paratypes are in the collection of the Snow Entomological Museum, University of Kansas; other paratypes in Bishop Museum and Kyushu University.

Group 3. (Group of *smaragdula*)

This group is characterized by the ♂ which has a pair of large excavated, longitudinally striated, velvety black area on the 4th to 6th terga. This group is separable from the preceding one only by this character which is unusual for the bees of any genera of the world.

This group includes two species, *smaragdula* (Fabricius 1787), and *waini* Shiokawa & Sakagami, 1969.

Pithitis (Pithitis) smaragdula (Fabricius)

Ceratina smaragdula: Vecht, 1952, *Zool. Verhand.* **16**: 15.
Pithitis smaragdula: Shiokawa & Sakagami, 1969, *Nature and Life in Southeast Asia* **6**: 146.

Overlooked by the previous authors is that this species has the strongest punctures among the named species of the Oriental *Pithitis*. The black velvety areas on the ♂ metasomal terga vary in size, from small to very large.

Vecht (1952) recognized 2 subspecies of *smaragdula* according to the color of the integument. They are the nominate subspecies and *aurata* Friese from Celebes and the Moluccas. I have seen 2♂♂ of *aurata* from Amboina in BISHOP. One of them is slightly, the other is very strongly golden coppery. I have also seen several specimens in BISHOP from the Philippines and Fukien, China, which have a very strong golden coppery reflection like *aurata*. Vecht says that *purpurascens* Cockerell, described as a variety of *sexmaculata* (=*smaragdula*) from Formosa, is perhaps only an individual aberration. I have seen more than 2 dozen specimens of *smaragdula* in BISHOP and KU taken in Formosa. All were slightly to distinctly bluish, but none of *purpurascens*. Thus, color of *smaragdula* is fairly variable.

I have seen more than 300 specimens of this species from the following areas: Amboina, which is the easternmost limit of its distribution so far known, Java, Borneo (Sabah and Sarawak), Malaya, Thailand, Cambodia, Viet Nam, Laos, India (Bengal, Pondicherry and Madras States, Punjab), Pakistan (Karachi), Kashmir, which is the northernmost record of *smaragdula*, China (Fukien), Hong Kong, the Philippines, Botel Tobago Islands (new record, 2♀♀ (Tadao Kano), in KU), Formosa, Miyako-jima in the Ryukyus (new record, 1♀ 1♂ (11.X.1951, R. M. Bohart) and 2♂♂ (27.X.1952 and 16.XI.1952, G. E. Bohart), all in BISHOP), in BISHOP, KU, LEIDEN, MP, SNOW and USNM.

It is interesting to report the fact that *Pithitis smaragdula* has been utilized as a pollinator of alfalfa in Punjab, India. Unfortunately, however, this species is erroneously known as *binghami* there. I have received from Mr Yasuo Maeta, Tohoku Agricultural Experimental Station, Morioka, 3♀♀ and 2♂♂ of the so-called *Ceratina binghami* of Punjab which were brought back to Japan by him from Dr G. E. Bohart's laboratory in Logan, Utah. Dr Bohart is successfully rearing *smaragdula* populations in his green houses at Logan. He informed me recently that "the determinations (of *Ceratina binghami*) were made in Ludhiana about 1965 by Dr. Suzanne Batra." I suspect, therefore, that Dr Batra's (1967) *binghami* might also be *smaragdula*, the habits of which were observed by her in Ludhiana, Punjab, India.

Dr A. S. Atwal of the Punjab Agricultural University has very recently informed me that he and his colleagues, Surinder Kumar and R. P. Kapil, published a paper on *Ceratina binghami*, with the title "The carpenter bee, *Ceratina binghami* Ckll. (Ceratinini: Hym.)", which was read at

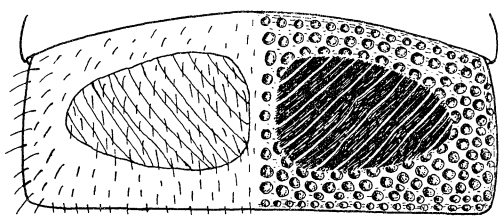

Fig. 14. Male 4th tergum of *Pithitis smaragdula*.

the 13th International Congress of Entomology held in August, 1968, in Moscow. The following is an extract of the introduction of their interesting paper.

"*Ceratina binghami* Ckll. is a brilliant green carpenter bee which is 0.65 cm. in body length and is very active on clover and other flowers on bright sunny days. It is widely distributed in Punjab, Haryana and Himachal Pradesh and it has been recorded up to an altitude of approximately 2000 meters. At Ludhiana, this bee has been recorded mostly on lucerne (*Medicago sativa*), berseem (*Trifolium alexandrinum*) and other clovers in spring and summer and on sanhemp (*Crotalaria juncea*), arhar (*Cajanus indica*), urd (*Phaseolus mungo*) and cottons (*Gossypium* spp.) later in the season. In the catches made on lucerne crop in the month of April-May, there were 12.2 individuals of *C. binghami* per 100 sweeps."

Although I have not seen the material they studied, it might be suggested that *Ceratina binghami* is *Pithitis smaragdula*. I am not sure, however, whether *Pithitis binghami* really occurs in Punjab.

Shiokawa & Sakagami (1969) give a brief note on the biology of this species.

Pithitis (Pithitis) waini Shiokawa et Sakagami

Pithitis waini Shiokawa & Sakagami, 1969, *Nature and Life in Southeast Asia* **6**: 146.

This is a dark blue species which is easily separable by its coloration from *smaragdula* to which it is very closely related so far as the black velvety areas on the male metasomal terga are concerned. Apart from the latter structure, this species is very similar to *indica* n. sp.

In addition to the type series preserved in the Zoological Institute, Hokkaido University, I have seen the following specimens of *waini* from India: 1♀, Lonavla, Poona, India, 22.XI.1957, F. L. Wain, in SNOW; 1♀, Kallar, 450 m Nilgiri Hills, S. India, XI. 1963, P. S. Nathan, in SNOW. The latter specimen was determined as *waini* with some hesitancy.

Group 4. (Group of *unimaculata*)

This group is composed of but 1 species, *unimaculata*, whose ♀ is also difficult to separate from other species unless the ♂ is associated. Color is variable, as discussed below. This group is easily recognizable by the ♂ which has a comb of hairs basally on the ventral sides of the hind femur.

Pithitis (Pithitis) unimaculata (Smith)

Ceratina unimaculata: Vecht, 1952, *Zool. Verhand.* **16**: 19.
Pithitis unimaculata: Shiokawa & Sakagami, 1969, *Nature and Life in Southeast Asia* **6**: 145.

Coloration of this species is fairly variable, and Vecht (1952) recognized 4 subspecies on this base, *unimaculata, javanica, palmerii,* and *nanensis.*

I have seen 36 specimens (22♀♀, 14♂♂, 35 in BISHOP and 1 in KU) of this species from Borneo (Sabah and Sarawak), and found that all of them are to be determined as the subspecies *palmerii* Cameron except for one ♀ (Cocoa Research Station, Quoin Hill, Tawau, Sabah, 22.VIII.1962, Y. Hirashima, in BISHOP), which is very black with slight blue and coppery reflections. This is an interesting aberration. I collected many specimens at the same locality with the latter; most of them were taken on the flowers of

Flemingea congesta, which were also attractive for many species of *Megachile* and *Nomia*.

From Thailand, Laos and Viet Nam, on the other hand, I have seen 40 specimens (27 ♀♀, 10♂♂, 37 in BISHOP and 3 in MP) which are separable into 3 groups as follows:

Subsp. *nanensis* (blue)	Intermediate form (blue with coppery reflection)	Subsp. *palmerii* (coppery, blue is feable, if any)
16 (11♀♀, 5♂♂)	5 (5♀♀)	19 (14♀♀, 5♂♂)

Blue form of *unimaculata* from that part of the Oriental Region is known as the subsp. *nanensis* Cockerell, as listed above. It is hardly separable from another subspecies named *javanica* Vecht from Java (I have seen 8 specimens (7 in MP and 1 in BISHOP) of *javanica*). Of the 19 continental specimens of *palmerii* (see above), most of them have a yellow marking on the tubercles except for 5 specimens (2♀♀, 3♂♂). In contrast to this, the tubercles were all dark in the 36 insular specimens of *palmerii* from Borneo (see also above) except in 1 ♂ specimen.

Male of this species is unique, in addition to the comb of hairs on the hind legs, in the following points.

Sixth tergum without a keel in middle of apical portion (fig. 21) (in all the Oriental species except for *unimaculata* ♂ which has the 6th tergum provided with a longitudinal keel in middle of apical portion (fig. 19). This keel often projecting beyond apical margin of same tergum, although it is weak in the *comberi* group); 7th tergum unusually short, rounded, with median portion of apical margin nearly straight or even slightly emarginate; apical area of 6th sternum broadly rounded.

For the species of *Pithitis*, the lateral faces of the propodeum are usually strongly shagreened or coarsely sculptured due to the close and shallow punctures. I have seen, however, an interesting specimen of *unimaculata* from Java (Soekaboemie, 14.V.1908, E. Cordier, in MP), whose lateral faces of the propodeum are nearly smooth and only microscopically lineolate, and the 1st paratergum is polished and impunctate.

Interesting case of speciation

I placed *smaragdula* which is a green species and *waini* which is a dark blue species together in the same group because of the characteristic feature of the ♂, which has the black velvety areas on the 4th to 6th metasomal terga. By the same reason the *smaragdula* group is separable from the *comberi* group, which is also composed of 2 differently colored species—the green *comberi* and blue *indica*. Regardless of the black velvety areas of the ♂ terga, however, *smaragdula* seems to be the closest relative of *comberi*, and *waini* of *indica*. It is conceivable that they are combined in 2 phyletic lines, *comberi—smaragdula*, and *indica—waini*. This is quite an interesting combination of species resulting from the comparative morphological study of them. Coloration of the integument also supports this relationship. This is inconsistent, however, with my system presented above.

I think *smaragdula* might have evolved from *comberi* or its ancestral form by a certain mutation by which the black velvety areas on the 4th to 6th terga of the ♂ were fixed. Likewise, *waini* seems to be a derivative of *indica* by a similar mutation. It is obvious that this sort of mutation took place in parallel on 2 sympatric species, and their deriva-

tives have grown to be placed in the same species group. Their phylogenetic relationship together with other Oriental species, is shown in fig. 15.

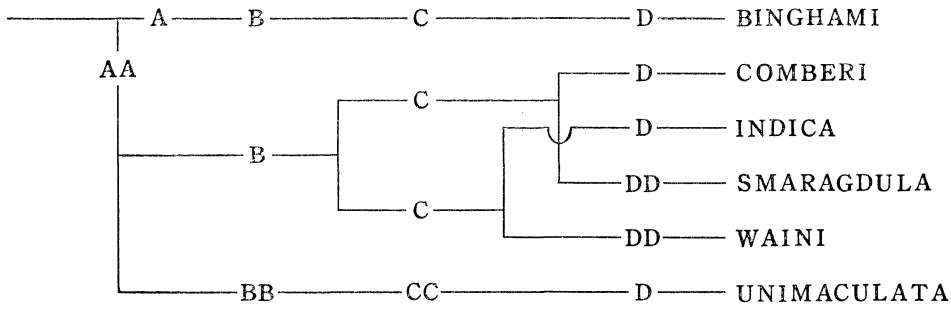

Fig. 15. Phylogenetic relationship of the Oriental species of *Pithitis* s. str.
A : ♀ with area of wax glands on 2nd sternum only.
AA : ♀ with areas of wax glands on 2nd and 3rd sterna.
B : ♂ without a comb of hairs on hind femora ventrally.
BB : ♂ with a comb of hairs on hind femora at base ventrally.
C : ♂ with 7th tergum well produced posteriorly.
CC : ♂ with 7th tergum much broader than long with apical margin broadly rounded.
D : ♂ without a pair of velvety areas on 4th to 6th terga.
DD : ♂ with a pair of excavated velvety black areas on 4th to 6th terga.

More species of *Pithitis* s. str. from India

In addition to the 6 species discussed above, I have seen more species of *Pithitis* from India.

A single ♀ specimen in the Paris Museum (Coll. O. Sichel, 1867), which is labeled as "*Ceratina rufipes* ♀ n. s. India," undoubtedly represents a distinct species. It is bright green as in *smaragdula* or *binghami*, but easily separable by the polished clypeus and in being entirely yellow except for the latero-apical portions only, punctures on the vertex, upper portions of the genal areas and the thorax well separated from each other with flat smooth interspaces, axillae with a long and curved spine which is distinctly separated from the scutellum (this feature shows an affinity to the African species), and legs red with well developed yellow markings. This is quite an interesting species, but unfortunately, is represented by only a single specimen of the single sex. I think the name *Ceratina rufipes* has not been published.

A ♀ specimen from South India (Nettapackam, Pondicherry State, X.1963, P. S. Nathan, in SNOW) may represent another good species if not a color aberrant of *binghami* or *smaragdula*. It is blackish with dull purple reflection throughout (tubercles yellow).

A ♂ specimen from Bombay (Mathéran, XI.1896, M. Maindron), Coll. J. DeGaulle, 1919, in MP) is coppery like *unimaculata palmerii*, but is provided with a pair of black velvety areas on the metasomal terga characteristic of the *smaragdula* group. From the morphological point of view, it is nearest to *waini*, and probably belongs to it.

Key to named Oriental species of Pithitis s. str.

Males

1. Metasoma with a pair of large, excavated, velvety black areas on 4th to 6th terga 2
   Metasoma without such areas on 4th to 6th terga 3
2. Green species, with or without bluish or bronzy reflections; tubercles yellow; hypostomal carinae distinct but not highly elevated; 7th tergum pointed at apex, nearly triangular when seen from above; black velvety areas on 4th to 6th terga very striking because of bright metallic color of integument ..... **smaragdula**
   Dark blue or blackish blue species, with or without slight coppery reflection; tubercles black; hypostomal carinae strong, distinctly elevated; 7th tergum with apex broad and rounded; black velvety areas of 4th to 6th terga might be overlooked unless observed carefully because of dark color of integument ..... **waini**
3. Ventral sides of hind femora with a comb of long curved hairs at base; similar hairs present on apices of hind trochanters ventrally; 6th tergum without a keel in middle of apical portion; 7th tergum broadly rounded, apical margin often slightly emarginate in middle; color of integument variable, blue to coppery; tubercles with or without yellow marking ..... **unimaculata**
   Trochanters and femora of hind legs without such hairs ventrally 4
4. Ventral sides of hind femora triangularly convex near base; this part with very short, sparse, fine hairs; apex of 7th tergum more or less broad, slightly rounded or nearly straight; color variable, green with bright blue-purple reflections, or green with brassy tint ..... **binghami**
   Ventral sides of hind femora not distinctly convex at base 5
5. Small, dark green species with brassy reflection; tubercles with pale yellow markings; hypostomal carinae strong; 7th tergum triangularly produced posteriorly with blunt apex ..... **comberi**
   Usually large, dark blue species; tubercles black, rarely with a small yellow marking; hypostomal carinae distinct but not highly elevated; 7th tergum with apex broad and rounded ..... **indica**

Females

1. Usually brilliant, green or blue-green species, with or without brassy or slight purple reflection; tubercles pale yellow or ivory 2
   Usually dull, blue (bright to dark), dark blue and coppery, or coppery species; tubercles often without yellow marking 4
2. Bright blue-green species, often with brassy reflection; yellow marking on clypeus well developed, usually with transverse bar apically (this bar lacking in Ceylonese specimens); 3rd sternum without area of wax glands; punctures on median portions of genal areas usually markedly smaller than those on upper or lower portions ..... **binghami**
   Yellow marking on clypeus without apical bar; areas of wax glands present on 2nd and 3rd sterna or at least basal portion of 3rd sternum blackened like that of 2nd 3
3. Larger, often bright green; hypostomal carinae moderate; punctures very strong, those on median portions of genal areas quite distinct, although slightly smaller than those on upper or lower portions ..... **smaragdula**
   Smaller, duller green with coppery reflection; hypostomal carinae strong, distinctly elevated; punctures on median portions of genal areas distinctly smaller than those on upper or lower portions ..... **comberi**
4. Medium-sized species; color variable, blue to coppery; punctures on upper portions of genal areas and lateral portions of mesoscutum very strong, often well separated from each other by flat, smooth, shining interspaces; hypostomal carinae rather strong

.....**unimaculata**
Usually larger, blue or dark blue species; punctures on upper portions of genal areas not specially strong, usually close 5
5. Dark blue or blackish blue species; hypostomal carinae strong..... **waini**
Brighter blue species; hypostomal carinae moderate or rather weak ..... **indica**

Distinctions between the African and Oriental species of *Pithitis* s. str.

Although I do not think I have seen sufficient African material to discuss their relationship with the Oriental species, the following discussion is made.

African species seem to have stronger punctures on the head and thorax, especially on the mesoscutum. In all the African species I have studied, the punctures on the mesoscutum are *very* strong even in the median portion, although those on the latter are *slightly* smaller than those on the lateral portions in *nasalis* only. In the Oriental species, punctures on the mesoscutum are not specially strong, and those on the median portion are usually smaller than those on the lateral portions. African species *caesia*, for example, which is smaller than the Oriental *smaragdula*, has larger punctures on the mesoscutum than in the latter.

Hypostomal carinae are often stronger in the African species than in the Oriental species.

In the African species, the spines on the axillae are very strong; they are sharper and longer, and more widely separated from the scutellum than in the Oriental species. It is only in the unnamed species listed in the group 5, among the African species of *Pithitis* s. str., that the axillae are briefly pointed.

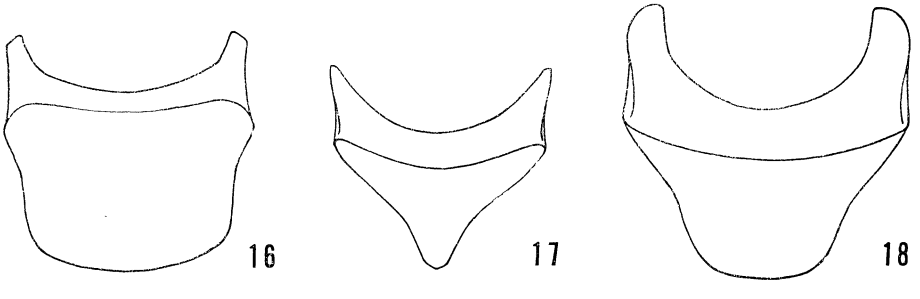

Fig. 16-18. Male 7th tergum of *Pithitis*: 16, *tarsata* (African); 17, *comberi* (Oriental); 18, *indica* (Oriental).

In the males of the African species, the apex of 7th tergum is *very broad and usually slightly rounded.* It seems that it scarcely serves as a diagnostic character for the species. On the other hand, the male 7th tergum of the Oriental species is variable in shape, and serves as one of the important specific characters.

On the ♂ 6th tergum of the African species, there is no longitudinal keel in the middle of apical portion, but a small triangular projection is present on the middle of *apical margin* (fig. 20). In the ♂♂ of the Oriental species, except for *unimaculata* only, there is a longitudinal keel on the middle of *apical portion* of the 6th tergum, although it is usually not strong. Apex of the keel exceeds the apical margin of the tergum in

most species. In *unimaculata* alone the ♂ 6th tergum is neither armed with a triangular tooth on the middle of apical margin nor with a longitudinal keel on the middle of apical portion (fig. 21). This structure may not be well observed unless the metasoma is dissected.

Apical margin of the ♂ 5th sternum is interestingly modified in some African species (the *tarsata*- and *nasalis*-groups), but it is simple in all the Oriental species.

Male 6th sternum of the African species also provides with a *striking modification* as described for each species groups (fig. 6-9), but *no marked difference* is found in the Oriental species.

Among the African and Oriental species, *unimaculata* is one of the most interesting species in view of the presence of a comb of hairs on the ventral sides of the ♂ hind femora. Such a comb of hairs on the ♂ hind femora, however, is present in the African species *aereola*, the type species of *Protopithitis*, and also in some species of *Ceratina* of African and Japanese species. Yet it seems that *unimaculata* may be the most specialized species in *Pithitis* s. str. because the 7th tergum of the ♂ is hardly produced posteriorly.

Two Oriental species, *smaragdula* and *waini*, are most conspicuous in having a pair of large black areas on the 4th to 6th terga of the ♂. These areas are excavated, longitudinally finely striated and clothed with black hairs. In *waini*, these areas are less hairy, more striated, and their margins are not sharply marked as in *smaragdula*. This is undoubtedly one of the most remarkable modifications seen in *Pithitis*.

Legs are normal in the African species, while the undersides of the hind femora of the ♂ are convex in 2 Oriental species, *unimaculata* and *binghami*. In *unimaculata*, there is a comb of hairs on the basal portion of that swelling, as already stated, while in *binghami* the basal portion of the corresponding portion is almost bare except for very short and fine hairs.

Distribution of the area of wax glands on the metasomal sterna of the ♀ is also interesting. In the subgenus *Protopithitis*, there is also a large area of wax glands on the base of 3rd sternum like the 2nd. In the subgenus *Pithitis*, however, the area of wax glands is either on the 2nd sternum alone or both on the 2nd and 3rd sterna. All the African species except the unnamed species listed in the group 5 belong to the first category, while all the Oriental species except *binghami* alone belong to the second one.

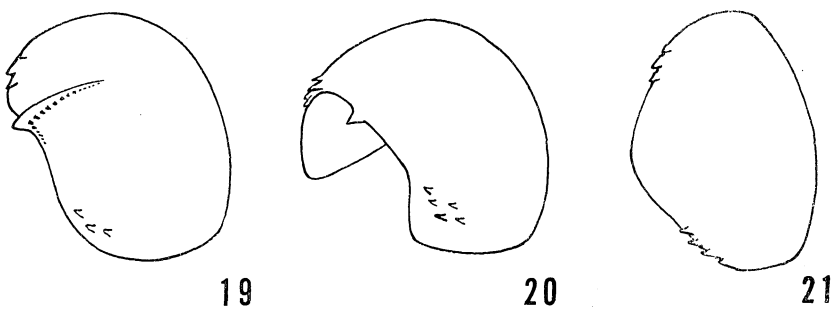

Fig. 19-21. Male 6th tergum of *Pithitis* (slightly diagrammatic): 19, *comberi* (Oriental) 20, *tarsata* (African); 21, *unimaculata* (Oriental).

Origin and pattern of the distribution of *Pithitis*

As can be seen above, it is now evident that *Pithitis* is predominantly African, although the classification of the African species needs further refinement. It seems also apparent that pronounced speciation has more frequently taken place in the African species. Therefore, it is conceivable that *Pithitis* originated in Africa. Undoubtedly Africa is one of the centers of the distribution of *Pithitis* today. Probably the Oriental species are descendents of the original stock of *Pithitis* which migrated from the Ethiopian Region into the Oriental Region. India is another center of the distribution of *Pithitis*. Five out of 6 named Oriental species are found there.

In the Oriental Region, the subgenus *Pithitis* alone is known. *Pithitis smaragdula* is widespread there. It has a range of distribution from Pakistan northward to Kashmir, eastward to the Malayan Region as far as Ambon, and northeastward to Taiwan, probably via the southeastern part of continental China. Another species, *unimaculata*, which is one of the strictly Oriental elements, is spread over the Malayan Subregion, but, interestingly, it is not found in India. For the map of distribution of the Oriental species, see Shiokawa & Sakagami (1969) (note my new records).

No species has been found which is common to both the Ethiopian and Oriental Regions.

No species of *Pithitis* is studied in this paper from the area between Africa and India such as Iran, Iraq or Saudi Arabia, or from any islands in the Indian Ocean. Probably it is worthy to note here that I have examined a series of *Ceratina* s. lat. from Iran taken by the Iranian Survey (USDA, Univ. of California, and Caradj College), through Dr G. E. Bohart, but could not find any *Pithitis* among them, although I do not intend to say that *Pithitis* does not occur in Iran.

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ADDENDUM

On July 11, I received from Dr R. P. Kapil, Punjab Agricultural University, Ludhiana, India, 8 specimens of the so-called "*Ceratina binghami*", all of which were collected in Ludhiana in May of this year. They were composed of 2 species, *Pithitis smaragdula* (2♀♀, 2♂♂) and *Pithitis comberi* (1♀, 3♂♂). From the result of this, it is probable that at least 2 species of the green "*Ceratina*" occurring in Ludhiana have been known as *Ceratina binghami*. The last named species, which is now understood as *Pithitis binghami*, is a separate and distinctive species, as indicated in the text. I would like to thank Dr Kapil for sending the interesting specimens.

BOOK REVIEW

PESTS OF SUGAR CANE

Editors: J. R. Williams, J. R. Metcalfe, R. W. Mungomery and R. Mathes. Authors: P. N. Avasthy, J. Bates, F. D. Bennett, S. Bleszynski, J. Breniere, F. T. Bullen, L. J. Charpentier, J. Dick, R. G. Fennah, D. W. Fewkes, W. V. Harris, W. H. Long, R. D. MacCuaig, R. Mathes, J. R. Metcalfe, G. W. Miskimen, H. Nagaraja, C. E. Pemberton, V. P. Rao, T. Sankaran, F. J. Simmonds, T. R. E. Southwood, J. R. Williams and G. Wilson. 568 p, 107 ill., 27 tables. Elsevier Publishing Co., Amsterdam, London & New York. 1969. $ 32.50

This book represents a very comprehensive treatment of a diverse subject by a large panel of experts. It is the outcome of a resolution at the 11th Congress of International Sugar Cane Technologists. The book dwells heavily on general problems and philosophy, and is not a handbook of sugar cane pests, though many are listed, or discussed in some detail. The treatment is clear, well organized and well documented. The illustrations are good and very helpful. The work will be very useful to many. The chapters are as follows:

Distribution, origins and spread of sugar cane insect pests. Most species are local species adapted to cane consequent to its cultivation, but some have been widely spread by commerce. None of the important pests are cosmopolitan.

The taxonomy of the crambine moth borers of sugar cane. Included are keys and lists of species.

The estimation of loss caused by sugar cane moth borers. Great losses in sugar production are caused by these borers, but precise assessment of losses is difficult.

Egg parasites (Trichogramma *spp.*) *for control of sugar cane moth borers.* Artificial propagation of these wasps is of disputed value. They are still used in Peru, India and the Far East. They may be of special use seasonally, as in early spring to augment population growth.

Tachinid flies as biological control agents for sugar cane moth borers. These are important parasites of larval moth borers in the Americas. Hymenopterous parasites are more important in the Old World.