BULLETIN

OF THE

EXPERIMENT STATION

OF THE

HAWAIIAN SUGAR PLANTERS' ASSOCIATION

ENTOMOLOGICAL SERIES
BULLETIN No. 19

STUDIES IN TROPICAL WASPS—THEIR HOSTS AND ASSOCIATES

(WITH DESCRIPTIONS OF NEW SPECIES)

FRONTISPIECE, 16 TEXTFIGURES AND 33 PLATES

By FRANCIS X. WILLIAMS

HONOLULU, HAWAII
January, 1928

To Dr. W. J. Pietrokowski - with kind regards
of Francis X. Williams

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ERRATA AND ADDENDA

Experiment Station, H. S. P. A., Entomological Series
Bulletin No. 19

Page 1, Line 11, "Guinea" should read "Guiana."
Page 15, Title, "Flies in Figs and a Braconid Wasp Parasite of One of Them" should read "Flies in Figs and a Braconid Wasp, *Microbracon lendicivorus* Cushman (1930), Parasite of One of Them."
Page 34, Line 3 of footnote, "internment" should read "interment."
Page 46, Lines 34 and 36, "2 and 3" should read "1 and 2."
Page 61, Line 35, "distinctly" should read "distantly."
Page 62, Plate VII, figure 39, lowest legend, "Tibial Claw" should read "Tarsal Claw."
Page 63, Line 19 of text, "oceli" should read "ocelli."
Page 72, Lines 11 and 14, "propodeum" should read "pygidium."
Page 82, Key, Line 8, "posteriro" should read "posterior."
Page 92, *Tachysphex bengalensis* Cam. under description of *Female*, line 5, "antennae with joint 2" should read "antennae with joint 3."
Page 99, Line 7, "a weedy relative *Alternanthera* species" should read "an Eclipta? sp."
Page 141, Line 9, "Angeniinae" should read "Ageniinae."
Page 176, Line 13, "amymoe" should read "amymone."
Line 15, "Eupristima" should read "Eupristina."

LETTER OF TRANSMITTAL

To the Experiment Station Committee
of the Hawaiian Sugar Planters' Association,
Honolulu, T. H.

Gentlemen:

I submit herewith for publication as Bulletin No. 19 of the Entomological Series a paper entitled "Studies in Tropical Wasps—Their Hosts and Associates," by Dr. F. X. Williams. The importance of this group of insects to the sugar industry in Hawaii is well illustrated in *Scolia manilae* in controlling *Anomala orientalis*.

Yours very truly,

H. P. Agee,
Director.

Honolulu, T. H.,

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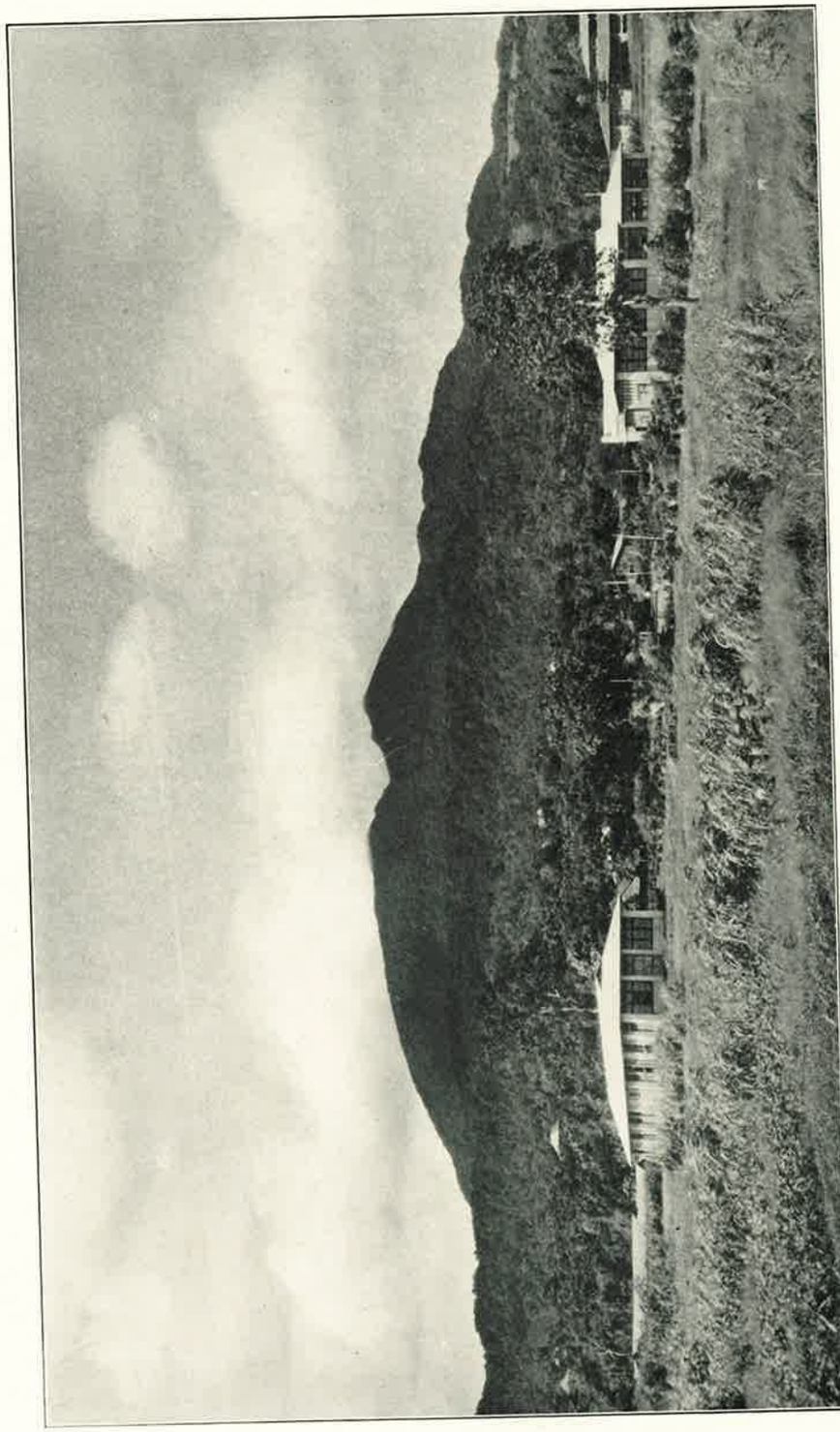


Mount Makiling and a part of the College of Agriculture, Los Baños, Luzon, Philippines. This circumscribed locality is exceedingly rich in plant and animal life. Hundreds of new species of insects have been described from here.

Studies in Tropical Wasps—Their Hosts and Associates

PREFACE

During the last several years, up to the middle of the year 1924, while engaged in foreign field work for the Experiment Station, the writer had opportunities, apart from his regular work, of studying the habits of many kinds of insects, chiefly wasps and their associates. The result of this work is in part recorded here, as well as a considerable amount of study on the classification of these insects done in the laboratory.

The countries visited include the coastal, sugar cane area of Queensland, Australia, the Philippine Islands, more particularly the region about Los Baños, on the island of Luzon; and in South America, Ecuador on the Pacific side, a country that because of its equatorial position and varied topography is particularly interesting, British Guinea, in the northern part of the continent, and Brazil bordering a large part of the Atlantic seaboard.

If one were to ask for general impressions regarding the wasp fauna of these several regions, the writer would say that as you proceed—in travel, or by studying representative collections—from the Northern Philippines through to Australia, a transition from darker to lighter colored wasps will be observed; this being particularly noticeable among the Eumenidae but also holds true for many other groups of Aculeates; South America offers a number of genera and a vast array of species of social wasps, whose variously formed nests are met with everywhere; while among the solitary kinds a larger percentage than would be expected have the costal edge of the forewings strongly infuscate, or these wings themselves conspicuously banded or marked in two colors. A similarity in form, color and habitus among many Hymenoptera and between Hymenoptera and other insects is very prevalent in the Neotropics.

No attempt has been made to delve deeply into or to discuss the literature referring to the subjects treated in this Bulletin,* and the observations, such as they are, fragmentary or otherwise, well known or not, appear herewith as a matter of accessible information and as a possible stimulus in a branch of a science which ought to serve its members both as a profession and as a pastime.

The type of *Tachysphex vitiensis* is in the collection of the Bishop Museum, Honolulu; the *holotypes* (first specimen types) of all the species described by me are in the collection of the Hawaiian Sugar Planters' Association, Experiment Station, Honolulu; where *allotypes* (opposite sex types—second specimens) have been described by me from the larrid wasps collected by Professor C. F. Baker, in the Philippines, these allotypes have been returned to Professor Baker, as well as available paratypes, and the greater part of his collection of Larridae. Para-

* Here may be mentioned *Biologie Der Hymenopteren*, 1927, by Dr. H. Bischoff, 598 pages and 224 figures, Berlin, which embodies a great amount of data on the habits of Solitary and Social Hymenoptera.

types, where available, will be distributed to the United States National Museum and to the British Museum.

Thanks are here extended to all those who have assisted me in this work; to Dr. G. A. K. Marshall, Chief of the Imperial Bureau of Entomology, London, and to members of his staff, particularly to Mr. James Waterston for comparing some of the wasps sent, with types at the British Museum; to Dr. L. O. Howard, Chief of the Bureau of Entomology, Washington, D. C., and to members of his staff, chiefly for determinations of insects, and Mr. S. A. Rohwer, of the Bureau, very kindly turned over to me all of the larrid wasps sent him from the Philippines by Prof. C. F. Baker, so that the entire lot could be worked up; to Dr. J. Bequaert of the School of Tropical Medicine, Harvard University, for determining most of the vespid wasps; to Dr. Morgan Hebard of the Philadelphia Academy of Sciences for determining various Orthoptera; to Mr. F. Muir for helpful suggestions; to Mr. O. H. Swezey for proof-reading, etc.; to the Colonial Sugar Refining Company for facilities afforded me while in Australia; to many gentlemen in South America; particularly to Mr. F. W. Goding, at that time American Consul at Guayaquil, and himself an enthusiastic entomologist; to Mr. F. W. Urich, Government Entomologist at Trinidad, B. W. I.; to Mr. H. E. Box, entomologist to Plantation Blairmont, British Guiana, and to other officials of that Plantation; to Dr. Angelo M. Da Costa Lima of the Department of Agriculture, at Rio de Janeiro, Brazil, and to many others.

Mr. H. F. Barnes, of the Rothampsted Experiment Station, Harpenden, England, has very kindly worked up the fig midges, and his paper is included in the chapter dealing with Philippine Fig Insects.

That the insect fauna of the Philippine Archipelago is in the main comparatively well known and will soon, it is hoped, be better known, is due for the most part, to the efforts of the late C. F. Baker, who was dean of the College of Agriculture, Los Baños, Philippines. Dean Baker was an indefatigable worker and an inspiring entomologist, and a man who will be greatly missed by many entomologists throughout the world. To him the writer was indebted for many facilities effected during his stay in the Philippines.

I

SOME FRIENDS AND ENEMIES OF PHILIPPINE WILD FIGS

(Referring mainly to the region about Mount Makiling, Los Baños, Luzon)

Wild figs form a very conspicuous element in the vegetation of the Philippine Islands. On the comparatively small bulk of Mount Makiling, at Los Baños, Luzon, where the culled or cut-over forest offers a particularly favorable environment for these trees, well over 50 species of the genus *Ficus* have been collected. Elsewhere in the Philippines these plants are also abundant and they total at least 200 species for the Archipelago. Many kinds, especially those that develop upon other trees and eventually strangle them, form a valuable forest cover, standing out conspicuously as giants with far-spreading crowns; others, like those belonging to the same natural group as the edible fig of commerce, but themselves with fruits rarely very tasteful, are generally small to medium-sized trees and likewise useful in shading the ground, particularly at low levels; and finally, a smaller number of species consisting of sprawling or climbing shrubs and stout, rope-like climbers (lianas) while numerous in individuals do not appear to be of much importance from a standpoint of water conservation. Viewed in the light of practical forestry the larger figs are commonly regarded as "weed trees," their wood being soft and generally inferior, and they may crowd out or kill valuable timber. Occasionally the bark-fibre of certain of these "strangling figs" is used as a sort of rope, while the very harsh leaves of *Ficus odorata* (Blanco) Merr., a lowland fig, are often employed by the natives for scouring purposes. The writer has found but three species of pleasantly edible Philippine figs; the best of these, the tolerably large seed-figs of *Ficus pseudopalma* Blanco, an ornamental, palm-like plant, are sweet and juicy with a pleasant flavor of their own, even the rather thick rind being palatable.

The genus *Ficus* then, with its wide geographical distribution, numerous species, comparatively soft wood, often large and juicy leaves and buds, and great quantity of fruit (which is a fleshy, flower-and-seed-bearing *receptacle* that has become invaginated into a sort of hollow globe with a more or less impassible scale-guarded aperture, or ostiole) must inevitably constitute the food supply, wholly or in part, directly or indirectly, of a great variety of animal life. A visit in the forest to a giant strangling-fig heavily laden with ripe fruit will often reveal quite a gathering of wild life; monkeys scurrying over its wide crown, and numerous hornbills and other birds feeding, with many figs often partially chewed and beak-marked on the ground beneath; and these are evidently relished by the wild hogs, as the disturbed condition of the soil about the tree shows. By night, the great fruit-eating bats or flying-foxes (*Pteropus*) will appear and take their share of the crop. Smaller bats of the genus *Cynopterus* are very much addicted to the fruits of *Ficus nota* and *hauili* and shrewd enough, it seems, to select the true seed-figs as the more palatable of the two forms.

The list of insects that attack Philippine fig trees, or that destroy, or are attracted to insects feeding upon them, is very great, and an adequate treatment

of their habits would require an enormous amount of time and labor; the present paper, then, is admittedly exceedingly incomplete and supplemented only to a small extent by the work of others. With the insect fauna of figs so little worked out, it follows that the identifications are frequently of a general nature, and so too the paper.

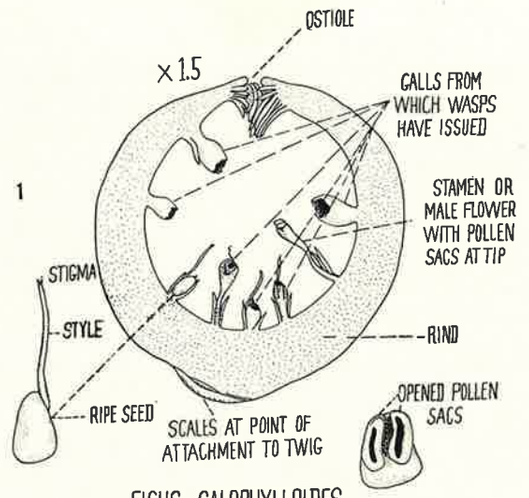
Fig-Wasps

The true fig-wasps (of several genera) belong to the superfamily Chalcidoidea, and are of special interest since they are the pollinating agents for the particular species of fig to which each is attached, a fact which in the case of the cultivated edible fig has been known for centuries. Furthermore, these curiously modified little wasps belong to a superfamily whose members are essentially parasitic upon other insects. Their structure, habits and the relation to the figs they pollinate, as well as the co-adapted structure and development of the figs themselves have been studied for several species; notably in the Smyrna fig of commerce, and for some of the wild figs, for example, for *Ficus Roxburghii* by Cunningham (Ann. Botan, Garden, Calcutta (1889), I, 13-47, pls. 1-4), for *Ficus nota* by Baker (Philippine Journ. Science, VIII (1913), 63-83, 4 figures), and for *Ficus macrophylla* of Australia by Pemberton (Hawaiian Planters' Record, XXIV (1921), 297-319, 2 pls. and 6 textfigs.).

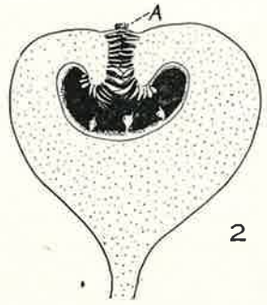
Grandi has published extensively on various species of wasps associated with figs, and his papers are to be found chiefly in the more recent numbers of the Bollettino del Laboratorio di Zoologia Generale e Agraria, Portici. His memoir on *Blastophaga psenes* (L.), the pollinator of *Ficus carica* (L.), the common edible fig is particularly worthy of note (l. c., XIV, 1920). More recently Grandi described several species of Philippine fig-wasps (Hyménoptères Sycophiles Récoltés aux Isles Philippines par C. F. Baker, I Agaonini; Phil; Jour. Sci. 33, no. 3, July, 1927, pp. 309-329, pls. 1-7.)

For a short illustrated paper by the writer, referring to Philippine fig trees that were studied chiefly in the Mount Makiling region, see Hawaiian Planters' Record, XXV, pp. 202-225, 1921.

To properly understand the more important activities of fig-inhabiting insects, it is necessary to explain the general structure and development of two common types of fig-receptacles or fruits. The fleshy interior wall of a fig is its flower- and seed-bearing surface. It may bear three types of flowers; male, gall and female, all very simple because the perianth or floral envelope which we commonly associate with ordinary flowers and which so embellishes them and serves in part the useful purpose of attracting pollinating birds and insects, is here rudimentary. The male flowers consist chiefly of a pair of anthers or pollen-sacs borne on a filament, the gall flowers are modified female flowers destined to form the food-chamber (modified seedless ovary) for the young fig-wasps, while the true female flowers have a stigma fitted for the reception of pollen and a seed-bearing ovary. Sterile or rudimentary flowers may also occur. A fig plant whose receptacles or figs contain these three types of flowers is said to be *monoecious*, and here belong all the Philippine strangling-fig trees examined by the writer, and in addition, *Ficus crassitora* Elmer, *Ficus malunuensis* Warb. and *Ficus nervosa* Hey., which are not of the strangling or "banyan" type but evidently exist throughout life as

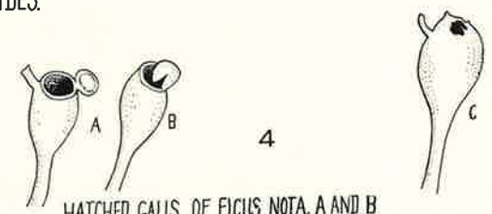


FICUS CALOPHYLLOIDES.



SECTION THROUGH 28MM. FICUS NOTA TO SHOW ♀ CERATOSOLEN WASPS BEGINNING TO ENTER AT A.

SECTION THROUGH FIG OF FICUS NERVOSA TO SHOW GIANT WASP GALL WITHIN. ×1.8



HATCHED GALLS OF FICUS NOTA. A AND B HAVE PRODUCED ♂ CERATOSOLEN WASPS. ENLARGED.

SECTION THROUGH MATURE 50MM. GALL FIG TO SHOW AN OSTIOLAR CHANNEL PARTLY FORMED AND DRIVEN THROUGH BY ♂ CERATOSOLEN WASPS. A, ANTHERS, B, EMPTY GALL.

PLATE I

independent trees. Then, there are numerous other species of fig plants ranging in size from large bushes to trees of fair stature and including also vines and intermediates between vines and bushes, that are said to be *dioecious* because each species is represented by separate male and female plants, the former bearing figs that contain gall flowers and fertile anthers, the latter only those containing fertile female flowers and sometimes sterile male flowers. Other species of figs, as reported by Pemberton (1921) have the male and female flowers in separate receptacles but on the same plant.

A section lengthwise through the ripe fruit of the handsome forest giant, *Ficus calophylloides* Elmer (Pl. I, Fig. 1), with only a few of the flowers sketched in—for the sake of clearness—shows the typical arrangement of flowers in the *monoecious* type. The fig has reached its maximum size, the less tightly-closed ostiolar channel now permitting the exit of various fig-wasps. A single male flower is figured; these are scattered throughout the receptacle and generally exceed the others in stature, and are thus better able to dust their pollen upon the fig-wasps when they issue from the galls. As can be seen, there are several sizes or types of gall-flowers; the smaller ones probably produced the true fig-wasps and some of their parasites, the larger sort, wasps of greater size that had perhaps appropriated and developed the galls in the first place. The female flowers, also scattered about the receptacle, seem always to have bifid stigmas and stemless ovaries, the seeds being usually comparatively broader at the base and more angulate than the galls. They are often relatively much more abundant in some species than in others.

As an example of a *dioecious* species, the common *Ficus nota* (Blanco) Merrill, because of its large and abundant fruits well serves to illustrate the structure of the interior of the receptacle. A section lengthwise through a mature male fig (caprifig) shows immediately below, and surrounding the innermost scales of the ostiole, a couple of rows or so of male flowers, the rest of the receptacle being packed with galls. A similar section through a mature female fig reveals the inner surface covered with female or true seed-bearing flowers, and sometimes with rudimentary stamens, just within the ostiole—as with the male fig.

The flower arrangement and relative number of flowers in dioecious forms may vary for the species or for the group; thus for example, in the male fig of the semi-climbing *F. caudatifolia* Warb., there was found to be only a single row of stamens surrounding the ostiole, whereas in *Ficus hauili* Blanco, among others, there are two or three rows there. In *F. linearifolia* Elmer, the stamens while predominating around the ostiole occur also on the sides and at the opposite end. The female fruits of *Ficus ribes* Reinw. and *F. ulmifolia* sometimes contain a few true galls in the mass of seeds, said galls being the larger and possessing a short style. From them issue non-pollinating wasps. While the stout vine, *Ficus megacarpa* Merrill, bearing fruits that may attain a diameter of three inches or more is truly dioecious, its flower arrangement presents quite a departure from what has been described; a ripe male fig showing the stamens and galls occupying the whole receptacle in two stories, the male flowers presenting the aspect of a solid forest, underneath which, from sessility to two-thirds the height of this upper story, are the galls. The female fig has a forest of intermingled female and

sterile male flowers, the latter being tall and densely packed. The seeds of *megacarpa* and of *bakeri* (of the same section) are quite elongate and compressed.

The life of a blastophagous or fig-pollinating wasp may be set forth briefly as follows: These wasps always issue from a *mature* fig. The males, which are quite flightless, hatch first; they immediately seek the females by biting open the occupied galls; after mating the males perish, with some exceptions within the receptacles. The females, on the other hand, are fully winged, and in seeking egress from the receptacle through the ostiole or by a hole drilled through the rind, inadvertently dust themselves with pollen from the ripe stamens; they take wing, and under proper conditions find and enter a *young* fig in the right stage of development, that is, one whose stamens are as yet undeveloped but whose gall and whose seed flowers are in the one case ready and adapted to receive the egg, and in the other the pollen to fertilize the seed-producing ovary.*

The young fig grows to maturity, the stamens and seeds ripen and wasps issue from the galls. In the case of dioecious figs the wasp, evidently unable to distinguish between the male and the female fruits, enters whatever sort is available; it is of course unable to reproduce in the seed or female fig because this is not modified to that end, though the pollen which is dusted over its bifid stigmas, as the wasp vainly seeks its proper host effects fertilization and thus, the complete development of the fruit.**

Once having entered a fig the wasp-pollinator never leaves it but soon dies.

A fig cannot be self-fertilized, inasmuch as the male and female flowers are never both in the proper stage of development at the same time in the same receptacle.

Figs that have never been fertilized do not, I believe, attain their full size and sooner or later fall to the ground in this immature condition.

Apart from the true fig-wasps—the only ones known to pollinate the figs—there is a large number of other fig-inhabiting wasps of more or less complex associations; all of these as adults appear to oviposit from the outside, never entering any save perhaps the very mature or perforated fruits; thus we find that some have extraordinarily long ovipositors with which they pierce far into the rind; in others a different habit or modification, such as an increase in size, serves its special purpose.

It may be said that in general the fruits of the strangling figs support a more varied wasp population than do those of the dioecious species. We encounter many gall-deformities and monstrosities among figs, the fruits modified by this gall hypertrophy appearing as pallid, enlarged, lopsided, tuberculate, or flattened spheres.

Prof. C. F. Baker, at Los Baños, Philippines, studied the habits and described

* In the case of the Chinese banyan (*Ficus retusa* Linn.) studied at Los Baños, it was noticed that the very young fruits, enveloped bud-like in several scales burst their bonds, so to speak, and almost suddenly, at the expense of firmness and solidity, swell to several times their original volume; and it is at this period when the ostiolar bracts are comparatively loosely arranged, that the wasp enters the receptacle. Only when the fig is fully mature does its ostiolar channel again become somewhat negotiable.

** The edible fig of commerce is the female fig of *Ficus carica* Linn. and its varieties. Male fig trees (caprifigs) planted among the former maintain the generations of *Blastophaga* wasps and thus the full ripening of the edible fig is assured.

some of the species of wasp associated with *Ficus nota* (1913), and Mr. P. H. Timberlake, formerly of the Hawaiian Sugar Planters' Experiment Station has to some extent identified a number of the Philippine fig-inhabiting wasps collected by the writer in 1920-1922. The notes which follow on some of these insects is an attempt to add to the biological knowledge in this interesting though rather difficult field of entomology.

How the Fig-Wasp Enters the Fig

Pemberton (1921) gives an excellent account of how *Pleistodontes froggatti* Mayr., the pollinator for the Moreton Bay fig (*Ficus macrophylla*), works its way into the fruit; entrance being effected by means of the strongly-hooked mandibles and the lengthened and saw-toothed mandibular appendages, and finally, by the legs. This particular species of fig insect has a very elongate head, and the mandibular appendages exceptionally developed; in other fig-pollinators examined these processes are short in comparison and corrugated rather than saw-toothed.

It is only at one point, namely, the middle of the ostiole, an area of overlapping scales leading into the receptacle of the fig, that the wasp gains entrance into the interior; this penetration is an arduous task at best and only accomplished by the loss of that portion of the antennae—the more uniform joints, which now serve no useful purpose in this heavy work—and the wings. Furthermore, she sacrifices, at least in some cases, a large quantity of body fluid, losing thereby the even configuration of her abdomen. At any rate, this was found to be true in the case of *Eupristina bakeri* Grandi, the wasp-pollinator of *Ficus Forstenii,* a large strangling fig with oval fruits. Several captive females were attempting to force a passage through the ostiole of a fig that seemed too large and too firm for entrance; nevertheless some managed to squeeze in, one after the other, using the base of the antennae, the mandibles and the legs for this work. The antennae of these wasps are worthy of consideration, in that while the longer, terminal portion is probably the seat of the sense of smell—as is usually the case among insects—the first three joints are to some extent used as a sort of crowbar for prying apart the outside scales of the ostiole; the first joint is large and stout and the pair is held straight forward; the two following joints are small, the third being produced outwardly as a tooth and employed somewhat like a mandible; joint 4 is quite small, and in order that this and the remaining ones be out of the way of the working part, it is articulated to the third well at one side of the end. In their tedious progress the wasps change from a horizontal to a vertical position; there seems to be a good deal of biting done at the ostiole and penetration proceeds slowly, until most or all of the thorax is out of sight; as the abdomen reaches the tight entrance past the outer scales, it exhibits muscular movements. the membrane between the body plates becomes visible until the turgidity reaches a bursting point when just as the insect is disappearing almost suddenly within and leaving its wings at the ostiole, a rupture (?) takes place, or a sort of pocket bursts at either lateral angle and a quantity of fluid is thereby discharged. Thus it would appear that these wasps facilitate their entrance into the fig by reducing at the right moment the size of the abdomen. This discharge was noticed in several wasps, as they slipped in; a fissure rather than a hole is made in entering, and it is this abdominal liquid that in some cases at least glues the loosened wings to the ostiole. An histological study of the abdomen at this point would be a desiderata here. With *Ceratosolen notus* (Baker), of the dioecious *Ficus nota,* the procedure in entering the fig is much the same and the wasp once within has quite the appearance of a cripple (Pl. III, Fig. 16). A number of these wasps may try to enter one fig (Pl. I, Fig. 2) simultaneously and this results in a jam and the participants thereof are then often attacked by ants. At first the ostiolar scales are closely overlapping and thus retard the wasps' progress. Here very probably, as in the case of *Ficus Forstenii* the wasp facilitates her entrance by discharging an abdominal fluid.

In Captivity Fig-Pollinating Wasps May Sometimes Be Induced to Enter Other Than Their Own Particular Species of Fig

Two small experiments along these lines showed that this was possible, although it would be expected to take place but rarely in nature. However, in view of the large number of species of wild figs that may occur in a single locality it is not unreasonable to suppose that hybridization might have taken place there. That a fig-pollinating wasp may oviposit and breed naturally in gall seeds of a fig foreign to it is occasionally possible where this fig is very closely related to its own host, for this has been shown by Pemberton (1921) to be true for *Pleistodontes froggatti* (Mayr), whose regular fig host is *Ficus macrophylla* but which also breeds successfully in the receptacles of the Lord Howe Island fig, *Ficus columnaris.* But whether these two figs are really distinct seems open to question.

In the first place, *Eupristina bakeri,* the fig-wasp for *Ficus Forstenii* was tried on the fig, at the proper receptive stage, of *Ficus retusa,* the "Chinese banyan," and while both species of trees are of the same type, i. e., monoecious and of a strangling habit, they are otherwise not very closely related, the fruits of *Forstenii* being oval and far larger than those of *retusa,* which are spherical. A *F. retusa* fruit was placed in a test tube containing some of the wasp-pollinators belonging to *F. Forstenii,* and while these wasps were not constantly watched, soon a pair of wings was observed protruding from the *F. retusa* ostiole, where the wasp's body had not altogether disappeared within, the ovipositor being flattened into some drying liquid discharged from the abdomen. Apparently without disturbing the ostiole, I sliced off lengthwise a portion of the wall of the receptacle, thus exposing the small interior. This comparatively immense *E. bakeri* wasp finally worked her way within. She lacked wings and the greater part of her antennae was broken off, the abdomen no longer rotund was shrunken at the apex and showed the lateral angles whence the body fluid had been discharged; she was active, however, though cramped in the little receptacle, and the ovipositor pointing under her body was separated from its sheath. She did nothing in the receptacle save walk about prying here and there with her head, using the now stubby antennae as a wedge apparently in an endeavor to force apart the flowers.

Another similar experiment was unsuccessful.

Ficus nota and *Ficus Barnesii* are rather closely related dioecious species with the receptacles of about the same size. Three *Barnesii* gall-figs, each about 24 mm. or nearly an inch in diameter, were placed in a tube containing a large quantity of *Ceratosolen notus,* the fig-pollinator for *F. nota.* After a while some of these *F. nota* wasps attempted to gain entrance into two of the *Barnesii* figs, one of which showed that it had already been entered by its own proper wasp. Into this latter fig at least a half dozen *C. notus* wasps were trying to crowd, losing wing and parts of the antennae in this endeavor; in less than an hour, however, all save one had given up the attempt as hopeless, the single individual having worked its way just out of sight was found struggling horizontally between the scales.

Some hours later the third fig of *F. Barnesii* with *Ceratosolen* wasps crowded at the ostiole was cut open and examined; several wasps had succeeded in gaining complete entrance and stood free on the inner scales, their abdomen depressed and with sharp lateral angles greatly suggesting an expulsion of body fluid, and the ovipositor still projecting needle-like behind. Now to be in readiness for oviposition an effort is made to pull the ovipositor from its sheath so that it points downwards beneath the forepart of the abdomen; in this some are immediately successful, curving down the abdomen, jabbing the ovipositor into the funnel-like stigma of a gall flower and then in bringing the abdomen back to the natural, more or less horizontal position the ovipositor is swung forward out of its sheath; in other cases the wasp has great difficulty or even fails—possibly due to abnormal conditions—in unsheathing her egg-laying apparatus, bending down the tip of her abdomen and then endeavoring to hook her claws into the ovipositor and draw it out.

Laying Eggs Within the Fig

To continue the experiment with *Ceratosolen notus* on *Ficus Barnesii,* this fig-wasp now attempted and with apparent success to oviposit within the galls of *Ficus Barnesii;* it would walk about the receptacle jabbing downwards the while; it seemed that very few ovipositions (?) occurred, and such as they were—for the conditions appeared unsuitable—occupied in one case about a minute.

Ceratosolen notus was also observed ovipositing within *Ficus nota,* its own proper host. Walking about the interior of the fruit and prodding downwards with the ovipositor at practically every step until she finds a suitable stigma, she jabs deeply into its funnel-like depression (Pl. III, Fig. 16) and in 15 or 25 seconds withdraws her blade and immediately resumes her prodding. The wasp dies soon after she has finished egg-laying.

The eggs, to quote Baker (1913, p. 67) "are inserted one through each style to just within the ovary, lying upon the ovule destined to furnish food to the developing larva." From his illustration, outlining the form of the egg within the gall flower, it is rather oval and seems to lack the long thread-like process that Pemberton (1921, Fig. 18) found in the egg of the Australian fig-pollinator, *Pleistodontes froggatti.*

The Issuance of the Fig-Pollinating Wasps From the Galls in the Interior of the Fig

Referring again to *Ceratosolen notus,* the wasp egg soon hatches, the little grub developing within the gall flower that likewise increases in size, growth probably being stimulated by the activity of its tenant, which in due time transforms into a pupa that rests curled in the feeding chamber. In about 5 weeks from the deposition of the eggs the adults make their way out of the galls; this development period, however, is no doubt variable, depending on conditions, and Pemberton (1921, p. 309) found in the case of *Pleistodontes froggatti* that: "When a winter season prolongs the development of the fig, the growth and maturity of the wasp must also be prolonged."

It often happens that several species of wasps, parasites or inquilines, or both, issue from the gall-seeds in such numbers that the true fig-wasps are greatly in the minority, or in certain figs even altogether absent; on the other hand, it can and does happen that a fig produces a "pure stand" of its pollinating wasps. The males, of whatever kind, it seems, are the first to hatch and they immediately busy themselves with searching for their females. At least in the case of the fig-pollinator they are wingless, more or less doubled up in posture and usually a pale yellowish brown color and altogether very different from the female. So many wasps issuing at about the same time present a confusing scene within the receptacle. The male *Ceratosolen* frees itself of the gall by not quite cutting off a neat lid (Pl. I, Fig. 4, A & B), issues, walks about and biting open a gall containing a female of its own species, mates with her still within, by inserting the prolonged end of the body curved beneath forward, and beyond his head, into the hole bitten out. The act accomplished he seeks another female; the latter enlarge the aperture made by their mates and are soon out in the receptacle. The lids of the galls vacated by the male fig-wasps often fall back upon the opening so that such galls may still have a tenanted look. The confusion within the crowded receptacle increases when all the various wasps have issued and mated, the males for the most part still active though nearly all are destined to end their short existence inside the fig, the females eager to gain freedom and take wing in search of a suitable young fig in which to lay their eggs.

How the Fig-Pollinators Leave the Fig

There is some difference of opinion in this regard, since the method of the wasp's egress, even for the same species of fig may not always be identical. It is established that some species of fig-pollinating wasps—*Pleistodontes froggatti,* for instance—issue from the receptacle by boring a hole through it at any point, and that others, as *Ceratosolen notus* (Baker) always make their exit by way of the ostiole, whose scales may sometimes wither and spread apart sufficiently to permit this; at other times, however, this ostiole may not of itself nor perhaps at the proper time allow such a passage so that the impatient fig-wasps must perforce bite their way, wholly or in part, through the ostiolar bracts, and it seems that here the males play an important role. Several times upon splitting open

a ripe male fig of *Ficus nota* it was observed that the ostiole was partly enlarged from the inner side, and to that extent crowded with *Ceratosolen* wasps, of which the males sometimes with a slight admixture of those of other species occupied the distal end, or that nearer the exterior of the fig, and sometimes with impatient females directly behind them. This widening of the ostiolar tunnel was found in varying degrees of progress (Pl. I, Fig. 5), and a male actually observed biting into the scales; furthermore, this scale debris, as small particles within and outside the ostiole, shows the nature of the work. A fig was examined just as the *Ceratosolen* exodus was about to take place. The gummy coating which sometimes overlies the exterior of the ostiole was perforated, the male wasps having bitten into and through it, and their seething mass struggled to get out, though when once freed the clumsy insects seemed at a loss what to do next and usually succeeded in tumbling off the fig. When a couple of dozen had fallen or been crowded off and many more were struggling about the ostiole, the first female *Ceratosolen* pushed their way up; they walked out briskly and immediately took flight; this continued for several minutes until probably more than 200 females had issued. Several of the dark parasites (?) with long ovipositors came out among them, and a single male parasite (?) was shoved through. Cutting open this fig revealed two female and a number of male *Ceratosolen* and a few males of another species of wasp remaining within.

We have seen from the foregoing that a considerable number of male *Ceratosolen* wasps may be present in the ostiole where it is being enlarged. With *Ficus integrifolia* Elmer, which is related to *Ficus nota,* and where but two figs nearly on the point of liberating wasps were examined, this was not found to be the case. One of these upon being split open revealed only three hatched wasps within; two were females, in the receptacle itself, while the male had already formed a narrow lane four-fifths the distance through the ostiole. He was quite stretched out in his working tunnel, in which he backed a little now and then, using the stout forelegs a good deal in pulling forward; the mandibles I could not see, but the sharp stiff antennae seemed to pry ahead; they were retracted into grooves in the face and pushed out again. The channel was rudely lined with particles of bitten-out (?) scales. This individual ceased his labors when nearly through the ostiole and when brought out into the open, resumed his normal, curled position. The second fig contained but one hatched wasp, a male *Ceratosolen,* that was working with body extended, within the ostiolar passage and was about three-fourths through its length. A single open gall near the ostiolar scales revealed his former home, while another gall had a small perforation and contained a female of his species and with which he had probably mated.

Ficus satterthwaitei Elmer, is another dioecious species, taller and more sylvan in habitat than *F. nota* but related to it. Two swollen gall figs were cut open, both were filled with wasps, male and female, and in one the ostiolar passage was broadly half bitten (?) through and there crowded with males only, of the fig-pollinating wasp.

Ficus pseudopalma Blanco is noted for its very large inmates, the female *Ceratosolen bakeri* Grandi, the pollinator, being over 3 millimeters in length. Without question the male *Ceratosolen* here, bite or pierce their way out; the

ostiolar tunnels being nicely cylindrical and one that was not yet connected with the outside world was found to be filled with male and perhaps with a very few female *Ceratosolen.* The width of the tunnel depends upon the number of workmen abreast and perchance too, upon some scale shrinkage.

With *Ficus Cumingii* Niz., similarly dioecious, the ostiolar scales not very numerous in the first place and in a fully mature fig quite loose and flexible, show no evidence that they are at all bitten by the wasps to clear a passage, for naturally the ostiole becomes widely open in this species.

On opening a ripe male fruit of *Ficus megacarpa,* a dioecious vine, the tough ostiolar scales were found to have drawn apart forming a channel much as in *Ficus nota,* although showing no signs of having been nibbled.

Ficus malunuensis Warb. is a tolerably large tree of the non-strangling type that bears monoecious fruit. Here the ostiole seems to open of itself, the scales folding back and drawing apart within the receptacle. But while no bitten scales were found, a single male had forced itself quite near the outer end of the still unopened ostiole, while following at a little distance behind was a female fig-pollinator.

Ficus nervosa Hey. is likewise a monoecious, independent tree. None but non-ostiolar emergence holes were found in the fruit.

Ficus retusa L., the Chinese banyan is a typical strangling fig. The *Grandiella* wasps (pollinators) bite and force their way through the ostiole.

The several genera of fig-pollinating wasps are natural penetrators; the females in their effort to escape from receptacles may work their way through the meshes of fine cloth, where other types of fig wasps are unable to do so. The latter, however, perhaps invariably possess greater longevity, Pemberton (1921) in experimenting with *Pleistodontes froggatti* of the Moreton Bay fig, found none that would live beyond four days.

The fig-pollinating wasps have enemies of many kinds. Ants such as *Phidologiton* and *Oecophylla* attack them as they enter the fig or issue therefrom, certain fly maggots monopolize the interior of the receptacle and abort the flowers there, beetle and moth larvae cause serious mechanical injury by eating away portions of the fig. Then there are numerous species of chalcidoid wasps that directly or indirectly affect the existence of the fig-pollinators; some of these without doubt are true parasites, while others may develop quite independently of the fig-pollinators, in galls which they appropriate and develop often to a comparatively immense size. Certainly also, these gall-developers may have parasites of their own. Such figs as *Ficus nota,* perhaps because of their large size and relatively thick rind do not appear to be favored by these gall-developers; on the other hand the monoecious types like *Ficus indica, retusa,* and others are frequently so crammed with large galls that few or none of the galls of the fig-pollinators have been able to develop, and even stamens would be lacking. The wasps responsible for this crowding out are stout (as females), usually brownish insects with comparatively short ovipositors. Particularly were these noted in the case of the Chinese banyan (*Ficus retusa*), and the results of their work was apparent in many figs of comparatively large size, and misshapen in being much flattened at the poles, tuberculate, or other-

wise malformed. Probably no fig-pollinator, in this case of the genus *Grandiella,* could ever work its way out of such a fig. Such gall-makers, and probably their parasites, are usually winged* in both sexes and some of them at least mate outside the fig; for males were found to wait in monopolizing fashion at an emergence hole on the surface of the receptacle and grasp the female as she issued. Wasps would often be seen with the ovipositor in the wall of the fruit of *Ficus retusa,* even before any fig-pollinating wasps had entered.** Thereafter, galls would develop, often without the trace of a style or stigma, and so increase in size as to crowd the receptacle as a tightly wedged and angulate lot, thereby the receptacle becomes more or less misshapen; later on, however, the affected fruit grows yet larger, up to 16 millimeters or more in diameter and becomes colored and softer in texture and eventually liberates an almost undiluted crop of stout, brownish gall-developers. Giant galls such as figured for *Ficus nervosa* (Pl. I, Fig. 3) are usually solitary, and in some cases at least the wasp issues through a basal instead of a distal perforation. One of these galls in a fig of *Ficus pruniformis,* 31 millimeters in length was itself 7.5 millimeters long.

At a certain period of their development while nearly all the various fig wasps are still within the galls, the receptacle of the figs of *Ficus nota* and many other dioecious kinds become more or less filled with a rather thick liquor. This fluid is absorbed, or seeps through the ostiole before very many or any at all of the male fig insects bite their way out of the galls. Occasionally the male of *Ceratosolen notus,* the fig-pollinator, may be seen for a short time operating in one of these partly inundated interiors, biting into galls under the liquor in search of females; normally however, this insect hatches out later in drier receptacles, and beyond its noticeably pilose hind feet, does not seem modified for work under wet conditions. But the case is quite different with the male of *Sycophaga nota* (Baker), a very slender wingless insect with a pair of glistening, silvery breathing tubes that extend nearly throughout the length of its body, and a pair of pilose "laminae" or processes extending prong-like from the enlarged terminus of the abdomen. Thus equipped the insect is able to pull itself under the liquor, wholly, or so that the tail with its air-silvered laminae floats, and to remain submerged for some time. It hatches from a gall which it characterizes by biting out a comparatively small flapped or lidded hole, and from which it sometimes has a little difficulty in withdrawing the diverging laminae. Its activities coupled with a great length of flexible body somewhat suggest the movement of a snake, as it dives into the liquor and inspects and bites into galls in search of its mate. They are active if brainless searchers, and have been seen to plunge into a gall evidently vacated by a male of their own species, and so elongate, extensile and flexible are these insects that before the end of the body is wholly drawn within the gall they are investigating, the head is

* Active flightless males, either parasites, hyperparasites or inquilines have been observed running over figs and entering them by perforations, in search of females. In addition to being observed on *Ficus retusa* such were also found on the dioecious *Ficus minahassae.*

** So also may certain *Ficus nota* wasps push their very long ovipositors through the rind and apparently oviposit when no *Ceratosolen* (fig-pollinators) have yet entered the receptacle.

beginning to issue at the same aperture. The sexes mate within the gall, which the male of course, because of his structure must enter headfirst. Baker (1913) remarks upon the astonishing development of the tracheal system in the male *Sycophaga,* which particular insect he suggests is a guest in its relations to *Ceratosolen notus.*

The male of *Apocrypta larvalis* (Baker) which Baker likewise thinks a guest in *Ficus nota,* is also fitted to work while the fig is still in liquor and is quite at home in it. Like the preceeding species it is very slender and its whitish abdomen shows a good development of glistening tracheae. It has no anal laminae, but a pair of wide hollows, possibly stigmata there. Mating probably occurs as in *Sycophaga nota.*

The several species of *Philotrypepsis* occurring in *Ficus nota* are probably parasites on *Ceratosolen notus* (See Baker 1913); the males are stouter insects than those of *Sycophaga nota* or *Apocrypta larvalis* and the larger-headed kinds suggest minute soldier termites or "white ants." *Philotrypepsis ashmeadii* Baker, male, is a comparatively slender species that mates by inserting (as in *Ceratosolen* or the fig-pollinator) the end of the abdomen into an open gall tenanted by a female. Quarrels over the females are of common occurrence among males of *Philotrypepsis. P. collaris* Baker of *Ficus nota* is in the male sex, a thick-set, large-headed insect with strong, toothed jaws, some long recurved bristles on the back of the head, and the wings represented by two pairs of filaments. It is relatively large, strong, and hustling and was by far the most conspicuous and numerous of the several species of males of guests and parasites that I observed on splitting open a fig on June 23, 1921. It may be seen biting frantically into a gall containing a female, the stout mandibles readily breaking off portions of the wall and thus soon making a good-sized hole. Now a second or even a third male may approach the gall and strive to gain a place of vantage there so as to enlarge the hole still more, but the first comer makes little lunges at his competitor and often the two will very briefly interlock jaws, the fight being rather a sparring bout than a mix-up and neither appears the worse for it. Or else the newcomer drives off the other. The emerging female is seized by one or more males.

The females of these non-pollinating wasps of *Ficus nota* are of course winged, superficially alike in form, and possess a very long ovipositor. The writer observed no great disparity in size between the galls and the various species of wasps tenanting them, in *Ficus nota,* as exists to the contrary in many other figs, particularly the monoecious species, (*Ficus retusa, calophylloides, pruniformis,* etc.) wherein the galls, as we have already seen, may be stimulated to great development, by large wasps.

Flies in Figs and a Braconid Wasp Parasite of One of Them

Of the many kinds of flies that are attached to Philippine figs, either attacking the healthy fruit or feeding in their decaying tissues, only a few will be mentioned here. The greater number of these insects belong to the *Orthorrhapha Nematocera,* a section which includes the more primitive flies, such as the various gnats and midges that have slender, loose-set bodies, the feelers

usually with many distinct joints, and a motile pupa somewhat resembling a mummified adult. Not in every part of their anatomy nor phase of their existence are these Diptera primitive, many show specializations in structure, mode of life and in kind of food.

Within the family Cecidomyidae or "Gall midges" are probably the most interesting of the fig-flies and insects that primarily attack the healthy, or at least, the non-decayed fruit. But outside the realms of figdom the cecidomyid larva, which is commonly of an orange color, may have very diverse habits; the well known Hessian fly, *Phytophaga destructor,* is often very injurious to crops of cereals, attacking the stem of the wheat, many species produce galls or other deformities on plants, a few burrow in the semi-liquid resinous exudation of certain coniferous trees, while others are predaceous, living freely and feeding upon mealy bugs, aphids or acari. A remarkable structure in many cecidomyid larvae is the so-called "breastbone", "sternal spatula", etc. (Pl. III, Figs. 12 and 15, for a species in *Ficus nota*) an organ that has been studied by a number of entomologists; it is sometimes regarded as an abraider or rasper of tissues but more correctly perhaps, as a structure which in connection with the chitinized anal papillae release the insect from its curved position to execute its characteristic leaps. Possibly it serves both purposes.

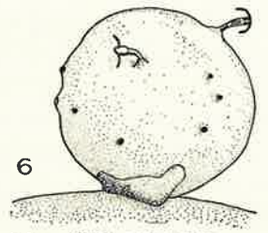
The fig cecidomyids may according to species live in the rind, freely in the receptacle of the fig, or as observed in the case of the strangling fig, *Ficus Forstenii,* they may produce galls on the leaves.

Of the rind-feeding species is a pale brown mosquito-like cecidomyid (*Meterdiplosis fici* sp. n. Barnes), having legs narrowly banded with blackish (Pl. II, Fig. 9) and whose orange-colored maggot lives in the outer zone of the thick rind of the fruit of *Ficus pruniformis.* This uncommon plant is a monoecious, rather stout, forest-loving vine that bushes out profusely at its terminal portion, in the crown of some forest giant. Its well peduncled fruit is greenish, of olive form and when ripe, over an inch in length; then it may be well peppered with the pupal chambers of this midge (Pl. II, Fig. 10A). A longitudinal section (Pl. II, Fig. 10) through a portion of the rind shows that the pupal chamber has well-defined indurate walls and a similarly hard though separable cap fitting into a slight depression formed through the natural loss there of the skin of the fruit. The pupa is snugly fitting and of an orange color and when ready to disclose the adult, works its way outwards, forcing off the cap, probably by means of its pointed headpiece, and partly extrudes itself through the opening thus formed. At least two species of chalcidoid wasps, one brilliant blue occupied some of these cells and one or both of these may be parasitic, or perhaps in one case, a secondary.

Meterdiplosis fici also lives in its early stages in the rind of the fig of *Ficus longipedunculata.*

The ripe figs of the "Chinese banyan" (*Ficus retusa*) are sometimes found with the pupal shells of a midge partly extruded through the rind (Pl. II, Fig. 6), which is slightly raised pimple-like at that point. These have yielded a small pale-colored cecidomyid.

Figs, particularly of the dioecious type, as *Ficus nota* and *Ficus hauili* are subject to the attack of cecidomyid flies that deposit their eggs within the



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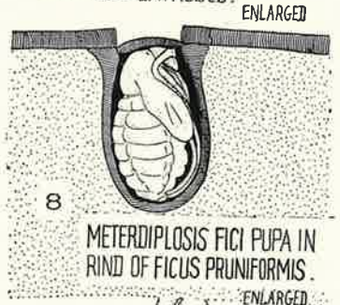
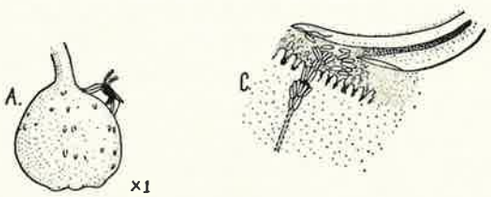
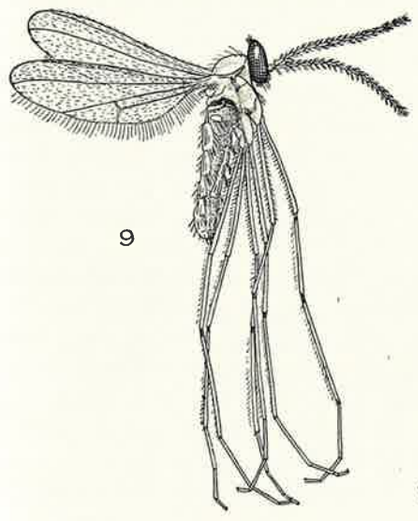
FICUS RETUSA WITH PUPAL SHELL OF A MIDGE EXTRUDED.



METERDIPLOSIS FICI PUPA IN RIND OF FICUS PRUNIFORMIS. ENLARGED



ASPHOTROPHIA FICI MIDGE ON FICUS NOTA. AT A, THE FLY IS LAYING HER EGGS IN A YOUNG FIG, AT B A VERTICAL SECTION THROUGH THIS FIG SHOWS THE PATHWAY OF THE OVIPOSITOR INTO THE SLIT-LIKE RECEPTACLE, WHILE AT C, MORE HIGHLY MAGNIFIED, IS A PORTION OF THIS RECEPTACLE SHOWING TWO BRACTS, SOME YOUNG FLOWERS, THE MIDGES EGGS AND PART OF THE PATHWAY OF THE OVIPOSITOR.



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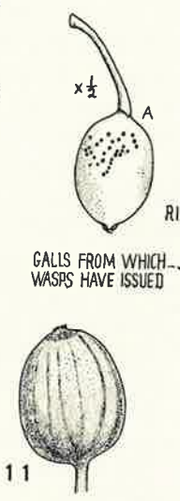
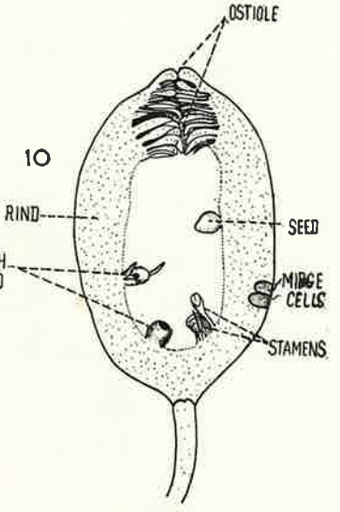
MIDGE, METERDIPLOSIS FICI INFESTING RIND OF FICUS PRUNIFORMIS. × 8.5



FICUS ULMIFOLIA DISTORTED FROM SPHERICAL BY MIDGE LARVAE. ×.83



FICUS PRUNIFORMIS IN SECTION. AT A, PEPPERED WITH EXIT HOLES OF METERDIPLOSIS AND ITS PARASITE? ×.5

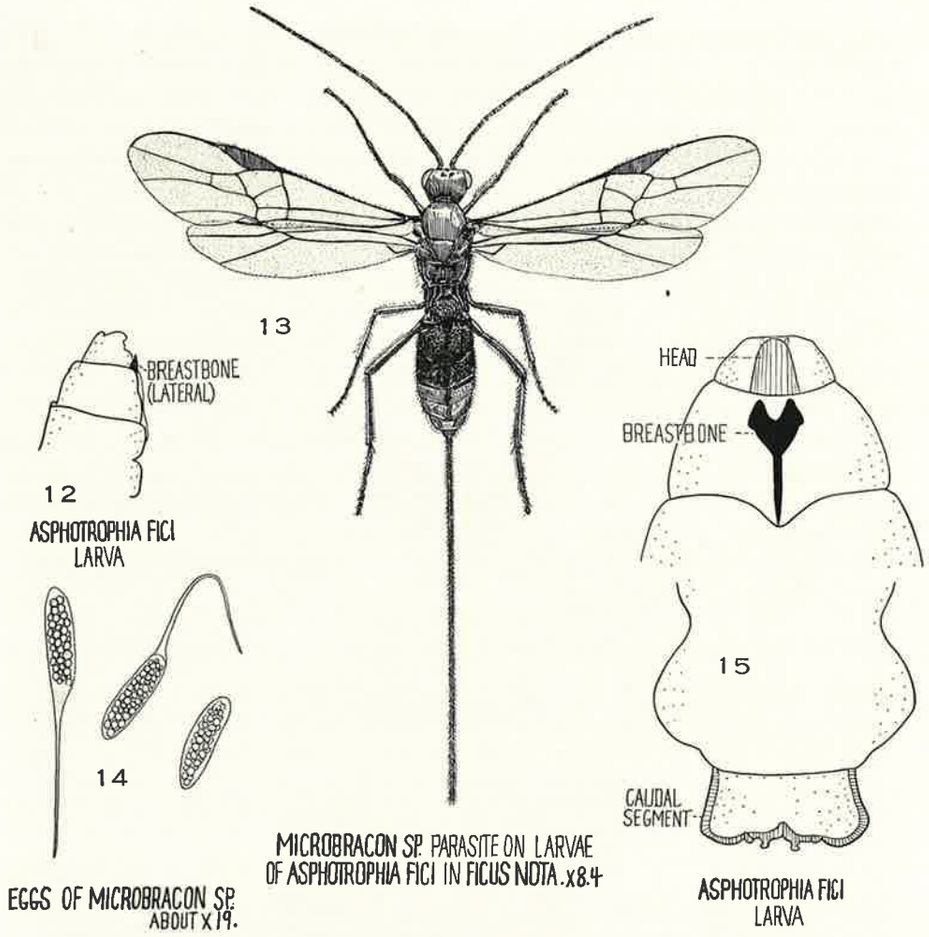
PLATE II

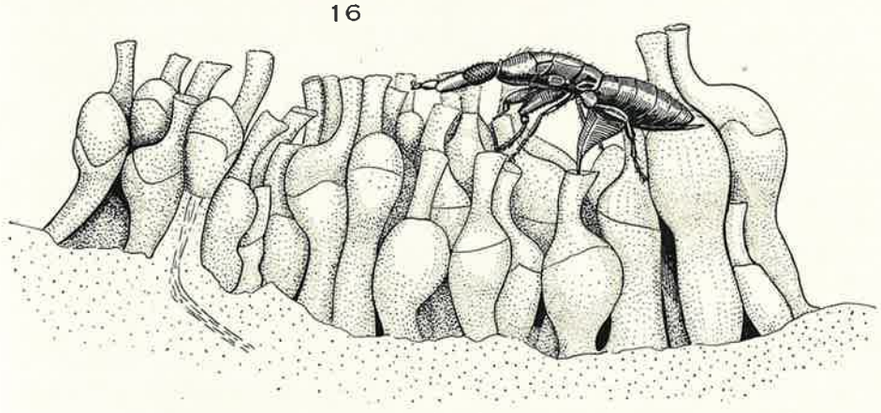
receptable, feed freely therein but pupate in the soil. *Asphotrophia* g. n. Barnes, *fici* sp. n. Barnes, the fly concerned with the common lowland *Ficus nota* is smaller than those breeding in the rind of *Ficus pruniformis* and *longipedunculata*, and with a comparatively stouter body and broader wings. The female is provided with a long, slender needle-like ovipositor that is very extrusible so that with it she is able to penetrate the solid rind of a young fig to the depth of five or six millimeters, or perhaps more. Early one dull morning two of these flies were observed at work, each upon a hard green fig (Pl. II, Fig. 7, A) about 15 millimeters in diameter, or about half grown. They assumed the pose as illustrated, remaining thus motionless or nearly so for almost half an hour. The only evidence of piercing from the outside was a little dot of moisture; splitting open the fig, as much as possible along the line of oviposition, showed (Pl. II, Fig. 7, B and C) that a quantity of rather elongate, glassy white eggs had been deposited within or almost within the yet small receptacular space; these hatch in a short time into glassy whitish maggots with a dark chitinous spot at the head end. Specimens about 1 millimeter in length are greenish white and while active, seem incapable of executing the leaps so characteristic of the older orange colored larvae. These younger *Asphotrophia fici* maggots were found in one case, in a fig of about 20 millimeters diameter, whose receptable was fairly well covered by pinkish-purple stigmas, and they lived freely beneath these on top of the ovaries. More mature maggots live on the top of the forest of stigmas. A hundred or more may occupy one receptacle, and while in some cases they appear to do but little damage to the flowers, being found in female as well as in male figs, an examination of other maggot-infested fruits showed receptacles bearing very small and anemic appearing flowers where robust pink ones were to be expected. (See Pl. IV, Figs. 17 and 18).*

When full fed the maggots leave the fig, probably enlarging an oviposition puncture for that purpose, drop to the ground, pupate therein and eventually issue as little brown flies. In the case of the common *Ficus hauili,* I once saw a number of active whitish midge larvae issue, one after another, from a hole in the side of a 22-millimeter male fruit, drop to the bottom of the container and bury themselves in the soil. Some 12 days later a number of pallid pupal shells lay fully exposed on the soil, the frail little flies being nearby. Such a *Ficus hauili* shows within the affected receptacle a forest of small undeveloped ovaries on slender wavy pedicles, the male flowers being quite normal. Fig. 11 shows an abnormal female receptacle of a *Ficus ulmifolia.* Normal figs are spherical or slightly flattened, and the above deformity was no doubt the work of the quantity of orange cecidomyid larvae within that had very much reduced the size of the seeds and the thickness of the walls of the receptacle. Another fig on the same tree was distorted in being flattened at the sides and with thin and yielding walls and undeveloped flowers and seeds, and contained a quantity of lemon-yellow midge larvae.

One might imagine that such active maggots living at large in the thick-walled hollow of *Ficus nota* would be free from insect enemies; this is not the

*** Possibly this poor condition may be brought about through the maggots' interference with the fig-pollinating wasp.**





A PORTION OF THE RECEPTACLE OF **FICUS NOTA** SHOWING THE FIG WASP **CERATOSOLEN NOTUS** OVIPOSITING IN ONE OF THE GALL FLOWERS. GREATLY ENLARGED

PLATE III

case, however, for a comparatively large braconid, *Microbracon* sp. (Pl. III, Fig. 13) with a long ovipositor and a body mainly reddish brown, greatly reduces its numbers. Being so much larger than its host, each wasp grub devours a considerable number of them, a condition quite unusual, I believe, among parasites of this type where a single host generally suffices as food for one or more of its parasites.

To the human eye a fig containing cecidomyid maggots may present a perfectly sound exterior; nevertheless the braconid is not at fault in its choice,

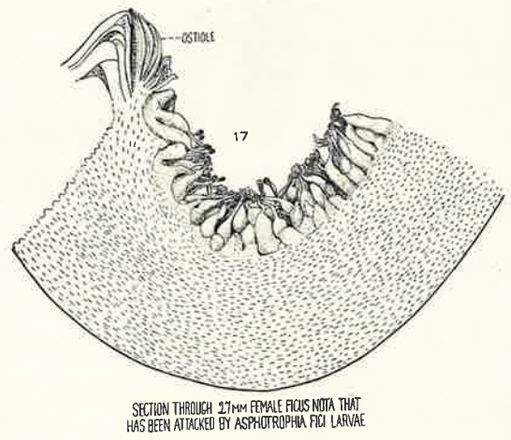


PLATE IV

and perching itself upon an infested receptacle gradually pierces it with its ovipositor, the guides buckling posteriorly in the process. A number of slender eggs about ¾ of a millimeter in length, not including the filament (Pl. III, Fig. 14) are deposited loosely among the orange-colored maggots, some of which are sooner or later killed, presumably by stinging; at any rate we find in the receptacle concerned some actively-leaping midge larvae, while others are limp and dead or nearly, and stickily massed together; they do not decay very readily and furnish the food for the externally-feeding wasp larva. That the latter is incapable of overcoming healthy maggots seems probable because such maggots may occur in figs, containing the wasp cocoons, even those that have produced adults. The wasp larva has a distinct head and the body is covered with short, erect and rather dense hair, perhaps a provision against the moisture, although never were either midge nor wasp larvae found in figs whose receptacles were more or less inundated by the liquor that so commonly is present at a certain period in this fig and others of its type. *Microbracon* spins a rather elongate slender cocoon within the fig, and the adult when it hatches leaves the receptable by means of a hole which it bites through the rind. Two dozen or more of the braconids may be produced from a single fig.

From decaying figs and fig-debris one may breed small flies of the families Mycetophilidae, Psychodidae, and occasionally a large one with speckled wings, belonging to the Rhyphidae, as well as slender Tipulidae.

Gall Midges (Cecidomyidae) Infesting Wild Figs in the Philippine Islands

By H. F. Barnes, B. A. (Oxford)
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A small consignment of midges bred from the wild figs in the Philippines was received during March 1927, from Dr. F. X Williams by the writer for identification.

The midges labelled No. 1 were two males and two females reared from *Ficus pruniformis,* Mt. Makiling, P. I. on January 7, 1921. Those labelled No. 3 were three females reared from *Ficus longipedunculata,* Los Baños, P. I. on February 11, 1922. Both these lots proved to belong to the genus *Meterdiplosis* Barnes which was erected for a solitary female (*M. nigrolineata* Barnes) caught at light at Kuala Lumpur, Selangor, F. M. S., on February 13, 1924. The genus is remarkable for the development of two basal filiform appendages with pubescent clubbed distal ends on the ovipositor. It is very gratifying to have received these specimens from the Philippine Islands, especially as males have turned up and the food plants have been discovered. The midges from the Philippine Islands differ from *M. nigrolineata* Barnes in the proportions of the wings and the antennal segments. In *M. nigrolineata* the wings are about 1/3 shorter than in the Philippine species, but the same width; the enlargements of the flagellar segments in *M. nigrolineata* are all about 3 times as long as broad, whereas in the Philippine species the proportion varies from 5½ times to 3 times as long as broad. It is therefore necessary to describe this Philippine species as *M. fici* sp. n. Dr. F. X Williams writes as follows: "No. 1 as a larva feeds in the rind of the fruit of *Ficus pruniformis,* and pupates in the rind in a hard-walled chamber whose top or cap is pushed off by the pupa which is partly extruded. No. 3 feeds in the rind of *Ficus longipedunculata.*"

M. fici sp. n.

Male. Length 4 mm. Head very dark. Antennae (see fig. A) 2 + 12, basal segments globular (not focussed in fig. A), first and second flagellar segments fused, flagellar segments basal node subglobular with basal ring of long stout setae and 8-12 moderately long looped circumfila, steam of 5th flagellar segment short stout, about as long as broad, distal node elongated cylindrical, slightly constricted, with two rings of circumfila, 8-12 loops, moderately long, and long stout setae between rings of circumfila,

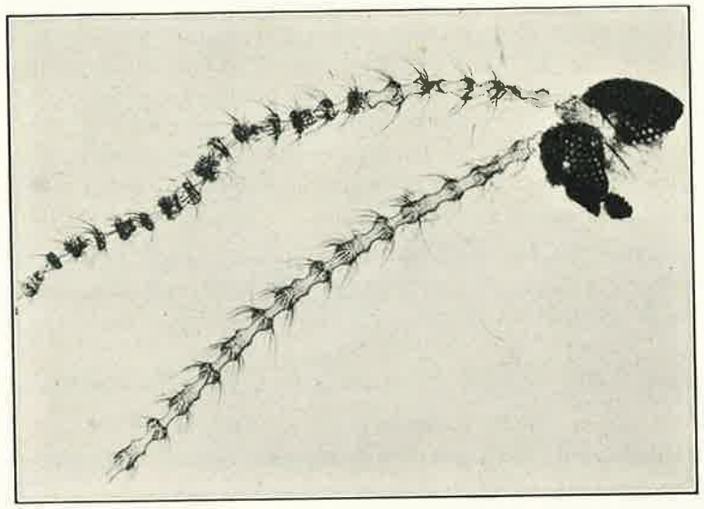


FIGURE A

neck of 5th flagellar segment about 1½ times as long as broad, stem of penultimate segment 2-3 times as long as broad, neck as long as distal cylindrical enlargement, about 3½-4 times as long as broad. Palpi; 3 segments, short, segments equal, almost globular, with long hairs. Thorax brown with long white hairs. Wings; hyaline with long hairs, twice as long as wide, 3rd vein reaching just beyond tip of wing, fifth vein simple, sixth simple. Legs; distal part of femora black, proximal end of tibia black, metatarsal segment black, and proximal ends of all post metatarsal segments black,

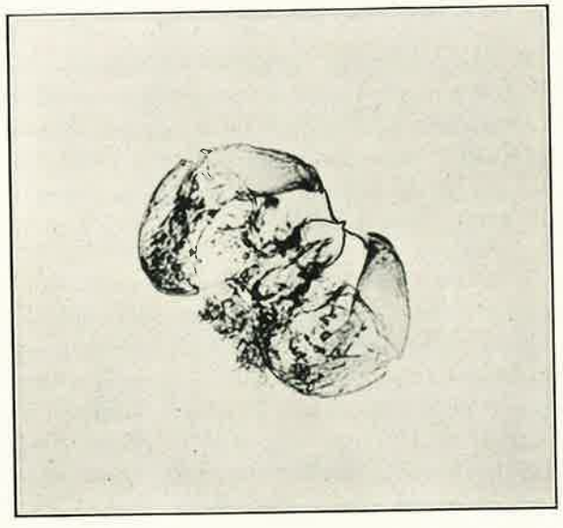


FIGURE B

rest of legs orange brown; colours of legs caused by color of long hairs; claws presumably simple and strongly curved, and empodium minute, as in female. Abdomen brown with long white hairs, black lateral line. Genitalia (fig. B); basal clasp segment short, stout, almost quadrate; terminal clasp segment very stout with long setae, with chitinised 'ongle,' slightly pectinate immediately proximal to apical hook; dorsal lamella extending almost to apex of terminal clasp segment and slightly roundly emarginate; ventral lamella spatulate; harpes stout, broadly rounded; style stout.

Co-types; Cecid. 516 and 517 in writer's collection.

Female. Length 5 mm. Antennae, 2+12; enlargement of 1st flagellar segment about 5½ times as long as broad, neck transverse, half as wide again as long, enlargement of 2nd flagellar segment about 4 times as long as broad; neck slightly longer than broad, 5th flagellar segment about 3½ times as long as broad, neck about 1½ times as long as broad, 11th flagellar segment (penultimate) just over 3 times as long as broad and neck nearly 3 times as long as broad. Wings; about 1/3 longer than in *M. nigrolineata* Barnes M. S. Claws simple and strongly curved, empodium minute. Ovipositor with long ventral club-headed filiform appendages. Otherwise about as in male.

Co-types; Cecid 514, 515, 518, 519 and 520 in writer's collection.

No. 2 of the consignment is a solitary female presenting a unique synthetic appearance having the antennal characters of the Oligotrophiariae, while the avipositor is typical of the genus *Asphondylia*. Under the circumstances although the specimen is in poor condition, it seems advisable to erect a new genus to contain this species.

Asphotrophia g. n

This genus is remarkable for the highly specialised aciculate ovipositor and the generalised antennae. The wings are as in *Asphondylia*, while the claws are stout and curved at right angles, the empodium being rudimentary.

Type species, **A. Fici** sp. n.

Asphotrophia fici sp. n.

Female. Eyes contiguous. Antennae; 2+14 ? (broken), basal segment quadrate, second subglobular, flagellar segments, some with basal enlargement twice as long as broad, others with more distally rounded oblong basal enlargement about 1½ times as long as broad, with neck as long as width of enlargement, basal whorl of stout setae as long as enlargement and half the neck, except one seta which extends almost to distal end of enlargement of next segment, each flagellar segment also with irregular less stout setae, circumfila not visible, presumably as in *Rhopalomyia*. Palpi; at least two segments, basal segment quadrate, second just over twice as long as first, oval. Thorax and abdomen uniform dull brown. Wings; 3rd vein well separated from costa, reaching costa at tip of wing, costa and 3rd vein densely covered with long dark hairs, subcosta joins costa at ½ length of wing, 5th vein forked. Legs; brown, densely haired, first tarsal segment much shorter than second, tarsal segments whitish; claws stout, simple, curved at right angles, empodium rudimentary. Ovipositor, aciculate as in *Asphondylia*, basal lamellae not so prominent.

Type; Cecid. 601 in the writer's collection.

The above is described from a solitary female 'Los Baños, P. I., 24.2.21'. Dr. F. X. Williams writes concerning it: "No. 2 is common in the fruits of *Ficus nota*, a large-fruited dioecious species. The female pierces for 5-6 millimeters, with her fine hard needle-like ovipositor, the rind of a young fig and deposits her eggs freely in the receptacle or at the end of the drilled hole, the

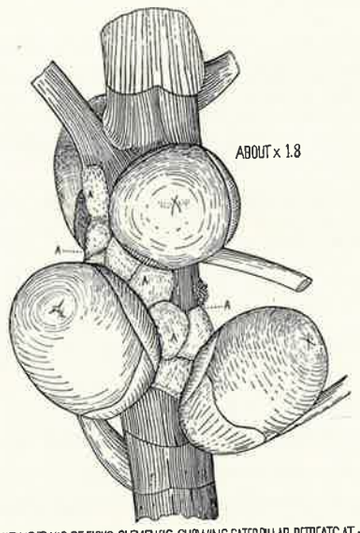
larvae live freely in the receptacle, later bore through the rind, drop to the ground and pupate therein."

No. 4 (Cecid. 602) a female whose pupa extrudes partly through the rind of *Ficus retusa,* the Chinese Banyan, is in too poor condition to identify.

Lepidoptera Attacking Figs

The caterpillars of several sepecies of butterflies attack the leaves of species of *Ficus;* among these are the handsome *Euploea* (Danainae), rather large insects often velvety blue and black or brown, with white marks, and in the male usually provided with conspicuous, hairy and extrusible anal scent glands. Kershaw (Butterflies of Hongkong, 1907, p. 13), mentions *Euploea* (*Crastia*) *amymome* Godert as feeding upon *Ficus variolosa* Lindl. and other plants. He also figures the scent glands (Pl. 5A, Fig. 5), the pupa, and the larvae of several species.

G. H. E. Hopkins, in his Butterflies of Samoa and Some Neighboring Island-Groups (Insects of Samoa, Part III, Fasc. 1, British Museum (Natural History, 1927), gives the food plant of the Samoan *Euploea* as *Ficus tinctoria* Forst. and probably others of the genus *Ficus* that are available. At Los Baños, Philippines, the larvae of an *Euploea,* velvety black with some blue spots, and expanding about 3½ inches, sometimes attacked the marcotted plants of *Ficus retusa,* a fig which in this condition suffered severely from the attacks of insects. The caterpillar is rather conspicuously banded and otherwise marked and bears long anterior and posterior fleshy appendages. It turns into a very handsome pendant pupa, silvery and gold with some gray-brown stripes and spots, and reminding one of a Christmas tree ornament. Sometimes a good deal of damage is done to the tender foliage before the culprits—conspicuous enough when seen —are discovered.



FRUITING TWIG OF FICUS CLEMENTIS SHOWING CATERPILLAR RETREATS AT A.

FIGURE 1

A large array of moth caterpillars partronize fig trees; the more obvious ones at least, belong to the superfamily Pyralidina. *Ficus carica,* the edible fig of commerce, suffers from the attacks of the caterpillar of *Ephestia cautella* Walk., a widely distributed moth of persumably Asiatic origin. It destroys particularly the dried figs, but also infests a number of other dessicated fruits, various nuts, beans, other seeds, meal, etc. (See Chittenden and Smyth, *The Fig Moth,* Bull. 104, Bur. Ent., U. S. D. A., 1911). It is then, rather a stored-product insect than an orchard pest.

The Philippine fig-moths are at least in great measure, insects whose larvae attack green figs, leaves or twigs; others being feeders on fig-debris accumulated in fruit-clusters, etc.

They are probably but rarely specific on one particular sort of fig.

Those collected by the writer have been identified by the U. S. National Museum, as follows:

Noctuidae

1. *Selepa celtis* Moore. Attacks fruit of *Ficus nota, hauili* and *indica.*

Lithosiidae

2. *Macaduma* sp. (probably new). On *Ficus ulmifolia.*

Schoenobiinae

3. *Cirrhochrista annulifera* Hamps. On *Ficus minahassae.*
4. *Cirrhochrista bifurcalis* Hamps. On fruits and shoots of *Ficus ulmifolia* and *Manillensis.*
5. *Cirrhochrista pulchellalis.* On fruit of *Ficus Forstenii.*
6. *Cirrhochrista* n. sp. On *Ficus ulmifolia.*
7. *Margaronia bivitralis* Guen. On leaves of *Ficus indica.*
8. *Margaronia sexpunctalis* Moore. Leafroller on *Ficus ulmifolia.*
9. *Polygrammodes spilosomoides* Moore. On fruit of *Ficus Forstenii.*
10. *Polygrammodes spissalis* Guen. On *Ficus auranticarpa.*
11. *Polygrammodes thoosalis* Walk. Attacks fruits of *Ficus crassitora.*

Galleriinae

12. *Lamaria adaptella* Walk. On fruit of *Ficus Forstenii* and *calophylloides.*
13. *Picrograma* n. sp. In organic debris on *Ficus pseudopalma.*
14. *Tirathaba* n. sp. On old fruits of *Ficus nota.*

Cosmopterygidae

15. *Pyroderces* sp. On twigs and fruit of *Ficus Clementis* and on *F. minahassae.*

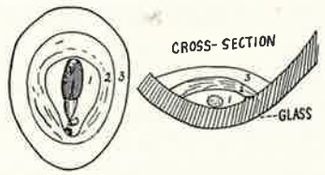
Glyphipterygidae

16. *Simaethis* sp. On *Ficus endothrix.*
17. *Tortyra* sp. Skeletonizes leaves and bores figs of *Ficus odorata* (Cocoon, text fig. 2.)
18. *Tortyra* sp. On *Ficus ulmifolia.*

Some of these species are quite injurious, *Selepa celtis,* for example attacking the figs of *Ficus nota, hauili, indica,* etc., and seemed quite ready to set at naught studies on the figs of *Ficus nota,* which had been carefully covered with cloth netting.

Text figure 1, shows a portion of a fruiting twig of *Ficus Clementis,* a huge strangling fig with an exceedingly viscid sap, which exudate forms the greater part of the retreats or coverways of a little moth caterpillar.

The majority or all of these caterpillar species may be heavily parasitized by Hymenoptera.



TORTYRA SP. (GLYPHIPTERIGIDAE)
COCOON OF MOTH. ATTACKING FICUS ODORATA

FIGURE 2

Coleoptera Attacking Figs

Beetles injurious to Philippine figs are represented by many species distributed in a number of families. Some are leaf-feeding Chrysomelidae, while the soft wood is attacked by numerous longicorn borers (Cerambycidae), but perhaps the most interesting fig Coleoptera are the snout beetles that attack the fruit and exist in great variety and appear to some extent to be attached to certain species or groups of related species of figs.

The following is a very incomplete list of fig-beetles collected by the writer on Mount Makiling. All were found as adults and were determined by the British Museum.

Scarabeidae

1. *Protaetia philippensis* F. Found eating fruits of *Ficus ulmifolia.*

Nitidulidae

2. *Lasiodactylus* sp. From *Ficus palawanensis;* probably a scavenger in the fruit.
3. *Haptoncus* sp. on *Ficus Forstenii.* Probably a scavenger in the fruit.

Lagriidae

4. *Lagria inoptera* E. Eating leaves of *Ficus endothrix.*
5. *Lagria* sp. On *Ficus ulmifolia.*

Chrysomelidae

6. *Abirus philippensis* B. Adult eating leaves of *Ficus retusa.*
7. *Chrysopida murina* B. On *Ficus retusa.*
8. *Aenidea* sp. On *Ficus retusa.*

Cerambycidae

9. *Epepeotes ambigenus* Chev. On cutting of *Ficus retusa.*
10. *Euclea irrorata* Newm. On *Ficus pseudopalma.*
11. *Coptops tetrica* Newm. Resting on badly bored limb of *Ficus ulmifolia.*
12. *Pterolophia* sp. On *Ficus minahassae.*
13. *Sybra* sp. From *Ficus ulmifolia.*

In addition to the above, there is a rather large number of nimble weevils: some *Balaninus*-like with long snouts, some with rather sombre coloration and others prettily patterned in white and black, etc., that as larvae feed in the rind of many figs and pupate in the soil. Wasp parasites have been reared from the immature stages of some of the species.

Some of the scrubby trees or unhealthy ones are heavily attacked by various insects, and the common lowland *Ficus ulmifolia* impressed me as suffering more than any other *Ficus* from insects of various Orders.

Bugs (Heteroptera and Homoptera) Attacking Figs

Many kinds of bugs attack figs and some appear attached to them. They were noticed particularly on the common dioecious lowland figs, such as *F. nota, hauili* and *ulmifolia.* Very noticeable among these are squat, mottled brownish pentatomid bugs of high polish and flavor that belong to the genus *Coptosoma* (in the wide sense). They are gregarious in habit, and as observed on *Ficus nota,* may be found in all stages on the more tender fig-bearing tubercles; the young may be lodged at the old petiole scars, and not being much on the move, remind one of an armored scale (*Lecanium sp.*). The eggs of *Coptosoma* may occur in masses and, or in a double row along a tubercle or fig stem. They are parasitized by a tiny wasp.

Another bug on *Ficus nota* is a stout little fellow somewhat suggesting a chinch-bug (*Blissus*). The two terminal joints of its antennae, as well as the apex of the next adjoining are blackish, and the remainder of these organs is pallid. The insect walks about in a brisk, jerky fashion, and rapidly waving the antennae up and down, bears a striking though superficial resemblance to a chalcid wasp.

Among the homopterous bugs are several species of tree-hoppers (Membracidae), and others (Tettigometridae) of rather similar aspect. Where *Coptosoma* is exceedingly ill-flavored and for that reason rather generally avoided by other insects, the grotesquely-formed Membracidae, also of gregarious habit, secrete a honey-dew like substance that makes them popular with certain ants, notably the disagreeably vindictive red tree-ant (*Oecophylla smaragdina* (Fabr.). One of these membracids is *Gargara luteipennis* Funkh., one of the less extravagantly modified of the family, with its broad, simple hunched back and plain brownish markings. Among the figs that it favors are *Ficus hauili,* and *nota.* Small herds of *Gargara,* chiefly immature, were observed resting among the fruits and on the fruiting branches of *Ficus nota,* and they were attended by red tree-ants, that occasionally carried an immature bug, tail first, in their jaws. These ants, it is well known, by using their larvae as spinning machines, make

leaf-and-silk nests in trees and often shelter the *Gargara* bug under a white silken sheet extended over a bunch of figs. No *Oecophylla* nests were found among the branches of *Ficus nota;* this was to be expected, however, because these insects select trees with smooth leaves for their domicile, *Citrus* trees being a great favorite, and the leaves of *F. nota* are somewhat rough and hairy. Inasmuch as *Oecophylla* is mainly arboreal it prefers to get to the fig tree by overhead travel; this is readily accomplished where the branches of the different trees intermingle, but may prove quite difficult and tedious if the branches of the one tree all but touch those of *nota;* in this case a bridge of living ants is formed over the short intervening gap; however flexible this bridge may be it is often parted through the action of the wind.

The psyllid bug, *Macrohomotoma williamsi* Crawford (Proc. Haw. Ent. Soc. VI, 37-38, 1925) occurs on *Ficus Clementis* on Mt. Makiling.

Ants on Fig Trees

Certain ants are very partial to such fig trees as *Ficus pseudopalma, nota* and *ulmifolia.* On the first tree commonly swarm the obnoxious little black *Dolichoderus* (*Hypoclinea*) *bituberculatus* Mayr, attracted thereto by the coccid bugs; other seekers of honey-dew among the ants patronize *F. nota,* and such ants as *Phidologiton* sp. invade the over-ripe and decayed figs, while *F. ulmifolia* may likewise be visited by several species. Among the ants favoring *ulmifolia,* largely because of the hollows or cracks its stems may afford for nesting purposes, is the large though timorous ponerine *Diacamma,* of which several species inhabit the Philippine Islands. *Diacamma* nests in small colonies, forming a sort of debris curtain over a desired cavity and in some cases at least does much of its foraging on the fig tree itself, gathering among other materials, moist or dried fig seed-masses which had been employed by certain fig-eating Pyralidina larvae in making their retreats along the twigs and on or near the fruits. One particular *ulmifolia* tree harbored other ants as well, viz., a species of *Polyrhachis,* a genus that is mainly arboreal and very well represented in Philippine forests, *Oecophylla smaragdina* (Febr.) attending homopterous insects and also frequenting the ostiolar region of ripened figs, and finally, the small aggressive ants of the genera *Phidologiton* and *Cremastogaster.*

A nest of *Diacamma* having been invaded presumably by *Phidologiton* first of all, the big occupants seized their young and rushed out to safety. Great size, powerful jaws and sting avail but little against such numerically superior foe, and they, helpless giants await the pillage of their home. The movements of *Phidologiton,* however, had interfered with a considerable group of shining black little *Cremastogaster* ants that commonly nest in broken branches, hollow twigs, etc., and while these are not nearly so strong as *Phidologiton,* especially in the mandibles, they have a very effective weapon in their anal discharge. Hedging in on the sides of a *Phidologiton* procession, *Cremastogaster* finally succeeded in cutting off a number of the enemy and in engaging it. The hostilities, however, seemed very mild, for actual hand-to-hand encounters were not frequent. When a *Crcmastogaster* met a *Phidologiton* it swung its pointed abdomen gun-like towards the head of the opposing ant and gave it a discharge

that often appeared to stupefy it, for here and there "bombed" *Phidologiton* could be found, head closely applied to the bark, the body reared posteriorly, thereby appearing as if about to execute a leap, and undoubtedly in a very unhappy condition. Occasionally, however, *Cremastogaster* became rash, for emboldened by success, it would seem, it approached too near its foe to find itself grappled by superior and relentless mandibles that never opened again, however much friends might aid their stricken comrade. Dead *Phidologiton* and *Cremastogaster* ants soon began to appear, though not in quantity, and the latter ant carried away some of its defunct enemy. Several hours later I found *Cremastogaster* in full possession.

II.

THE HABITS OF THE WASPS OF THE GENUS LARRA

The genus *Larra* comprises medium-sized to rather large wasps that are recognizable in the field as much perhaps by their habits as by their appearance. Other related wasps—as certain *Notogonidea*—may closely resemble them, but the student who is accustomed to distinguish insects at large, will note that the gait of *Larra* is hardly as animated, and her flight, though swift, is perhaps a trifle heavier. Furthermore, she is more prone to keep to the ground than her cousins and frequently burrows quite out of sight when searching for mole crickets, the common prey of many, if not of the entire genus. This refers to the female, for it is she that is the easier separable, being in the first place of the usual larger size than her consort, and more polished in appearance, chiefly because she is less hairy and freer of the tiny pits that may dull the body of the opposite sex. Finally, she seems more purposeful in behavior, her feeding and hunting periods suggesting greater regularity of life.

Many species of *Larra* are known to science though nowhere do they appear to exist in great variety. They are more common in the tropical regions; temperate Europe and North America seem to be represented only by *Larra anathema* (Rossi) Coq. and *Larra analis* Fabr. respectively. Some species are wholly black, others have the abdomen tipped with reddish, and in others still it is entirely rufous. The American tropics appear to harbor a greater proportion of the bicolorous type.

At least ten species of *Larra* are known to prey upon mole crickets. Long ago Henri Fabre, the celebrated French entomologist, in Souvenirs Entomologique, 3*me* Edition, 3*me* Série, Chapter XII, p. 231-233, made note of what was undoubtedly *Larra anathema* (Rossi), but referred to in his work as *Tachytes anathema* Van der Lind., as searching the burrows of mole crickets (Courtilière), and Ferton (Ann. Soc. Ent. France, LXXIV, p. 67, 1905) found that this *Larra* has the same habits in Corsica. In 1915 or thereabouts, Mr. F. Muir, while in Formosa, dug up several parasitized mole crickets that inhabited a compost heap and thus secured cocoons of what was undoubtedly a species of *Larra,* which unfortunately was not reared to maturity. Imms (A General Textbook of Entomology, p. 581, 1924) under the Family Larridae says, "*Larra anathema* chooses *Gryllotalpa.*"

The writer has studied nine tropical species that attack and parasitize these insects.* As we should anticipate, the various *Larra* are not indiscriminate in

* In addition to mole-cricket wasp-parasites of the genus *Larra*, the handsome "Blue Ant" (*Diamma bicolor* Westw., Thynnidae) of temperate Australia has been found by A. D. Hardy (Victorian Naturalist XXVIII, 33-38, 1911) to be almost certainly parasitic upon *Gryllotalpa coarctata* Walk. The female of *Diamma* is nearly an inch long; wingless, ant-like and metallic purple with red antennae. It is an active and powerful insect and is not carried by the winged male, which, as an exception among the Thynnidae, is smaller than his mate. Hardy noticed one of these wasps at Kew, Victoria, struggling backwards with her captive, a male *Gryllotalpa coarctata*, toward a concealed burrow. The cricket had been paralyzed by the wasp which stung it again when it showed signs of returning animation. The wasp was not permitted to store her victim with which she was backing down into the tunnel.

their tastes but favor a particular species of mole cricket as a viand for their young.

Since in many parts of the world the Gryllotalpinae are agricultural pests of importance, a short account of their form and habits will not come amiss here. The name *Gryllotalpa* is made up of the Latin words *Gryllus,* a cricket, and *Talpa,* a mole. A brief inspection of one of these sturdy insects will convince, at least the rustic, of the aptness of these terms, for while the mole cricket is naturally classified among the saltatorial or leaping Orthoptera, which includes the long- and the short-horned grasshoppers and the various crickets, its mode of existence has brought about the development of the forelegs as diggers rather than the increase in size of the hind legs for purposes of leaping. As a jumper then, the mole cricket does not make a particularly good showing. In travelling through the earth it digs tunnels of not much greater diameter than that of its own subcylindrical and unadorned body, and the comparatively short antennae well provided with sensory hairs enable it to feel and probably smell its way forward, for the compound eyes are somewhat reduced and cannot be of much use in the stygian gloom of burrows; the cricket, furthermore, is so formed as to be unable to look readily over its shoulder, and hence the pair of posterior processes or cerci furnished with erect sensory hairs also substitute in a measure for eyes and serve to feel danger from the rear. Both pairs of wings are of a rather flexible nature. The fully-winged insects are good fliers and are then attracted to light. The forelegs work sideways quite like those of the mole and somewhat resemble them in the miniature; they are very stout and strong, as soon becomes obvious when one of these nervous creatures forces its way between your fingers—and the thick burrowing nails of the mammal find their analogy in the stout dactyls of the fore tibiae and tarsi of the insect.* The fore femora are flattened, and armed beneath with a broad knife-like process that must be of great assistance in digging. These limbs terminate in the tibiae and tarsi; the latter are so hinged to the former that the set of stout nails of both joints work across each other as a pair of shears. Roots that lie in the path of a digging cricket are said frequently to be cut off by this contrivance, which would in a measure substitute for the mandibles themselves! Apart from other characters, the two common genera of mole crickets—*Gryllotalpa* and *Scapteriscus*—are separable because in the first genus the anterior tibiae bear four dactyls as against two in *Scapteriscus.*

It is mainly in the jumping Orthoptera that the sound-producing organs are obviously present, being situated usually on the tegmina or modified forewings. They are, I believe, very seldom developed or functional in the female, although Baumgartner (1905) has shown that the female *Gryllotalpa borealis* Burmeister produces quite a loud distinct chirp, which he thinks may serve as a means of recognition in the dark burrow. These insects are nocturnal and chirp within their tunnels, though usually quite near the surface or the aperture. The "ear" of the mole cricket is situated on the fore tibia; in *Gryllotalpa* it is placed in a

* Other digging insects may have the forelegs comparable in development and more or less in efficiency with those of the Gryllotalpinae; for example, cockroaches of the subfamily Panesthiinae, ground beetles, both as larvae and adults, of the tribe Scaritini, many lamellicorn Coleoptera, and the underground young of cicadas.

deep fold, whereas in *Scapteriscus* it appears as an exposed membrane extended over an oblong frame. The anterior portion of the mole cricket is strongly armored except beneath, but the posterior extremity is soft and thinly chitinized; from that quarter, however, warned of a rear attack by the sensitive processes already referred to, the insect is able to squirt an ill-smelling and exceedingly viscid liquid as a charge which must often suffice to disconcert an aggressor.

Aside from tunnelling at some depths, mole crickets make the well-known and extensive burrows that are so close to the surface of the ground as to raise and crack it and give the work a Lilliputian semblance to that of the mole itself. These superficial galleries do not appear to be occupied during the day and are probably made for feeding, travelling and chirping purposes; the deeper retreats providing the cricket a fairly secure shelter and a place wherein to moult and to rear its brood.*

Observations have shown that the mole cricket is rather prolific and long lived. In the temperate regions it hibernates, at least as an immature insect. According to Giard (Traité Elementaire D'Entomologie, 1879) the common European mole cricket (*Gryllotalpa vulgaris* Latreille) forms an egg-chamber almost the size of a hen's egg and lays from 200 to 400 rounded eggs. These hatch in three to four weeks, remain together as pallid little insects under the protection of the mother; after the first moult they assume a darker shade and disperse, each one shifing for itself, and in due time following a second moult penetrate deep into the soil for winter quarters. In spring this brood moults twice before assuming the adult stage the same year. Some writers have asserted that this insect does not reach full growth before the end of the third year. In tropical species, Van Zwaluwenburg (Bull. 23, Porto Rico Agri. Exp. Sta., 1918) writing of the "changa" or West Indian mole cricket (*Scapteriscus vicinus*** Scudder) has found that it as a rule undergoes eight moults and that it requires about a year for a generation to develop. There is also a pre-oviposition period of from two to three months. The eggs are laid in clusters in a large chamber and the freshly hatched young have no maternal care and begin feeding almost at once, at first gregariously. Eggs of *Gryllotalpa africana* (Beauv.) in the Philippines were secured from a captive specimen. A well formed egg-chamber contained thirty-three eggs, which measured 2.5 by 1.5 millimeters; they were tough and leathery and in color a sort of pale greenish olive, largely obscured, however, by a fine whitish powder.

Entomologists are generally agreed that mole crickets may be both carnivorous and phytophagous, although some assert that the damage done to plant roots is merely incidental to their soil activities, in their search for insects and other animal life. Chitinized remains of insects have been found in the alimentary tract of mole crickets and they do not hesitate at devouring one another when confined in a sufficiently small space. I have fed *Scapteriscus* both on earthworms, and on vegetable tissues such as portions of potatoes and bean pods. Probably all the species of Gryllotalpinae are more or less, and some exceedingly

* A departure from the ordinary type of mole cricket is found in the genus *Cylindracheta* of Australia, whose few, very elongate and slender species burrow in the stems of plants, to which they may naturally cause a great deal of damage.

** Best known in literature as *Scapteriscus didactylus* Latr.

detrimental to agriculture. According to Van Zwaluwenburg (Bull. 23, Porto Rico Agric. Exp. Sta., 1918) the changa (*Scapteriscus vicinus*) is the most serious insect pest of general agriculture in Porto Rico. This insect, he goes on to say, "feeds primarily on vegetables, animal food seeming to form only a small part of its diet." Tender roots and seedlings are eaten, and if the little plants be small and tender enough almost the entire sprout is pulled into the soil and there consumed.* Two species of *Scapteriscus* occur abundantly in the sandy soil at Belem, Pará, Brazil, and I was informed by one of the city gardeners there that the cricket "canta bom" (sings nicely). It doubtless performs less pleasing tasks as well.

Maxwell-Lefroy (Indian Insect Life, 1909) writes of *Gryllotalpa africana* a very common and widespread old world species: "When its burrows are near the surface, damage is caused to the roots of plants and the insect is destructive to this extent."

Harris (Insects Injurious to Vegetation, 1862) in speaking of the European mole cricket states that "They live on the tender roots of plants and in Europe, where they infest moist gardens and meadows, they often do great injury by burrowing under the turf and cutting off the roots of grass, and by undermining and destroying in this way, sometimes whole beds of cabbages, beans and flowers."

In the Hawaiian Islands the immigrant *Gryllotalpa africana* is found on the islands of Kauai and Oahu, and while it is not regarded as a primary pest here, it frequently attracts notice in destroying newly planted sugar cane or canes recumbent on the ground in wet places, and again by causing leaks in irrigation ditches (see Swezey, Hawaiian Planters' Record, XXVII, p. 38-39; 4 figs., 1923).

Generally speaking, mole crickets prefer low moist places; muddy spots along creeks are almost sure to harbor them, while the sandy margins of streams are sometimes a perfect network of their superficial burrows. These insects do not

* This insect, better known in literature as *Scapteriscus didactylus* (Latr.) is very abundant in the low sandy country of equatorial Brazil, and has gained a strong foothold in southeastern United States, playing havoc there among seed beds, truck gardens, etc. Locally known as the "ground puppy" (See Chittenden, Journ. Econ. Ent., p. 149, Feb., 1920) it has been successfully controlled by the proper application of poisoned baits to which molasses has been added (Report of the Entomologist, U. S. Dept. Agriculture, Bureau of Ent. p. 17, to June, 1926). Wolcott (Boletin No. 32, Estacion Exp. Insular, Puerto Rico, pp. 80-81, 1924.) gives the most efficient control of this cricket in Porto Rico, as poisoned bait: Paris Green 3-4 parts mixed with wheat flour 96-97 parts, the whole being moistened a little, applied, preferably at nightfall, at the rate of 300 pounds per acre on land that has been first cleared of vegetation. The "changa" he says, has no parasites, though it has plenty of enemies, principally birds. Wetmore (Birds of Porto Rico, Bull. 326, U. S. Dept. Agric. 1916) in speaking of bird enemies of the mole cricket (*Scapteriscus vicinus* Scudder), mentions the Cuban green heron (*Butorides virescens cubanus* Oberholser) and the Porto Rican sparrow hawk (*Falco sparverius loquacula* Riley) as standing first and second in a list of birds whose stomachs were observed; in the heron 54.33% and in the sparrow hawk 28.69% of the food was mole crickets. He advocates the protection and encouragement of these birds; by planting bamboos along irrigation ditches in the case of the heron, and by placing tall perches from which the falcon may watch for its prey.

In addition to the *Larra* wasps that parasitize mole crickets, a flesh-fly, *Sarcophaga sternodontis* Towns, sometimes parasitizes *Scapteriscus vicinus* in Porto Rico (Wolcott, Journ. Dept. Agric. Porto Rico, VII, 225, 1923. Listed as *Sarcophaga robusta*). A nematode worm (*Anguillula gryllotalpae* Duff.) has been found to be a parasite of the European mole cricket (*Gryllotalpa vulgaris* Latr.) (See Diesing, C. M., Systema Helminthum, V. p. 135, 1851).

readily become wet, as a vestiture of short hair interposes a film of air between their body and the water or mud; hence they float easily and being powerful and rapid swimmers are prepared to some extent to cope with floods which not infrequently fall to their lot.

One would not ordinarily consider the scurrying mole cricket as food for man, yet in places in the Philippine Islands and probably in some other countries as well, *Gryllotalpa africana* is eaten with gusto by the natives. There it goes by several local names. The Pampangans, among others, are said to be very fond of this insect and cook it in a number of styles, one being to fry it in fat, and another to boil it in vinegar and salt. They are caught in the rice fields, when after a dry spell these are inundated by rains. Then the Pampangan walks about in the shallows and stirring up the mud with his feet floods out the crickets which float up to the surface to be picked up and placed in a bamboo tube. They are also captured at electric lights. These morsels are prepared for cooking by removing the legs. In certain districts they sell for about 25 centavos the hundred.

The student who has some knowledge of the types of prey selected by the solitary wasps will be quick to note that in many cases the hymenopteron attacks insects or spiders, considerably smaller and less powerful than herself, and that here she meets with little difficulty in overcoming them. Thus, tiny wasps of the family Pemphredonidae store their cells with still more tiny aphids or plant lice, and others like some of the *Cercceris* gather small beetles, and many Crabronidae prey on feeble flies. On the other hand, the "Tarantula Hawks" (*Pepsis* species) conquer hairy giants several times their own weight, and the sphecid wasp *Priononyx atrata* St. Farg., and the larrids *Tachytes rufofasciatus* Cresson, and *Tachysphex propinquus* Viereck, are among those that very commonly attack comparatively huge short-horned grasshoppers, and may overcome these only after a furious struggle. *Larra* falls within this second or super-wasp category. Experiments have shown that sufficiently often she will subdue a fully matured mole cricket, an insect which in bulk and brawn is greatly the superior of the agile wasp. Skill and agility then, rather than strength, count with the aggressor. If she must victimize mole crickets, then their habits and stout resistance are to be considered, but in such wise, nevertheless, as serves the wasp. The prey of other solitary wasps is usually rendered helpless and stowed away, one might say, without consulting its wishes in the matter. Apparently this could not be done in the case of mole crickets. *Larra,* unlike the usual run of fossorial or "digger" wasps, does not dig a nest hole and store it, in this case with mole crickets; these actually store themselves. In this way she does not share all the difficulties of nesting activities of other wasps.* True enough, the hunt for mole crickets may be arduous or quite unsuccessful and the tired wasp, caked with mud, will issue from the ground where she had been following damp burrows; eventually, however, she enters a tenanted tunnel, drives the

* The beautiful metallic blue-green wasp *Chlorion lobatum* Fabr., of India that hunts the massive brown cricket (*Brachytrypes achatinus* (Stoll) utilizes the victim's deep burrow for its internment; the cricket, moreover, is not stung with lasting effect, but appears satisfied to remain underground and be gradually eaten alive by the wasp grub. (See Hingston, R. W. G., Journ. Bomb. Nat. Hist. Soc., 30, 1925 and 31, 1926).

terrified occupant out to the surface of the ground and there attacks it with great skill, taking a flying leap on the scurrying insect's back and despite frantic struggles administers several stings that render it helpless for a period sufficient for her to securely glue the egg on it.* The cricket recovers completely, it seems, is abandoned by the wasp and hastily burrows into the ground to live its life until the developing wasp grub demands its vitals for the completing meal. The cocoon is formed where the host is devoured and in due time gives forth an adult wasp. Very rarely was a *Larra* wasp observed making the least attempt to carry away her victim. Has she lost this habit so prevalent among the solitary wasps or did she never acquire it? At any rate, in view of the cricket's quick recovery as well as its comparatively immense weight, lugging it away would scarcely be practicable.

The evidence at hand shows that the wasp prefers to grapple with her victim above ground where the powerful though but little flexible cricket is at a disadvantage.

In many tropical countries where two or more species of *Larra* occur, and one of these is of considerably larger size, investigation has shown that at least two kinds of mole crickets likewise differing in size live in these lands and there serve as a prey, large species for large, and small species for small wasp species. Such a condition obtained in Queensland, Australia, the Philippines, and Para, Brazil. Another biological character among these wasps is based upon the position of their egg on the mole cricket—whether it be affixed across or mainly to one side of the mid-ventral line of the thorax, or far removed therefrom. Parallel cases of different egg-positions exist within other genera of wasps, notably in the black wasps (*Tiphia*) that attack the grubs of May or June beetles (Scarabeidae) and in the *Methoca* that parasitize the larvae of tiger beetles (Cicindelidae).

Australian Larra

Larra Femorata (Saussure) and Its Black Phase **Larra Scelesta** Turner

(Plate V, Figs. 26 and 27)

These two Australian wasps were studied during the winter of 1919, at Halifax, on the Herbert River, North Queensland. In both forms the wasp's body is entirely black, but in *Larra femorata* the second and third pairs of legs are largely reddish. A good-sized *L. femorata* measures 16 or 17 millimeters in length; *L. scelesta* averages rather larger, up to 19 millimeters or so long, and with the legs mostly black. But while there appears to be no real structural distinction between the two in either sex, it is here that a biological habit comes to the rescue—for according to my experiments, at least, each form very much prefers a distinct species of mole cricket.

In common with many other Hymenoptera these wasps are frequent patrons of the flowers of the leguminous plant, *Crotalaria* sp., a common roadside

* In watching such a battle, one is impressed with the fact that the mole cricket is very conscious of its danger, even before the wasp, which it may now be viewing for the first time in its life, launches her attack.

weed. Male *Larra* were more often seen at these blossoms; the females, however, devoted much of their time to hunting mole crickets, and so were not very frequently observed feeding save at the commencement and particularly towards the end of the day.

Wasps hunting for their prey were sometimes found afield, but all the stingings and egg-layings noticed were carried on in test tubes or in glass tumblers. It was determined that *Gryllotalpa coarctata* Walker, a cricket much resembling the widespread *Gryllotalpa africana* Beauv., was the prey of *Larra femorata.* Some of these crickets I dug up in cane fields, but they could be secured in abundance only and in many stages of growth, when tunneling the moist soil which margined a small and sluggish watercourse choked with the noxious though handsome water hyacinth (*Eichhornia*). It is a long-winged mole cricket that is about 30 millimeters in length. The larger species, *Gryllotalpa nitidula* Serville, as observed from male specimens is short-winged and about 37 millimeters long. Its thoracic shield is brightly polished and hairless. This insect was more rarely taken, and then mainly in a field of young sugar cane. Towards sunset, with the weather sufficiently warm, their characteristic chirpings could be heard here and there, as subdued music scattered over the land, and by approaching with considerable caution and correctly locating the alert insect one might evict him by the sudden scoop of a trowel, from a tunnel several inches underground. When cornered, this cricket is a savage fighter. It was preyed upon by *Larra scelesta.*

Commencing with *Larra femorata,* the smaller insect, she was given immature specimens of *Gryllotalpa coarctata,* but it was soon found that she was quite equal to the task of overcoming full-grown crickets that were sometimes twice as large as, and many times heavier than herself. At first the crickets were loosed in a large cage containing soil, and wasps then introduced, but the test-tube or jelly-tumbler methods proved more satisfactory, since operations could then be watched with a hand lens. The wasp is first placed in the test tube and then headfirst, her huge bewildered prey. The sequence to such an insertion, watched many times, is about as follows: *Larra,* sometimes with hesitancy at the formidable size and activity of the mole cricket, pounces upon its back and quickly coiling herself about its thorax thrusts her sting through the membrane between the origin of the second and third pairs of legs, in effect to very considerably quiet the furious struggles; then, with more time and care, with a pivoting movement she shifts her abdomen slightly forward along the cricket, which is stung again in the mid-ventral line but between the first and second pairs of legs and anterior to the median plate of chitin; finally, she pokes and feels with the point of her abdomen, about the side and underside of the head and stings her victim to one side, apparently between the cheek and the mouth-parts. Perhaps these three or more stings pierce nerve centers, though causing paralysis for a very short time only. During this strenuous encounter the wasp seems not to use her jaws. A necessarily brief pause follows; *Larra* is soon at work again; she may now pinch with her jaws and seem to pry apart the space on the under side of the thorax, between the first two pairs of legs and at the base of the forelegs. Sometimes also the skin is licked. At each nip administered by the wasp the imperfectly stupefied cricket may wince. This

total process is termed "malaxation" and is perhaps more often than not omitted, the more careful process of egg-laying alone following the battle. The wasp again mounts her victim, assumes thereon a crosswise, stinging posture and reaches about with the tip of the abdomen in the space between the first two pairs of legs and employs the obviously sensitive, paired sting-sheath to determine the spot on which to glue her egg. In this operation she is very particular, and may swing about more than once in an effort to attain the opposite or far underside of the cricket, which perhaps by this time has partly recovered and is again struggling; the wasp, however, holds on grimly, her four posterior legs extended to either side, the anterior pair more in advance or sometimes resting on the ground. When ready to oviposit she braces herself, presses the tip of her abdomen against the membrane, forcing the sheath to divide V-like, while the sting itself forms the third or dorsal leg of the tripod, from whose base the egg slips out tail-first to be very firmly pressed and glued against the cricket's body, the pressure seeming to relax as the broader, head end of the egg is reached. It is secured transversely and somewhat to one side of the mid-ventral line (Pl. V, Fig. 27), the head end facing outwardly and fitting in a conformable curve in a fold of the skin where the cricket can neither reach nor rub it off in its subsequent meanderings through the soil, for it soon recovers from the wounds and makes for shelter. The operation, from attack to including oviposition, may not take over 58 seconds nor extend beyond two minutes.

With the all-black, and rather larger *Larra scelesta* and the big *Gryllotalpa nitidula,* the procedure was much as just related, although the struggles were sometimes fiercer. *Larra femorata* would not attack this large mole cricket and *Larra scelesta* often hesitated at the task—as the disparity in size between wasp and prey may be very great. The *Gryllotalpa* sometimes succeeded in squirting the viscid, quickly drying fluid upon her foe, thus binding wings and legs together and completely breaking up her morale. But even this disagreeable liquid was not always so effective. That the wasp is sometimes hard put by her prey is shown by specimens of *Larra* which were captured in the field and found with a portion of the forelegs lacking.

A test-tube battle was as follows: A wasp somewhat enfeebled by confinement was given a mature *Gryllotalpa nitidula.* She found great difficulty in subduing it, for the cricket struggled fiercely and attempted to double up its stiff body and reach its aggressor; the wasp, however, went about her work with what seemed a great deliberation and tenacity of purpose, and though several times falling off the cricket's back, she finally succeeded in stinging it so that it could not run about. Egg-laying met with further difficulty, for the victim by moving its semi-paralyzed middle pair of legs would disturb the wasp's abdomen, and this interference with oviposition was no uncommon thing, and I once saw what must have been a vexed wasp grasp the rebellious leg in her mandibles.

On July 6, a mature *Gryllotalpa* was placed in a tumbler partly filled with soil and then was introduced a good sized *Larra scelesta,* seriously handicapped by the loss of part of one foreleg. The wasp ousted the orthopteron from the scant soil and then ensued a furious battle, the cricket striving to bite its adversary and to seize it with its forelegs, the wasp avoiding a face-to-face encounter

was time and again thrown off the cricket's back and finally gave up the struggle when the cricket brushed her off in entering the soil.

In one instance a *Larra scelesta* parasitized a *Gryllotalpa coarctata,* normally the prey of *Larra femorata.*

The egg of *Larra scelesta,* as that of *L. femorata,* is laid to one side of the ventral line.

We find, at least under artificial conditions, that some *Larra* wasps will fear a large mole cricket, though attacking a smaller one of the same species. One *Larra scelesta,* apparently in a doubtful frame of mind, got up crosswise on her intended victim and seemed about to sting it, when appearing to realize the immensity and uncertainty of the task, hastily dismounted and made off.

Both *Larra femorata* and *scelesta* sting their prey similarly, i. e., in the three ventral places. The wasps do not always chew at or malaxate their victims, but one may hardly conclude that in some cases the process is required while in others it is not.

It seems that the most favorable time to induce the wasp to attack her prey is when freshly captured, for a cricket then placed in the test tube will have the effect of making the hymenopteron cease her vain and frightened efforts to escape and will arouse her hunting instincts so that the victim is usually pounced upon (Pl. V, Fig. 26) and then almost invariably parasitized.

About fifty crickets were parasitized by this aggregate of *Larra,* and hopes were high for rearing a number of wasps. But a single cocoon was obtained, however. The mild, North Queensland winter was probably responsible for this failure; wasps in general require warmth for their early stages and the comparatively few species about at this season would seem to indicate adverse conditions. Some of the *Larra* eggs failed to hatch, while those that did disclose larvae required a very long incubation period. With the Philippine *Larra luzonensis* the egg hatched in four days, while two eggs of *Larra femorata* took each 17½ days to do so. In one instance, with the latter species over a month elapsed from oviposition to a quarter-grown larva. The egg of *Larra scelesta* measures about 1.75 by 0.40 millimeters; it is a little curved and blunter at the slightly thicker head end. Generally speaking, for a wasp that measures 15 to 19 millimeters in the female sex, her egg is comparatively small, if we consider the two other larrids, and their eggs, viz.: *Notogonidea manilae* Ashm. of the Philippines and which is 7 millimeters long but produces an egg 1.66 by 0.47 millimeters, and *Liris magnifica* Kohl. a stout wasp about 18 to 21 millimeters long with an egg approximately 4 millimeters in length. The small size of the egg in *Larra* is probaby to its advantage since it is carried about on a lively insect, while in the remaining Larridae the victims are both more or less paralyzed as well as pent up in a cell. Furthermore, the egg of *Larra* is securely glued, practically for its entire length, whereas in wasps with well-quieted victims, it is fastened for only part of its length to the host and that not too securely, so that were the victim very active it might be brushed off.

Like the Philippine species (Williams, 1919) the larva as it grows, gradually almost encircles the thorax of the mole cricket, which weakening by degrees finally ceases its activities and is at last consumed by the voracious grub. The cocoon is of the usual type among Larridae (Pl. V, Fig. 24).

A third Australian *Larra, L. melanoscelis* Turner, is a handsome, silvery banded insect easily separable from the other two by its head being much broader between the compound eyes. It was found to be commoner in southern coastal Queensland towards Brisbane, where individuals were seen along the margins of a pond and alighting on the floating leaves of an aquatic plant there. Nothing was learned of its prey.

Philippine Larra

Larra luzonensis Rohwer

(Pl. V, Fig. 25)

This is the most frequently seen of the three species known to occur in the Philippines. It is very closely related to *Larra femorata,* from which it can be most conveniently distinguished—though not invariably—by having only the hind femora reddish. A short account of its habits has already been published (Williams, Philippine Wasp Studies, Bull. 14, Ent. Ser. Exp. Sta., H. S. P. A., 1919). The wasp attacks the common, widespread tropical *Gryllotalpa africana* Beauv. Additional data were secured also at Los Baños, Philippines, in 1921 and 1922, when a few of the wasps were bred and sent to the Hawaiian Islands in 1921. Unfortunately only females issued. These wasps, except in a part of Occidental Negros were found difficult to secure. However, in 1925, Mr. C. E. Pemberton, Associate Entomologist to this Experiment Station, by sugaring the leaves of corn at Los Baños, succeeded in capturing this wasp in sufficient quantity * so that in June and July he was enabled to make three large consignments of parasitized mole crickets to Honolulu. From these lots totalling 577 parasitized crickets, 184 wasps are known to have issued, in addition, 79 cocoons were buried on two sugar cane plantations. These *Larra* were liberated at the Manoa Substation, Honolulu, and at Ewa, Waialua, and Kahuku sugar plantations, all on the island of Oahu. On September 3, 1926, the wasp was found to be well established in three places on Waialua plantation, about ten individuals being seen hunting among mole-cricket burrows in the damp trenches alongside the sugar cane, and in addition, a young mole cricket with a *Larra* egg across its chest was taken floating in a ditch. On September 7, a single female was caught in a moist spot in a field of sugar cane at Ewa plantation. On October 2, a female was observed on a screen window of one of the Honolulu beach hotels. It is now plentiful in the foothills to an altitude of at least 1700 feet in the hills behind Honolulu, and an abundance of males and fewer females may be readily taken on the honey-dewed *Scaevola* bushes at the head of Manoa Valley.

Larra luzonensis attacks and parasitizes her prey in the regular *Larra* manner, and when unwilling to operate in a test tube she was placed in a tumbler, where she became keenly interested in the upheaving movements of the scant soil representing a mole cricket frantically striving to penetrate to safety. Crickets that are not in good condition may be so recognized by *Larra* and are often

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* 19 Wasps were used in this work, and so the average number of parasitizations per wasp was 30.

rejected. Mature crickets seem less resistant to stings than are young ones. The sting between the second and third pair of legs is the most quieting. More rarely not one but both cheeks are stung. The egg is glued as usual, between the first two ventral segments but quite evenly or in part across the mid-ventral line. Thus she is to some extent distinguished biologically from her very close Australian relative that fixes her egg to one side of the mid ventral line. The egg-laying capacity seems limited to a very few per day and seldom would one egg follow at all closely upon the first. Two ovipositions per day was above the average. Perhaps when one egg has reached its full development in the wasp's body it stimulates the laying impulse; wasps that are not ready for oviposition will when placed in a test tube with a cricket endeavor to escape, or occasionally, with the stimulus developing along with the egg, make a feint at attacking the *Gryllotalpa.* A battle in a jelly tumbler partly filled with soil reads thus: "Wasp dug in, cricket rushed out after having attempted to defend itself by squirting its viscid fluid; it was loath to enter the soil as if realizing danger there, but was spared that trouble, however, when the wasp issued therefrom and immediately pounced upon its back, and while she was thrown off once or twice, her superior activity won out and the prey, finally overcome, was parasitized."

Larra sanguinea Williams

(Pl. V, Fig. 24)

Another, though much rarer enemy of *Gryllotalpa africana* in the Philippines is *Larra sanguinea,* of which but a single pair was seen and captured. These were taken at the College of Agriculture, Los Baños, Luzon,* on December 5 and 6, 1921. The female parasitized 18 crickets in 11 days, and but for a mishap to her sting would have accounted for many more. As it was, the lot was shipped to Honolulu, where it yielded eleven females and one male, of which, on February 17, 1922, eight females were turned loose in Manoa Valley, Honolulu. Evidently the insect has failed to become established. This wasp is easily separable from *Larra luzonensis* because her abdomen is largely reddish; she is also somewhat larger, slightly silky, with a wider space above between the eyes, and with much less activity. She proved a good worker and on one occasion parasitized three mole crickets in one day. Once, this wasp enclosed in a tumbler with earth and a mole cricket, dug down after it and was presently seen to emerge, clinging backwards to the underside of the terrified victim and stinging it meanwhile, so that it became too weak to enter the soil again, and was parasitized. The sticky fluid that the mole cricket squirts upon her enemy, at times hardly serves to effectively disconcert her, for a pursuing wasp, her mouth-parts clogged up with soil mixed with this secretion may attack just the same, in the case in point, there was rather a long chase on top of the ground, *Larra* proving quite agile in evading the cricket when it charged; *Gryllatalpa* is not, however, a very flexible insect, and though it tried to keep its foe from securing an advantageous position on its back by bending the body and interposing its legs, all defence was overcome by the wasp. In one case, *Larra sanguinea* parasitized

* What appears to be the same insect was taken by F. C. Hadden in June and September, 1927, at Taihoku, Formosa.

a quite immature cricket, when the twain were well out of sight in the soil, and again, she stung her small prey underground, but pulled it out to the surface and there glued her egg upon it. The egg is a good 2 millimeters long, and while placed between thoracic segments two and three it occupies a transverse position well to one side of the mid-ventral line, in fact, it is situated latero-ventrad; this because the wasp assuming a rather oblique—as distinguished from the nearly crosswise position of some other *Larra,* oviposits on the near side of her victim.

Up to December 16, this wasp did efficient work, but now evidently some mishap had befallen her sting, for while eagerly attacking mole crickets, she was quite unable to paralyze them, and after long struggles the crickets remained unhurt and *Larra* was committed to the cyanide bottle to become the type of a new species.

Larra carbonaria (Sm.)

(Pl. V, Fig. 21)

This fine glossy, all-black insect measures, in examples from the southern Philippines, up to 25 millimeters, or about an inch in length. As far as my observations go it is wholly a forest insect, as seems also its prey, the big 39-millimeter-long mole cricket, *Gryllotalpa hirsuta* Burmeister. Thus, this wasp differs in habitat from *Larra luzonensis* and *Larra sanguinea* which appear to favor the cultivated lowlands where *Gryllotalpa africana* abounds.

Specimens of *Larra carbonaria* were taken by me only from the lower portion of the Mount Makiling forest. It is rather variable and widely distributed in the Philippines, as the collections of C. F. Baker, dean of the College of Agriculture at Los Baños, show. The shafts of sunlight that penetrated through the foliage along the trail made bright patches in which these wasps, as well as others, would often pause to bask. Occasionally, female *Larra* were seen hunting on the forest floor; one such was observed on the morning of January 17, 1922, digging in damp soil next an old and partly sunken log. Here she opened up a burrow and soon was to be heard buzzing squeakily within. She could not, however, drive out her prospective victim, so I captured her and found a 13.5-milimeter-long mole cricket, head first at the blind end of its burrow. When placed together the wasp parasitized this very immature cricket and laid her 2-millimeter-long egg well to one side of the median line, between segments one and two of the thorax. The *Larra* grub at first feeding from an external position on its host eventually works head and thorax into its prey (Pl. V, Fig. 21) and finally consumes, to a greater or less extent, the skin and harder parts. The cocoon is spun in the usual interesting manner, the grub working from a frail silken hammock elaborates about herself a ring of agglutinized sand grains to which she constantly adds and thus finally encases herself.

While *Larra carbonaria* was not uncommon and could even be captured by placing a large test tube or a tumbler over her while more or less engrossed in the chase, the big mole cricket was far more difficult to secure. I saw no evidence of these insects in superficial burrows. A pile of dug-up soil may reveal their tunnels, of which one was traced at a depth of about six inches for

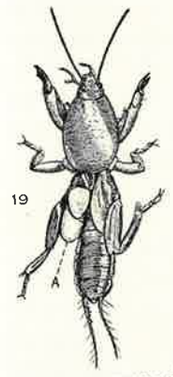
a distance of several feet. The female *G. hirsuta* I never took, though there was a long-winged one, or more, in Dean Baker's collection. At the close of the day the males emit their harsh and powerful, far-reaching note, a sustained cicada-like sound that carries for a distance of several hundreds of feet, far outstripping the song of the frogs, other crickets and the cicadas that keep it company, and is so very different from the mild chirp of its relative *Gryllotalpa nitidula* of the Australian sugar cane fields. However, it is probable that mole crickets may be able at times to vary their song. Thus forewarned I hurried down the darkening, wooded ravine, electric torch and mattock in hand, and easily guided by the several stridulations, to an area near the Molawin river. As one nears the musicians, or rather the din-makers, care must be exercised, as they are shy creatures and hush up on suspicion. When very near at hand the individual noise is almost deafening; it is for this reason perhaps that the cricket is difficult to exactly locate, for it must be accurately placed, else the sudden dig with the mattock will be of no avail. Of four evenings' search: on the first of these two were heard but neither captured; the second evening four were heard and two caught, one of which I crippled; the third time I heard one and caught none, while on the last day I heard three and crippled one of these. By persistent digging a few specimens were secured uninjured—they were very difficult to locate in the day time and hunting for them in the evening was limited to the rather short time during which they stridulated. A strong wasp usually met with little difficulty in overcoming the adult crickets; in one instance, however, while attacking readily enough, she was unable for many minutes to subdue the big insect, the chief trouble being to paralyze the fore paws, which desperately parried and pushed aside the wasp's abdomen. None of these *Larra* was reared to maturity, and but two cocoons were formed, one being 20 and the other 21 millimeters long.

South American Larra

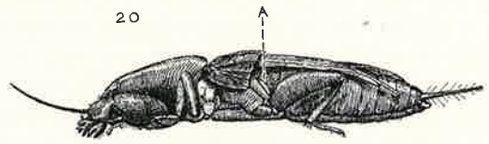
Ecuador

Seven or eight species of South American *Larra* were found, from 1922 to 1924, and representing Ecuador, British Guiana and Brazil. In Ecuador, specimens were taken on the west or Pacific side of the Andes, at Bucay, at 1000 feet, and on the eastern or Amazon basin slope, at Tena, at 1850 feet. While mole crickets were abundant at Baños, at 6000 feet, no *Larra* were for certainty seen there. The low front lands of British Guiana furnished *Larra guiana* Cam.; others occurring in Brazil, as in the Rio de Janeiro region through to that of Sao Paulo, on the Serra do Mar at an elevation of over 2500 feet. At Pará two species were sufficiently abundant.

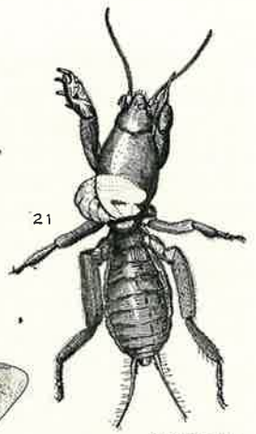
The blossoms of *Mikania micrantha* H. B. K., a widespread, half-climbing composite plant, as well as those of *Alternanthera ficoidea* (L.), R. Br., a common Amarantaceous weed, of *Borreria laevis* (Lam.) Griseb., *Borreria tenella* C. and S. of the family Rubiaceae, and *Cordia* sp. of the Boraginaceae, were favorite wasp flowers in South America and on the first two species many *Larra* were captured; of these, *Larra aethiops* (Sm.) and *L. transandina* n. sp. from Ecuador may be entirely black, *L. altamazonica* n. sp. and *L. pacifica* n. sp. also from that country having the abdomen wholly or in part red. Unfortunately I did not at



MOLE CRICKET WITH LARVA OF LARRA SP. AT A. x1.2
ECUADOR

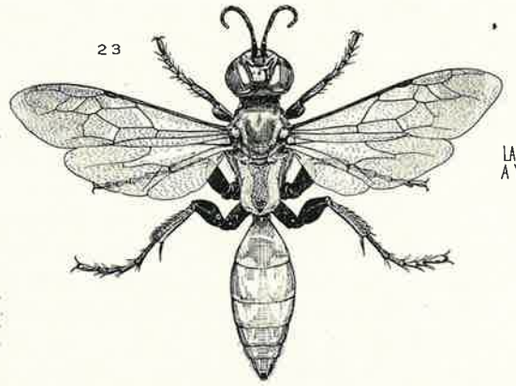


MOLE CRICKET WITH EGG OF LARRA SP. AT A. x1.5
ECUADOR



LARVA OF LARRA CARBONARIA DEVOURING A YOUNG GRYLLOTALPA HIRSUTA. x2.8
PHILIPPINES

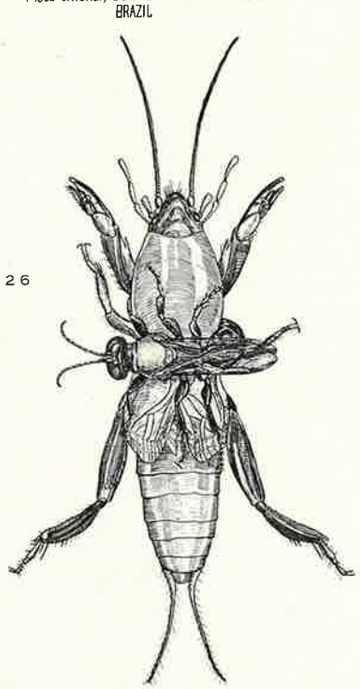
PUPA OF LARRA SP.
ECUADOR x3.3



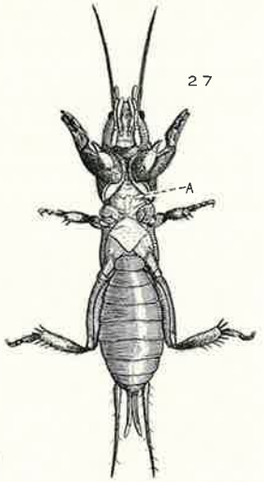
LARRA AMERICANA ♀ AN ENEMY OF THE MOLE CRICKET, SCAPTERISCUS DIDACTYLUS. x3
BRAZIL

HATCHED COCOON OF LARRA SANGUINEA
x2.2 PHILIPPINES

LARVA OF LARRA LUZONENSIS THAT HAS NEARLY COMPLETED ITS MEAL ON GRYLLOTALPA AFRICANA. x3
HAWAIIAN SPECIMENS



LARRA SCELESTA ATTACKING GRYLLOTALPA NITIDULA.
AUSTRALIA x 1.5



GRYLLOTALPA COARCTATA BEARING EGG A, OF LARRA FEMORATA, VENTRAL VIEW. x1.3
AUSTRALIA

PLATE V

first separate these red and black species, and as a result the following brief observations made at Tena, at 1850 feet, Eastern Ecuador, cannot be narrowed down to one of the several red and black species taken in that locality. The wasp in question is separable from others also in a biological sense, for instead of laying her egg on the underside of the thorax of a cricket apparently of the genus *Gryllotalpa,* she affixes it head-end upwards, alongside one of the sclerites or plates on the side of the thorax above the base of one of the hind legs so as to be somewhat hidden by this and the overlying wings (Pl. V, Fig. 20). It seemed, however, that the wasp after stinging her victim in about the usual *Larra* manner, though employing considerable care in stabbing under both sides of the cheeks, abandoned it without ovipositing; this proved otherwise, for a few days later when one of these crickets was re-examined the growing wasp grub was discovered glued to its host's side and feeding at that point. Then it was seen that the wasp in fastening her eggs assumes a longitudinal position along her victim's body, her head to the cricket's tail end. Five ovipositions were secured in a few days during February and March, 1923, from two wasps, and both young and mature crickets were parasitized. One of these wasps kneaded or chewed at the base of the cricket's forelegs and at the membrane between the pro and mesosternum, though paying no attention thusly to the side of the thorax where the egg was soon to be affixed. Over 2 weeks were required from egg to the full-grown wasp larva. The feeding larva is illustrated in plate V, Fig. 19, and the pupa in Plate V, Fig. 22. The latter is rather mildly spinose. None was reared to maturity.

British Guiana

Larra guiana Cameron (Timehri, II, 3rd. Ser., 433-434, 1912).*

But few specimens of this red and black insect were found and none of the Guianan specimens was experimented with. They were taken at Blairmont, Berbice County, British Guiana, and near Sao Paulo, and 1 ♀ from Pará, Brazil.

Brazil

Brazil, with the region chiefly about Belem, Pará, furnished much of interest on the habits of some of these wasps. One must not, however, fail to mention the elevated, red-soil prairie land near Sao Paulo, notably near the city of Campinas, which in well-chosen areas of Compositae, Labiatae and other plants, formed a veritable paradise for bees and wasps, as well as for many other kinds of insects. Here were found, several red and black *Larra* species, though not abundantly. In late March, 1924, at Villa Americana, a tiny suburb of Campinas, I captured a fine *Larra guiana,* and induced her to parasitize a half-grown mole cricket, genus not ascertained. She glued the pearly white egg transversely in the groove between the first and second segments of the thorax beneath, and mostly to one side of the median line. This hatched in four or five days, the wasp

* This species may be a synonym of *Larra gastrica* (Tasch. Zeits. f. d. Ges Natur. neue folge, 1870, Bd. II (whole ser. Bd. 36) p. 5-6.) which in the ♀ likewise has the wings uniformly fuscous; in *Larra americana,* (Sauss. Reise d. Novara, Zool. II, p. 1, 1867, Hymen. p. 74, n. 4. ♂ ♀) the basal half of the wings is paler in both sexes.

grub growing rapidly so that in a few days it had killed the cricket by its voracious appetite; it was sitting up in a curved position, with the remnants of the cricket's head and thorax and appendages to one side, on its lap, the abdomen severed at the waist and practically uneaten. This wasp grub, as not infrequently happens, had more food than necessary for its development, since a large part of its victim remained unconsumed when it began spinning the superstructure of the cocoon, a sort of frail hammock from which it could reach the walls and bite out soil grains with which to construct its oblong and oval cask. The beginnings of the latter were well in evidence late in the day as an agglutinized soil-grain band some 8 or 10 millimeters wide that encircled the grub's body. This still very wet and flexible structure was more or less suspended in place by a number of radiating stays of weak silk. About four and a half hours later this band had been so added to and shaped from both edges as to form the cask complete save for a small central aperture at the larger, or head end. When this little hole had been capped, the grains of sand there showed as a disc of slightly different texture and shade from that of the body of the cocoon. Here we see a cocoon that is hardly spun but cemented, and this latter type of work is common to the Larridae and many other wasps. From the laying of the egg to the formation of the cask about two weeks had elapsed. Nearly a month after the cask had been formed, or on May 5, I broke it open, to reveal the fat yellowish white wasp grub, which judging from the fact that it had been in the larval stage so long, and because of the sluggish pulsations (16 to 17 per minute) of its heart or dorsal vessel, as well as the not wholly tropical nature of the region, was holding over thus until next season's rains.

I spent nearly two months, (May and June, 1924) in and near Belem, capital of the state of Pará, a region very rich in insects and a favorite collecting ground of H. W. Bates and other naturalists. Belem sits on a point of land formed by the entrance of the Guamá river into the Pará and is about 86 miles from the Atlantic. From the city one has easy access both to the moist virgin forest, as well as to open, more or less cleared and weedy land. Hereabouts we have mainly clean sand, an agreeable change, when one does much digging for insects, from the usual type of soils which demanded a too frequent changing of clothes. Through the kindness of the authorities of the far-famed though now decadent Museu Goeldi, which is situated in the small though attractive zoological and botanical gardens of Belem, I was able to do much of my *Larra* work in these grounds; for among many species of wasps found in the city itself were *Larra americana* (Pl. V, Fig. 23, ♀; Pl. VI, Fig. 31 ♂; Fig. 36 ♀ vertex) and *Larra scapteriscica* n. sp., its smaller relative. These patronized an Amarantaceous weed that overgrew some of the unkept land. Belem, Pará, is the only place where wasps of this genus were found truly abundant, for they could be seen on any favorable morning in the little public parks, and even in gardens feeding at flowers or examining one of the very numerous superficial burrows of *Scapteriscus tenuis* Scudder or *Scapteriscus didactylus* * (Latreille), two mole crickets that occurred in large numbers, even to the extent of tunnelling the scant soil between the cobblestones in city streets.

* This is the "*changa*" or Porto Rican mole cricket, also known as *Scapteriscus vicinus* Scud.

What few people here were interviewed seemed very loath to dig up mole crickets even for good pay. The parks were full of the cricket's burrows, but opportunity for capturing these insects in a more secluded place came my way when I was enabled to rent as a laboratory, a room in a house surrounded by a large cricket-infested garden, the whole establishment being used by two collectors of animals, birds and fishes, as a concentration camp from which to ship their living ware. Here I exhumed over 200 crickets, besides many other interesting insects, as beetle larvae, and the nests of various wasps including that of *Tachytes mergus,* a larrid wasp that preys on the powerfully-jumping little tridactyline crickets, one or more *Notogonidea* wasps, *Larra* itself, a tiny social bee, etc., etc.

Among other characters, that of size serves to distinguish the two species of *Scapteriscus* of the region, a full grown *S. tenuis* measures about 23 millimeters long, while *S. didactylus* is 34 millimeters in length. The latter is rather the more common of the two and both species occur intermingled in the ground. The most favorable time of the day for digging up these insects was the early morning when not all of them had yet left their superficial night burrows, often of considerable length, for greater and safer depths. This depth did not seem to bother the wasps, however, which were able to oust them from their retreats when the sun was high in the heavens. As a rule, the demand for mole crickets was greater than the supply, since in digging them up many are killed and crippled. The usual plan of work consisted in spending an early hour or more in securing crickets in the garden and then later in the morning to go to the botanic gardens with a supply of crickets, some test tubes and a net and to capture the female *Larra* there and secure parasitizations in the test tubes and to bring back some few of the wasps for egg laying in the laboratory. At least two species of *Larra,* both of them red and black occur in this humid region. *Larra americana* Saussure, the larger and more frequent of the two, ranges in the female from 14 to 20 millimeters long and with the wings suddenly darkened mainly for their apical half, while in *Larra scapteriscica* n. sp., the length is from 12 to 14 millimeters in the female and the wings are generally more evenly infuscate. Other characters help to separate the two, the most dependable perhaps, are the biological ones, i. e. *Larra americana* preys on *Scapteriscus didactylus* and lays her egg just to one side of the mid-ventral line between segments 2′ and 2′ of the thorax, while *Larra scapteriscica* preys on *Scaptericus tenuis* and lays her egg equally or nearly equally across the mid-ventral line between segments 2′ and 2′ of the thorax. That their choice of prey-species is strictly adhered to was several times proven. A note of May 18, 1924, reads: "This morning, on two occasions I first offered to two separately imprisoned *Larra americana,* the mole-cricket, *Scapteriscus tenuis.* They did not accept these, but when a young *Scapteriscus didactylus* was substituted they actually could not await its insertion into their test tubes, each trying to get at the orthopteron while it was being squeezed past the cloth plug that stoppered up these containers"; and May 29: "I first gave a *Larra scapteriscica* an immature *Scapteriscus didactylus;* this she pounced upon and proceeded to sting (?), but almost immediately realizing her error, got off. A moment later she was presented with a *Scapteriscus tenuis,* which she attacked and parasitized. Even among their proper host-species not all individuals are

acceptable. Battles at large may be witnessed if one exercises a little patience, and I relate two such encounters taking place in the botanic gardens. "June 18. At about a quarter to ten in the morning, a *Larra americana* was observed hunting for her prey in a flat space with a sparse outlay of very low weeds. She had located the superficial burrow system of a *Scapteriscus didactylus* and was examining it minutely, piercing it occasionally and entering, or merely digging a little and then hardly investigating beyond a head-and-shoulder's depth. She touched the ground with her antennae as if trying to smell out her hoped-for victim. A couple of male *Larra* occasionally circled low and swiftly over the scene of the hunt, the larger of the two was rather attentive to the female so that when he whizzed close by her or perhaps struck her, she vibrated her wings. After poking about here and there, our huntress with very considerable interest entered a part of the superficial burrow, disappearing quite out of sight, as she had done once or twice previously. Now you could hear her squeakily buzzing within and soon she came out, tense with excitement, one might say, on the tip toes of expectancy, vibrating her wings and running about a little as though the cricket should issue forth from somewhere; however, nothing of the sort happened, so she resumed her search, and while alert, her ardor became less. She inspected this portion of the burrow and that one, once nearly disappearing in the soil. Finally she investigated the tunnel which she had been digging and that had stirred up such hopes, and quickly issued therefrom, expectant and seeming to know almost where to search for her now aroused victim; for about 9 inches away a rather small *Scapteriscus* suddenly pushed head and thorax out of the ground and paused for an instant, then came to the surface and attempted to escape; the wasp, however, was on the lookout, she pounced on it and subdued the struggling insect. At this juncture, I carefully placed a test tube over the twain; *Larra* quite unmindful of this act proceeded with her work, but soon noticing some small ants crawling on the base of the tube outside, the annoyed wasp with her inherent dislike of such insects and appearing to know that when ovipositing on the victim at her feet she must be undisturbed for some seconds, tried to drive away these ants by darting at them and striking against the glass."

If one carefully throws the proper species of cricket so it falls near a hunting *Larra* she will attack it readily. This had just been done when at a little distance away in the sand, another *Larra americana* was seen clinging to an active young *Scapteriscus* which was vainly twisting its body and running; despite this activity the egg was laid and *Larra* got off her victim, which went off on the run. One sees then, that there are different degrees in the severity of stinging, and one of the captive wasps usually quite severely stung her victims so that they were reduced to immobility, from which they recovered with comparative slowness.

These Pará *Larra* as with others observed, sting their victims in a systematic manner; first, one or more stings are administered in the center between the third and second pairs of legs, then between the second and first pair, and here perhaps more time is employed, and finally, beneath, on the side of the mouth parts or cheeks. Malaxation—kneading or chewing at the victim—is very often practiced, and one *Larra* that seemed to do this very vigorously to its poor victim was later found to have attempted the removal of a firm young *Larra* grub from its position on the cricket, in order to glue her egg in its place. A compromise seemed

to have been effected, however, and the egg was placed under the larva. This dual development was not followed out. Occasionally, a mole cricket that seems doomed by parasitization to serve as food for these wasps, cheats death by a timely moult, and the writer has twice found a freshly moulted laboratory specimen and nearby its cast skin bearing an egg upon it.

Many of the *Larra* were very eager to attack their prey, but when loath to do so, success sometimes followed if wasp and cricket were vigorously mixed up in the bottom of a test tube.

Ovipositions varied from one to three per day, and the intervals were usually considerable, though I did occasionally succeed in inducing a wasp to lay in rather quick succession, i. e., in reducing the time between the laying of the first and second egg to five or six minutes. Oviposition may be recognized—apart from seeing the egg issue, by the rather progressive trembling of the wasp's abdomen and its sharper curve as it appresses the egg in place. As a rule then, the *Larra* were unable to lay one egg immediately after another—this did not, however, always prevent one from attacking a second *Scapteriscus,* stinging it in the usual fashion and then sitting musingly upon her victim's back to be suddenly brought out of her trance by the recovery of the energetic cricket which struggles anew. The stinging has to be repeated and the wasp attempts to oviposit but her action is not vigorous, her body seeming to ineffectively curve around her victim and no egg is then forthcoming. One might conclude that not more than one or two ripe eggs are to be found at one time in her ovaries.

A number of oviposition records of these two *Larra* were kept. The wasps were placed for a short time in a test tube with their prey, and that method failing, in a jar with a little soil in which the crickets might burrow. The latter method was probably the better one and not so exhausting on the wasp. The following are the better records:

Larra scapteriscica

May 27	2	*Scapteriscus* parasitized
May 28	2	" "
May 29	3	" "
May 30	3	" "
May 31	2	" "
June 1	2	" "
June 2	3	" "
June 3	2	" "
June 4	1	" "

9 days, 20 eggs

Wasp released on account of my moving away.

Larra scapteriscica

June 17	2	*Scapteriscus* parasitized
June 18	1	" "
June 19	2	" "
June 20	2	" "
June 21	2	" "
June 22	1	" "

6 days, 10 eggs

Larra scapteriscica

May 29	2	*Scapteriscus* parasitized
May 30	3	" "
May 31	2	" "
June 1	1	" "
June 2	2	" "

5 days, 10 eggs

Larra americana (small specimen)

June 17	2	*Scapteriscus* parasitized
June 18	2	" "
June 19	0	" "
June 20	1	" "
June 21	3	" "
June 22	3	" "
June 23	3	" "
June 24	2	" "
June 25	2	" "
June 26	2	" "
June 27	2	" "

11 days, 22 eggs

June 28. Wasp stung but did not parasitize.

We see then that these wasps did not keep long in good condition as captives—one would expect their normal life to be of several weeks' duration. They were fed with honey and water and usually spent the night underground.

Two lots of parasitized *Scapteriscus* of both species were prepared during May and June, 1924, and one of about 50 specimens was shipped away in early June, but was delayed en route and so nothing came of it; the second lot with a total of about 66 crickets were taken to Honolulu via New York and San Francisco, a journey covering 28 days. By examining some of the small tins containing the parasitized *Scapteriscus,* both before and during this summertime voyage, an idea of the length of the life cycle of these *Larra* could be formed. Thus, about two weeks were required from egg laying to the spinning of the cask by the larva, and the entire life cycle in some cases occupied as much as 65 days, although about 50 days is perhaps a better average. All the wasps issued in the morning and mated readily in captivity. A few emerged and died en route, and upwards of two dozen issued in or before arriving at Honolulu. *Larra americana* prevailed in numbers. But it was only after considerable coaxing that these two wasp species parasitized *Gryllotalpa africana* that is common on the island of Oahu, Hawaiian Islands. The eggs were placed just as on the *Scapterisci* in Pará. A few of the egg-layers were probably unmated and none of their eggs hatched while those laid by other and mated females hatched in one or two cases, but the larvae were feeble and died in infancy. Two or three unmated *Larra americana* were liberated in Honolulu; a few died in captivity awaiting males, while on August 22 and 23, 1924, three males and three females (mated) *Larra americana,* and one male and four females (mated) *Larra scapteriscica* were set free in a wet field of sugar cane at Kahuku Sugar Plantation Company, Oahu, where mole crickets were much in evidence. The small number of wasps liberated as well as the apparently rather unsuitable prey for them makes the chances of their successful introduction here seem rather slight.

Liris Fabr.

This genus contains a moderate number of species of medium to rather large size, *Liris ducalis* Smith, measuring up to 30 millimeters long. None, as far as known, inhabits the New World. They are strong, swift fliers and altogether active and alert insects.

Liris haemorrhoidalis Fabricius

Subspecies **magnifica** Kohl

This is one of the handsomest of wasps. The female is about 21 millimeters in length and has the greater part of the body clothed with a glittering golden pile. This insect was studied at Halifax, North Queensland, Australia, and has much the same habits as *Liris aurata* of the Philippines, China and India. It was seen chiefly on the blossoms of *Crotalaria,* a leguminous plant, and flying or basking along the edges of cane fields, or again, in open spaces hunting its cricket prey.

The nest-hole of *magnifica* was found to be of greater length and depth than the tunnel of any other wasp observed, and my excavations in this connection

may have suggested to the curiosity, certainly justified, of more than one passerby, some sort of mining operations. On occasion, as in *Liris aurata* in the Philippines, the Australian species may lighten her task by taking advantage of the burrow of an animal or of some artificial excavation as a fitting place within which to start her own tunnel. The soil along the Herbert River, Queensland, is naturally alluvial and it revealed in the order of depth, black soil, sandy soil and finally muddy sand. Here I estimated two *Liris* tunnels measured in a straight line from mouth to terminus, as six and a half and five and a half feet, respectively, with a vertical depth of each of four and a half feet. Some other holes were not so deep, one extended two and a half, and another three and a quarter feet underground, but the first of these two at least lay deep in a plough furrow. They were then, as a whole, much inclined, the first tunnel descending rather steeply for perhaps three feet, then almost vertically for one and a half feet more, and finally at the last following a subhorizontal course. In fact, one might say that only the muddy nature of the lower stratum prevented the wasps from penetrating to greater depths.

In the beginning it proved quite a task to find the nest holes of this wasp, as it was difficult to follow these insects to their burrows. More often than not a wasp burdened with her prey was able to swiftly fly away with it, and even when the great weight of the paralyzed cricket necessitated a more or less terrestrial journey the chances of my success were not great. In such a case the trip frequently terminated within a field of well-grown sugar cane, a dense and noise-producing medium through which to travel.

Early in June, 1919, near the edge of a field of tall cane, a *Liris* was found struggling along with a very heavy young cricket (*Gryllus*) whose antennae were held in her jaws. She was headed for the big cane and hopped along laboriously with her burden. With considerable difficulty and often on hands and knees, I followed the vexed wasp—for she seemed aware of my presence—through about one hundred feet of cane. While keeping to the ground a great deal she attempted also, but with indifferent success, to scale the slippery cane stems and essay a sailing flight therefrom. So long as I refrained from quick gesticulation and did not make an unreasonable amount of noise, likewise the wasp remained too much engrossed in her victim and in the desire to reach her nest to pay undue attention to other objects. When she ascended well up a stem her course could be intercepted by gently interposing my hand, up which she would crawl, and then by lowering it the danger of a lengthy sailing flight, and thus of losing her, was obviated. But she was disturbed several times so that she dropped her burden and at a louder crash than usual abandoned the cricket altogether. Of course, her burrow was not discovered.

Better luck attended me in dogging the footsteps of the second *Liris*. She was hunting near the cane field, running along the harrowed ground, investigating beneath the clods and taking short flights and rests. To expedite matters, I captured a heavy young cricket and tossed it so that it fell quite near the wasp, then sunning herself. She approached and rather leisurely seized it, but very soon the cricket, which probably had been pinched to numbness in my fingers, suddenly awoke to realities and struggled violently in the wasp's grasp. A vigor-

THE AUSTRALIAN WASP LIRIS HAEMORRHOIDALIS ON THE SOIL-HEAP OF HER BURROW. × .6

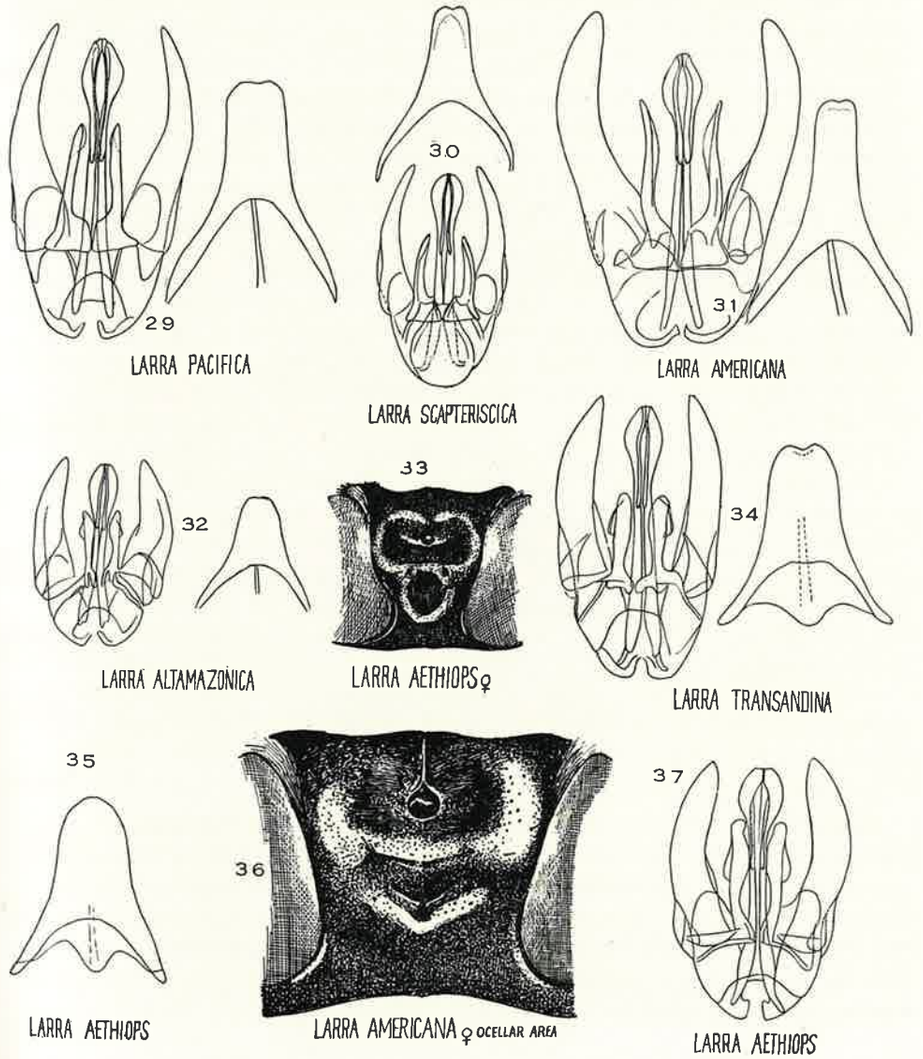


PLATE VI

ous sting soon quieted it.* Following a considerable delay, she grasped her victim by the antennae and crawled with it into the cane field, which she penetrated only for perhaps thirty feet and then entered the burrow of some animal.

Another heavily-burdened *Liris* deserted her burden after she had dragged it with great labor through about one hundred feet of cane. I have noticed a similar abandonment of prey in the case of the American larrid, *Tachytes rufofasciatus* (1913) and with a large black Australian *Chlorion* that finally adandoned an unmanageably heavy *Conocephalus*-like grasshopper.

Obviously our wasp does not finish with her tunnel for some weeks, since much labor is involved in excavating and storing it, for there are times when field crickets of suitable size are relatively scarce. Those burrows whose entrances have not been effaced by aging or erosion are readily betrayed by a considerable subconic heap of light sandy soil accumulated around their mouth and that contrasts strongly with the darker adjacent ground. Sometimes the proprietress will sun herself upon this cone but will alertly stand up to face any intruder (Pl. VI, Fig. 28). As with *Liris aurata* in the Philippines, more than one female wasp may patronize the same burrow, at least to some depth; on several occasions I noticed two such, but these did not appear to be on particularly amicable terms. They work also during the hours of darkness—as was ascertained by observing the amount of soil present at the burrows' entrance a short time before sunset and then again a little after 7 A. M. the following morning, when a notable addition of fresh soil had increased the size of the cone. Other wasps are known to work during the night, and the Peckhams (Instincts and Habits of the Solitary Wasps, Bull. 2, Scientif. Ser. No. 1, Wis. Geol. and Nat. Hist. Survey, 1898) have commented upon the nocturnal industry of *Crabro stirpicola* in Wisconsin, while quite recently Petrunkevitch (Jour. Exp. Zool., V. 45, No. 2, July 5, 1926), in experimenting with the tarantula (*Cyrtopholis portoricae*), and the tarantula-hawk (*Pepsis marginata*) in Porto Rico, found that the wasp on one occasion dug a hole and stored it during the night.

CELL OF LIRIS HAEMORRHOIDALIS, SUBSPECIES MAGNIFICA
× 1.13

FIGURE 3

The cells of *Liris* are quite ample (text figure 3), and contain a varying number of victims. The first nest of *Liris* dug up contained three cells, of which one imprisoned a single cricket, fairly active and alert and across whose breast between the first two pairs of legs was affixed the wasp's egg; the second cell revealed a cocoon, while the third, which was quite large, had remains of crickets

* The wasp will not always accept a cricket thrown down before her; such insects may suffer only the slightest examination.

and fifteen fly larvae, each eight or nine millimeters long. These flies were muscoid parasites deposited by the mother as eggs or young larvae upon and near the cricket.

A second nest yielded a perfect cocoon (text figure 4), three dead crickets, one of which was parasitized, and other cells with remains of crickets and of cocoons.

The most extensive burrow was one with the numerous cells, all down near the mud zone. One side branch terminated apparently in two cells, each with a cocoon, while a second branch gave forth eight or nine chambers, some of which contained immature and mostly solitary crickets with wasp eggs or young larvae attached; the former cricket victims retaining considerable liveliness while those with larvae were enfeebled or dead. A single cell was stored with three crickets.

A fourth nest of three cells showed contents as follows:

Cell 1	1	mature	female	cricket	and	2	immature	crickets
Cell 2	1	"	"	"	"	2	"	"
Cell 3	1	"	"	"	"	1	"	"

A cricket in each cell was parasitized in the usual place.

The cells are smooth-walled, more or less oval and of very ample proportions; one measured 45 by 18 millimeters. In relation to the long axis, they are horizontal or nearly so, and when fully stored are stoppered with sandy soil. The crickets stored are always fairly well grown, of either sex, and often mature, and while frequently moving briskly when disturbed, they nevertheless have been so incapacitated by the wasp's sting as to be quite unable to dig their way out of the cell.

The wasp's egg is about 4 millimeters long and somewhat curved. A well-grown larva measures 22 millimeters and as in related genera bears conspicuous lateral processes on the thorax (text figure 3). The cocoon may exceed a length of 21 millimeters. It is broadest at the head end and a shade paler there; its texture is rather brittle since its constituents are agglutinized grains of sand.

None of the wasps was reared. Natural conditions here were difficult to imitate—with the young wasps housed so far underground where both temperature and moisture conditions must have been rather uniform through long periods of time.

COCOON OF LIRIS HAEMORRHOIDALIS, SUBSPECIES MAGNIFICA
× 1.8

FIGURE 4

The Larrid Wasp **Tachytes mergus** Fox and **Tridactylus,** Its Cricket Prey

The large garden at No. 55 Rua Mundurucus, Belem, Pará, was a rich field for the biological entomologist. Five or six kinds of larrid wasps, a bee or two, and several ants mined its clean sandy soil, while at least four species of crickets

of more or less subterranean habit served as prey for as many of the larrid wasps. Of these the little *Tachytes mergus*, a wasp found in both North and South America, stored its burrows with one of the "sand or pigmy mole crickets," probably the widespread *Tridactylus apicalis* (Say), a tiny creature plentiful in Pará, with wonderful leaping powers and whose superficial burrows suggest those of the true mole crickets (Gryllotalpinae) on a small scale. *Tachytes mergus* is a stout blackish insect about 9 mm. long, a very distinct species in having unusually slender mandibles for the genus, a clypeus in the female armed with two prong-like processes, and with the triangular pygidium provided with comparatively few stout bristles. During my two months' stay (throughout May and June, 1924), in and near Belem, this wasp was often seen engaged in nesting activities. She digs a rather short sloping burrow, biting out the earth and backing to the surface with the load held to her chin and breast by means of mouth and fore legs; when a couple of inches or so from the mouth of the burrow she deposits her load, and balancing herself on the middle pair of legs scrapes back the soil by means of the fore legs whose tarsi are provided, rake-like, with a few stiff spines, and finally, she may brush it still farther away with the third pair. The nest seems a single-celled affair. In seeking her victims the little *Tachytes* briskly examines the superficial upheaved burrows, proceeding in runs, or a short flight takes her to another hunting ground; as the *Tridactylus* is exceedingly active in its immense, lightning swift leaps, the wasp does not follow up its tunnels but merely pokes in her head and fore part and then backs out; sometimes quite expectant. Or she will pass back and forth between two proximate openings in a tunnel, with great rapidity, much in the same manner as an eumenid wasp that when striving to anticipate the moves of her prospective victim, wheels swiftly from one end to the other of the leaf-roll that harbors the uneasy caterpillar. But even with such precautions, *Tridactylus* by one of its marvelous leaps may succeed in escaping her enemy; the wasp, however, is herself very swift and sometimes captures and even stings the orthopteron while in mid air. The relatively small cricket, which may be young or full grown, is easily carried nestwards on the wing and stored to the number of a half dozen or so in an ample cell; several such provisioned cells were exposed; in one case especially noted all the inmates were active, in fact, when I attempted to bottle some of them they disappeared in tremendous leaps. Presumably these insects are paralyzed for the anterior or digging legs; at any rate they lack the initiative to dig their way out. The wasp egg is secured probably across the breast of one of the crickets; a quarter grown larva was found in one cell feeding on the provender. In digging for mole crickets (*Scapteriscus*), the prey of wasps of the genus *Larra,* cocoons of *Tachytes mergus* as well as of *Notogonidea* sp., also a cricket-hunter, were often unearthed. The cocoons are cylindrical and rounded at both ends and composed of grains of sand glued and spun together to form a rigid cask. Several wasps were hatched from them.

Not many Tridactylinae appear to be of economic importance. Dr. A. da Costa Lima in his Catalogue of Economic Plant-Feeding Insects of Brazil (Archivos da Escola Superior de Agricultura e Medicina Veterinaria VI, p. 110, 1922) states that *Tridactylus politus* Bruner sometimes causes much injury to the *Eucalyptus* seedlings in the Botanical Gardens in Rio de Janeiro.

The tropical American tridactyline genus *Rhipipteryx,* of which seventeen species are listed in Kirby's Catalogue (1906) contain some comparatively large striking forms. An excellent figure of a *Rhipipteryx* is to be found in the Cambridge Natural History V, Insects by David Sharp, p. 338, 1895. *Rhipipteryx marginata* Newman measures 12 or 13 millimeters long, is dull blackish, more or less margined with pale yellowish; its forelegs do not suggest digging abilities, nevertheless it does penetrate the soil, for in excavating in earth banks on the edge of the jungle in the Pará district, I often exposed a neat cell containing one of these insects in the last (?) or next to last stage, the cast skin lying beside the cricket. The adults were common on moist banks, other soil masses, leaves of shrubs, etc.; they proved very strong jumpers, but the decidedly slow planing flight on ample wings, subsequent to the leap, made them easy to capture.

Larra pacifica n. sp.

(Pl. VI, Fig. 29 ♂, armature)

Female, type: Length 13.5 mm. Rather slender. Head and thorax black, abdomen reddish, mandibles reddish apically, spines on legs dark reddish, wings moderately infuscate for apical half. Clypeus with margin gently produced as a low wedge with its middle third or less subtruncate, rather widely polished along its middle edge and with but few punctures there; antennae (broken), the left one still with 3 joints, but interocular space at vertex obviously greater than antennal joints 2+3; second joint hairy though rather polished; depressed area at vertex posterior to ocelli small, shallow and extended posteriorly as a heavy impressed line; vertex with well separated punctures; mesothorax separately but heavily punctured; disc of propodeum so closely punctured as to produce a reticulate effect, and with a fine carina for three-fourths its length and lying in a low and longitudinal trough, pleura polished and with finer, well-separated punctures; posterior face densely punctato-reticulate and with indistinct carinulae on outer upper face, a median impressed line; anterior tibiae with some spines on upper surface; wings with the abcissae in following order of increasing length: 2, (5 and 1 subequal), 3 and 4; 2 being very narrow, and 5 well truncate from the costal margin. Pygidium about 2 times as long as wide, its margins bowed out, somewhat constricted before the narrow apex, the disc with sparse punctures. Vestiture: sparse, pale golden.

Male: allotype: Length 12.5 mm. Spines and abdomen paler than in female; clypeus gently rounded out, slightly truncate mesially; joint 3 of antenna fully one and one-half times as long as 4; interocular space at vertex wide, about equal to joints 2, 3 and 4; depressed area posterior to ocelli about as in female. Puncturation of thorax denser than in female, the pleura of propodeum finely and closely punctured and with some fine close wrinkles; disc lacking carina, depressed mesially towards apex, posterior face punctato-granulate, in certain lights with fine, more or less transverse carinulae and with a median fovea, widening above. Abcissae about as in ♀. Last ventral segment fairly elongate and parallel-sided, slightly notched apically; armature, rather slender, sagittae with apex spatulate from dorsal side. Vestiture: silvery golden and rather dense.

Female, type. Bucay, Eastern Ecuador, 1,000 feet, October, 1922. Male, allotype, and six male paratypes, Tena, Eastern Ecuador, 1,850 feet, February, 1923 (F. X. Williams).

Distinguished chiefly by its broad vertex and weak depressed area at vertex posterior to the eyes with its linear extension (to occiput in ♂), and with the pygidium slightly constricted at apex. Somewhat related to *Larra americana* Sauss. of Pará, Brazil.

Larra aethiops (Smith)

(Plate XXXIII, Fig. 235, ♀ pygidium; Pl. VI, Fig. 33, vertex, ♀; Fig. 37, ♂ armature)

As the description of this wasp is rather brief though good for the time (Ann. and Mag. Nat. Hist. XII, 4th Ser., p. 56-57, 1873), and since it is closely related to the following species, I append a description of it based on specimens from Ecuador. One of these females was compared for me with the type in the British Museum:

Female: Length 17 mm. Stout, shining black including most of spines; mandibles reddish except at base, wings dark fuscous with violet reflections, clypeus gently rounded out but with a very shallow emargination mesially, polished and rather closely punctate only for its basal half, second antennal joint glabrous, 3 longer than 4; interocular space at vertex narrow, about equal to 3+¼ of 4; vertex shining, with well scattered punctures, depressed area posterior to ocelli deep and semicircular, and posterior to this it is polished and with only a few punctures; dorsum of thorax strongly punctured, scutum with an obscure and fine carina part way down the middle, pleura with strong separate punctures; disc of propodeum with rather large, very close-set punctures giving a reticulate effect, in the middle and at sides with more or less indistinct fine transverse carinulae, only a slight basal indication of a longitudinal carina, pleura with finer, more separate punctures, posterior face punctured between fine, more or less obscure transverse wrinkles and with a fine median impressed line; anterior tibiae with a row of spines above; wings with abcissae in the following order of length: 2 (5 and 1 subequal), 3 and 4; truncation (5) oblique and rather curved off the margin; abdomen very polished; pygidium about 2¼ as long as wide and tending to be parallel-sided, the extreme apex pale brownish and drawn to a point. Vestiture: very sparse, silvery, except on mesonotum where it is mainly brownish.

Male: Length 14 mm. Much like the ♀ but duller and more pilose. Mandibles all reddish, clypeus with a very gentle median emargination and rather heavily punctured back from the base; antennal joints 3 and 4 subequal; interocular space at vertex about equal to 3+⅔ of 4; wings not quite as fuscous in this sex; disc of propodeum with a slight carina about half its length, otherwise punctato-granulate, with no less-closely punctured, and therefore shining area at the apex; last visible, ventral segment dark, broad and angularly rounded outwardly; armature with broad pilose claspers and the sagittae with the rather slender head not more chitinized than the remainder.

The females (2) are from Tena and vicinity, Eastern Ecuador (1850—2,000 ft.); males from Tena (1), and from Bucay (3) 1,000 ft., Western Ecuador.

The female is recognized mainly by the subparallel-sided, narrow pygidium, the male chiefly by the tolerably slender head of the sagittae and by the uniformly punctato-granulate disc of the propodeum. The clypeus of the male may be slightly rounded out, and the last visible ventral segment is rather variable. Two of the males have the abdomen more or less suffused with reddish.

Larra transandina n. sp.

(Pl. VI, Fig. 34, armature ♂)

Female, type: Length 17.75 mm. Head and thorax black, abdomen red, mandibles tinged with dark red; wings infuscate, with violet reflections, spines dark brown. Clypeus broadly rounded out, quite shallowly though widely notched mesially, polished and almost without punctures along the margins, widely so mesially; frons polished and sparsely punctured; depressed area on vertex deep angulate semicircular, the thick horseshoe ridge sparsely punctured, separated on either side in front in certain lights by a fine impressed line, second antennal joint glabrous, 3 longer than 4, the interocular space at vertex slightly less than 2+3; about equal to 3+½ of 4; scutum with separate and strong punctures, the scutellum more polished and with finer sparser punctures, pleura with shallow punctures; disc of propodeum with strong close punctures, more polished on either side of median line for more than apical half, with a weak median carina for basal half and some delicate carinulae across the middle, posterior face rather polished, shallowly punctured, a median impressed line running above into a rather

obscure substriate wedge; legs strongly spinose, with a strong row of spines for more than the apical half, on the fore tibiae above. Wings with abcissae in the following order of increasing length: 2 (1 and 5 subequal), 3 and 4, the truncation (5) oblique and with a short stub. Abdomen polished; pygidium with the sides outbowed, about one and one-half times as long as wide, the disc with very few punctures. Vestiture: very sparse, pale golden on face, pleura and legs.

Distinguished from *L. aethiops* (Sm.) ♀ mainly by having the sides of the pygidium outbowed and not nearly parallel-sided.

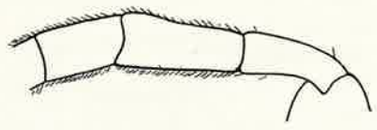
Male, allotype: Length 12.5 mm. Very like the ♂ of *L. aethiops;* differing rather doubtfully from it, having the disc of the propodeum punctato-granulate, excepting an area at the apex where by reason of less close punctures it is there rather polished. Clypeus as in *aethiops*, nearly transverse for middle margin, interocular space as in *aethiops* and like it the post ocellar depression is rather deep.

Female, type and male allotype, Tena, Eastern Ecuador, 1923; paratypes, 14 ♀ ♀ from Tena and Bucay, Ecuador, and Campinas, Brazil (1), and 3 ♂ paratypes from Tena, Eastern Ecuador, 1923 (F. X. Williams). 1 ♀ paratype is all black and 1 ♂ paratype has the abdomen reddish.

Larra altamazonica n. sp.

(Text Fig. 5, fore part antennae, ♀; Pl. VI, Fig. 32, armature, ♂; Pl. XXXIII, Fig. 230, pygidium, ♀, type)

Female, type: Length 12 mm. Head and thorax black, abdomen red, mandibles mainly reddish, tarsi partly brownish, spines dark brown to nearly black, wings rather lightly infuscate. Clypeus rounded out, tending slightly to form a low wedge, the disc with a few large scattered punctures and finer more close set ones at sides and base, the margin broadly almost impunctate; frons and vertex polished and with the punctures scattered; depressed area at vertex semicircular and very deep, the space posterior to it very polished and practically impunctate; joint 2 of antennae glabrous, 3 much longer than 4, interocular space at vertex about equal to joints 2+3; mesothorax with large, well-separated deep punctures; disc of propodeum with large close punctures almost reticulate, particularly for the basal two-thirds along the broadly though shallowly depressed middle, where it is also duller, a slight indication of a fine median carina; pleura polished, with rather fine, well separated punctures, posterior face with a median impressed line and closer punctures, femora particularly stout, fore tibiae with spines above; wings with abcissae in following order of increasing length: 2 and 1 subequal, 5 (3 and 4, subequal). In paratype: 2, (1 and 5 subequal), (3 and 4 subequal); the truncation is oblique, and rounded from the margin. Abdomen polished, pygidium particularly broad, the margins rather well outbowed, the apex acute, the disc with a few large lateral and some smaller punctures mesially and about as long as wide. Vestiture: very sparse, wanting on face and vertex, yellowish silvery elsewhere, except pale brown on mesonotum.



LARRA ALTAMAZONICA ♀

FIGURE 5

Male, allotype: Length 10 mm. Abdomen much invaded by blackish; mandibles and spines mainly reddish brown, wings slightly paler at base. Clypeus very gently rounded out, subtruncate in the middle, not punctured near the margin, punctures in the middle field away from base well scattered, frons punctured along sides and above, vertex rather coarsely and separately punctured, the two depressions rather deep, the post-ocellar one arcuate posteriorly as in ♀; antennal joint 3 very little longer than 4, and together a trifle greater than interocular space at vertex; thorax with large though well separated punctures; disc of metanotum nearly all granulate punctured, a polished,

large punctate apical area, a very slight median furrow and apical depression crossed by a few carinulae and a trace of a longitudinal carinula, the pleura with rather fine, well spaced punctures, posterior face subgranulate, with an incised line; abcissae of forewings in following order of increasing length: 2 (very short), 1 and 4 (subequal), 3 and 4 subequal); last visible ventral segment very slightly notched, armature as figured. Vestiture: silvery with slight golden tinge, rather dense on frons and thorax.

Type; from Tena, Eastern Ecuador, 1,850 feet, 1923; allotype, Belem, Pará, Brazil, May, 1924; paratypes, 2 ♀ ♀ and 1 ♂, Jabaty, Para, Brazil, May, 1924. (F. X. Williams.)

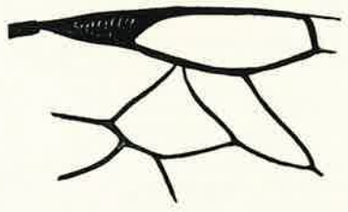
The ♀ is easily distinguished by its glossy vertex with its semicircular, very deep depressed area plus the very broad pygidium. The paratype has abcissa 2 of forewings longer than in the allotype. It is close to *L. aethiops* but has less infuscate wings.

Larra scapteriscica n. sp.

(Text fig. 6, venation, ♂ allotype; Pl. VI, Fig. 30, armature, ♂ allotype; XXXIII, Fig. 237, pygidium, paratype)

Female, type: Length 11.35 mm. Head and thorax black, abdomen red, mandibles reddish apically, spines mainly reddish brown, wings lightly infuscate for apical half. Clypeus gently rounded out tending to be wedge-shaped, with close punctures except broadly along the middle edge where the punctures are very sparse, and narrowly on either side; frons with some fine punctures, the post-ocellar depression rather shallow and wedge-like posteriorly, the area behind it sparsely punctured; antennal joint 3 much longer than 4, interocular space at vertex about equal to joints 2+3, or 3+4. Notum and pleura with close punctures; disc of popodeum without a median carina, and but slightly and broadly depressed mesially, appearing granulate (as close punctures and fine, mainly transverse carinulae, the latter more developed mesially), pleura with close punctures, the posterior face with fine transverse wrinkles and punctures and a median impressed line; fore femora with a row of six subequal spines from apex to about middle of upper side; abcissae of forewings in following order of increasing length: 2 (very short), 5 and 1 (subequal), 3 and 4; pygidium about 1⅔ as long as wide, marked off pyriform by a submarginal groove, disc with quite sparse and weak punctures. Vestiture: rather sparse silvery pile.

Male, allotype: Length 10.5 mm. Colored as in ♀; wings infuscate for apical portion. Clypeus about as in ♀; post-ocellar depression rather shallow, broadly angulate and with a posterior median furrow from it; interocular space at vertex about equal to antennal joints 2+3+4, joint 3 much longer than 4; disc of propodeum punctato-granulate, with a median carina extending to near apex; abcissae of forewings in following order of increasing length: 2 (exceedingly short, the two veins almost fusing at the radius), 5, 1, 3 and 4. Last visible ventral segment about as in *Larra pacifica*, as also the armature, 3 but in *scapteriscica* the apex of the sagittae is pointed and not curved spatuliform.



LARRA SCAPTERISCICA ♂

FIGURE 6

Type, 9 ♀ ♀ and 2 ♂ ♂ paratypes, Belem, Pará, May-June, 1924; allotype and 2 ♀ ♀ paratypes, Jabaty, Pará, May, 1924. (F. X. Williams).

Related to the larger *L. americana* and *pacifica;* it differs from *L. americana* in the ♀ also in lacking the median carina of the propodeum, the notal punctura-tion, particularly that of the scutellum is coarser, and the pygidium is rather pyriform instead of nearly straight sided as in *L. americana;* from *L. pacifica* ♀ it may be distinguished by the definite though shallow post-ocellar depression and the lack of a furrow proceeding posteriorly from it; the ♂ differs from these two species in the armature (sagittae), the second abcissae and slight differ-ences at the vertex, the post-ocellar depression being somewhat more distinctly and more deeply margined posteriorly in *scapteriscica.*

The males of some of these South American *Larra* are very difficult to dis-tinguish; the following table, however, should work out fairly well for the females.

FEMALES

1. The depression behind the two posterior ocelli is exceedingly shallow and weakly indicated wedge-like posteriorly and interrupted there by a deeply incised line extending toward the occiput.....*L. pacifica.*
   The depression behind the two posterior ocelli shallow or deep; if shallow it is well indicated posteriorly and sometimes interrupted there by a feeble line or a narrow wedge.....2.
2. Second joint of antennae (=1st. joint of flagellum) polished, glabrous, or with a few scattered hairs; post-ocellar depression deep and well rounded semi-circularly posteriorly in the depression.....3.
   Second joint of antennae pilose and pitted much like the following; post-ocellar depression shallow, and margined more or less wedge-like posteriorly.....5.
3. Pygidium scarcely longer than wide; wings nearly clear, abdomen red.....*L. altamazonica.*
   Pygidium distinctly elongate, wings always distinctly infumate, abdomen red or black.....4.
4. Pygidium nearly parallel-sided; abdomen black.....*L. aethiops.*
   Pygidium not parallel-sided but wedge-like, abdomen red or black....*L. transandina.*
5. Forewings infumate from base to apex; vertex behind post-ocellar area with rather sparse but strong, regularly spaced punctures.....*L. guiana* (?) (=*gastrica?*)
   Forewings paler for basal half or more, vertex behind post-ocellar area very sparsely punctured to almost impunctate, except next the occiput.....6.
6. Larger wasps; generally at least 15 mm. long; propodeum with a median carina extending a considerable distance down from the base; scutellum with a few large scattered punctures among many well separated small ones; pygidium with each side nearly straight.....*L. americana.*
   Smaller wasps, from 11-14 mm.; propodeum with the median carina very weak, only basal, or wanting; punctures on scutellum larger and deeper, thus obscuring the few, slightly larger ones, pygidium more or less pyriform.....*L. scapteriscica.*

MALES

1. Post-ocellar depression shallow, its posterior margin not much angulate; species with the interocular space wide, equal to or greater than the length of antennal joints 2 + 3 + 4.....2.
   Post-ocellar depression rather deep and narrower, with a well rounded or angulate posterior border (in the depression), interocular space narrower, usually less than antennal joints 3 + 4.....3.
2. Sagittae of armature gently sinuate, turned outwardly at tip, where they are spear-like.....*L. americana.*
   Sagittae of armature very nearly straight but widened dorso-ventrally at the tip somewhat spatuliform and there rounded.....*L. pacifica.*
   Sagittae of armature gently arcuate inwardly, slightly spatuliform dorso-ventrally and pointed at tip.....*L. scapteriscica.*
3. Wings but slightly infumate.....*L. altamazonica.*
   Wings well infumate.....4.
4. Disc of propodeum punctato-granulate, but at the apex the punctures become separate and a polished curved area is thus formed; abdomen in part or wholly reddish, sagittae more slender at head.....*L. transandina.*
   Disc of propodeum uniformly punctato-granulate lacking a less closely punctured and therefore polished apical area; abdomen black to red, sagittae with head thicker.....*L. aethiops.*

There are several males from the lowlands of British Guiana which I cannot satisfactorily separate from *L. transandina* or *L. aethiops;* the male of *L. guiana* (= *L. gastrica*), judging from the several females which I have identified as this species should have a wider vertex than *transandina* or *aethiops*.

Larra rubricata (F. Smith, Cat. Hymenop. Brit. Mus., p. 286, 1856) as described and by comparison for me with the type in the British Museum, is plainly a *Notogonidea* (subgenus *Cratolarra* Cam.), having the hind tibiae carinate, the second abdominal tergite somewhat carinate and the pygidium very nearly bare and provided with subapical bristles.

III.

THE LARRIDAE OF THE PHILIPPINE ISLANDS

The collections upon which this paper is based consist of about 2,200 specimens of Larridae, mainly from the Philippine Islands, but including also wasps from Singapore, Borneo, Japan, etc. About two-thirds of this material, embracing all of that from Singapore and Borneo, was collected by C. F. Baker, Dean of the College of Agriculture, Los Baños, Philippines, while the remaining third was collected chiefly by the writer, with smaller collections from C. E. Pemberton and F. Muir, of the Hawaiian Sugar Planters' Experiment Station.

The Philippine Islands of Sibuyan, Samar, Leyte, Palawan and Basilan, from which Professor Baker also secured collections, were not visited by the writer; the bulk of the Larridae, however, come from Mount Makiling, Los Baños, Luzon, and the immediate vicinity, an exceedingly rich biological region.

The Philippine Archipelago belongs to the Indo-Malayan Subregion, a part of the Oriental Region, and it lies wholly within the torrid zone, its southern extremity approaching to within a few degrees of the equator. It is only in the loftier mountains then, that temperate conditions prevail.

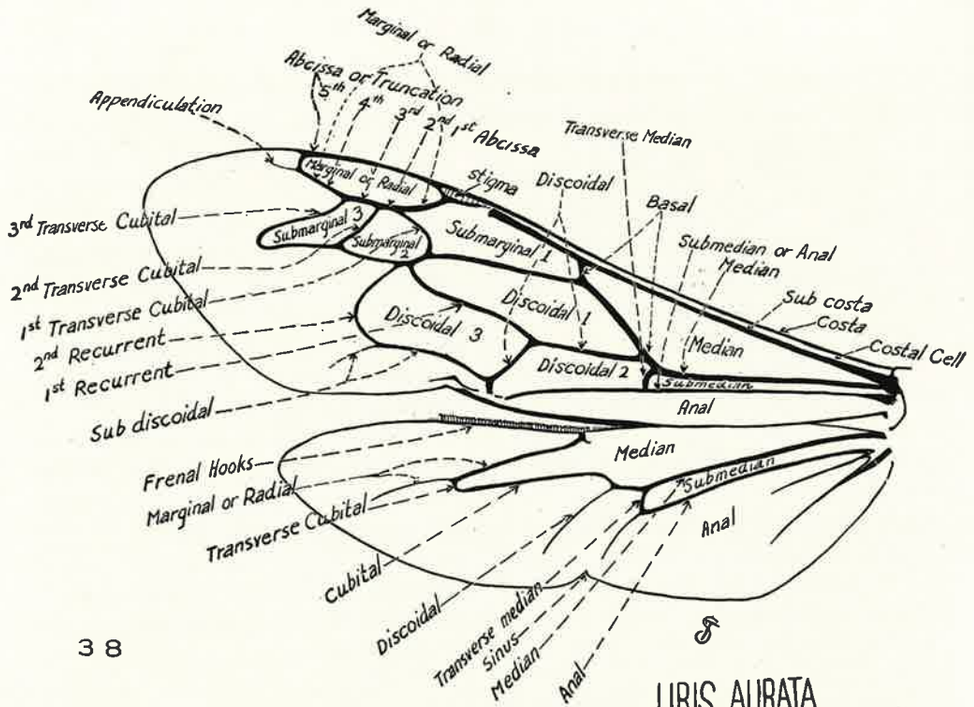
The great majority of commonly observed wasps in which the ovipositor or egg-laying apparatus has become so modified as to function mainly as a sting are classified by Ashmead under two great superfamilies, the Vespoidea and the Sphecoidea (or Sphegoidea). The Vespoidea includes the various social wasps (*Vespa, Polybia, Polistes, Icaria,* etc.), their relatives, the Eumenidae and the Masaridae of solitary habit; most of the spider wasps, or the Psammocharidae, and a large group, the Scoliidae, and others that prey upon the grubs of beetles. Such wasps have the prothorax usually well developed and produced arch-like posteriorly so that the hind angles extend to the tegulae or scales at the base of the forewings. The Sphecoidea—often regarded as a single family—are all solitary and I believe generally recognized as the wasps most closely related to the bees, and here the prothorax may be hardly more than a collar, and the lateral angles while frequently well produced as lobes that extend below and at times beyond the tegulae very rarely come into actual contact with them.

In the main the writer favors Ashmead's classification of the Sphecoidea (Can. Ent., XXXI, p. 145-155, 1899) as appearing to him best adapted for handling this great assemblage of wasps.

The Larridae form one of 12 or 13* families of Sphecoidea and while they have probably arisen from more than one stem—since they are here made to include such distinctly related genera as *Larra* and *Nitela*—constitute nevertheless a fairly natural group.

The following table built up from various sources may serve with the aid of illustrations (Pl. VII, Figs. 38 and 39) of *Liris aurata* to separate the Larridae from the rest of the Sphecoidea. It is used here, not to show relationship but as a convenient table of elimination.

* The Cerceridae are usually included in the Philanthidae and the writer here follows Rohwer (in Hymenoptera of Connecticut, 1916) in separating them.



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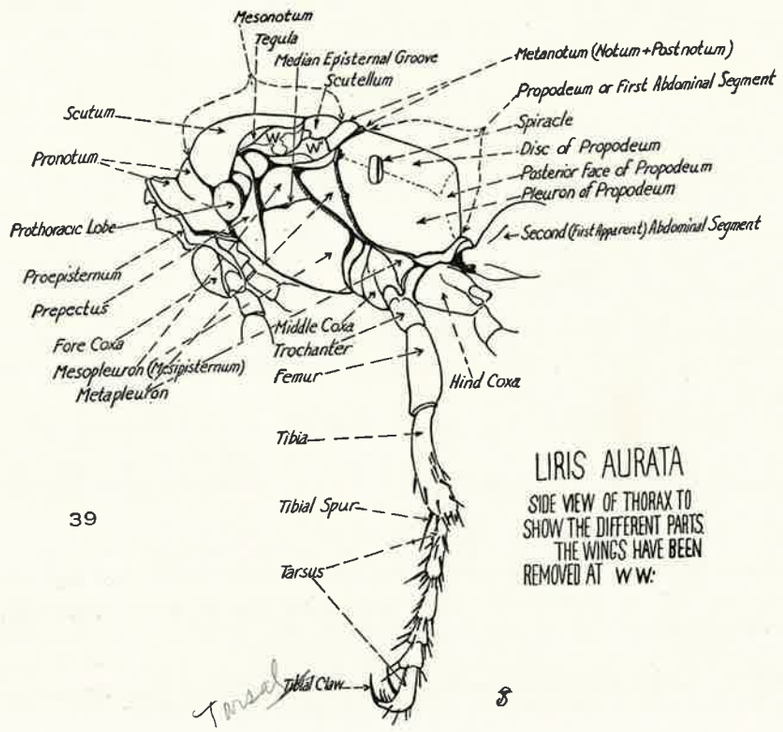
LIRIS AURATA
WINGS TO SHOW VEINS AND CELLS



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LIRIS AURATA
SIDE VIEW OF THORAX TO SHOW THE DIFFERENT PARTS. THE WINGS HAVE BEEN REMOVED AT W W.

PLATE VII

1. Middle tibiae with two apical spurs—*Mellinidae, Nyssonidae, Stizidae, Sphegidae* and *Ampulicidae.*
   Middle tibiae with but one apical spur or with none.....2.
2. Prepectus wanting.....*Cerceridae* and *Bembicidae*
   Prepectus present .....3.
3. Eyes deeply emarginate within, mandibles not notched beneath; abdomen oval or clavate; generally spider-catching wasps with mud-daubing habits . . .*Trypoxylonidae.*
   Eyes most frequently normal (rather deeply emarginate in *Trachypus* (Philanthidae) a neotropical genus, which has three submarginal cells and the abdomen long-petiolate) .....4.
4. Abdomen petiolate, the petiole, often very short, is angular in cross section and formed mainly or wholly by the first ventral segment; marginal cell terminating acutely on the costal margin.....*Pemphredonidae* or *Psenidae.*
   Abdomen usually sessile, if petiolate then the petiole is more or less rounded in cross section and formed by the first dorsal segment; when the first segment is sessile then its dorsal and ventral parts both join the thorax.....5.
5. Abdomen with a constriction between the first and second ventral segments forming a wide transverse notch there (*Aphilanthops*), or the constriction encircling between the first and second or more segments (*Philanthus*), or the first abdominal segment forming a distinct petiole (*Trachypus*); three submarginal cells; eyes often emarginate; ocelli perfect.....*Philanthidae.*
   Abdomen without any such constrictions; eyes rarely shallowly emarginate (Pisonopsis) .....6.
6. Forewings with but one submarginal cell; hind wings with at least one well defined and closed cell; ocelli perfect.....7.
   Forewings with from one to three submarginal cells; if with but one submarginal (*Nitela*, and *Rhinonitela* N. Gen.) then the venation of the hind wings is nearly obsolete; posterior ocelli sometimes distorted; mandibles frequently notched within; eyes usually converging towards vertex or parallel within.....*Larridae.*
7. Head large, subquadrate, temples broad; eyes strongly converging towards clypeus; first submarginal and first discoidal cells separate, abdomen often petiolate.. .....*Crabronidae.*
   Head of moderate size, transverse; eyes nearly or quite parallel within; first submarginal and first discoidal cells confluent; metanotum and propodeum more or less armed, abdomen sessile.....*Oxybelidae.*

The Larridae then, have but a single apical spur on the intermediate tibiae, the prepectus is defined, the marginal cell more frequently truncate and with an appendiculation, the mandibles often notched on the lower side nearer the base, the eyes entire (slightly emarginate within in the American genus *Pisonopsis,* which thus and in venation approaches *Pison* (Trypoxylonidae)), and usually converging towards the vertex or more or less parallel-sided, the ocelli perfect or the posterior pair reduced and distorted. The larvae, so far as I have observed them, have the lateral thoracic tubercles particularly well developed in maturer specimens; this applies to the larger species, and at least to the genus *Silaon* which includes very small wasps. The cocoons are oblong cylindrical, tapering slightly more towards the base, and rounded at the ends and fashioned of the materials—comminuted and glued together—in which the full-fed grub finds itself (see text figure 4, and plate V, figure 24). Much resembling the cocoons of the Larridae are those of many *Pison* and of some *Trypoxylon,* but these are as a rule more evenly cylindrical, while in some Bembicidae and Gorytinae, etc., on the other hand, the basal portion is usually more conical.

The most typical Larridae are those with the posterior ocelli distorted and the mandibles notched beneath, nevertheless the genus *Lyroda,* which has the three oceli perfect is in all other respects a true larrid, and from *Lyroda* it is an easy step to *Plenoculus,* having the second submarginal cell petiolate, and further, to *Silaon,* in the wide sense, where the mandibles are not, or rather feebly notched

beneath. The Old World genus *Liris* while having the posterior ocelli distorted has the mandibles feebly or not notched. The Neotropical genus *Scapheutes* in facial aspect and sometimes in markings, suggests a crabronid, the well facetted eyes converging strongly towards the clypeus. It would seem that where the vertex is narrow, as in typical Larridae, the two posterior ocelli through lack of space have thereby become reduced or distorted.

The Philippine Larridae have both Australian and Oriental affinities, the latter predominating. To some extent insular variations occur, but these are not sufficiently pronounced nor stable enough as a rule to warrant separating into species. Most of the species that are found in the Philippines appear to be peculiar to that archipelago; the following Larridae, however, are known to occur outside these islands as well: *Larra carbonaria* (Smith), *Notogonidea subtessellata* (Smith), *Notogonidea laboriosa* (Smith), *Notogonidea manilae* (Ashmead), *Liris aurata* Fabr., *Tachysphex bengalensis* Cameron, *Lyroda formosa* (Smith) and *Lyroda venusta* Bingham. It is only fair to state, however, that these wasps have not been sufficiently collected in Malasia and elsewhere in the Orient, nor studied in the proper comparative manner to justify any very definite conclusions as to their endemicity, distribution and variation in the Philippines. Two larrid wasps described from the Philippines are here made synonyms of Indian species; others perhaps will share a similar fate in the future.

Little taxonomic work has been done in representatives of this family of insects from the Philippines. F. Smith (Cat. Hym. Brit. Mus. Pt. IV, p. 278, 1856) described *Notogonidea laboriosa* (as *Larrada laboriosa*) from the "Philippine Islands." W. H. Ashmead (Proc. U. S. N. M., XXVIII, p. 130, 1905) described *Notogonidea manilae* (as *Notogonia manilae*). S. A. Rohwer (Proc. U. S. N. M., XXXVII, p. 659 and 660, 1910) described *Notogonia crawfordi* and *Notogonia manilensis,* these having now been found, as suggested by the describer, to be one species, and now determined as the female and male of the Indian *Notogonidea laboriosa* (Sm.); and the same author in "Philippine Wasp Studies", Ent. Ser. Bull. 14, Exp. Sta., H. S. P. A., Honolulu, Part I, 1919, describes *Dicranorhina luzonensis, Cratolarra pitamawa, Tachytes banoensis, Notogonidea luzonensis* (a synonym of *N. subtessellata* (Sm.) of India), *Notogonidea williamsi* (a synonym of *N. manilae*), and *Larra luzonensis.* In Part 2, "Philippine Wasp Studies", F. X. Williams describes *Hyloliris mandibularis,* new genus and species, and in the present bulletin (No. 19) 1 genus and 28 species are described as new out of a total of 12 genera and 41 Philippine species.

Among the more important papers relating to Larridae are those by Kohl (Die Gattungen und Arten der Larriden *Autorum,* 1884), and Die Gattungen der Sphegiden (Annalen des K. K. Natur. Hofmus., Bd. XI, Heft. 3, 1896), by Fox (The North American Larridae, Proc. Acad. Nat. Sci. Phil., 1893), by Ashmead (Can. Ent. 31, 1899, etc.), by Rohwer (in Hymenop. of Connecticut (Bull. 22), 1916, and in Proc. U. S. Nat. Mus., etc.), and by Turner (Ann. and Mag. Nat. Hist. 1916, etc.). F. Smith and P. Cameron have also done considerable work in the sphecoid and other wasps. The writer has drawn from the works of all these specialists.

The figures of the antennal joints and of the armatures, and usually also of the last ventral segments are drawings made by the use of the camera lucida, and the armatures, unless otherwise indicated, are shown from the ventral side and with their vestiture omitted. The propodeum is really the first abdominal segment that has become inseparably fused to the posterior part of the thorax (as shown by Snodgrass in Proc. U. S. Nat. Mus., 39, p .37-92, 1911, 16 pl. and 19 text figs.), but for the sake of convenience it is considered a portion of the thorax so that the segment which forms the waist or *stem* of the abdomen is here treated as the first abdominal segment.

It is perhaps needless to state that old and worn examples of these and other wasps cannot always be readily identified, as through digging, or other nesting activities such parts as the clypeus and mandibles become worn down and incisions, angles and puncturation are more or less effaced.

Wing venation while very essential in classification may vary somewhat even within the species, as will become evident in studying the "abcissae" of the forewings in a series of a species.

Key to the Genera of Larridae Found in the Philippine Islands

1. The two posterior ocelli not round and convex—more or less distorted, flattened and reduced ..... 2.
   All three ocelli perfect—round and convex 9
2. The upper portion of the head between the compound eyes and including the ocelli, joining the face at an obtuse angle; there is a ridge or swelling bordering the inner margin of the compound eyes, at least on the face ..... 3.
   The upper portion of the head joins the face in a gentle curve; there is no ridge nor swelling bordering the inner margin of the eyes 8
3. The mandibles have no teeth within, or at least they are very slightly notched there (Figs. 168, 169); in the ♀ the pygidial area is bare or nearly so and devoid of apical bristles (Fig. 117) ..... 4.
   The mandibles have one or two teeth within (Fig. 166) ..... 5.
4. The posterior border of the pronotum, as viewed from above is straight, or at most slightly arched into the mesonotum; the tarsal claws are not toothed beneath, and in the ♀ the pygidium is very polished (Fig. 117) ..... *Larra* p. 66
   The posterior border of the pronotum is bluntly angulated or wedged into the mesonotum; in the ♀ the tarsal claws have a tooth beneath before the middle; in the ♀ the pygidium is dull, at least in the Oriental species. (Figs. 126 and 176) ..... *Motes* p. 69
5. Mandibles strongly notched beneath (Fig. 164) ..... 6.
   Mandibles not or very slightly notched beneath (Figs. 165 and 166) ..... 7.
6. First abdominal segment subpetiolate, its apex much narrower than the diameter of the second segment; top of the head above the facial angle nearly flat; the anterior ocellus in a scarcely depressed area; hind femora frequently with a spine or tooth near base; forewings often with a dark cloud (Fig. 81) ..... *Dicranorhina* p. 86
   First abdominal segment short, its apex but little narrower than the second segment; top of head with a more or less depressed area in which lies the anterior ocellus ..... *Notogonidea* p. 70
7. Mandibles with a subapical tooth, besides being dentate before the middle; pygidium of ♀ shining, practically bare; ♂ with very long mandibles (Fig. 121 and text fig. 8) ..... *Hyloliris* p. 84
   Mandibles without a subapical tooth; pygidium of ♀ covered with fine bristles; mandibles of ♂ not unusually long ..... *Liris* p. 82
8. Posterior ocelli linear, hooked at upper end and extending toward fore ocellus and thus appearing sinuate much like a question mark; pygidium in ♀ covered with pile or with bristles; fore femora of ♂ in the Philippine species not emarginate beneath near base ..... *Tachytes* p. 87
   Posterior ocelli showing as short simple hooks in flat, oval and obliquely arranged areas; pygidium in ♀ bare and shining; fore femora of ♂ always emarginate beneath near the base ..... *Tachysphex* p. 92

9. Fore wings with three cubital cells; hind wings with some well-defined veins....10.
Fore wings with only one complete cubital cell; hind wings with only pale indications of veins; small black wasps.....11.
10. Mandibles strongly notched beneath; second cubital cell not petiolate; ♀ with a well-margined pygidial area.....*Lyroda* p. 93
Mandibles at most weakly emarginate beneath; second cubital cell petiolate; ♀ without a defined pygidial area.....*Silaon* p. 94
11. Frons and clypeus modified in the middle into a compressed, beak-like process which contributes to form the large basin-like antennal scrobes; mandibles not bidentate apically; eyes hairy; pronotum not angulate. (Fig. 100)..*Rhinonitela* p. 97
Frons and clypeus normal, though the latter often well carinate; eyes naked; no well-margined antennal scrobes; mandibles at least in the ♀ bidentate apically (Fig. 109).....*Nitela* p. 95

In some of the tables to species that follow, the width of the interocular space at the vertex is frequently compared with the length of certain antennal joints, and to ensure an accurate comparison here, the antenna has been detached and glued in its desired portion across the vertex.

Larra Fabricius

Fabricius, J. C., Entom. system. II, p. 194 and 220, n. 144.
Genotype **Larra anathema** Rossi

Head but little wider than thorax; mandibles notched on underside, but not or very weakly toothed on inner margin; the two posterior ocelli subobsolete, flat and transverse. Pronotum with the posterior margin transverse or gently outcurved and little or not at all depressed below the level of the mesonotum; propodeum long, broad and truncate at apex; legs stout and spinose. Abdomen rather elongate; pygidium bare, polished, often more or less sulcate at sides. Third ventral segment without a longitudinal ridge-like swelling.

A well distributed genus of medium-sized to rather large (25 mm.), usually polished wasps that prey upon mole crickets. The males are somewhat more pilose than the females. The frequent variation in sculpture, male armature and last visible ventral segment, etc., add greatly to the difficulty in separating, or holding together, certain of the species.

Key to Philippine **Larra**

Females

1. Fore tibiae with some spines along the fore or dorsal surface; second antennal joint pilose; joint 3 nearly twice as long as 4; interocular space at vertex distinctly more than joints 2+3; abdomen in part red.....*saguinea* p. 67
Not as above—no spines along dorsal surface of fore tibiae; second antennal joint nearly glabrous, polished; joint 3 not nearly twice as long as 4, abdomen black.2.
2. Wings dark fuscous brown with a purple effulgence; hind femora black, disc of propodeum usually coarsely reticulate or with very irregular cross wrinkles and with no smooth polished area.....*carbonaria* p. 67
Wings pale fuscous or nearly clear; hind femora more or less reddish; disc of propodeum with some well-defined transverse wrinkles and a smooth polished area on either side towards apex.....*luzonensis*, p. 68

Males

1. Interocular space at vertex slightly less than interocular space at clypeus; antennal joint 3 much longer than 4; abdomen in part reddish.....*sanguinea* p. 67
Interocular space at vertex about ½ as wide as interocular space at clypeus; antennal joints 3 and 4 subequal, or 4 the longer; abdomen black.....2.
2. Hind femora black; disc of propodeum rather coarsely reticulate, with no smooth area; wings infuscate.....*carbonaria* p. 68
Hind femora more or less reddish; disc of propodeum with some transverse wrinkles and more or less reticulate and sometimes partly polished; wings very pale fuscous.....*luzonensis* p. 68

Larra sanguinea n. sp.

(Fig. 41, clypeus, ♂ ♀ ; 96, antennae, ♂ ♀ ; 117, pygidium, ♀ ; 128, last ventral segment and armature, ♂).

Female, type: Length 16 mm. Head and thorax black; abdomen polished, reddish, the three apical segments mainly blackish; mandibles partly, and spines reddish; tegulae reddish brown; wings infuscate, subhyaline at base; clypeus but little rounded out, subtruncate, its middle third there thickened as a fine carina, punctate and not very polished, frons mainly highly polished; joint 2 of antenna pilose, 3 more than 1½ times as long as 4, and together about equalling the wide vertex which has rather large and well-spaced punctures, depressed area on vertex, shallow and widely arched posteriorly; thorax also coarsely punctured; disc of propodeum with but a faint indication of a median carina, with separate punctures becoming dense, basally and there reticulate; some weak, transverse wrinkles from near the base; pleura polished and punctured; posterior face strongly punctured, more densely so about the median impressed line. Legs strongly spinose, the fore tibiae with several spines on the front or dorsal surface. Abcissae of wings in following order of increasing length: 2, 5, 1, 3 and 4; (in the ♀ paratype: 5, 2 and 1 subequal, 3 and 4); the truncation (5) curved from margin. Abdomen almost impunctate above; pygidium very smooth and polished with but few delicate punctures. Vestiture of head, thorax and legs silvery, rather more abundant than usual among *Larra*.

Male, allotype: Length 11 mm. Much like the ♀; similariy colored, more pilose, puncturation coarser. Clypeus produced mesially into a polished and distally impunctate and very shallowly emarginate lobe; antennae stout, joint 3 noticeably longer than 4; interocular space broad. Puncturation quite coarse; disc of propodeum feebly carinate (not at all carinate in paratype), and as in ♀ more densely punctured at the base along the middle and sides; pleura polished and with well separated punctures; posterior face strongly and in places confluently punctured, and with a median impressed line. Abdomen banded with silvery pile; last dorsal segment with its thin apical margin subtruncate; last ventral segment broadly and shallowly notched; armature with unci but little expanded at tip. Silvery pile, rather long and abundant.

Type and allotype, Los Baños College, Luzon, December 16, 1921, and January 1922 (F. X. Williams). From the type 9 ♀ ♀ and ♂ ♂ were reared, of which 8 ♀ ♀ were liberated February 17 in Manoa Valley, Oahu. It has not been recovered. Paratypes, 1 ♂ and 1 ♀ hatched in Honolulu.

This insect is apparently very rare about Los Baños,* and belongs to the series among the *Larra* with the vertex broad. Preys on *Gryllotalpa africana*.

Larra carbonaria (Smith)

(Fig. 97, antennae, ♂ ♀; 118, pygidium, ♀; 129, from Los Baños, Luzon; 131, from Samar, last ventral segment and armature, ♂; 21, wasp grub on *Gryllotalpa hirsuta* cricket.)

Smith, F., *Larrada carbonaria*, Jour. Linn. Soc. p. 102, ♀, 1858.

Female: Length 15.5-25 mm. Deep black; mandibles in part dark red; tip of pygidium pale reddish; wings dark fuscous with purple reflections. Clypeus gently rounded out for its entire margin though very weakly but broadly emarginate at the sides, broadly polished from the margin and with some large though sparse punctures invading; antennal joint 3 somewhat longer than 4 and less than interocular space at vertex; depressed area on vertex, as viewed from above, rather small, deep and subtriangular. Mesonotum with medium size separate punctures, finer on scutellum and post-scutellum, the sides more coarsely punctured; disc of propodeum rather coarsely reticulate, more densely so on the sides and with a short imperfect to nearly full-length carina, but the sculpture varies so in that the disc may have various oblique wrinkles, and in southern forms some wrinkles may become parallel or subconcentric on either side of the median carina; posterior face with a well-impressed line and transverse wrinkles; pleura punctured. Wings with abcissae in following order of increasing length: 2, 5, 3, 1 and 4; the truncation (5) subangulate from margin and slightly emarginate. Abdomen smooth and polished; pygidium broad, the sides arcuate,

* What appears to be the same insect but with the legs practically all blackish, was taken by F. C. Hadden in June and September, 1927, at Taihoku, Formosa.

the disc with a broad lateral piliferous sulcation and a shallower median one from apex, the disc not very polished, its surface being finely scratched and with some long and large punctures, of which a few of the more lateral ones bear a good-sized erect bristle. Vestiture very sparse, yellowish white pile.

Male: Length 8-15 mm. Less polished and more pilose than the female; clypeus with its middle portion drawn out as a rounded lobe, impunctate along the edge; antennal joints 3 and 4 subequal or 3 a little shorter, the interocular space at vertex about equal to or a little less than joints 2+3; depressed area on vertex much wider than in ♀, angulate on bottom; scutellum impressed; propodeum reticulate though variable, the carina short or wanting. Wings with abcissae in following order of length: 5, 2, 3, or these subequal, 1 and 4. Last ventral segment rounded out and usually very slightly bilobed at apex; armature with claspers arched sabre-like. Vestiture sparse and silvery. Wings not so dusky as in ♀.

38 ♂ ♂ and 27 ♀ ♀ from Mt. Makiling and Los Baños, Luzon; Bohol, Samar, Mindanao, Basilan, and Singapore, (C. F. Baker, F. X. Williams). Also native to Sumatra, (Maidl, 1925), Tenasserim and Singapore, (Bingham, 1897). This species is quite variable and I do not feel certain that all are *L. carbonaria;* the southern forms are in general different to some degree from those of Luzon, but also variable among themselves; in some, the hind femora are reddish and either these or the typically all-black-legged ones may or may not have the armature with the broader claspers (Fig. 131). The interocular space at the vertex and antennal joints 2 + 3 are not always in the same proportion.

About Los Baños this species attacks the very large *Gryllotalpa hirsuta* Burm. This is the largest Philippine larrid.

Larra luzonensis Rohwer

(Fig. 40, clypeus, ♂ ♀; 169, mandible; 98, antennae, ♂ ♀; 119, pygidium ♀; 132, 133, last ventral segment and armature, ♂; 134, last ventral segment of ♂ from North Central Luzon, with the hind femora nearly black.)

Rohwer, S. A., Bull. 14, Ent. Ser. Expt. Sta. Haw. Sugar Planters' Assn., p. 10-11, 1919, ♀.

Female: Length 11.5-16 mm. Black; scape in part, mandibles, the hind femora red. Clypeus gently and nearly evenly rounded out; antennal joints 3 and 4 subequal, interocular space at vertex less than joints 2+3; first two joints of antennae very little pilose, polished; face above antennae and vertex polished, latter with fine, well spaced punctures; depressed area on vertex wide, moderately deep, subangulate at bottom, the line arching to the compound eyes. Thorax above with moderate sized close punctures (on scutum they are not quite so close-set in its very near relative, *L. femorata* Sauss. of Australia); disc of propodeum transversely punctato-striate or wrinkled, with a median raised line, and above on either side of disc is a longitudinal polished, rather sparsely punctate area, the wrinkles not or weakly invading; pleura mainly punctate though not very strongly so; posterior face shining, punctato-striate. Abcissae in following order of increasing length: 5 and 2 subequal, 3 and 1 subequal, 4; or 5 and 2 subequal, and 1 and 3 subequal. Pygidial area broad, very polished, a rather narrow lateral but no median sulcus; sparsely punctate.

Male: Length 7-11 mm. Colored about as in ♀; more silvery pilose and duller, with sculpture a little coarser. Clypeus with the rather narrowly produced portion without punctures to apex; antennal joints 3 and 4 subequal or 3 a little shorter; interocular space at vertex equal to or very slightly greater than 3+4. Disc of propodeum with a more or less well defined carina, and transversely wrinkled, and punctate, with no smooth area to either side; pleurae punctato-wrinkled and smooth at base. Abcissae variable; in some: 2 (1, 5), 3, 4; or (2 and 5), (3 and 1) and 4. Truncation somewhat curved from margin. Last ventral segment typically rounded out at apex, sometimes lightly emarginate; armature with claspers not much curved for apical portion and there tapering to a point.

Specimens far to the south (Mindanao, and Sandakan, Borneo) occasionally have the legs redder than in the typical form and one ♂ from Neuva Viscaya, Luzon, has the hind femora nearly black, and the last ventral segment slightly

notched (Fig. 134). Armature similar to that of *L. femorata* of Australia, and to *L. rufipes* (Sm.) of India and Celebes, as exemplified by C. F. Baker's specimen's from Surigao, Mindanao, Sibuyan; and Sandakan, Borneo. It can hardly be considered more than a geographical race of *rufipes,* which according to Bingham (Fauna, British India, Hymenoptera, I, p. 201, 1897) may exist as a variety with anterior legs above, and the base of the femora of all legs dusky black.

A series of 95 ♂ ♂ and 48 ♀ ♀ from Los Baños, Mt. Banahao, Mt. Makiling and Manila, Luzon; Negros, Samar, Mindanao, and from Sandakan, Borneo. (C. F. Baker, C. E. Pemberton and F. X. Williams); 1 from Culasi, Panay, (McGregor, Collector).

The commonest of the Philippine species. Introduced by Pemberton in 1925, into Oahu, Hawaiian Islands and found to have become established there by September, 1926.

Motes Kohl

Kohl, F. F., Die Gattungen der Sphegiden, Annalen des K. K. naturhistorischen Hofmuseums, Bd. XI, Heft 3, p. 351-2, Taf. VIIII, Fig. III, ♀ pygidium.
2 African species; males unknown.
Syn. *Leptolarra* Cameron, P., Ann. and Mag. Nat. Hist., V, 7th series, p. 29-30, 1900.
3 Indian spp. ♀ ♀.

Related to *Notogonidea* and *Larra.*
Clypeus not emarginate mesially; second joint of antennae pilose; mandibles without a tooth within; notched beneath. Pronotum angulate into mesonotum, and closer to its level than in *Notogonidea;* legs stout, the hind tibiae not sharply carinate as in *Notogonidea;* tarsal claws, with a tooth beneath before the middle only in the ♀. Third abdominal segment beneath near the base flattened on either side, thus forming a short, low and poorly developed ridge.
♀. Pygidium in genotype (from Africa) nearly parallel-sided; almost bare and with no apical bristles; the last dorsal segment in the ♂ is rounded out for the hind margin and without raised or thickened sides; armature simple.
Ethiopian, oriental and neotropical.

Motes larroides n. sp.

(Fig. 55, ♂ ♀, clypeus; 176, tarsal claw, ♀; 168, mandible, ♀; 126, pygidium, ♀; 88, antenna, ♂; 135 and 136, last ventral segment and armature, ♂.)

Female, type: Length 13 mm. Slender, particularly the abdomen; rather polished, especially head and propodeum. Black; mandibles in part red; wings with a slight yellowish tinge, venation rather light brown. Clypeus gently rounded out for its produced portion but tending to form a low blunt wedge and with a piliferous sulcus extending from either lateral angle to near the compound eyes, not well beveled, the smooth area with a very few punctures and very minutely aciculate; antennae with joints 3 and 4 subequal; interocular space at vertex a little less than joints 2+3. Head finely punctured and recalling that in *Larra;* thorax more finely punctured; disc of propodeum with a sharp median carina extending nearly to apex, with strong raised cross wrinkles here and there connected by little raised lines giving the disc a semi-reticulate aspect; pleura with fine oblique wrinkles starting above from a longitudinal raised line, finely roughened between these wrinkles; posterior face with transverse wrinkles, the impressed line diverging rather narrowly above. Wings with marginal cell quite obliquely truncate and with abcissae in following order of increasing length: 2, 3 (nearly equal), 5 (truncation) a very little longer, 1 and 4 subequal. Legs stout, but with the tarsi rather long, well spined; fore tibiae with one spine on dorsal side nearer base and with several apical ones. Abdomen with four sericeous, greyish white bands, third ventral segment with a weak and rounded longitudinal ridge near the base; pygidium about twice as long as wide; the lateral bounding carinae low, gently arched, but straightening out towards the truncated apex; under low magnification the disc appears dully naked, but is covered with very fine and short erect pile arising from close-set little punctures; also with some very sparse slender erect bristles. Vestiture: short white pile, somewhat golden tinged on vertex and on mesonotum, sparser on abdomen.

Male, allotype: Length 7.1 mm. Much like the ♀. Clypeus more narrowly produced and with the piliferous furrow to either side; antennal joints 3-5 somewhat arcuate; 3 very little shorter than 4; 2+3 about equal to interocular space at vertex. Head and thorax somewhat more coarsely punctured than in ♀; disc of propodeum about as in ♀, though hardly reticulate; no dorsal spine on fore tibiae; abcissae in following order of length: 2, 3, 5, 1 and 4. Abdomen not long; third ventral segment with a very short inconspicuous median ridge; last visible dorsal segment rounded out, sides not raised nor thickened; last ventral segment rounded apically and narrow; armature simple, sagittae with long hair.

Type, Los Baños, Luzon, June, 1916, (F. X. Williams); allotype, Los Baños, Luzon, (C. F. Baker); paratypes, 10 ♂ ♂ and 11 ♀ ♀ from Mount Makiling, Los Baños and Tayabas, Luzon; Negros, Palawan and Mindanao; other specimens, 17 ♂ ♂ and 9 ♀ ♀, same localities, (C. F. Baker, F. X. Williams). Females vary in size from 9 to 15 mm. and males from 5.7 to 9 mm.; the clypeus varies somewhat in being blunter or more acute. A large female from Singapore and a large male from Surigao, Mindanao, have lightly infuscate wings with a darker suffusion beyond their middle. The wings are hardly yellow-tinged in some specimens. There is some, perhaps varietal variation in the armature (see Figs. 135 and 136).

Notogonidea Rohwer

Rohwer, S. A., Proc. Ent. Soc. Wash., XIII, p. 234, 1911.
Syn. *Notogonia* Costa, Ann. Mus. Zool. Napoli, Vol. 4, 1867, p. 82 (1864).
Genotype (*Tachytes nigra* Van de Linden) = *Larra pompiliformis* Panzer.

Head slightly wider than thorax, with a longitudinal fold or swelling along inner eye margin; forehead prominent; mandibles well notched beneath and dentate within; pronotum angled more or less wedge-like, into the higher mesonotum; propodeum usually rather long; legs often long, the hind tibiae sharply carinate along the upper side; claws rarely toothed within; wings with marginal cell truncate, 3 submarginals; third ventral segment of ♀ beneath more or less convex, the convexity more or less compressed into a longitudinal ridge; pygidium well margined, pilose (nearly or quite bare in subgenus *Cratolarra*).

Notogonidea is the dominant genus of the Larridae in warm countries. It is poorly represented in Europe and in the United States. These wasps present many difficulties in systematic entomology, and the genus may be regarded as a center around which such closely related genera as *Liris, Larra, Motes, Hyloliris, Dicranorhina* and others are grouped.

The marginal part of the clypeus may often slope down from the main part of the clypeus in more or less of an angle, and is here referred to as the "bevel" (Fig. 62),; at other times the front edge is merely rounded off.

Key to Philippine **Notogonidea**

Males

1. Head and thorax with long, sparse, erect white hair, some of it quite as long as the width of the scape or first joint of the antennae; dorsum (disc) of propodeum with a wide shallow trough for its apical portion; clypeus well produced, subtruncate, with sharp lateral angles (Fig. 67); leg black...*N. liroides*, p. 73
   Not as above....2.
2. Produced, front part of clypeus subtruncate, not or very widely and shallowly emarginate in the middle, the bevel well marked and with a band of deep though rather sparse punctures (Fig. 65); pile of face pale yellow, legs black ....*N. laboriosa*, p. 73
   Not as above; clypeus generally distinctly rounded outwardly....3.

3. Disc of propodeum shining and with prominent transverse carinae; hind femora at least in part, and all tibiae more or less reddish; clypeus depressed along the edge; *Larra*-like species....*N. larriformis*, p. 74
   Not as above....4.
4. Fifth abcissa or truncation of marginal cell greater than, equal, or nearly equal to third abcissa, and with the lower angle extending farther distally than the upper or marginal angle (Fig. 92); usually smaller species....5.
   Fifth abcissa distinctly less than the third; the lower angle often extending less distally than the marginal one (Fig. 80)....10
5. Front portion of clypeus with the sides usually well rounded (Fig. 56), not angulate, and often with a furrow extending on either side into the margin; disc of propodeum dull finish, very finely granulate or reticulo-granulate....Subgenus *Cratolarra*, 6
   Front portion of clypeus with the sides rather angulate (Fig. 60); at most only a pit at the lateral angle; disc of propodeum reticulate with finer or coarser raised lines or carinulae....7.
6. Last ventral segment (inner spatha) of abdomen shallowly notched (Fig 150)....*C. pitamawa*, p. 81
   Last ventral segment of abdomen rather deeply notched (Fig. 152).*C. flavipennis* p. 81
7. Joint 3 of antennae distinctly shorter than 4 (Fig. 77); disc of propodeum rather dull finish, reticulate but not coarsly so....*N. negrosensis*, p. 74
   Antennal joints 3 and 4 equal or subequal (Figs 85-87); disc of propodeum shiny finish, usually coarsely reticulate....8.
8. Third joint of antennae not or hardly 1½ times as long as its width at apex (Fig. 87); bevel of clypeus practically without punctures; silvery pile of body rather long....*N. bakeri*, p. 74
   Third joint of antennae very nearly 2 times as long as its width at apex; bevel of clypeus usually with a few punctures or little depressions; silvery pile shorter.9.
9. Front margin of clypeus gently rounded out, very slightly depressed, or straight in the middle (Fig. 59)....*N. ligulata*, p. 75
   Front margin of clypeus gently rounded out, very slightly produced in the middle (Fig. 58)....*N. manilae*, p. 75
10. Head and thorax with quite sparse long white hair, some of it at least equal in length to the width of the scape or first joint of antennae; disc of propodeum rather shiny and rather coarsely reticulate....*N. silvicola*, p. 76
    No such long hair....11
11. The tip of last ventral segment is a rather strong notch or incised wedge (Fig. 145); mesopleura very finely punctate; disc of propodeum dull finish, and mainly with transverse carinulae. A rather large and very common species; length to about 10 mm....*N. subtessellata*, p. 77
    Not wholly or at all as above....12.
12. Mesopleurae strongly wrinkled so as to rather efface the median episternal groove; front margin of clypeus well rounded out, not incised in the middle; the bevel wide, convex and smooth (Fig. 66)....*N. mindanoensis*, p. 79
    Not as above....13.
13. Last ventral segment broadly truncate at apex (Fig. 148); front margin of clypeus gently rounded outwardly; not incised in the middle; joint 3 of antennae shorter than 4 (Fig. 89)....*N. robusta*, p. 80
    Last ventral segment more or less bilobed at apex (Fig. 147); front margin of clypeus more or less incised or depressed in the middle....14.
14. Disc of propodeum with the transverse carinae well marked, recurved (towards apex of propodeum)....*N. rohweri*, p. 78
    Disc of propodeum with transverse carinae, nearly straight across; sometimes nearly obsolete; margin of clypeus lightly depressed in the middle....*N. robustoides*, p. 78

Females

1. Pygidium bare, polished....Subgenus *Cratolarra* 2.
   Pygidium densely covered with hair....*Notogonidea* 3.
2. Size up to about 15 mm.; wings with a yellowish tinge; pygidium rather uniformly and densely punctate and with 4 or 5 apical bristles of about equal size (Fig. 124)....*C. flavipennis*, p. 81
   Size up to 11 or 12 millimeters, wings usually clearer, pygidium scarcely punctate in the middle except about base, and generally with 2, sometimes more, apical bristles of large size (Fig. 125)....*C. pitamawa*, p. 80
3. Front portion of clypeus subtruncate, slightly notched in the middle, densely and rather coarsely punctate on the bevel almost to the margin; the punctures nearest the margin more or less confluent (Fig 65); wings rather yellowish, length 15 mm. ....*N. laboriosa*, p. 73

Clypeus sparsely or not punctate on the bevel or on the marginal thickening, polished .....4.

4. Head and thorax with long, sparse erect white hair, some of it quite as long as the width of the scape or first joint of the antennae; dorsum (disc) of propodeum with a wide shallow trough for its apical portion; legs black..... .....*N. liroides*, p. 72

Not as above .....5.

5. Median sulcus on posterior face of propodeum with its margins widely diverging above as a pair of raised, sometimes interrupted arcs which may extend to the sides of the propodeum (Fig. 170); size up to 10 or 11 mm.; bristles on disc of propodeum rather recumbent and stout; disc of propodeum pilose nearly to base (Fig. 127) .....*N. robusta*, p. 79

Not in above combination.....6.

6. Bristles on disc of propodeum long, stout and recumbent; mesopleura finely wrinkled-punctate and with the median episternal groove broad, shallow and with irregular transverse carinulae.....7.

Bristles on disc of pygidium delicate and suberect; mesopleura only punctate and with the median episternal groove well marked and often with regular transverse carinulae .....8.

7. Pygidial bristles pale yellow; pile of body golden; size 11 mm. or more..... .....*N. mindanaoensis*, p. 79

Pygidial bristles dark brown or blackish; pile of body silvery; size 15 mm..... .....*N. silvicola*, p. 76

8. Slenderer than usual and superficially like *Larra*; hind femora and all the tibiae reddish; pygidium nearly twice as long as wide.....*N. larriformis*, p. 73

Not as above.....9.

9. Disc of pygidium with a bare and polished wedge-shaped area extending from the base to the middle or beyond (Fig. 123); disc of propodeum dull finish; length to about 10 mm.....*N. robustoides*, p. 77

Not as above.....10.

10. Fifth abcissa or truncation of marginal cell distinctly less than third abcissa; size 12-16 mm.; head and mesonotum with very fine punctures; vertex at its narrowest point between the eyes much less than the length of antennal joints 2+3; disc of propodeum dull finish .....11.

Fifth abcissa greater than, equal, or nearly equal to third abcissa; size to 11 mm.; head and mesonotum with larger deep punctures; vertex at its narrowest point between the eyes equal to or only slightly less than antennal joints 2+3; disc of propodeum reticulated (network of raised lines), shining.....12

11. Clypeus with strong though not at all densely placed punctures on bevel to near margin (Fig. 64) .....*N. rohweri*, p. 78

Clypeus with the bevel almost free of punctures (Fig. 63)....*N. subtessellata*, p. 76

12. Clypeal margin usually with a minute though comparatively deep notch a short distance inside from the lateral angles (Fig. 58); interocular space at vertex less than antennal joints 2+3; disc of propodeum usually rather coarsely reticulate, sparsely white pilose; length to about 9 mm.....*N. manilae*, p. 75

Clypeus without this deep notch; interocular space slightly greater than antennal joints 2+3; disc of propodeum coarsely reticulate; head and thorax with more and longer pile; length to about 11 mm.....*N. bakeri*, p. 74

Notogonidea liroides n. sp.

(Fig. 67, clypeus ♂ ♀; 137, armature and last ventral segment, ♂.)

Female, type: Length 11.8 mm. Rather dull black; tips of mandibles dark red; wings transparent, slightly darkened along outer margin. Head wide; clypeus broadly produced, subtruncate, shallowly notched mesially and slightly again near lateral angles, very finely and shallowly reticulate, no bevel, but narrowly polished and impunctate, a few scattered shallow pits; antennae slender, joints 3 and 4 subequal; interocular space at vertex very slightly greater than joint 3. Head and thorax minutely reticulate and finely punctate; disc of propodeum reticulate; median carina not attaining apex; shallow longitudinal sulcus best developed for its apical half; sides finely obliquely wrinkled. Legs slender, fore tibiae with 2-3 little spines along median dorsal surface. Wings with abcissae in the following order of length: 5, 2, 3, 1 and 4. Abdomen with four incomplete sericeous white bands; pygidium with sides practically straight, subtruncate at apex, not over 1½ times its greatest width, coarsely punctate for the fine appressed yellowish brown pubescence and the sparse, fine suberect bristles, the base mesially almost bare. Silvery pile on head, and in addition, head and thorax with fine, sparse and long, erect white hair.

Male, allotype: Length 8.75 mm. Clypeus more narrowly produced and not incised; interocular space at vertex about equal to joints 2+3. Wings with abcissae as follows in order of increasing length: 2, 5, 3, 1 and 4. Last ventral segment subtruncate apically; armature with claspers acute at tip and the sagittae spatulate.

Type and allotype, from Los Baños, Luzon, November, 1921, and August, 1916. (F. X. Williams); paratypes, 4 ♂ ♂, Los Baños, Mount Banahao, Luzon; and Samar (College of Agriculture Collection and C. F. Baker Coll.); and 8 ♀ ♀, Los Baños, Luzon; Sibuyan; Iligan, Mindanao; Basilan; (C. F. Baker Coll.)

A distinct species that stands apart from the others of the genus.

Notogonidea laboriosa (Smith)

(Fig. 65, clypeus ♂ ♀; Figs. 138 and 139, armature and last ventral segment ♂.)

Larrada laboriosa Smith, Cat. IV, p. 278, ♀. Philippine Islands.
Notogonia laboriosa, Bingham, Fauna Brit. India, Hymenop., I, p. 204, ♀.
Notogonia crawfordi Rohwer, Proc. U. S. Nat. Mus., 37, p. 659, 1910, ♀.
Notogonia manilensis Rohwer, ibid. p. 659-660, ♂.

Female: Length 11-16 mm. Rather dull black; tips of mandibles dark red; wings with a strong yellow tinge. Clypeus broadly subtruncate, slightly notched and densely punctate almost to margin; antennal joints 3 and 4 subequal; interocular space at vertex slightly less than joints 2+3. Head and thorax finely punctate; disc of propodeum dull finish, with an incomplete carina, some fine transverse carinulae, and some granulations and reticulations, the pleura mainly almost smooth, but with some large transverse carinae towards apex and on sides of posterior face. Wings with abcissal order as follows: 5, 2, 3, 1 and 4. Abdomen with four incomplete silky white bands; pygidium with sides gently curved outwardly, about 1½ times as long as its greatest width, covered with fine golden pubescence and with scant, delicate, short, erect hairs. Pile of body yellowish white, that of disc of propodeum rather long.

Male: Length 6.5-11 mm. Like the female, but with clypeal bevel less strongly punctate; posterior femora emarginate along posterior (ventral) side; last ventral segment gently bilobed apically; claspers of armature slender, subclavate apically.

48 ♂ ♂ and 34 ♀ ♀; from Los Baños, Tayabas, Baguio, Luzon; Mindoro; Oriental and Occidental Negros; Batbatan, (Baker, Muir, Pemberton, McGregor and Williams). Also 2 ♀ ♀ from the island of Formosa (F. Muir). Further distribution: Japan, Riukiu Islands and India and probably China.

A common species best recognized by the punctate clypeal bevel, large size, yellowish wings, and tawny white pubescence. When compared with *N. basilissa* Turner ♀ of Australia, two of which I have before me, it differs only in having a somewhat broader pygidial area.

Notogonidea larriformis n. sp.

(Fig. 167, mandible ♀; 149, armature and last ventral segment, ♂.)

Female, type: Length 12.5 mm.; slender, abdomen rather elongate; black; thorax somewhat polished; most of mandibles, the tibiae and tarsi of all the legs plus the hind femora, red; wings slightly darkened along apical margin. Clypeus gently rounded outwardly, lightly incised mesially, lateral angles obtuse, the bevel shining, almost without punctures (much as in figure for *N. subtessellata*); antennae rather short, joints 3 and 4 subequal; interocular space at vertex slightly less than joints 2 + 3. Head and thorax very finely punctate; disc of propodeum with median carina extending down to the somewhat depressed apical part, with rather well marked carinulae, between which it is slightly rugulose, sides obliquely wrinkled, posterior face nearly flat, with a linear fovea for its upper half or more, slightly and obliquely wrinkled. Legs rather stout, no spines on dorsal surface of fore tibiae. Wings with abcissae in following order of length: 2 and 5 subequal, 3, 1 and 4; 5 scarcely oblique. Abdomen with four incomplete sericeous bands; pygidium with gently outbowed sides, in length, about 1½ times its greatest width, bare, polished and almost impunctate mesially as a blunt basal wedge, otherwise covered with short golden pubescence and a few suberect longer hairs. Body with sparse silvery pile.

Male, allotype: Length 7.5 mm., much like the ♀. Clypeus not incised, bevel polished, almost impunctate, sulcate transversely; last ventral segment very lightly bilobed at apex; claspers of armature broad, pointed at apex; sagittae spatulate.

Type and allotype, Los Baños, Luzon, July, 1916 and 1917, (F. X. Williams); paratypes, 5 ♂♂, Los Baños, Luzon, and Samar, (C. F. Baker); and 12 ♀♀, Los Baños, Luzon, and Samar, (F. X. Williams, C. F. Baker).

A distinct species suggesting a *Larra* in some ways. Not common.

Notogonidea negrosensis n. sp.

(Fig. 60, clypeus, ♂; 77, antenna, ♂; 140, armature and last ventral segment ♂.)

Male, type: Length 6 mm. Dull black; tips of mandibles dark red; wings transparent, rather broadly infuscate along outer margin and again below stigma across to the hind margin. Clypeus produced and just a very little rounded out and slightly carinate mesially the rather narrow polished and almost impunctate edge hardly beveled off; antennae with joint 3 distinctly shorter than 4; 2 + 3 subequal to the interocular space at vertex. Head and thorax with exceedingly fine punctures; disc of propodeum dull finish, finely reticulate and with an incomplete carina, posterior face rather shining and with some transverse carinulae, pleura finely obliquely wrinkled. Wings with abcissae in the following order of length: 3, 5 and 2 subequal, 1 and 4. Abdomen with three imperfect bands of silvery sericeous; last ventral segment rounded subtruncate; sagittae of armature slender and a little sinuate apically. Sparsely silvery pilose.

Type, Cuernos Mts. Negros, (C. F. Baker); paratypes 8 ♂♂, Mt. Makiling and Los Baños, Luzon; P. Princesa, Palawan; and Occidental Negros, and Singapore, (C. F. Baker, F. X. Williams).

Not plentiful; ♀ unknown.

Apparently somewhat related to *N. manilae,* but as can be seen, differs from it in being *dull* black, with antennal joint 3 shorter than 4, and in the peculiarly formed sagittae.

Notogonidea bakeri n. sp.

(Fig. 87 antenna, ♂; 143, armature and last ventral segment ♂.)

Female, type: Length 9.25 mm. Rather shining black; mandibles reddish for more than their apical half; wings transparent except a little dusky along outer margin. Clypeus broadly produced, very slightly bowed outwardly, a distinct median notch, the well marked bevel polished, practically impunctate; antennal joints 3 and 4 subequal, interocular space at vertex slightly more than joints 2+3. Head and thorax deeply and rather coarsely punctate for the genus; median segment rather coarsely reticulate and with an incomplete median carina, pleura finely reticulo-striate, posterior face with a sublinear groove and transversely carinulate. Legs delicately spinose. Wings with abcissae in following order of length: 2, 3 and 5 (subequal), and 4 and 1 (subequal). Abdomen with five broken sericeous bands; pygidium about 1⅓ times as long as its greatest width, with very fine appressed pale golden pubescence and a few erect, delicate pale hairs. Rather long, mainly silvery pile on body with some of it golden on mesonotum and end of abdomen.

Male, allotype: Length 7.5 mm. Clypeus well beveled, polished as a very low rounded wedge, not incised; antennal joints very short, 3 and 4 noticeably less than interocular space at vertex; sculpture coarser; armature with sagittae rather slender and not much bent; apex of last ventral segment narrow and slightly bilobed.

Type, from Samar, (C. F. Baker); allotype, Occidental Negros, October, 1921, (F. X. Williams); paratypes, 10 ♀♀ and 15 ♂♂; mainly Los Baños, Mt. Makiling, also from Tayabas, Luzon; Samar; (C. F. Baker and F. X. Williams). The type is a fresh specimen and less coarsely sculptured than some of the others. This species, which appears rather uncommon is best recognized in the ♀, by

the coarse sculpture and rather long pile, and in the ♂ by the short antennal joints, and the armature. The pile often has a golden tinge, and ♀♀ may be up to 11 mm. in length and with the clypeus slightly notched before the lateral angles.

Notogonidea ligulata n. sp.

(Fig. 59, clypeus ♂; 86, antenna, ♂; 142, armature and last ventral segment, ♂.)

Male, type: Length 7 mm. Rather shining black; tips of mandibles red; wings transparent, but dusky along outer margin. Clypeus with the produced portion, gently rounded out; bevel with a very few punctures; antennae with joints 3 and 4 subequal, and together a little greater than interocular space at vertex; head and thorax rather coarsely punctate; disc of propodeum somewhat coarsely reticulate and with an incomplete median carina, the pleura obliquely wrinkled, the posterior face with a narrow sulcus and transverse carinulae. Wings with abcissae in order of increasing length, as follows: 2, (5 and 3 subequal), 1 and 4; four broken abdominal bands of sericeous white. Last ventral segment moderately incised at apex; armature with the spatuliform sagittae well armed, except on inner ventral side, with stout very short spinules. Body rather sparsely clothed with silvery pile.

Type, 1 ♂, Kolambugan, Mindanao, (C. F. Baker); paratypes, 5 ♂♂ Kolambugan and Dapitan, Mindanao, and Palawan, (C. F. Baker).

This species which seems to be quite rare is closely related to *N. manilae* (Ashm.), but averages slightly larger in size; the clypeus is not at all produced in the middle but straight or even a little depressed there, and the armature is more heavily chitinized, with the sagittae stouter and more fully armed with short spinules.

Notogonidea manilae (Ashmead)

(Fig. 58, clypeus, ♂♀; 92, venation, ♀; 85, antenna, ♂; 141, last ventral segment and armature, ♂.)

Notogonia manilae Ashmead, Proc. U. S. N. M. XXVIII, p. 130 ♂♀, 1905. Type from Manila, Philippines, (Fr. W. A. Stanton).

Notogonidea williamsi Rohwer, Bull. 14, Ent. Ser. Experiment Station, H. S. P. A., p. 9 and 10, 1919, ♀.

Female: Length 6.5-8.25 mm. Rather shining black; mandibles in part red; wings slightly darkened along outer margin and beyond the middle in part; clypeus gently rounded out, delicately notched mesially and again very finely near the lateral angles*; bevel nearly impunctate; antennal joints 3 and 4 subequal; 2 + 3 greater than interocular breadth at vertex. Head and thorax rather coarsely punctured; disc of propodeum coarsely reticulate, pleura obliquely wrinkled, posterior face transversely carinulate and reticulate. Wings with abcissae in following order of length: 3 and 5 subequal, 2, 1 and 4; or 5, 3, 2 and 1 subequal, 4. Abdomen with three broken sericeous bands; pygidium with sides a little outbowed, not more than 1½ times its basal width, covered with pale golden pubescence and with a few longer pale erect hairs.

Male: Length 5-6.5 mm. Clypeus gently rounded out and usually a very little produced mesially; interocular space a little less than antennal joints 2 + 3. Last ventral plate narrow at apex and there very lightly bilobed; armature with claspers acute, the sagittae subclavate and in part covered with short spinules.

The series before me numbers about 520 specimens, from Mount Banahao, Makiling and Limay, Los Baños, Tayabas, Luzon; Mindoro, Cebu, Negros, Palawan, Samar, Mindanao, Basilan, with a smaller aggregate from Sandakan, Borneo, Amboina, Singapore, the Island of Penang, and Formosa, (C. F. Baker, F. Muir, C. E. Pemberton and F. X. Williams). A somewhat larger insect from

* Sometimes this fine lateral notch is absent.

Japan,* and *N. retiaria* Turner of Australia are very close to, if not varieties of *N. manilae,* the ♂ armature differing slightly in chitinization and form of the sagittae. It is a variable species; the sculpture of the disc of the propodeum while commonly coarsely reticulate, may be finely so or mainly provided with, fine more or less transverse, or oblique carinulae.

Notogonidea silvicola n. sp.

(Fig. 62, clypeus, ♂ ♀; 78, antenna, ♀; 120, pygidium of ♀, lateral view; 144, armature and last ventral segment, ♂; 84, hind femur, ♂, to show posterior edge.)

Female, type: Length, 14 mm. Stout. Rather dull black, mandibles in part very dark red; wings a little infuscate and broadly darkened apically. Clypeus broadly rounded outwardly, very, very slightly incised mesially, with a broad polished, almost impunctate bevel, having a thin margin and some large setiferous punctures at its base; antennae rather slender, joints 3 and 4 subequal, each being greater in length than the width of the interocular space at vertex. Head and thorax finely punctured, mesopleura shallowly so and with fine wrinkles about the median episternal groove; disc of propodeum with median carina extending almost to apex, rather coarsely reticulate, the transverse carinulae most obvious in the formation of this network, which is in places irregularly subdivided into little pits, pleura finely obliquely wrinkled, posterior face with a strong linear sulcus not extending to the dorsum, irregularly transverse carinulate, strongly so along the upper sides, also some reticulations on this face. Wings with abcissae in the following order of length: 5, 2, 3, 1 and 4. Abdomen stout, with three incomplete silvery white bands; pygidium with sides slightly outbowed, about 1⅓ times as long as greatest width, covered with fine appressed golden pubescence and with some semi-recumbent rather long and stout dark bristles. The pile on the body is short, sparse and silvery, with a suggestion of gold; it is erect on the propodeum and some of it is longer and erect on the mesopleurae.

Male, allotype: Length 8.5 mm. Clypeus gently rounded out, with very sparse punctures on the thin, margined bevel; joints 3 and 4 subequal; interocular space at vertex somewhat less than joints 2 + 3, but greater than joint 3. Head and thorax less finely punctured than in ♀; mesopleura finely and shallowly punctured and partly very finely wrinkled; disc of propodeum coarsely reticulate and with a median carina not extending to apex, pleura finely striato-granulate. Wings with abcissae in order of length as follows: 2, 5, 3, 1 and 4. Last ventral plate broadly though very shallowly bilobed at apex; armature with claspers narrowly drawn out at apex and with sagittae curved inwardly slightly above their middle length. Pile, white and with some of it on the head and thorax as long as or longer than the width of scape or first joint of the antennae.

Type, from Los Baños, Luzon, Sept., 1917, (F. X. Williams); allotype, Mt. Makiling, Luzon, (C. F. Baker); paratypes 7 ♀ ♀, Mt. Makling, (Pemberton, and Williams); Baguio, Luzon; Basilan, Surigao, Mindanao, and Sandakan, Borneo, (C. F. Baker).

Abcissa 5 is shortest in one ♀ specimen.

This wasp, as far as my observations go, is a forest inhabitant. It is about the same size as the very abundant N. *subtessellata,* but is a somewhat stouter insect, with a less incised clypeus, slightly narrower interocular space at vertex, different sculpture and stouter pygidial bristles. The armature in the two is quite unlike, and the ♂ is also distinguishable because of the rather long hair and the hind femora not being emarginate posteriorly.

Notogonidea subtessellata (Smith)

(Fig. 63, clypeus ♂ ♀; 79, antenna ♀; 80, venation ♀; 122, pygidium, side view ♀; 83, posterior femur ♂; 164, mandible, ♀; 145, last ventral segment and armature, ♂.)

* Apparently the well distributed Oriental *N. tristis* (Sm.)

Larrada subtessellata F. Smith, Cat. Hymenop. British Museum, Pt., IV, p. 277-278, 1856, ♀. India, Sumatra, Java.

Notogonia subtessellata, Bingham, Fauna British India, I, p. 202-203, 1897, ♀ ♂, India, Ceylon.

Notogonidea luzonensis Rohwer, Bull. 14, Ent. Series. Exp. Sta., H. S. P. A., p. 9, 1919, ♀. Los Baños, Philippines.

Female: Length 11-14.5 mm. Dull black; mandibles in part dark red; femora all black, or the hind ones red; wings with a slightly darkened outer border. Clypeus with the produced portion gently rounded outwards, well notched mesially; bevel wide, polished and almost inpunctate; interocular space at vertex narrow, about equal to, or less than antennal joint 3 which is subequal with 4. Head and thorax very finely punctured; disc of propodeum, with an incomplete median carina, with very fine and close to medium, transverse carinulae combined with reticulations or granulations, pleura obliquely striate to almost smooth, posterior face more or less transversely carinulate, the median sulcus linear, its margins outcurving when rather near the disc and thus forming but a small wedge there. Wings with the abcissae in the following order of length: 5, 2, 3, and 1 and 4 subequal; 5 often considerably greater than 2; the truncation (5) with the lower angle usually somewhat rounded and often extending less distally than the upper or marginal angle. Abdomen with 3 rather broken sericeous bands of silvery; pygidium about 1¼ times as long as wide, broadly bare mesially at base and there polished and without punctures, covered with fine appressed golden pubescence, with sparse suberect pale and delicate bristles. Pile of body silvery, with more or less of a golden tinge.

Male: Length 7-10 mm. Clypeus more narrowly produced, rounded out, a little depressed mesially, poorly beveled though the rounded edge polished and with only a few punctures; antennal joint 3 shorter than 4; interocular space at vertex a little less than joints 2 + 3. Posterior femora emarginate towards base, along posterior (ventral) side. Wings with abcissa 2 often much the shortest. Last ventral segment sharply notched at apex; claspers bulky and heavily chitinized.

This common species, of which there are about 300 specimens before me, is very widely distributed; in the Philippines it is represented from Mount Makiling, Los Baños, Baguio, Luzon; Mindoro, Panay, Cebu, Negros, Batbatan, Leyte, Samar, Palawan, Mindanao and Basilan; with examples also from Sandakan, Borneo, Singapore, Hongkong and Japan. It also occurs in India, Sumatra and Java and has been introduced into the Hawaiian Islands from the Philippines, in 1921. (Baker, Muir, Pemberton, McGregor, Robinson, Terry and Williams).

The hind femora may be red in both sexes. Its nearest Philippine relative seems to be the smaller *N. robustoides;* the armature of both being somewhat alike, though *N. robustoides* has the better defined hair-tuft arising from a heavily chitinized piece on the inner side of the claspers. They differ also in clypeus and posterior face of propodeum.

Notogonidea robustoides n. sp.

(Fig. 90, antenna, ♂; 123, ♀ pygidium; 146, last ventral segment and armature, ♂.)

Female type: Length 9.25 mm. Moderately slender and somewhat dull finish; mandibles in part dark red, wings slightly darkened apically, venation brownish. Clypeus very like that of *N. robusta* (Fig. 61, ♀), a median emargination and small lateral notch, the bevel slightly narrower than in *robusta;* antennae with joints 3 and 4 subequal and each about equal to interocular space at vertex. Head and thorax minutely punctured; disc of propodeum a little less stout than *N. robusta,* the median carina extending nearly to apex, the disc is partly reticulate, as in *robusta,* and there are well-spaced transverse carinulae; pleura with some fine, nearly vertical wrinkles, and very finely granulate, posterior face much as in *robusta,* the foveal margins diverging and arching above much as in the figure for *robusta.* Wings with abcissae in the following order of increasing length: 5, (3 and 2 subequal), 1 and 4; the truncation vertical as in *robusta.* Abdomen with 3 silvery sericeous bands; pygidium rather broad and with the naked area extending far down, the pile and erect bristles thereon are pale golden.

Male, allotype: Length 9 mm. Produced portion of clypeus subtruncate, with a very shallow emargination mesially and a wide, hardly beveled, polished impunctate marginal area, densely punctate before this area; antennal joints 3 and 4 subequal and together somewhat more than interocular space at vertex. Head and thorax finely punctured; disc of propodeum with a median carina extending part ways from base and with well-spaced transverse carinulae, between which the surface is more or less regulose; pleura obliquely wrinkled for basal half, posterior face with rather indistinct and well-spaced transverse carinulae and a rather wide furrow diverging above to admit the acute wedge. Wings with the abcissae in the following order of length, 5, 2, 3, 1 and 4. Hind femora with the posterior margin nearly straight, a very slight emargination near base. Three sericeous white abdominal bands; last ventral segment gentyl bilobed apically; armature with claspers broad and with a well localized tuft of hair on their inner side.

Type, from Los Baños, Luzon, July, 1916, (F. Muir); allotype same locality, August, 1916, (F. X. Williams); paratypes 9 ♂♂ and 12 ♀♀, from Mount Banahao, Los Baños and Tayabas, Luzon; Negros, Samar, Leyte, Borneo and Singapore, (Baker, Muir and Williams). The females are all from the Philippines, chiefly from Luzon, and measure up to about 10 mm.; the males are generally proportionately large for the opposite sex and I hesitate somewhat in associating them with the females. Males from Singapore and Borneo have the hind femora red and well emarginate along their posterior border near the base; this emargination is faintly discernible or not at all present in some of the more northern examples, and joint 3 of the antennae may be noticeably shorter than 4. The vestiture in both sexes is silvery, sometimes with a touch of gold.

Notogonidea rohweri n. sp.

(Fig. 64, clypeus, ♀; 147, last ventral plate and armature, ♂.)

Female, type: Length, 12 mm. Stout. Black; disc of propodeum dull; mandibles with a little dark at about their middle length; wings slightly darkened along outer margin; clypeus with the middle portion rounded out and angularly notched mesially; it is much as in *N. laboriosa* save that the bevel is distinctly though rather sparsely punctured; antennae rather slender, joints 3 and 4 subequal; interocular space a little less than the length of 3 or of 4. Head and thorax minutely punctate, the mesopleura even more finely so; disc of propodeum with a delicate median carina not reaching apex, finely and transversely carinulate, the carinulae slightly recurved mesially, finely granulate in between, pleurae with some fine, more or less obsolete almost vertical wrinkles, the rest practically smooth, posterior face, rather shining and finely and obscurely transcarinulate, median furrow with sides diverging narrowly at apex (dorsum). Wings with abcissae in following increasing order of length: 2, 5, 3, 1 and 4. Abdomen with four broken, white sericeous bands; pygidium about 1¼ times as long as wide, the close punctures covered with short golden pubescence, with a sprinkling of longer, nearly erect pale bristles. Vestiture of body silvery.

Male, allotype: Length, 8 mm. Clypeus distinctly emarginate mesially and with sharp lateral angles, the bevel a little roughened but practically impunctate; antennal joints 3 and 4 subequal; interocular space at vertex slightly less than joints 2 + 3. Somewhat more coarsely punctured and sculptured than in the ♀, but the mesopleura very minutely reticulate and punctate; Wings with abcissae 2 and 5 subequal; hind femora almost straight on posterior border. Last ventral segment gently bilobed at apex.

Type and allotype, from Mount Makiling, Los Baños, Luzon, (C. F. Baker); paratypes, 3 ♀♀ and 2 ♂♂, from Mount Makiling, Los Baños, Luzon; Negros, Sibuyan and Mindanao, and 1 ♂ from Singapore, (all C. F. Baker). A large ♀ from Cuernos Mts., Negros, measures 15 mm. long. Abcissae 2 and 5 are sometimes subequal. The ♂♂ are rather variable, even to the armature, the claspers and sagittae being more or less acute; the clypeus in a large ♂ specimen from Kolambugan, Mindanao, is, like that of the ♀, sparsely punctured on the

bevel, and the hind femora are rather distinctly emarginate in all but the type, which is the only ♂ from a northern island.

Not a common wasp.

Notogonidea mindanaoensis n. sp.

(Fig. 66, clypeus, ♂; 91, antenna, ♀; 153, last ventral segment and armature ♂.)

Male, type: Length, 8.25 mm. Rather dull black; mandibles dark red at tip; wings rather broadly infuscate along outer border and in the whole of the radial cell. Clypeus broadly rounded out, not emarginate, the wide bevel polished and practically without punctures; antennae with joint 4 a little longer than 3; interocular space at vertex about equal to 2 + 3. Head and thorax with close-set, moderately fine punctures; mesopleura quite rugulose, the wrinkles interfering with the median episternal groove above; disc of propodeum with the median carina extending about half way down, transversely carinulate, with sparser little carinulae in between forming reticulations except mesially, pleura steeply obliquely wrinkled, posterior face with a short median furrow and irregularly and rather coarsely reticulate. Wings with abcissae as follows: 2, 5, 3, 1 and 4. Abdomen with three sericeous white bands; last ventral segment very slightly notched. Armature, with sagittae with a wide, thinly chitinized inner portion and with the claspers usually obliquely and delicately subtruncate. Vestiture largely with a pale golden tinge; that of the propodeum mainly erect and fairly long.

Female, allotype: Length, 11.5 mm. Stout. Dull black; more than the apical half of the mandibles dark red, tarsi somewhat brownish. Clypeus much like that of *N. silvicola*, its nearest relative, gently rounded out and slightly incised mesially, lateral angles rather sharp, bevel broad, polished and practically impunctate; antennae rather slender, joint 3 a little longer than 4 and slightly greater than interocular space at vertex. Head and thorax minutely punctured; mesopleura delicately wrinkled from below the median episternal groove; disc of propodeum with a rather strong median carina almost to apex and rather coarsely reticulate, pleura imperfectly striate over a finely granulated surface, posterior face with a strong linear sulcus spreading out from about 3/4 the length of the face to meet the rather large dorsal wedge. Wings with venation pale brown, slightly though broadly darkened apically; abcissae in following order of length: 5 and 2 subequal, 3, 1 and 4. Abdomen broad and with three light golden sericeous bands, and in certain lights a fourth one on subapical segment; pygidium much as in *N. silvicola*, with bright golden pubescence and some semi-recumbent rather long yellow bristles. Vestiture pale golden, rather sparse.

Type from Lake Lanao, Mindanao, (F. X. Williams), November, 1921; allotype, Sandakan, Borneo, (C. F. Baker); paratypes, 5 ♂♂ from Mt. Makiling, Luzon; Mindoro; and Sandakan, Borneo. A large ♂ from Lake Lanao, Mindanao, measures 10 mm. in length. The ♂♂ are somewhat variable, even to armature, but the rugosity of the mesopleura as well as the large, thinly chitinized area on the sagittae seem to be distinctive.

Evidently a rare insect.

Notogonidea robusta n. sp.

(Fig. 89, antenna ♂; 61, clypeus of ♀; 170, posterior face of propodeum, ♀; 127, pygidium; 148, male armature.)

Female, type: Length, 9.75 mm. Rather dull black; mandibles reddish for more than their apical half; wings slightly infuscate apically, the venation dark. Head large; clypeus very like that of *N. laboriosa*, i. e. gently rounded out and mesially incised, but there is a distinct notch in from the lateral angle (Fig. 61); antennal joints 3 and 4 subequal and each about equal to the interocular space at vertex. Head and thorax very minutely punctured; disc of propodeum dull black, and with well spaced transverse carinulae and more or less reticulate to either side, the median carina extending to apex, pleura in part with fine oblique wrinkles and in part almost smooth, posterior face with the rather short, vertical fovea with its sides diverging and arching widely towards the dorsum, the broad infitting wedge with a convex dorsum or base, face with some fine subobsolete transverse carinulae, arched and stronger on the wedge. Wings with abcissae in the following order of length: 3 and 5 subequal, 2 a very little

longer, 1 and 4. Abdomen with three silvery sericeous bands, as usual appearing broken in certain lights; pygidium broad, about 1¼ times as long as greatest width and with a small naked basal area. The pile and bristles are golden, or bronzy gold.

Male, allotype: Length, 7.5 mm. Clypeus subtruncate; slightly arcuate, the lateral angles sharp, moderately beveled, the smooth polished area extending farther basally in its middle portion; antennal joint 4 longer than 3; 2 + 3 about equal to interocular space at vertex. Disc of propodeum about as in female, a little more reticulate. Posterior femora not emarginate on ventral (posterior) side; last ventral segment subtruncate at tip; armature with claspers finely drawn out at tip; the sagittae outcurved.

Type from Mt. Makiling, Luzon, (C. F. Baker); allotype Mt. Makiling, Luzon, January, 1922, (F. X. Williams); paratypes 8 ♂♂ and 8 ♀♀, from Mt. Makiling, Los Baños, and Tayabas, Luzon; Mindoro, Negros, Palawan and Mindanao; (Baker, Muir, Pemberton, Williams), and over 100 specimens of both sexes from above localities and Mt. Banahao, Pagsanhan, and Baguio, Luzon; Leyte; Sandakan, Borneo; and Singapore, (Baker, Williams).

The species is at least in some cases a forest insect, and in general way very much resembles *N. robustoides*; the clypeus in the ♀ has a very slightly wider bevel, the propodeum is generally slightly stouter and the pygidium is more heavily punctured and has a much smaller naked area. In the ♂ the clypeal disc is often slightly depressed mesially at the margin.

Cratolarra Cameron

(Subgenus of **Notogonidea.**)

Cameron, P., Ann. and Mag. Nat. Hist. V, 7th. Ser., p. 34, 1900.
Genotype *Cratolarra femorata* Cam., Khasia, India, ♀.

Female. Differs from *Notogonidea* in having the pygidial field, except for a very, very few sparse hairs, naked and polished; and in having the posterior edge of the collar thicker, more prominent and more nearly approaching the level of the mesonotum. The claws are not toothed beneath. From *Larra* it may be separated by the mandibles being clearly toothed within, the angulate posterior border of the pronotum, the more or less keeled second ventral abdominal segment and the bristle-tipped pygidium. Second antennal joint pilose.

Male. Characters not so good. Pronotum as in ♀; clypeal margin not or hardly angulate laterally; not or hardly beveled; this produced portion with a furrow in the margin on either side (hardly distinct in the ♀), and much as in Fig. 55, for *Motes;* armature more simple, as in *Larra*, the claspers quite slender.

The insect in general body form rather suggests a *Lyroda*. Only two species have been described.

Notogonidea (Cratolarra) pitamawa Rohwer

(Fig. 56, clypeus, ♂♀; 57, ♂ from Palawan; 125, pygidium, ♀; 93, venation ♀; 150 and 151, last ventral segment and armature ♂.)

Rohwer, S. A., Bull. 14, Exp. Sta. Hawaiian Sugar Planters' Assn., Ent. Ser., p. 7 and 8, 1919, ♀. Los Banos, Luzon.

Female: Length 8-12 mm. Rather slender and dull black; mandibles in part red; wings slightly darkened along outer margin. Clypeus with the middle portion gently rounded out and so waved there as to produce three broad, low and obscure teeth, the median one of which may be very inconspicuously emarginate, bevel polished, with very few punctures; antennal joints 3 and 4 subequal, 3 about equal to the interocular space at the vertex. Head, and thorax (including pleura) very minutely punctured; disc of propodeum dull, usually with some evidence of a median carina, and rugulose, with indications of transverse carinulae or wrinkles, posterior face in part transversely wrinkled and with an impressed median line very slightly widening dorsally. Wings with the rather short marginal cell obliquely truncate, and with the abcissae in the

following order of increasing length: 2, 5, 3, 4 and 1. Three sericeous abdominal bands; pygidium polished, with 2-4 apical bristles, quite long and narrow, hardly punctured along the middle, and over twice as long as wide. Vestiture: sparse whitish pubescence.

Male: Length 4.8-7.8 mm. Much like ♀. Clypeus with rounded bevel hardly angulate, more or less produced, impunctate (or in others sometimes with scattered punctures); antennal joint 3 a little shorter than 4, and together somewhat greater than interocular space at vertex. Disc of propodeum granulate or rather finely reticulate, with or without a carina, the margins of impressed line of posterior face diverging arcuately above. Last ventral abdominal segment more or less bilobed or emarginate at apex; armature with slender claspers and sagittae.

A ♂ from Los Baños, Luzon (reared), (F. X. Williams); 33 ♂♂ and 46 ♀♀, Mt. Makiling, Los Baños, Tayabas, Baguio, Luzon; Mindoro, Negros, Samar, Palawan, Basilan and Mindanao, (C. F. Baker, F. X. Williams); extra-Philippine specimens from Sandakan, Borneo, Island of Penang, Singapore, (C. F. Baker).

A species that varies in size, propodeal sculpture and in the clypeus and last ventral segment of the ♂. This variation is to some degree insular. Particularly in specimens from Puerto Princesa, Palawan, does the clypeus become more produced and sparsely though deeply punctured (Fig. 57). The emargination in the last ventral segment may be quite pronounced with those possessing either type of clypeus. The propodeal carina may be quite lacking. But the intergrades are such that all the variations must be placed under a single species.

Notogonidea (Cratolarra) flavipennis n. sp.

(Fig. 124, pygidium ♀; 152, last ventral segment, ♂.)

Female, type: Length, 14 mm. The larger size, more evenly and heavily punctured pygidium, which is also very, very finely reticulate thus giving the disc a less polished appearance than in *C. pitamawa*, are good specific characters to distinguish it from the foregoing species. The wings also are strongly tinged with yellowish brown; the clypeus is depressed transversely along the middle width of the bevel, where there is an irregular line of punctures; there is but a trace of the median propodeal carina, while the impressed line on the posterior face diverges near the dorsum and is there well raised above the plane of the infitting wedge, which is very finely cross striate. The vestiture of the face and thorax and abdomen is tinged with golden.

Male, allotype: Length, 8.75 mm. Clypeus very like that of *C. pitamawa*, produced in the middle as a broad low and blunt wedge, with a slight little emargination near the rounded lateral angles; bevel with a few punctures near the margin; disc of propodeum mainly granulate and with only a slight indication of a median carina, pleura with moderate oblique wrinkles, and punctured, posterior face with transverse wrinkles and the impressed line plainly diverging and arcuate above and raised above the infitting wedge. Wings tinged with yellow, vestiture with golden tinge, the sericeous bands of the abdomen silvery. Last ventral segment rather deeply notched; armature like that of *C. pitamawa*.

Type from Los Baños, Luzon, July, 1916, (F. X. Williams); allotype same locality, (C. F. Baker); paratypes, 1 ♀, Los Baños, October, 1915, College of Agriculture Collection, 7 ♀♀, Mt. Makiling, (C. F. Baker); 3 ♂♂, Mt. Makiling, Los Baños, and Malinao, Tayabas, Luzon, (C. F. Baker). I separate the males from those of *C. pitamawa* mainly by their larger size and yellowish wings.

It is obviously a rare insect.

Liris Fabricius

Fabricius, Syst. Piez., p. 227, (1804).

Genotype **Liris aurata** Fabr.

Very close to typical *Notogonidea;* differs from it in having the mandibles not or very slightly excised beneath. The third ventral segment is well keeled in the ♀, and the hind femora of the ♂ are not emarginate beneath.

These wasps are generally larger than *Notogonidea;* the largest, *L. ducalis* (Smith) of India attaining a length of 30 mm. There are over a dozen species distributed in the Oriental, Australian, Ethiopian and Palaearctic regions. Some of the species have a wide range. There is a species inhabiting the Samoan Islands and which is evidently a derivative of the Australian or Oriental region and perhaps the farthest outlying *Liris* in the Pacific.

Key to Separate the Species of Philippine **Liris**

1. Females (antennae 12-jointed) .....2.
   Males (antennae 13-jointed) .....4.
2. Clypeus not sunken mesially on anterior margin, and with only a small median notch; eyes above lying at a considerable distance from posterior margin of head; head and thorax with much golden pile; legs in part orange red. A row of spines on anterior tibiae above.....*L. aurata*, p. 82
   Clypeus strongly sunken and notched mesially on anterior margin; eyes above close to posteriro margin of head; legs black. No spines on anterior tibiae above...3
3. Wings well infuscated; interocular space at vertex about equal to length of antennal joint 3; length 16-18 mm.....*L. mindanaoensis*, p. 84
   Wings slightly infuscate; interocular space at vertex a very little more than length of antennal joint 3; length 12.75-13.5 mm.....*L. intermedia*, p. 83
4. Clypeus rounded out, not notched mesially, legs in part orange red..*L. aurata*, p. 82
   Clypeus slightly notched mesially; legs all black.....5.
5. Produced portion of clypeus almost truncate, the lateral angles nearly as high as the middle portion, strongly punctate to near margin; little or no golden pile .....*L. intermedia*, p. 83
   Produced portion of cylpeus rounded out so that the median portion is noticeably higher than the lateral angles; polished and rather sparsely punctate for a considerable distance in from margin; head and thorax with some golden pile.....*L. mindanaoensis*, p. 83

Liris aurata Fabr.

(Fig. 94, head of ♀, (dorsal); 44, clypeus ♂ ♀; 165, mandible ♀, (dorsolateral); 171, last ventral segment and armature ♂.)

Female: Length 16-23 mm. Black; base of antennae and legs mainly orange red. Golden pile on head, thorax and legs; wings fusco-hyaline, pygidium with golden pile.

Male: Length 9-17 mm. Colored much like the ♀.

108 specimens of both sexes of this common though rather elusive insect. From Luzon, Mindoro, Sibuyan, Cebu, Negros, Panay, Samar, Philippines, (C. F. Baker, F. Muir, F. X. Williams); and from Java, Amboina, Selangor and Formosa, (C. F. Baker and F. Muir).

It also occurs in Africa, India, China and Japan.

From *Liris haemorhoidalis* subsp. *magnifica* Turner, of Australia it differs mainly in color.

Liris intermedia n. sp.

(Fig. 43 ♂ clypeus; 177, last ventral segment and armature, ♂.)

Male, type: Length, 9.5 mm. Dull black; tips of mandibles dark red; wings nearly clear, slightly infuscate at tips and in marginal cell, venation brownish, Clypeus broadly produced and there, almost truncate, slightly incised mesially, lateral angles prominent and about as high as middle portion, densely punctate nearly to this margin; mandibles with a sharp tooth within; antennal joints 3 and 4 subequal, interocular space at vertex slightly greater than 2 + 3. Head and thorax finely and densely punctured, mesonotum dull, shallowly furrowed for a little more than half its length, pleura very, very finely reticulate or aciculate into little areas; disc of propodeum with delicate cross wrinkles and finely reticulate, the one obscuring the other, with a short median carina lying in a sulcus that extends to apex, pleura with fine oblique, more or less effaced wrinkles, posterior face with transverse wrinkles and a rather deeply impressed line, whose margins fork dorsally as for the reception of an acute wedge. Wings with abcissae in following order of length: 5, 2, 3, 1 and 4; the two recurrent veins close together. Abdomen with three dull silvery sericeous bands; last ventral segment well notched; uncal pieces as seen from below thicker at their apical portion than at the base of the sagittae. Vestiture: sparse, silvery, often with a tinge of gold, pale golden on sides of mesonotum, some longer, sparse erect white hairs, the patch ventral of forewings on mesopleura thin and visible only in some lights.

Female, allotype: Length, 12.5 mm. Stout. Dull black; tips of mandibles dark red. Clypeus broadly and subtruncately rounded out, as in Fig. 42, for *L. mindanaoensis*. deeply notched and depressed mesially along the edge; a very narrow impunctate marginal strip from the notch to lateral angle; before this strip the clypeus is closely and deeply punctured, with some of the outer punctures extending confluently to and into the strip; mandibles bidentate within; antennal joints 3 and 4 subequal, 3 about equal to—less if anything—than interocular space at vertex. Head and thorax finely and closely punctured, the thorax less finely so; disc of propodeum with a shallow median sulcus extending to apex, a mere basal vestige of a longtitudinal carina and with fine transverse wrinkles obscured by fine reticulations, the wrinkles or carinulae recurved mesially, pleura with fine subobsolete oblique wrinkles, posterior face with subobsolete transverse wrinkles and the impressed line widening above as for the reception of a narrow wedge. The nearly transparent wings have the abcissae in the following order of length: 5, 2, 3, 1 and 4. Three dull silvery bands on abdomen; second ventral segment strongly and narrowly keeled for its basal third; pygidium about 1⅔ times as long as wide; well rounded at tip and slightly inbowed from before the tip to the widest portion, covered with fine bronzy pile and with scattered darker erect setae. Vestiture: sparse and as in male, except silvery and not gold tinged.

Type, Los Baños, Luzon; allotype, Mt. Makiling, Luzon, (C. F. Baker); paratypes 1 ♂ Lake Lanao, Mindanao, November, 1921, (F. X. Williams); and 1 ♂ and 1 ♀, Los Baños, and 1 ♀ Sibuyan Island, (C. F. Baker).

Liris mindanaoensis n. sp.

(Fig. 42, clypeus ♂ ♀; 95, top view of head; 166 mandible ♀ (dorsolateral); 178, last ventral segment and armature, ♂)

Male, type: Length, 12 mm. Rather dull black; tip of mandibles dark red, wings mildly infuscate, with a tinge of yellow and darker along outer margin and marginal cell. Clypeus with the producer portion rounded out and bilobed or notched, lateral angles sharp and much lower than the middle, quite sparsely punctured for a considerable distance from the margin; mandibles with a sharp tooth within; antennal joints 3 and 4 subequal; interocular space at vertex, equal to or very little less than joints 2 + 3. Head finely punctured; mesonotum with larger close punctures and with distinct median sulcus that extends for more than half its length; pleura mainly very finely aciculate, lending an exceedingly fine reticulate appearance; disc of propodeum with fine subobsolete transverse wrinkles and reticulations, still less distinct in the broad and shallow median sulcus which extends almost to apex, the longitudinal carina lacking, pleura granulate and with fine weak oblique wrinkles, posterior face with impressed line and rather poorly defined transverse wrinkles. Wings with abcissae in following order of length: 5, 2, 3, 1 and 4; 5 and 2 being subequal, and 4 nearly twice as long as 1; recurrent nerves close together at second submarginal cell. Abdomen with three silvery golden sericeous bands; last ventral segment well notched apically, armature with uncal pieces, as seen from below, slightly thicker at their

apex than at base of sagittae. Vestiture: sparse pale golden pile with sparser and longer erect pale hairs, the patch on mesopleura under fore wings rather thin and visible only in certain lights.

Female, allotype: Length, 18 mm. Dull black; very little dark red at apex of mandibles. Clypeus broadly rounded out, deeply notched and depressed mesially along the edge, with a narrow impunctate marginal area, before which it is heavily punctured, especially about the notch, where the punctures are more or less confluent; mandibles bidentate within; antennal joints 3 and 4 subequal, 3 slightly more than interocular space at vertex. Head and thorax finely punctured; the mesonotum a little depressed mesially at its anterior end, as in *L. intermedia*; pleura very finely aciculate; disc of propodeum dull, with fine, recurved transverse wrinkles, not reticulate, and with a shallow median sulcus extending to apex, median carina very weak and imperfect, pleura with fine incomplete oblique wrinkles, posterior face with some incomplete transverse wrinkles, the median impressed line receiving a narrow wedge above; wings with abcissae in following order of length: 5, 2, 3, 1 and 4; the two recurrents very proximate on the second submarginal. Abdomen with three narrow and rather dull silvery sericeous bands; second ventral segment with a good carina extending less than half its length; pygidium shaped much as in *L. intermedia*, slightly narrower, not quite twice as long as wide, with bronzy gold pile and suberect bristles or setae. Vestiture: quite sparse silvery pile, with sparser longer erect white hair; sericeous patch on mesopleura below fore wings thin and visible only in certain lights.

Type and allotype, from Zamboanga, Mindanao, October, 1921, (F. X. Williams); paratypes, 1 ♂ and 2 ♀♀, Surigao, and 1 ♀ Kolambugan, Mindanao, (C. F. Baker).

Liris melania, intermedia, mindanaoensis, and a species from the Samoan Islands, are very closely inter-related, though widely distinct from the *aurata* group, where the clypeus is only rather feebly notched mesially and where there is a considerable space above between the eyes and occiput.

Liris melania Turner (Ann. Mag. Nat. Hist. 8th. Series, Vol. XVII, p. 248-249, 1916), comes from the Cairns district, North Queensland, Australia. The three specimens of *melania* in the Experiment Station here from Halifax, North Queensland, have much more confluence among the clypeal punctures than its three relatives, while the patch on the mesopleura beneath the base of the fore wing is rather conspicuous and silvery. *L. mindanaoensis* also has darker wings and slightly duller mesonotum than *L. melania,* which like it has the interocular space at vertex a very little less than antennal joint 3, although this character may prove invalid in a large series. The Samoan species is most polished, and adorned with sparse pale golden vestiture, while the margin of the produced portion of the clypeus (♀) is practically truncate and not slightly broken by an angle as in the other three species.

Dalara (**Hyloliris** Williams)

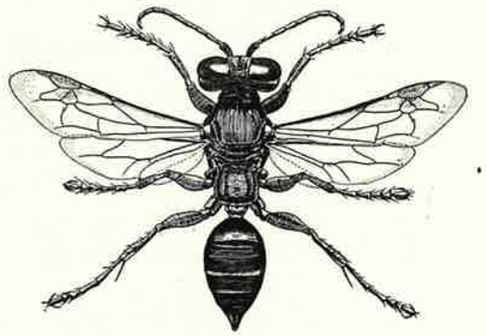
Williams, F. X., Bull. 14, Ent. Ser. Exp. Sta., Hawaiian Sugar Planters' Association, p. 49-51, 141-142, Figs. 19, 20 and 70, 1919, ♂ ♀.

Genotype *Hyloliris mandibularis* Williams.
Related to *Liris* and *Dicranorhina.*

Head proportionately large; face much as in *Liris;* with a swelling along inner eye margin; a transverse swelling on forehead; two posterior ocelli reduced, flat transverse and approximated; clypeus very wide and well produced; mandibles not excised beneath, unidentate within before the middle and then again towards the apex. Pronotum well beneath the level of the mesonotum, gently angulate into it. Meso-metathorax short and stout; propodeum not long, subtruncate at apex. Legs rather long and stout; posterior tibiae not as strongly carinate as in *Liris* or *Notogonidea;* venation much as in *Liris.* Abdomen short, subsessile; second ventral segment with a faint indication of a longitudinal carina from base. ♂: Hind femora more or less modified. ♀: Pygidium bare.

? Dalara Rizzma 1984

But one species of this distinct East Indian genus is known.



Hyloliris mandibularis, ♀ Type.

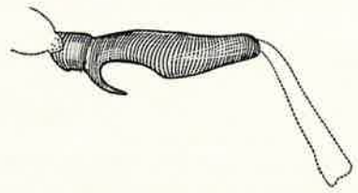
FIGURE 7

Hyloliris mandibularis Williams

(Text fig. 7, ♀ type; 45, clypeus ♀; text fig. 9, head ♂; text fig. 8, hind femur, ♂; 175, armature ♂; 121, pygidium ♀.)

Williams, F. X., Bull. 14, Ent. Ser. Exp. Sta. Hawaiian Sugar Planters' Assn., p. 50-51, 1919.

Female: Length 12.5 mm. Dull black; mandibles except at apex, basal joint of antennae, and tegulae light brown; forewings dusky along part of costa and all of marginal cell and a little more. Clypeus produced, cleft mesially and obliquely emarginate at lateral angles; mandibles long, with one tooth before the middle and another near apex within; antennal joint 3 slightly longer than 4; 1+2 about equal to interocular space at vertex. Head and thorax minutely punctured; disc of propodeum not margined, dull, with indistinct fine transverse wrinkles and finely rugulose. Legs moderately spinose; claws not dentate; a rather weak tarsal comb on fore legs. Wings with abcissae as follows: 2 (much the smallest), 5, 3, 1 and 4. Pygidium narrowly constricted at apex, its apical half or more concave in lateral profile, polished and coarsely and irregularly rugose.



Hyloliris mandibularis ♂ Hind femur.

FIGURE 8

Male: Usually a little smaller than ♀. Clypeus slightly emarginate mesially and rather swollen at the sides where the mandibles articulate; mandibles very long, with a tooth near the base, a low swelling midway, and another tooth ⅔ the distance from the base to apex. Antennae slender as in the ♀, joints 2+3 less than interocular space at vertex. Disc of propodeum well margined, its posterior face more sloping than in ♀, dull and little sculptured. Posterior femora beneath emarginate near base and drawn out into a strong spine. Pubescence of ♂ ♀, golden on face, otherwise nearly bare.

Type and allotype and 8 ♀ ♀ and 6 ♂ ♂ paratypes, from Mt. Makiling, Los Baños, Luzon, August, 1917. A pair of paratypes deposited in the U. S. National Museum in 1920, (F. X. Williams); 2 ♀ ♀, one from Los Baños, the other from the island of Basilan, far to the south, (C. F. Baker). The Basilan

Hyloliris mandibularis, ♂ Head.

FIGURE 9

specimen has more golden pubescence on the body and the scape or first antennal joint is light reddish. It is evidently widely distributed in the Philippines and probably extends to the south of them, but owing to its secluded forest habits is rarely taken.

Dicranorhina Shuckard

Shuckard, Lardner's Cabinet Cyclopaedia, Natural History, Insects (Swainson and Shuckard, 1840).
Syn. *Piagetia* Ritsema, Ent. Mo. Mag. IX, p. 121, 1872-3.
Genotype *D. ritsemae* Rits., p. 121-123, Figs. a to e.

Mandibles incised on the lower border and dentate within. Clypeus often well produced. A fold along inner eye margin and a transverse swelling on forehead. Posterior ocelli flat, transverse and reduced. Collar of pronotum rather long; pronotum angled into mesonotum. Venation as in *Notogonidea*. Posterior femora more or less modified on ventral side, especially in the ♂. Abdomen with the basal segment forming a short petiole, its distal end far narrower than the segment following (the second segment). ♀ pygidium well defined, sparsely pilose.

A small genus confined to the Oriental and Ethiopian regions.

Dicranorhina luzonensis Rohwer

(Fig. 46, clypeus ♂ ♀; 75, antenna ♂; 81, hind femora ♂ ♀; 172, armature and last ventral segment ♂.)

Rohwer, S. A., Bull. 14, Ent. Ser. Exp. Sta. Hawaiian Sugar Planters' Association, p. 6 and 7, ♂ ♀, 1919.

Female: Length 9.5-10 mm. Dull black; abdomen somewhat polished; mandibles except tip, forepart of clypeus, scape of antennae, tegulae and lateral pronotal lobes, most of forelegs, and pygidium pale reddish; wings with a subapical dusky band. Clypeus notched mesially; antennal joints 3 and 4 subequal, or 3 slightly longer than 4; interocular space at vertex somewhat less than joints 2+3. Head and thorax with very fine close punctures. Disc of propodeum with median carina almost to apex, reticulate and combined with slightly oblique and irregular fine wrinkles from the carina. Abcissae of forewings in following order of increasing length: 2 and 5, or 2, 3 and 5 subequal, or 2, 5, 3, then 1 and 4; the two recurrents sometimes quite proximate at second submarginal cell. Pygidium broad, flattish, triangular with large well-separated punctures some of which at or near apex bear pale brownish appressed bristles. Vestiture: sparse, silvery.

Male: Length 6.5-9 mm. Colored as in ♀. Clypeus with two strong teeth; antennal joint 3 slightly longer than 4; joints 2 + 3 a little more than interocular space at vertex; disc of propodeum as in ♀, carinate, cross wrinkled and reticulate mixed; pleura finely and incompletely wrinkled and granulate. Last ventral segment slightly bilobed at apex; armature with sagittae with minute prickles.

13 ♀ ♀ and 12 ♂ ♂, Los Baños, Luzon, (C. F. Baker, F. X. Williams).

1 ♂ Pampanga, San Fernando, Luzon, (F. X. Williams), and 1 ♂, no locality label.

This curious semi-domiciliary insect is evidently closely related to *D. ritsemae* (Ritsema) of Java.

Dicranorhina palawanensis n. sp.

(Fig. 76, antenna, ♂; 82, hind femur ♂; 173, last ventral segment and armature ♂; 47, clypeus.)

Male, type: Length 6.25 mm. Rather dull black; scape beneath, mandible except base, forelegs except femora in part, tegulae and pronotal lobes, more or less, yellowish; apex of mandibles and antennae more or less reddish. Clypeus with produced portion truncate, very slightly emarginate mesially. Antennal joint 3 distinctly longer than 4; 2+3 approximately equal to interocular space at vertex. Head and thorax very finely punctured; scutellum and postscutellum slightly impressed; disc of pronotum with a triangular silvery sericeous area at the base, a short basal carina, a shallow median sulcus from carina to apex, the disc finely reticulate, no cross wrinkles, pleura not sculptured, smooth and polished, posterior face with well incised line, a rounded wedge above. Wings banded subapically with fuscous, with abcissae in following order of increasing length: 5, 2, 3, 1 and 4, 4 at least twice 1; two recurrents well separated on second submarginal cell. Last ventral segment slightly bilobed at apex; armature with sagittae subspatulate at tip.

1 ♂, type, from Puerta Princesa, Palawan, P. I., (C. F. Baker).

Tachytes Panzer

Panzer, G. W. F., Krit. Revis. Faun. Deutschl., II, 129, 1806.

Body generally stout and often very pubescent and bee-like; pygidial area well margined and covered with appressed pubescence; mandibles incised beneath, dentate within; fore ocellus perfect, hind pair very elongate, placed obliquely and with the upper end forming a hook or flat spiral, front not raised along the inner orbits as in "*Notogonia*" (Cresson).

A genus of general distribution; 7 species, from the Philippines—all of these belonging to the more robust, bee-like division that prey on certain long-horned grasshoppers. A difficult group.

Key to the Species of Philippine **Tachytes**

1. With yellowish wings and coal black body; no paler sericeous bands on abdomen; interocular space at vertex less than length of third antennal joint.....
.....*suluensis*, ♂ ♀, p. 88
Not as above; abdomen pale sericeous banded.....2.
2. Portions of femora and all tibiae and tarsi honey yellow; length 9.5-12 mm.; apex of median impressed line of disc of propodeum (always as viewed from above), a narrow opaque wedge in shape, almost flat and without carina, apically slightly wrinkled; armature of ♂ with claspers bearing a large bristle just below apex (Fig. 154).....*surigensis*, ♂ ♀, p. 88
Not as above, size usually larger; at most posterior of fore legs pale brown; ♂ armature with sagittae bearing no subapical bristle, though sometimes with a number of small ones.....3.

8. Fore tibiae and tarsi mainly pale brown; interocular space at vertex about equal to antennal joints 2+3; clypeus plainly notched mesially, and strongly punctured right up to the differentiated margin, where these punctures are about their diameter apart ..... *banoensis*, ♂ ♀, n. 89
Fore tibiae and tarsi black or nearly black; clypeus notched mesially or entire; when notched the punctures above and near the differentiated margin are rather sparse and usually much more than their diameter apart ..... 4.
4. Size to 18.5 mm., wings rather yellowish; only three silvery bands on abdomen; clypeal margin entire and the disc strongly punctured, but rugulose before the differentiated margin; apex of median impressed line of propodeal disc is a narrow flat wedge without carina or swelling; interocular space at vertex about equal to 3rd antennal joint ..... *silvicola*, ♀, p. 89
Size to about 15.5 mm.; wings slightly or not yellowish; apex of median impressed line of propodeal disc with the wedge carinate or with a swelling; four fairly distinct abdominal bands ..... 5.
5. The differentiated margin of the clypeus between the teeth entire and with its base-delimiting line nearly straight; apex of median impressed line of propodeal disc a nearly flat wedge with a low and gradual carina ... *silvicoloides*, ♀, p. 90
Differentiated margin of the clypeus notched or entire, its base-delimiting line obsolete or curved ..... 6.
6. Clypeal margin in ♂ entire, very slightly notched mesially in ♀; apex of median impressed line of propodeal disc a medium-wide, and low-carinate flattish wedge ..... *bakeri*, ♂ ♀, p. 90
Clypeal margin ♂ ♀ distinctly notched mesially; apex of median impressed line of propodeal disc a rather wide wedge with a subcarinate median swelling at its base (wide end) ..... *magellanica*, ♂ ♀, p. 91

Tachytes suluensis n. sp.

(Fig. 110, bare apical propodeal area ♀; 159, armature and last ventral segment ♂.)

Female, type: Length 18.5 mm. Stout. Head and thorax dull black, abdomen somewhat polished black, wings tawny yellow, a trifle fuscous along outer border. Clypeus well rounded outwardly, not incised mesially and with three teeth including the modified lateral angle on either side; the differentiated marginal part finely rugulose at base and transversely depressed below the level of the densely punctate disc; joint 3 of antenna slightly longer than 4; interocular space at vertex narrow, less than joint 3; vertex of head dull, irregularly pitted with larger and smaller punctures. Thorax and propodeum with a very finely punctato-granulate surface; median impressed line of disc of propodeum obsolete, the bare apical area wedge-like, flattish, polished and slightly and very finely reticulate at apex; second abcissa of forewings less than third. Abdomen short, rather depressed, without paler banding; pygidium ¼ or less longer than wide, the sides slightly arched and forming a subacute apex; disc covered with fine golden bristles. Vestiture: golden pile on frons and more or less on legs, erect brownish hair on thorax and on first abdominal segment (= first apparent segment) and venter of second.

Male, allotype: Length 15.5 mm. Of similar appearance to the ♀. Differentiated edge of clypeus smooth, three lateral teeth. Pygidium with broad, thin, rounded, posterior margin, and covered with silvery golden pile; last ventral segment club-like, as viewed broadside, and gently emarginate at apex; armature with a hair-tuft ventrally before the middle length of claspers, the two unci with a spine ventrally.

Type, from Dapitan, Mindanao; allotype, and 7 ♂ ♂ and 6 ♀ ♀ paratypes from Surigao, Mindanao, (C. F. Baker).

Tachytes surigensis n. sp.

(Figs. 70 and 71, clypeus, ♂ ♀; 114, bare apical area of propodeum, ♂; 154, last ventral segment and armature of ♂.)

Female, type: Length 12.25 mm. Black, but more or less obscured by the pale golden pubescence; base of mandibles yellowish, remainder reddish; all the tibiae, tarsi and apex of femora brownish yellow; wings with slight yellowish tinge, tegulae and veins pale. Clypeus rounded out, entire, the differentiated marginal part thin, shining and somewhat upturned; two lateral teeth, the lateral angle being scarcely differentiated in this case; before the margin it is shining and rather sparsely

punctured; interocular space at vertex with rather fine, well-spaced punctures and greater than third antennal joint, which is about equal to the fourth. Thorax very finely punctured; disc of propodeum finely granular in appearance, median impressed line dull and not very obvious, the bare apical area (always as viewed from above), a narrow, almost flat wedge, non-carinate and rather dull; abcissae 2 and 3 of wings subequal. Abdomen with four silvery sericeous bands; pygidium with sides straight and tapering to a subacute apex. Vestiture: pale golden pile and pubescence, rather dense.

Male, allotype: Length 11.5 mm. Appearance similar to ♀ but differentiated edge of clypeus is notched mesially, tridentate (including the rather modified angle) laterally, with the margin between the notch and the teeth straight and not curved, strongly punctured before the edge; antennal joints 3 and 4 subequal; interocular space at vertex considerably greater than antennal joint 3; 2nd abcissa of wings shorter than 3rd. Pygidium subtruncate at apex, covered with fine silvery bristles; last ventral segment (broadside on) is rather swollen before apex, which is somewhat deeply emarginate; armature with claspers bearing a rather extensive ventral tuft of hair, and subapically on dorsal side a rather large isolated bristle, the two unci rounded out ventrally near apex and rather sharply so at apex.

Type and allotype and 4 ♂ ♂ paratypes, from Surigao, Mindanao, (C. F. Baker).

Tachytes banoensis Rohwer

(Fig. 53, clypeus ♀; 111, bare apical area of propodeum ♀; 155, armature and last ventral segment ♂.)

Rohwer, S. A., Bull. 14, Ent. Series, Experiment Station, Hawaiian Sugar Planters' Association, p. 8 and 9, 1919, ♀.

Female: Length 12-15 mm. Black; mandibles yellowish brown at base, dark reddish apically; fore tibiae and tarsi pale brown. Clypeus rounded out and heavily punctured to the base of the polished differentiated edge, which is notched mesially and with three lateral teeth (including angle); antennal joint 3 a little shorter than 4; 2+3 about equal to interocular space at vertex, which has scattered larger and smaller punctures. Thorax very minutely punctured; disc of propodeum granulate; the impressed line weak, the bare apical area appears as a narrow, nearly flat, and often finely and more or less transversely striate wedge. Abdomen with four silvery sericeous bands; pygidium with margins slightly outbowed, subacute at apex, the disc covered with fine golden bristles. Vestiture: face and thorax and legs in part with fine brassy yellow pile and erect longer pubescence.

Male: Length 10-12.5 mm. Marked, punctured and clothed about as in ♀; clypeus very similar; interocular space at vertex about equal to joints 2+3; 3 shorter than 4; abcissa 2 of forewings a little shorter than 3; impressed line of disc of propodeum subobsolete; pygidium rounded-truncate at apex; its pile silvery; last ventral segment semicircularly emarginate; armature with unci tapering to an acute point at apex, rounded beneath before apex.

Type, Cat. No. 22108, U. S. Nat. Mus., Los Baños, Luzon, P. I., (F. X. Williams). Other specimens: 40 ♀ ♀ and 75 ♂ ♂ from Los Baños, and Negros, (F. X. Williams); from Polillo, (Taylor); and from Leyte, Samar and Mindanao, (C. F. Baker).

The male is described here for the first time.

Tachytes silvicola n. sp.

(Fig. 52, clypeus ♀; 116, bare apical area of disc of propodeum ♀.)

Female, type: Length 17 mm. Rather dull black; mandibles nearly black, tegulae in part pale brown, wings with a good yellowish tinge, venation light brown. Clypeus with the produced portion gently rounded out and with three lateral teeth; the margin with some longitudinal wrinkles, the space before this is shining rugulose and sparsely punctured, and finally, more basally, are densely-set punctures; third antennal joint slightly longer than fourth and subequal with interocular space at vertex; interocular space with mainly larger well-spaced piliferous punctures. Thorax closely

punctured, the pleura smoother; disc of propodeum finely and closely pitted with a very fine reticulate effect, median impressed line slight though obvious enough in certain lights, the bare apical area a sharp wedge, shining and mainly smooth, pleura nearly smooth, becoming rugulose towards posterior face which is very finely and irregularly transversely wrinkled, the median impressed line there quite deep and widening out above into the bare apical area; legs spinose, as usual; wings with third cubital cell extending somewhat farther distally than the marginal; abcissae in the following order of length: 5, 2, 3 and 1 subequal, 4. Abdomen with only two well-marked silvery sericeous bands; pygidium broad at base, the sides for the most part nearly straight, subacute at tip, thickly covered with appressed bronzy (perhaps golden when fresh) bristles. Vestiture: face with tawny pubescence, legs in part with pale tawny pile, but also with pale brownish pubescence, thorax with sparse pale golden pubescence on sides of notum, the pleura particularly, and the propodeum with longer and shorter pale yellowish pubescence, but not at all dense, the ground color of the body being plainly visible.

Type, Los Baños, Luzon, June, 1917, paratypes, 2 ♀ ♀, Los Baños, Luzon, July, 1916, and June, 1917, (F. X. Williams).

This robust, forest-dwelling species may be considered the northern representative of *Tachytes suluensis* from the island of Mindanao. The three specimens are somewhat worn.

Tachytes silvicoloides n. sp.

(Fig. 74, clypeus ♀; 115, bare apical area on dorsal surface of propodeum ♀.)

Female, type: Length 15 mm. Rather dull black; mandibles in part dark red, wings slightly tinged with yellow, tegulae in part and venation, pale brown. Clypeus gently rounded out in the middle with an exceedingly slight median emargination; the boundary line where the differentiated edge is separable from the rest of the clypeus is practically straight; three well defined lateral teeth, main disc of clypeus is convex, the more anterior portion polished and sparsely punctured, the basal densely so, with some quite large bristle-bearing punctures; the third and fourth antennal joints are about equal and the interocular space at vertex about equal to the length of the third joint. Vertex with larger and smaller separated punctures. Thorax closely punctured above, pleura with more sparse punctures of larger size and smaller, very close and shallow punctures, giving a very fine reticulate effect; disc of propodeum finely and closely pitted, with a fine reticulate effect, the median impressed line more or less obscured and roughened by fine wrinkles, the bare apical area smooth, pyriform, somewhat swollen mesially at distal (broader) end, pleura nearly smooth, posterior face finely reticulate (transverse carinulae and pits in combination), with a deep median impressed line, trough-like and polished and flattening out at summit to form the bare apical area. Wings with abcissae in following order of increasing length: 5, 2, 3, (3 very little longer than 2), 1 and 4. Abdomen with four sericeous silvery bands that are narrower than usual and not conspicuous; pygidium broad, with sides nearly straight (slightly outbowed), subacute at apex and covered with appressed bronzy (perhaps golden when fresh) bristles. Vestiture: tawny pubescence on face and chiefly on dorsal edges of thorax and propodeum, silvery golden on pronotum and portions of legs. More pubescent than in *silvicola*.

Type, ♀, Island of Samar, (Baker).

The structure of the clypeus, in being nearly or quite transverse at the base of the rim, and the pyriform, bare apical area of the propodeum serve to distinguish this species from the others.

Tachytes bakeri n. sp.

(Figs. 72 and 73, clypeus, ♂ ♀; 113, bare apical propodeal area ♂; 160, armature and last ventral segment, ♂.)

Female, type: Length 13.5 mm. Black; apex of mandibles dark red, tegulae in part pale brown, wings nearly transparent, the outer margin slightly darkened, venation brown. Clypeus gently rounded out, with three lateral teeth, the differentiated anterior margin marked off from the main disc by a curved line, polished, very slightly emarginate and a little rugulose; before this rim the convex disc is polished and very sparsely punctured, especially mesially, but the main area is exceedingly fine reticulate, with large, very scattered punctures and smaller closer set ones next to and before the polished area; antennae with joints 3 and 4 subequal. Vertex with minute reticulations and large scattered punctures; notum of thorax densely though shallowly punctured, the pleura likewise; disc of propodeum finely reticulate, though this sculpture is coarser than in the other Philippine species, the median impressed line not very well differentiated by reason of these reticulations, bare apical area flattish, with a low carina, pleura nearly smooth, posterior face finely reticulate and with a deep median impressed line; wings with abcissae in following order of length: 5, 3, 2, 1 and 4. Abdomen with four silvery sericeous bands; pygidium about as in *silvicoloides*. Vestiture: pale tawny on face and thorax, except on prothorax, where it is nearly silvery, as also on sides of propodeum, head thorax and propodeum and first abdominal segment above, with long erect pubescence.

Male, allotype: Length 12 mm. Very like the ♀. Clypeus rounded out, not emarginate, although slightly depressed as a small area mesially and just before margin which is very narrow, polished and almost impunctate; three lateral teeth; main disc of clypeus is convex with exceedingly fine reticulations and well-spaced punctures, except near margin; antennal joints 3 and 4 subequal; interocular space at vertex about equal to joint 3. Propodeum about as in ♀, the reticulations somewhat larger; bare apical area carinate for its length. Last ventral segment broadly notched; claspers beneath with a large piliferous area, unci well rounded out beneath. Vestiture about as in ♀; last dorsal segment with silvery pile.

Type, from Surigao, Mindanao, (C. F. Baker); allotype, Tangcolan, Bukidnon, Mindanao, (C. F. Baker); ♂, paratype, Surigao, Mindanao, (C. F. Baker).

A species with clypeal margin not or very slightly notched mesially.

Tachytes magellanica n. sp.

(Figs. 54 and 69, clypeus, ♀ ♂; 112, bare apical area of disc of propodeum ♀; 156, last ventral segment and armature, ♂.)

Female, type: Length 16 mm. Black; mandibles dark red for apical half or more, wings with a slight yellowish tinge, tegulae in part yellowish brown, venation brown. Clypeus rounded out, the differentiated margin somewhat thickened, notched mesially and with three lateral teeth; just before the margin is a smooth polished and almost impunctate area with the main portion of the clypeus duller and well punctured; antennae with joint 3 slightly shorter than 4 and a little less than interocular space at vertex, which shows a very minute reticulate effect and well spaced punctures. Notum of thorax thickly though shallowly punctured; disc of propodeum finely reticulate, with the median impressed line distinct; bare apical area rather broad, with a subcarinate median swelling at its wider end, pleura nearly smooth, posterior face with rather fine shallow punctures, median impressed line delicately, transversely wrinkled, widening and flattening at summit; wings with abcissae in following order of length: 5, 2, 3, 1 and 4. Abdomen with four rather well-defined sericeous white bands; pygidium wide at base, the sides for apical half or more very slightly inbowed, subacute at apex. Vestiture: pale tawny on face and thorax, legs and sides of propodeum, not dense on thorax with longer pale pubescence. As usual, darker bristle-like hairs on abdomen.

Male, allotype: Length 12.7 mm. Much like ♀. Clypeus with margin somewhat thickened and notched and with three lateral teeth; third antennal joint slightly shorter than 4; interocular space at vertex slightly greater than joint 3. Last dorsal segment truncate, with rather sparse, silvery pile or fine bristles; last ventral segment broadly emarginate at apex; armature with claspers terminating as fine subclavate processes and with a small circumscribed piliferous patch on the underside—as figured for *Tachytes suluensis;* unci well rounded out beneath.

Type and allotype, Island of Sibuyan, (C. F. Baker); paratypes, 1 ♀, N. W. Panay, (C. F. Baker); 1 ♂, Los Baños, Luzon, (C. E. Pemberton); 1 ♀, Los Baños, Luzon, (F. X. Williams); 1 ♂, Island of Sibuyan, (C. F. Baker). The ♂ and ♀ from Los Baños are not typical; in the ♀ the third antennal joint is considerably less than interocular space at vertex and the bare apical area has a very small swelling at apex (broader end).

Tachysphex Kohl

Kohl, F. F., Berl. Ent. Zeitschr., XXVII, p. 166, 1883.
Genotype *T. filicornis* Kohl.

Often slighter in form than *Tachytes*, and seldom very hairy; head and prothorax rather short; mandibles excised beneath and dentate within; no swelling along inner margin of eyes, although the face is convex above the antennae and the ocelli are placed on a convexity, the fore ocellus is perfect and situated at the fore base of this convexity, the posterior pair are flattened, lengthened and nearly reniform, their margin forming a sort of hook, and they are placed obliquely near the upper edge of the convexity. These ocelli while aborted, are proportionately much larger than those of *Notogonidea* and its near allies. Marginal cell truncate, three submarginals; fore legs of ♀ provided with a rake of bristles; fore femora of ♂ emarginate near base beneath; ♀ with a glabrous, polished and usually acute pygidial area.

A genus of wide distribution, though very poorly represented in the Philippines. There is a large number of North American species, particularly in the semi-desert regions.

Key to the Species of Philippine **Tachysphex**

Clypeus of ♂ ♀ with the convex disc joining the base of the differentiated marginal strip as a gentle, more or less punctate arch; the lateral angles in ♂ approximately 90°; size ♂ ♂ 5.5-8.5, ♀ ♀ 7-10mm.....*bengalensis*, p.

Clypeus of ♂ ♀ with a rather well-defined, polished and almost or quite impunctate bevel reaching to the base of the polished marginal strip; the lateral angles in ♂ obviously greater than 90°; size ♂ ♂ 5-5.5, ♀ ♀ 7.75 mm.....*mindorensis*.

Tachysphex bengalensis Cam.

(Fig. 50, clypeus ♂ ♀; 158, armature ♂ lateral view.)

Tachysphex bengalensis Cameron, P., Mem. and Proc. Manchester Soc. (4) II, p 144, N. 3, ♀, 1889. Asia, India (Bengal).

Female: Length 7-10 mm. Black; the disc of propodeum rather dull, apical portion of mandibles reddish. Clypeus gently produced, the thin polished margin drawn out mesially into a slight lobe, with one less-defined lobe on either side of it; the disc or main area of the clypeus strongly punctured except towards margin; antennae with joint 2 obviously shorter than 4; and 2+3 about equalling interocular space at vertex; frons densely, vertex rather sparsely though deeply punctured; thorax with moderate-sized, deep punctures; disc of propodeum irregularly and rather finely reticulate; no median carina, though the apex mesially is usually rather polished and slightly depressed; pleura obliquely striate, posterior face punctato-striate and foveolate; fore tibiae and tarsi with a comb of long yellow bristles; abcissae of wings in following order of length: 5, 3, 1, 2 and 4. Pygidium about twice as long as wide, sides slightly outbowed for basal half; very slightly constricted for apical portion, which is narrow and acute, the disc with a few scattered punctures. Vestiture: erect white pubescence on head and thorax; three sericeous silky white bands on abdomen.

Male: Interocular space about equal to antennal joints 2+3+4; clypeus with the produced portion subtruncate, the marginal strip very narrow; last ventral segment rather shallowly emarginate at apex; armature with the ventral part of each uncus with a number of small teeth subapically.

14 ♀ ♀ and 3 ♂ ♂, from Los Baños, Luzon, (C. F. Baker, F. X. Williams).

Tachysphex mindorensis n. sp.

(Fig. 51, clypeus ♂; 157, armature ♂, lateral view.)

Male, type: Length 5.5 mm. Very like *bengalensis*. Black; mandibles partly reddish; clypeus with the anterior drawn-out portion gently rounded out and with a polished edge mesially and a small polished bevel separated from the edge by a transverse impressed line; antennal joints 2 and 3 subequal, 4 longer; interocular space at vertex about equal to 2+3+4. Sculpture and wings as in *bengalensis*. Last ventral segment rather shallowly emarginate; armature with the ventral subapical part of each uncus with a single large tooth. Vestiture: silvery pubescence and pile.

Female, allotype: Length 7 mm. Differs very slightly from the preceding; the rim of the produced portion of the clypeus is polished, ample and subtruncate and with three lobes, the median one in the allotype is slightly bilobed; antennal joint 3 is slightly less than 4, and 2+3 equal to the interocular space at vertex. The sculpture and puncturation is as in *bengalensis;* the wing venation with the abcissae in the following order of increasing length: 5 and 3 subequal, 1, 2 and 4. Pygidium shaped as in *bengalensis*, but yet more sparsely punctured.

Type, San Jose, Mindoro, December, 1921, (F. X. Williams); allotype, Cuernos Mts., Negros, (C. F. Baker); paratypes, 1 ♂ and 4 ♀ ♀ from Negros, and from Mt. Makiling and Los Baños, Luzon, Philippines, (F. X. Williams, C. F. Baker).

These two species are very closely related, and the ♀ ♀ not very readily separable; the ♂ ♂, however, differ definitely in character of clypeus and of the uncus of the armature.

Lyroda Say

Say, T., Journ. Nat. Hist. Bost. I, p. 372 (1837).
Genotype *Lyroda subita* Say.

Head wider than thorax; mandibles notched beneath, dentate within; three perfect ocelli; compound eyes with inner orbits nearly parallel; pronotum rather long, transverse and rather thickened posteriorly and hardly depressed beneath the level of the mesonotum; legs spinose; three submarginal cells, none petiolate; abdomen subpetiolate; pygidium well defined, pilose.

A widely distributed genus represented by only a few species.

Key to the Species of Philippine **Lyroda**

Abdomen partly red.....*formosa*.
Abdomen all black.....*venusta*.

Lyroda formosa (Sm.)

(Fig. 48, clypeus, ♂ ♀; 163, armature, ♂.)

Morphota formosa F. Smith, Journ. Linn. Soc., p. 17, 1859, ♀.

Female: Length 9-11 mm. Black; basal portion of abdomen red. Clypeus with three lateral teeth and between these and the median notch are two blunter ones, densely punctured to the teeth; antennal joint 3 longer than 4, interocular space about equal to 2+3+4; disc of propodeum with the flattened area small and carinate and more or less finely rugulose; abcissae in following order of increasing length: 5 and 2 subequal, 3, 1 and 4; or 5, 2, 3, 1 and 4. Pygidium densely clothed with fine brownish-gold pubescence, with sparse longer bristles intermixed.

Male: Much like the ♀. Produced margin of clypeus with sharp lateral angles, slightly excavate mesially and there with a subtruncate process bent down and below the level of the emargination; interocular space at vertex about equal to antennal joints 2-5 inclusive; joints 3 and 4 subequal; last ventral abdominal segment with a small lobe in the apical emargination; armature with a rather prominent spine on each uncus beneath, claspers quite acute and slightly curved at tip. Vestiture: silvery with golden tinge on frons and notum of thorax.

35 ♀ ♀ and 32 ♂ ♂. Mainly from Los Baños, Luzon; also from Mindoro and Negros, (C. F. Baker, F. Muir, and F. X. Williams).

It occurs also in Celebes and parts of India.

Lyroda venusta Bingham

(Fig. 49, clypeus ♂ ♀; 161, armature ♂.)

Bingham, C. T., Fauna British India, Hymenoptera, Vol. 1, p. 210, 1897, ♀. Tenasserim, India.

Very like *L. formosa*, but the abdomen is entirely black. Antennal joints and interocular space as in *L. formosa;* but in the ♀ the clypeus has small additional teeth on the produced portion, and in the ♂ the small median lobe is less prominent. The armature has the claspers more uniformly and bluntly tapering than in *formosa*, and the spines on the ventral side of the uncus are far less conspicuous. There is some variation in the clypeus of both species but they are, none the less, easily separable on the clypeus and on color character, which seems constant.

18 ♀ ♀ and 15 ♂ ♂ from Los Baños, Mt. Makiling, Baguio, Luzon; Sibuyan and Samar, (C. F. Baker, F. X. Williams). Specimens from Sandakan, Borneo and Singapore, (C. F. Baker), also belong to this species.

Silaon Piccioli

Sylaon Piccioli, Bull. Soc. Entom. Ital. I, 1869, p. 282, T. 1 (*Silaon*).
(Also see Rohwer, S. A., Proc. U. S. Nat. Mus. 40, No. 1837, p. 585-6, 1911.)

Eyes converging on inner margin towards vertex; three perfect ocelli; mandibles not or scarcely toothed, and if emarginate beneath, only feebly so; propodeum short, marginal cell appendiculate; three cubital cells, the second petiolate and receiving one or both recurrent veins, transverse median vein varying in position as regards the basal. No defined pygidial area.

A group of thickset, small-sized wasps that need further study; they are seemingly absent from the Australian and Ethiopian regions, poorly represented in the Orient and very numerous in some of the more arid and warmer portions of the United States.

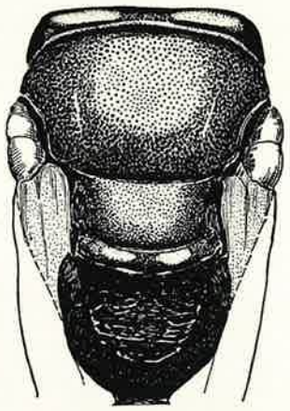
Silaon lagunensis n. sp.

(Fig. 107, head ♀; text fig. 10, ♀, thorax and propodeum (dorsal); 105, venation, fore wing ♀.)

Female, type: Length 5 mm. Black; mandibles reddish for more than their apical half; a wide spot on pronotum on each side, pronotal lobes and tegulae in part, a wide spot on each side on metanotum, fore femora beneath at apex, a small spot at apex of mid femora and a stripe above on all tibiae, pale creamy yellow; venation brown. Mandibles very shallowly and widely emarginate beneath; clypeus with a carina starting from a bump in the middle of the frons and widening and thickening, smooth and polished, and disappearing before the well-produced and rounded-out middle portion. elsewhere the clypeus is roughened by punctures; some oblique striae above antennal sockets; elsewhere the head has strong punctures, dense on frons and more separate on vertex; the three ocelli form less than an equilateral triangle, the posterior pair forming the longest side; no swelling behind the ocellar area; antennae with short joints; 2, 3 and 4 subequal; interocular space at vertex, wide, nearly equal to that at base of mandibles. Dorsum of thorax has fine separate punctures, larger on the mesopleura; disc of propodeum with a well margined area in the form of a triangle with the apical end truncate, and enclosing large reticulations, pleura with separate oblique wrinkles; posterior face with transverse wrinkles and a rather ill-defined, smoother triangular area mesially. Forewings with transverse-median vein received before the basal, and the first and second cubital cells each receiving a recurrent vein. Abdomen with fine separate punctures on dorsum of first segment, the punctures less pronounced on the remaining segments. Vestiture: very sparse, silvery.

Type, College of Agriculture, Los Baños, Luzon, May 20, 1921, (F. X. Williams).

This species is distinct from the many other species, chiefly Nearctic, that I have examined, the propodeal area being the main distinguishing feature. It belongs to the *Siloan compeditus* group, as divided by Rohwer (Proc. U. S. Nat. Mus., vol. 40, p. 586, 1911).



SILAON LAGUNENSIS ♀

FIGURE 10

Nitela Latreille

Latreille, P. A., Gen. Crust. and Insect., IV, 1809, p. 77, ♀.

Three perfect ocelli; eyes naked, converging towards vertex; mandibles not notched beneath, bifid at, or near the apex, at least in the female. Pronotum usually broad and prominent, shoulders angulate, and with the rest of the thorax and propodeum, often coarsely sculptured. Legs not spinose. Forewings with a more or less appendiculate marginal cell, one complete cubital and the first discoidal complete, the second nearly or quite complete; venation of posterior wings vestigial. No differentiated pygidial area.

Small, mainly black wasps, that occur apparently in all the principal zoological regions.

Key to the Species of Philippine **Nitela**

1. Scutum coarsely reticulate; frons with large scattered punctures and dense and very minute reticulations.....*rugosa*, p. 95
   Scutum more or less transversely wrinkled; frons almost smooth, or finely punctured 2
2. Pronotum sharply drawn out at the lateral angles; disc of scutellum about ¼ wider than long .....*bicornis*, p. 96
   Pronotum with the lateral angles prominent though very little drawn out; disc of scutellum nearly or quite ½ wider than long.....*luzonensis*, p. 97

Nitela rugosa n. sp.

(Fig. 108, front view of head of ♂; text fig. 11, pro-mesonotum, ♂; 162, armature lateral view, ♂; 102, venation ♂.)

Male, type: Length 4.10 mm. Black, rather dull on head; most of mandibles reddish, tarsi in part, and the tibiae pale brown, venation pale yellow. Mandibles simple, not toothed; clypeus with disc raised and carinate; anterior edge produced,

rounded out for a narrow median space, with low lateral angles; antennal joints 2-4 or more, subequal and 2-4 hardly equalling interocular space at vertex; ocelli, large, in not quite an equilateral triangle. Head with large scattered punctures and exceedingly minute reticulations. Thorax shining and very coarsely reticulate; pronotum with the lateral angles sharply drawn out (more extensively than as figured for *N. bicornis* n. sp.); a V-shaped carinal process extending posteriorly and mesially from the transverse humeral carina to the anterior edge of the scutum; posterior portion of scutellum and post-scutellum with some longitudinal carinulae; disc of propodeum coarsely reticulate, pleura and posterior face finely wrinkled, the latter with a margined median line, the margins diverging at summit. Forewings typical; the second discoidal cell with the discoidal vein translucent and not completely shutting in the cell. Abdomen smooth and polished. Armature with claspers simple, tapering to apex. Vestiture very sparse, confined mainly to clypeus and lower part of face, where there is silvery pile.

NITELA RUCOSA ♂

FIGURE 11

Type: 1 ♂, Los Baños, Luzon, Nov. 20, 1921, (F. X. Williams).

Nitela bicornis n. sp.

(Fig. 106, portion of prothorax and scutum; 101, scutellum; 104, clypeal margin ♀.)

Female, type: Length, 4.5 mm. Rather dull black, except the abdomen which is very polished; mandibles dark red at apex, venation pale yellowish. Mandibles with a tooth above, just before apex; clypeus somewhat rounded out, very slightly emarginate mesially, the disc carinate; ocelli large, brown, nearly in an equilateral triangle, the two posterior ocelli forming the longest side; antennae with joints 2 and 3 subequal, 4 longer than either; 2 + 3 + 4 somewhat greater than interocular space at vertex. Frons and vertex nearly smooth, with very fine, well-spaced punctures. Propodeum with a transverse sulcus, interrupted mesially by a posteriorly-pointing, sharp wedge-like extension from before, and terminating and limiting behind, the sharp humeral angles; pronotum also somewhat depressed mesially on posterior edge; mesonotum with rather fine transverse wrinkles, somewhat granulate in the middle field and with a few oblique wrinkles at posterior end; scutellum with six pits on anterior margin, the disc rather smooth with fine punctures and traces of longitudinal striae; disc of propodeum with large reticulations and finely rugulose on these areas, pleura rather coarsely and obliquely wrinkled, posterior face with fine transverse wrinkles and a large triangular area at summit developed from a rather weak median impressed line. Legs stout, not spinose. Forewing with normal venation as in *N. rugosa;* 2nd discoidal cell open for a portion of its outer end; venation of secondaries subobsolete. Abdomen smooth. Vestiture very sparse; silvery pile on lower part of face.

Type, Los Baños, Luzon, July 25, 1921; paratype, 1 ♀, on the old Forestry Station Building, Los Baños, Luzon, June 29, 1921 (F. X. Williams).

Nitela luzonensis n. sp.

(Fig. 109, cylpeus and mandibles ♀; 103, scutellum and metanotum ♀; text, fig. 12, adult ♀, type.)

Female, type: Length, 5.75 mm. Black; head rather dull; propodeum and abdomen shining; tips of mandibles red, venation yellowish brown. Mandibles toothed near apex; clypeus much as in *N. bicornis*, arched-carinate mesially, somewhat rounded out and slightly emarginate in the middle; antennal joint 3 a little longer than 2, and 4 a little longer than 3; interocular space at vertex about equal to 3 + 4; ocelli arranged in an equilateral triangle. Head (under high binocular power) very finely granulate, slightly fine reticulate towards clypeus, some very fine indistinct punctures. Pronotum rather shallowly and widely sulcate transversely for its posterior portion and with a few longitudinal carinulae and a median bisecting carina narrowing from anterior portion of sulcation; mesonotum with transverse wrinkles, the posterior ones arching posteriorly as they approach the middle; scutellum with seven (or more) pits on anterior border, its disc and that of the metanotum more or less transversely wrinkled; disc of propodeum appearing as if varnished, with large rather coarse reticulations, the little areas slightly roughened; median carina present, pleura horizontally rather coarsely wrinkled, posterior face transversely wrinkled, particularly for lower portion, the median impressed line widening above into a large, delicately, transversely-wrinkled triangular area. Legs rather stout; wings with venation typical, as figured.

NITELA LUZONENSIS ♀ x5.3

FIGURE 12

Type, ♀ taken on the trunk of a tree, Los Baños, Luzon, January 1, 1922, (F. X. Williams); paratypes, 2 ♀ ♀, Los Baños, Luzon, July, 1917 and 1922. (F. X. Williams); paratypes, 2 ♀ ♀, Surigao, Mindanao and Sandakan, Borneo, (C. F. Baker).

This species is evidently related to *N. sculpturata* Turn. of Queensland, Australia. It is also allied to the smaller *N. bicornis,* but has the ocelli arranged in quite an equilateral triangle; the prothorax and the scutellum are also different.

Rhinonitela new genus

Head in front view subquadrate; eyes gently converging towards vertex; lower part of frons and clypeus produced into a sharp, strongly arched beak which widens at the clypeal margin to form a small triangular area; mandibles not excised beneath nor toothed; labial palpi 4-, maxillary palpi 6-jointed; antennae situated each in a deep basin bordered laterally by the rostrum and the eye margins; eyes finely pilose. Pronotum rather long, with well-rounded shoulders and a median depression where it joins the mesonotum; propodeum subquadrate, truncate posteriorly; fore and middle tibiae with one, posterior tibiae with two apical spurs; forewings much as in typical *Nitela,* with a weakly appendiculate marginal cell, one cubital and a first and a second discoidal, the last not being complete; the discoidal vein is only slightly curved beyond the first discoidal cell. Hind wings with venation practically obsolete. Pygidial area not defined.

Genotype *Rhinonitela domestica* n. sp. ♀. The large, keeled beak-like fronto-clypeal process, the hairy eyes, and the apically non-bifid mandibles form the basis for this genus. Allied to *Nitela*. In general form suggesting one of the Bethylidae.

Rhinonitela domestica n. sp.

(Fig. 99, forewing; 100, front view of head, ♀).

Female, type: Length, 3 mm. Black; apex of mandibles, antennae in part, and tarsi brownish, venation yellowish brown. Sculpture not coarse for a niteloid wasp. Clypeus and frons as figured, basin of antennae margined above by a fine carina extending from the frontal wedge to the carinate eye margins. Clypeus a low wedge in front marginal outline; antennae (with terminal joints lacking) with joints 3 and 4 subequal; interocular space at vertex wide, equal at least to joints 2 + 3 + 4. Ocelli forming a right-angle triangle; frons delicately reticulate, vertex more minutely so. Dorsum of thorax with very fine scale-like structure; the median posterior margin of the pronotum and the anterior median part of the mesonotum depressed; there is a short pronotal ridge in this depression and a transverse impressed line not far from the posterior margin of the pronotum. Disc of propodeum with fairly large though delicate and orderly reticulations, the pleura subhorizontally, the posterior face transversely, wrinkled; legs not spinose; wings about as in *Nitela;* the free end of the discoidal vein but slightly curved from the main portion. Abdomen smoothly polished. Vestiture: very sparse; pale pile.

Type, 1 ♀ taken in 1922, on the old Forestry Station Building, Mt. Makiling, Los Baños, Luzon, (F. X. Williams); paratype, 1 ♀, same locality, January, 1922, (F. X. Williams). A second species of this genus occurs in British Guiana. (See page 168.)

Habits of the Philippine Larridae

With the advantages of a perpetual summer temperature many Philippine wasps, among other insects, are to be found in abundance at any time of the year. This does not signify, however, that one season is as productive as another, for in the tropics as elsewhere, though usually in lesser measure, the changes in meteorological conditions profoundly affect the life of insects. Not high temperature alone but also sufficient moisture are among the requirements necessary to bring wasps to maturity. Thus, the beginning of the warm rains is usually a herald of the increase of wasp life, while the cooler or the drier seasons tend to produce opposite effects, for it is then that many of these insects, as full-fed grubs that having spun their cocoons remain quiescent for weeks or for months. In the hot and dry weather after the first part of the year many solitary wasps are about, probably as the result of intermittent rains. Species that dwell in the shade of forests seem less influenced by the seasons than do their relatives of the more open lowlands.

All the Larridae are insects of great activity and mainly lovers of sunshine. While certain of the psammocharid spider wasps possess superior running powers, none I believe excels them on the wing nor in their quick pivoting movements when on the ground. Hunters of such nimble insects as grasshoppers and crickets, as well as of certain ground-dwelling spiders cannot be laggards. Small heteropterous bugs and insects of the book-louse family (Psocidae) furnish the prey of smaller larrid wasps.

The habits of the males are of little interest when compared with those of the females, for nesting activities hardly concern them; most of their time is devoted to feeding at flowers, basking in the sunshine, playing or quarreling, and courting their mates.

At Los Baños, Luzon, where nearly all the writer's observations were made, some of the chief wasp plants are: the pretty little border plant, *Alternanthera versicolor* Regel of the Amarantaceae, and a weedy relative *Alternanthera* species that is perhaps more attractive to insects; the cultivated sweet potato, *Ipomoea batatas* Lam. whose nectaries on the leaf petioles are visited by many honey-loving Diptera and Hymenoptera, and among the Larridae, chiefly by the wasps of the genera *Notogonidea* and *Liris;* a species of *Crotalaria,* also furnished with attractive nectaries; *Premna odorata* Blanco, a common indigenous tree of the Verbenaceae whose wide cymes of flowers are conspicuously visted by large wasps, such as the greater *Scoliidae, Eumenes, Zethus, Chlorion* and the larrid, *Tachytes banoensis* Roh. Such plants as corn and sorghum when infested by aphids or leaf-hoppers, and trees and shrubs when loaded with pests of the same order may in consequence become attractively sprinkled with "honey dew", the same dropping also on the ground below and frequently drawing veritable gold mines of honey-feeding insects. Meal hours for the growing wasp grubs are all hours; for adult wasps they range almost throughout the sunshine, but it is chiefly in the morning—say from 8:30 or 9, to 11—that these insects seem busiest, although prior to retiring late in the afternoon, some wasps feed again. Females employ a large part of the day in nesting activities.

Common feeding grounds ensure the meeting of the two sexes; the alert males however, make the most of their opportunities—since it is well known that with many solitary bees and wasps, the male being the first to hatch out does not abandon his place of birth, but awaits there the issuance of the female. Some (*Larra*) species may even go so far as to keep watch on the female as she goes about hunting her prey.

It is probable that nearly all the Larridae are diggers of one kind or another and that they pass the night in holes. I know of but a single mud-dauber among these wasps, as here defined, a polished black Ecuadorean *Notogonidea,* (*N. lutusator* F. X. Williams) that gathers mud on the forest trails. Certain it is that the females in some of the genera, such as *Liris* pass the night in their own nest-holes; and one may often unearth from sand-heaps or banks larrid and other wasps of either sex that have sought this shelter in default of the sun.

What fragments of the life histories of a few of the Philippine Larridae are known, have been published largely in Bulletin 14, Entomological Series, Experiment Station, Hawaiian Sugar Planters' Association, pp. 131-142, 1919. To this are added a few notes made by the author in 1920-1922.

The biology of the genus *Larra* is treated at some length in another part of this bulletin. Probably all of these wasps prey upon mole crickets (Gryllotalpinae) which they drive to the surface of the ground and there sting to partial paralysis so that they may lay their egg upon it. The cricket quickly recovers, digs into the ground where it resumes its ordinary life, to be eventually destroyed by the hungry *Larra* grub, which upon full growth spins its cask-like cocoon in the darkness. Several weeks later the adult hatches and easily works its way to

the top of the ground. *Larra luzonensis* Rohwer, is the commonest of the Philippine species, that attacks the abundant *Gryllotalpa africana* of the lowlands—particularly of the rice fields. She lays her egg quite or almost evenly across the mid-ventral line between the first two ventral segments. *Larra sanguinea* Williams, is a somewhat less active and much rarer insect than the preceding, and also an inhabitant of the open lower levels; she likewise preys upon *Gryllotalpa africana* and secures her egg beneath on the thorax but well to one side of the mid-ventral line. *Larra carbonaria* Sm., is a large jet black species that dwells in the forest and there attacks the huge pugnacious *Gryllotalpa hirsuta.* The egg is laid to one side of the mid-ventral line of the thorax.

Nothing appears to be known of the nesting habits of the genus *Motes,* but the prey probably consists of crickets of some sort.

The *Notogonidea* are well known as enemies of various crickets (Gryllidae), of which young ones suitable in size are perhaps more ordinarily selected, and stored in several-celled burrows in the ground. *Notogonidea subtessellata* (Sm.) is a large and common Indian, Malayan, and Philippine species that in the Philippines not infrequently nests in soil in boxes or flower plots in nursery sheds at the College of Agriculture at Los Baños. By taking advantage of this nesting habit the wasp was successfully introduced from the Philippines into Honolulu, Oahu, (Hawaiian Islands) and thence of its own efforts is known to have spread to the islands of Hawaii and Maui of the archipelago. In India, the nesting habits of this species have been recorded by Bingham (Fauna of British India, Hymenoptera, Vol. I, 202, 1897), by Maxwell-Lefroy (Indian Insect Life, 201-202, pl. X, fig. 7, 1909), and by Dutt (Memoirs Dept. Agriculture, India, IV, p. 198-199, 1912).

Notogonidea manilae (Ashm.) is a small abundant wasp that preys on the minute cricket, *Nemobius histrio* Saussure, both young and adults being used. The burrow in the single case observed was short and three-celled. *Notogonidea (Cratolarra) pitamawa* Rohwer, so far as noted, makes short, one-celled burrows which she stores with immature gryllid crickets. These three species appear to be mainly open-country insects, but *Notogonidea silvicola* Williams, and sometimes at least, *Notogonidea robusta* Williams, are found in the lower portion of the Mt. Makiling forest.

In *Liris, L. aurata* Fab. is a large, deep-digging species that stores one or more kinds of *Gryllus* or *Gryllus*-like crickets. Sometimes full-grown crickets are selected, but smaller ones are more easily captured or met with, and managed.

Hyloliris mandibularis Williams, is a woodland form that burrows in decaying wood or perhaps uses ready-made holes therein and stores them with *Calyptotrypus* sp., a wood cricket with remarkably long antennae. The wasp was seen to nest as a colony, and has the curious habit of raising the wings much as in some of the social wasps.

Dicranorhina luzonensis Rohwer, is commonly found about dwellings, where it runs along the railings and the outside walls. It has a peculiar easy gait, the fore part of the body being raised considerably higher than the posterior. Occasionally it is seen inside rooms at dusk. It seems to like dry conditions and makes few-celled burrows in steep banks, or in the dry soil beneath the stilted

houses. These nest-holes are provisioned with a curious little wood cricket, most probably *Cycloptilus dewitzi* (Saussure), several being placed in one chamber and the egg affixed to the underside of one of them. The larva and the cocoon are of the usual larrid type: i. e., the larva having the well-developed lateral thoracic nipple-like processes; the cocoon is made of finely cemented material, oblong and well rounded at both ends. The insect is plentiful during the winter and the subsequent drier months of the year.

The genus *Tachytes* contains seven Philippine wasps of stout build and great activity. *Tachytes banoensis* Rohwer, a common species at Los Baños catches a bright-colored, long-horned grasshopper of, or near the genus *Conocephalus,* and formerly referred to as *Xiphidium.* None of the nest-holes of this open-land species was found; but it is known that *Tachytes* in other regions may dig extensive many-celled nests. Of the biology of the remaining six species, nothing is known. *Tachytes silvicola* Williams is a large heavy species that inhabits the lower forest on Mount Makiling at Los Baños.

Tachysphex contains two Philippine species. Short-horned grasshoppers (Acrididae) usually constitute their prey. Shallow, quickly-dug one-celled burrows are the rule and several may be stored in a day. In Occidental Negros, a species of *Tachsphex* was found nesting in some flower pots filled with soil that were placed on the railing of a porch.

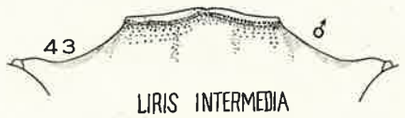
In the United States, the common *Lyroda subita* Say preys on little crickets of the genus *Nemobius,* while in the Philippines, *Lyroda formosa* Smith was found capturing grouse-locusts (Tettigidae). Thus it would appear that closely related wasps may not have closely related prey.

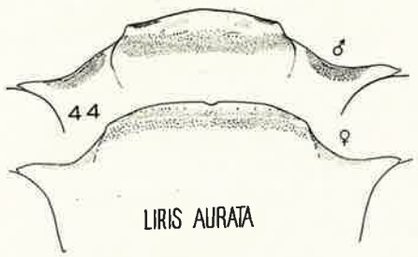
The genus *Silaon* (sens. lat.) seems to be rare in the Philippines. In the United States, where these wasps are abundant they nest in hollow brambles or in the ground, and store Psocidae (book lice), heteropterous bugs, or small acridid grasshoppers. The Hawaiian *Silaon rohweri* Brid., is common in the drier parts of the island of Oahu and nests in dead plant stems, storing them with a lygaeid bug, *Nysius* species, (Bridwell, J. C., Proc. Haw. Ent. Soc. IV, No. 2, p. 398-400, 1920). These small wasps are noted for the quantity of soil pellets and small debris with which they partition and stopper their cells.

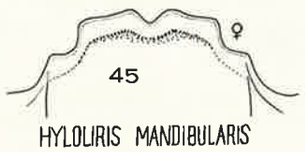
The little black *Nitela* nest in holes in dry wood and store plant lice (Aphididae) and in the case of *N. merceti* Br. studied by Brauns, the provender consists of young Psocidae (book lice), (Brauns, H., Biologisches uber sudafrikanishe Hymenopteren. Zeitschr. f. Wiss. Insectenbiol. VII, p. 240, 1911).

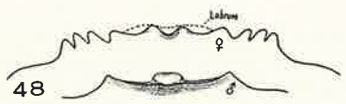
It is obvious from the foregoing that the biology of these Philippine insects has scarcely been more than touched. Detailed information on the habits of most species—their habitats, type of burrow, and particular kind of prey, leaves an open and interesting field for many years to come.

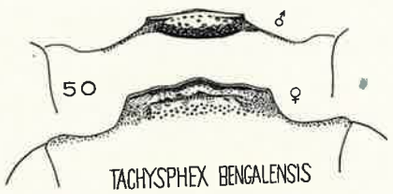
The habits of the Larridae in other parts of the world have been studied to some extent (See Ferton, in Ann. Soc. Ent. France, Fabre in Souvenirs Entomologique, etc., etc.).

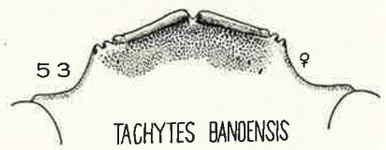












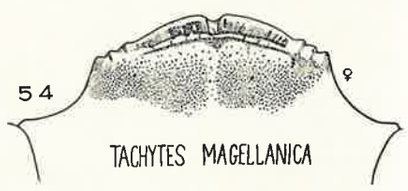
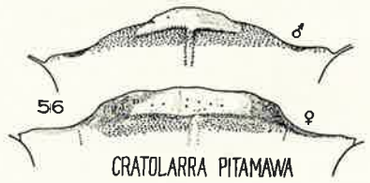
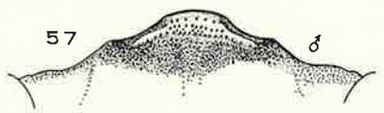
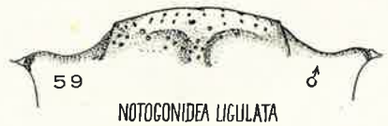
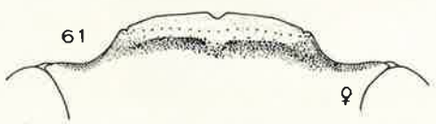


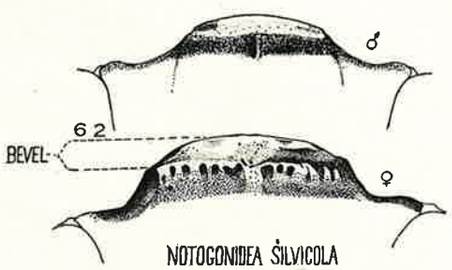
PLATE VIII

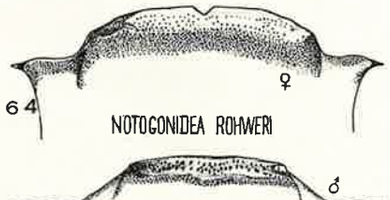












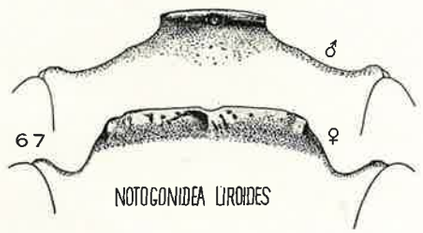
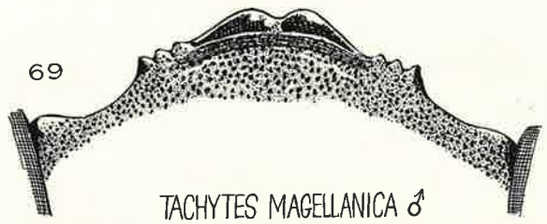
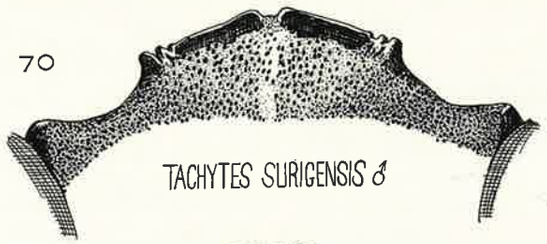


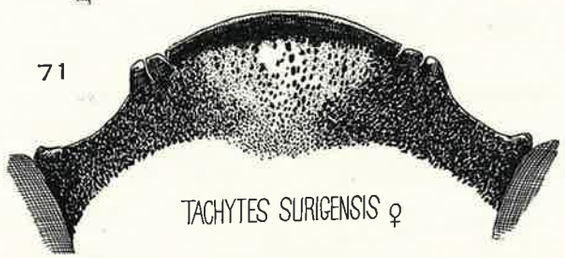
PLATE IX



69 TACHYTES MAGELLANICA ♂

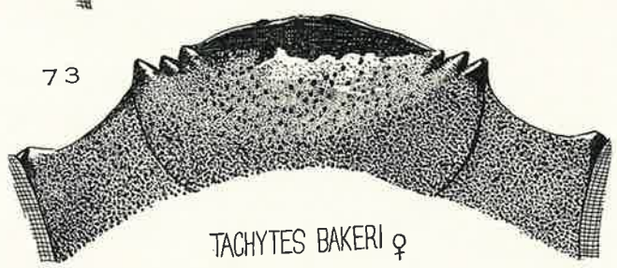


70 TACHYTES SURIGENSIS ♂



71 TACHYTES SURIGENSIS ♀

72 TACHYTES BAKERI ♂

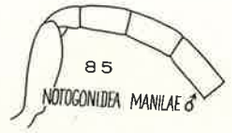


73 TACHYTES BAKERI ♀

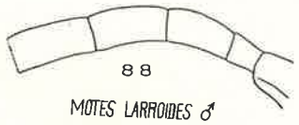
74 TACHYTES SILVICOLOIDES ♀

PLATE X

75 DICRANORHINA LUZONENSIS ♂



85 NOTOGONIDEA MANILAE ♂

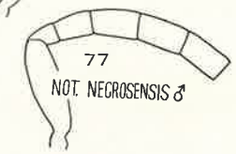


88 MOTES LARROIDES ♂

76 DICRANORHINA PALAWANENSIS ♂

86 NOT. LIGULATA ♂

89 NOTOGONIDEA. ROBUSTA ♂



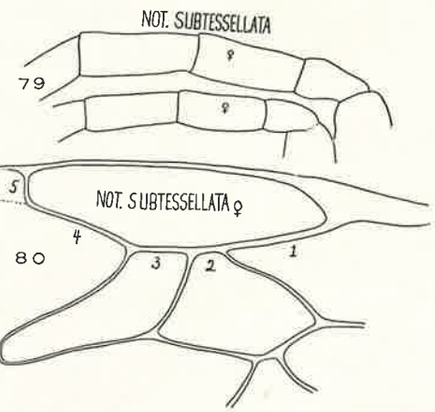
77 NOT. NECROSENSIS ♂

87 NOT. BAKERI ♂

90 NOT. ROBUSTOIDES ♂

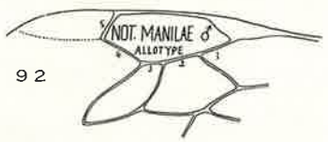
78 NOT. SILVICOLA ♀

91 NOT. MINDANAOENSIS ♀

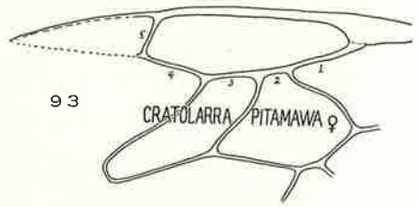


NOT. SUBTESSELLATA ♀ 79

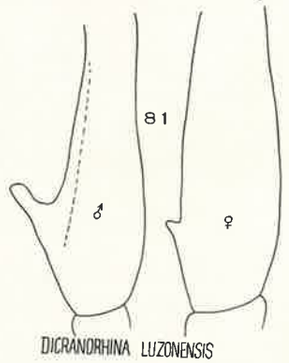
NOT. SUBTESSELLATA ♀ 80



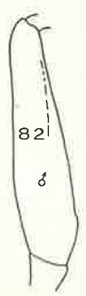
92 NOT. MANILAE ♂ ALLOTYPE



93 CRATOLARRA PITAMAWA ♀

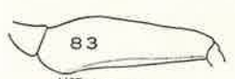


81 ♂ ♀ DICRANORHINA LUZONENSIS



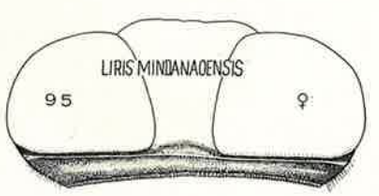
82 ♂ D. PALAWANENSIS

94 LIRIS AURATA ♀



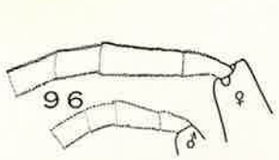
83 NOT. SUBTESSELLATA ♂

84 NOT. SILVICOLA ♂

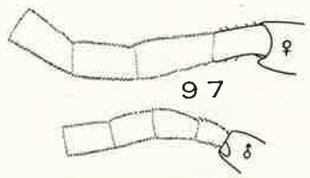


95 LIRIS MINDANAOENSIS ♀

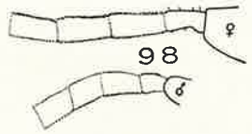
PLATE XI



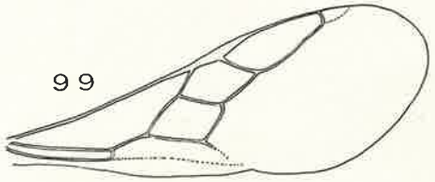
LARRA SANGUINEA



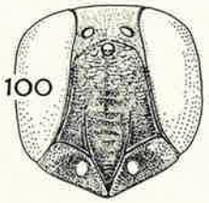
LARRA CARBONARIA



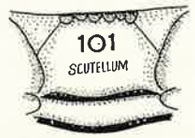
LARRA LUZONENSIS



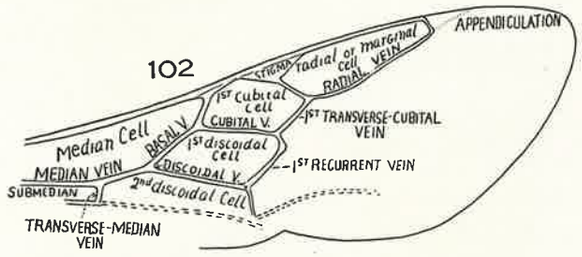
RHINONITELA DOMESTICA ♀



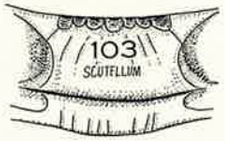
RHINONITELA DOMESTICA♀



NITELA BICORNIS♀

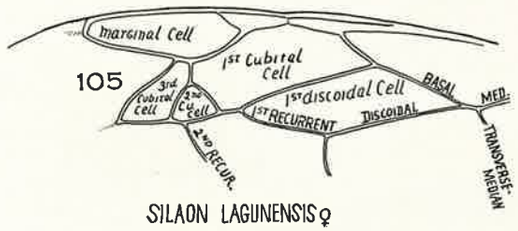


NITELA RUGOSA♂

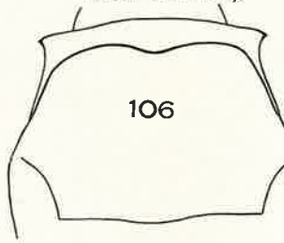


NITELA LUZONENSIS♀

NITELA BICORNIS♀



SILAON LAGUNENSIS♀



NITELA BICORNIS♀

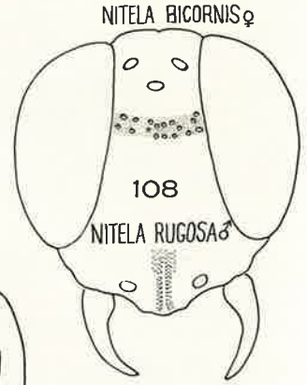
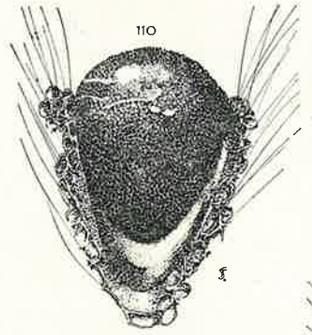
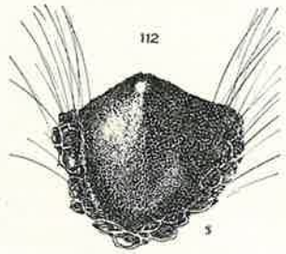


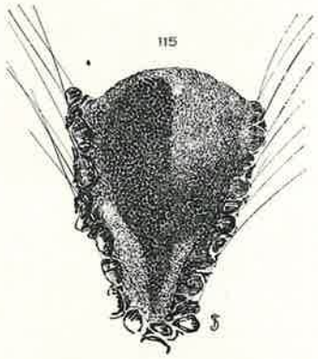
PLATE XII



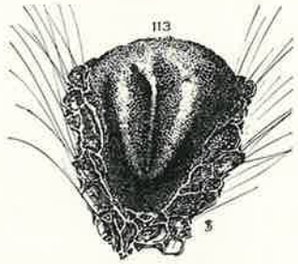
TACHYTES SULUENSIS
PARATYPE ♀

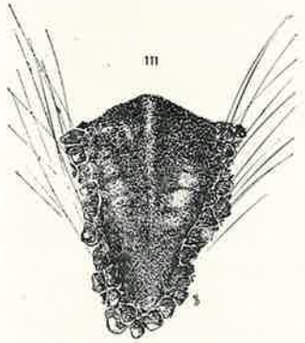


TACHYTES MAGELLANICA
PARATYPE ♀



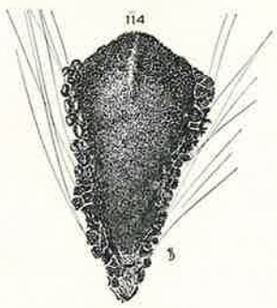
TACHYTES SILVICOLOIDES
TYPE ♀



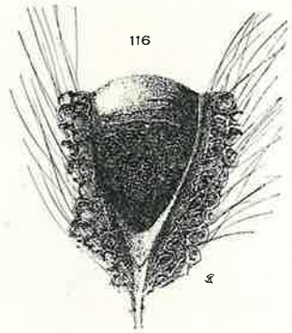


TACHYTES BANOENSIS
♀

TACHYTES BAKERI
ALLOTYPE ♂

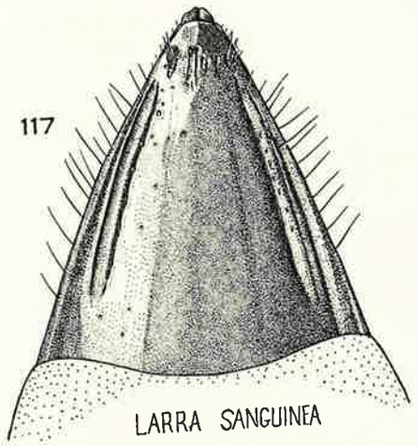


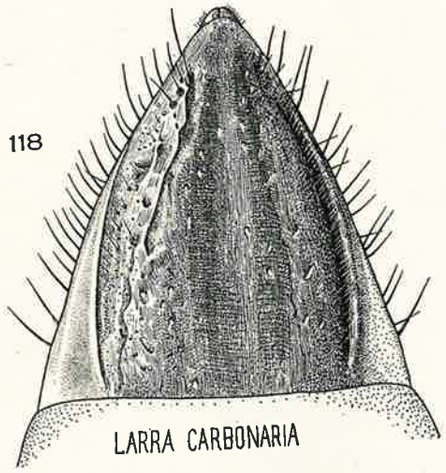
TACHYTES SURIGENSIS
PARATYPE ♂



TACHYTES SILVICOLA
TYPE ♀

PLATE XIII


117
LARRA SANGUINEA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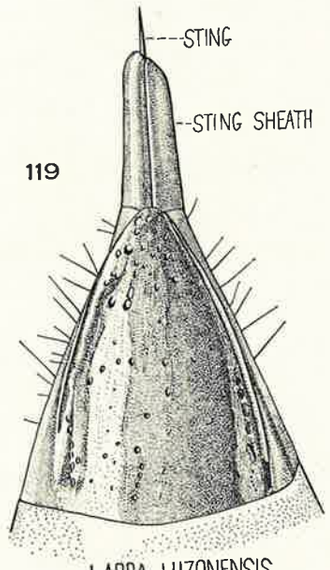
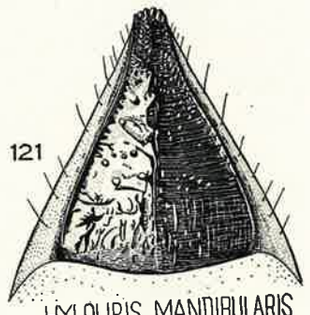


119
LARRA LUZONENSIS


120
NOTOGONIDEA SILVICOLA. ♀ LATERAL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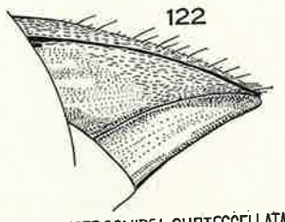
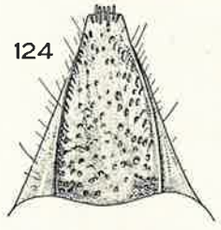
HYLOLIRIS MANDIBULARIS


122
NOTOGONIDEA SUBTESSELLATA ♀

123
NOTOGONIDEA ROBUSTOIDES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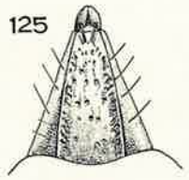
CRATOLARRA FLAVIPENNIS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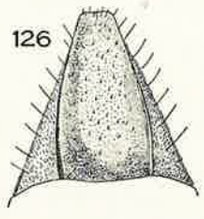
CRATOLARRA PITAMAWA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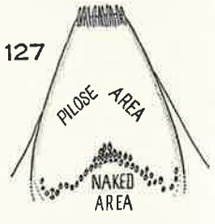
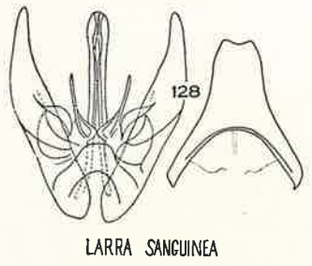
MOTES LARROIDES



127
NOTOGONIDEA ROBUSTA

PLATE XIV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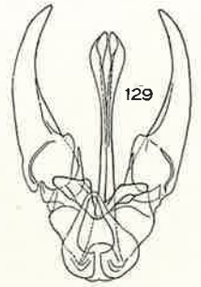
LARRA SANGUINEA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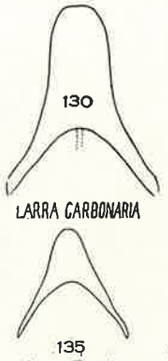
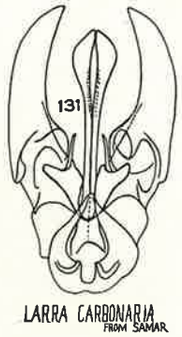
LARRA CARBONARIA FROM LUZON

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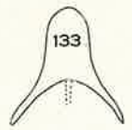
LARRA CARBONARIA FROM SAMAR


132
LARRA LUZONENSIS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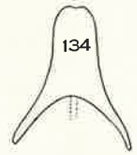
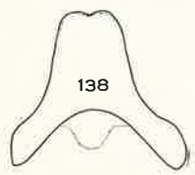

134
LARRA LUZONENSIS VAR


MOTES LARROIDES, MINDANAO.


136
MOTES LARROIDES, LUZON.


137
NOTOGONIDEA LIROIDES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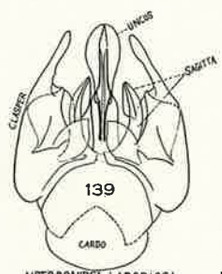
NOTOGONIDEA LABORIOSA



NOTOGONIDEA LABORIOSA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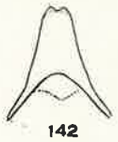
141


NOTOGONIDEA NEGROSENSIS


NOTOGONIDEA MANILAE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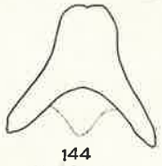
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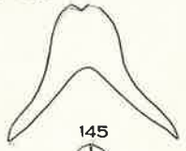
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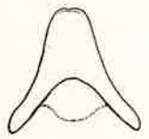
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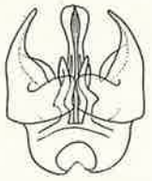
NOTOGONIDEA LIGULATA


NOTOGONIDEA BAKERI


NOTOGONIDEA SILVICOLA


NOTOGONIDEA SUBTESSELLATA


NOTOGONIDEA ROBUSTOIDES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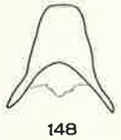
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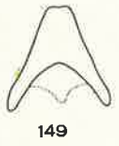
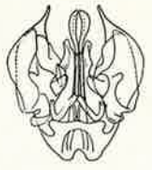

149


150
CRAT. PITAMAWA


152
CRAT. FLAVIPENNIS


153


NOTOGONIDEA ROHWERI

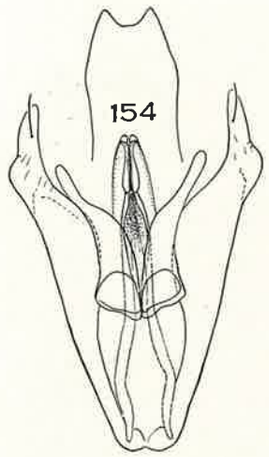

NOTOGONIDEA ROBUSTA


NOTOGONIDEA LARRIFORMIS


151
CRATOLARRA PITAMAWA


NOTOGONIDEA MINDANAOENSIS

PLATE XV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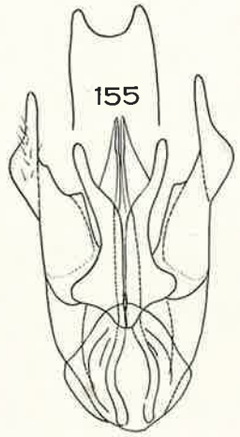
TACHYTES SURIGENSIS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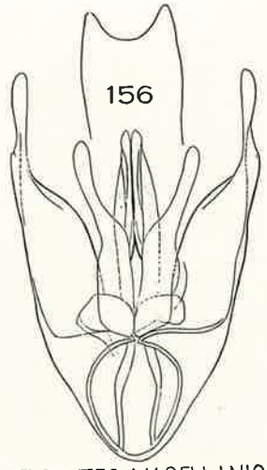
TACHYTES BANOENSIS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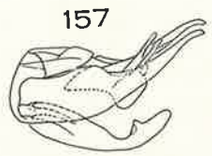
TACHYTES MAGELLANICA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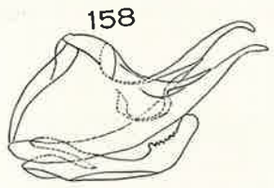
TACHYSPHEX MINDORENSIS
LATERAL VIEW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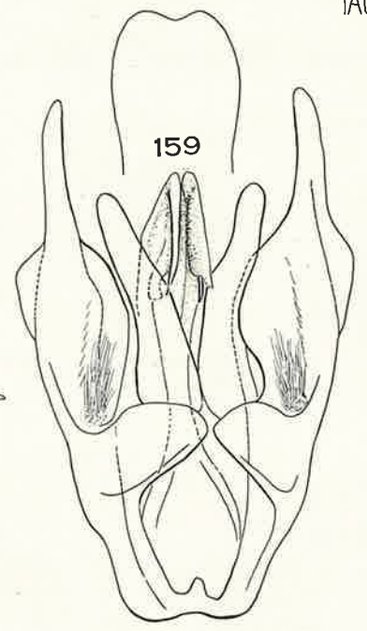
TACHYSPHEX BENGALENSIS
LATERAL VIEW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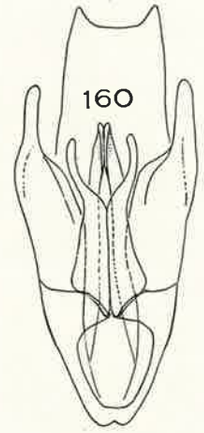
TACHYTES SULUENSIS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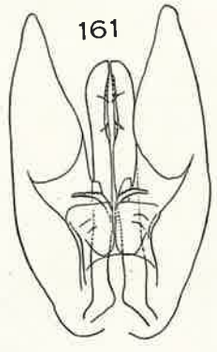
TACHYTES BAKERI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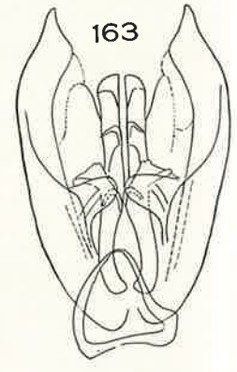
LYRODA VENUSTA


162

NITELA RUGOSA
LATERAL VIEW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LYRODA FORMOSA


164

NOTOGONIDEA SUBTESSELLATA ♀


165

LIRIS AURATA ♀


166

LIRIS MINDANAOENSIS ♀


167

NOTOGONIDEA LARRIFORMIS ♀


168

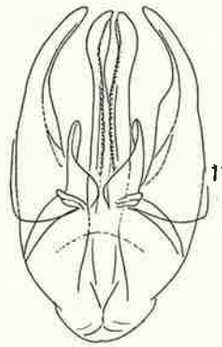
MOTES LARROIDES ♀


169

LARRA LUZONENSIS ♀


172

DICRANORHINA LUZONENSIS



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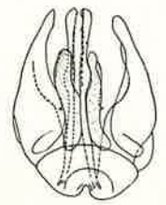

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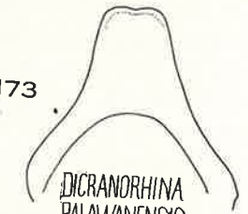
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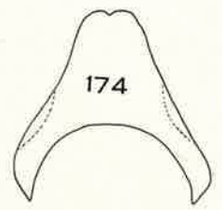
DICRANORHINA PALAWANENSIS.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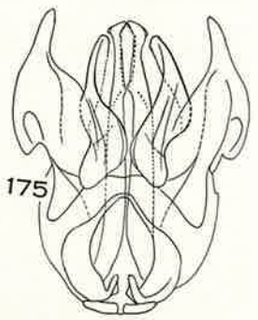
HYLOLIRIS MANDIBULARIS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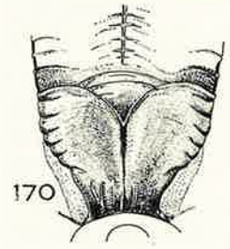
HYLOLIRIS MANDIBULARIS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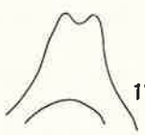
NOTOGONIDEA ROBUSTA ♀


176

MOTES LARROIDES ♀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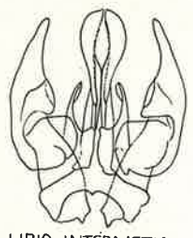
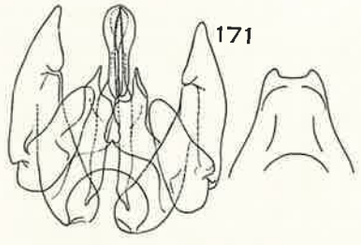
LIRIS INTERMEDIA



LIRIS INTERMEDIA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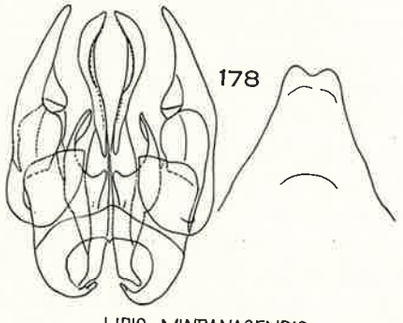
LIRIS AURATA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LIRIS MINDANAOENSIS

IV

SOME WASP-ENEMIES OF COCKROACHES

There is no accounting for tastes among wasps. Those of us who have inadvertently sampled the flavor of the stink-bug (Pentatomidae) on berries may wonder that such an ill-smelling creature can serve as food for the larvae of certain wasps (*Astata* and *Bicyrtes*). To us the cockroach would be a dish hardly less unpalatable, and yet in like manner does it furnish nourishment for an even greater number of Hymenoptera. While there are wasps tiny enough to find in a single egg-capsule of a cockroach sufficient food for several to many of their young, as in *Solindenia picticornis* Cam. (Eupelmidae) and *Tetrastichus hagenowii* (Ratzeb.) (Eulophidae), and others of greater size that require the content of an entire egg-capsule to develop a single individual, as in the grotesquely-formed species of *Evania* (Evaniidae), this paper deals only with larger stinging wasps belonging to the family Sphegidae of the Sphegoidea, and that parasitize the active roach itself. We have already made note that in the spider-wasp family (Psammocharidae) there are a few species that prey on cockroaches (Bingham, C. T., Journal Bombay Society, XIII, 1900, mentions *Pompilus bracatus* Bingham and *Salius verticalis* Smith as having this habit) while in the sphegid subfamily Astatinae is *Astata boops* (Schrk.) said to sometimes store small cockroaches (Sharp, D., Cambridge Natural History of Insects, VI, part 2, 1901, p. 119, teste St. Fargeau), and finally in the Larridae, also of the Sphegoidea, the palaearctic *Tachysphex lativalvis* Thomson captures the roaches *Ectobia livida* and *Ectobia lapponica,* (Ferton, Ch., Annales de la Société Entomologique de France, LXX, 1901, p. 100, and LXXXIII, 1914, p. 103; and Adlerz, G., Kungl. Svenskapsakademiens handlingar, Uppsala et Stockholm, 1906).

Those whose acquaintance with the cockroach family, or Blattidae, is limited to the kitchen and its surroundings are hardly at fault for frowning upon such insects, but to the specialist on this group who has access to extensive collections, literature, and to a wide range of country, they present a field containing hundreds of species, representing many beautiful and curious forms, and strange habits. Cockroaches are first of all, tropical insects, and certain of them possessing qualities of great travellers, viz, adaptability to food, climate and to domicile, have spread, chiefly through the agency of commerce, to diverse regions of the globe, so that it has not always been an easy matter to establish their original habitat. Islands that perhaps within historic times had few or none of these insects upon them, now support a tolerably large foreign cockroach population.

The Blattidae belong to the order Orthoptera, that includes, grasshoppers, crickets, stick insects, etc., and are sometimes referred to as the Cursorial Orthoptera on account of their often very great running powers; they undergo incomplete transformations; eggs are laid as a horny capsule or ootheca, formed inside the body of the mother, and carried about by her at the end of the body for a time and then deposited in a suitable place; or less often the insect is viviparous, as in mammals; there are no marked changes from infancy to maturity

save that of size and the more usual, perhaps, acquisition of wings. The family includes very small species, as *Myrmecoblatta rehni* Mann (Psyche, 1914) of Mexico, that lives in the nests of certain ants of the genera *Formica* and *Camponotus,* and measure but 5 millimeters in length, and the perhaps even more diminutive *Attaphila* species (See Wheeler, on Ants, Columbia University Press, New York, 1910), that inhabit the nests of fungous-growing ants. In the East Indies and in other tropical countries, very small, fully-winged cockroaches are sometimes attracted to light. The genus *Nocticola* is represented by two cave-dwelling species from the Philippine Islands, and of which the male of one of them is hardly 4 mm. long (Bolivar, Ann. Soc. Ent. France, 1892, p. 29). Going to the other extreme in size we find in the neotropical genus *Blaberus,* kinds that may attain a length of body of 75 mm. or 3 inches, as in *B. stollii* Brunner. An even larger insect is the heavily armored, wingless *Gromphadorhina portentosa* Schaum from Madagascar, that measures 78 mm.

Among the handsome cockroaches are the delicate green *Panchlora,* the East Indian *Corydia petiveriana* Linn. with effective markings of orange yellow, velvety black and whitish, and the quaint little two-spotted *Euthyrrapha pacifica* (Coq.) of the islands of the Pacific Ocean. Rather elegant species are some of the diurnal forms, which by a combination of markings, shape, posture and active flying about vegetation strongly suggest certain wasps. *Protagonista fusca* Hanitsch of Borneo is believed by Hanitsch to generally adopt a hymenopteron-like attitude in holding the wings and tegmina slightly open, (Hanitsch, R., Journ. Sarawak Museum, III, part 1, No. 8, p. 98-99, Fig. 11, 1925). As regards the resemblance of cockroaches to other arthropods, there are certain wingless kinds that particularly when rolled up have much the appearance of some myriapods, and of the land crustacea that go by the names of wood-lice or armadillo bugs.

A rather small proportion of Blattidae are adapted to living in and about the habitations of man. Civilization is detrimental to many species, because these inhabit natural forests and fields. Many are tree-dwelling insects, others (*Panesthia,* etc.) burrow in decaying wood and a number are to be found under dead leaves and other debris. Some rely upon great swiftness for safety, others depend much on their resemblance to the bark of trees, etc.; sluggish species may have numerous strong spines on the legs and possess great strength, and in this connection I remember how painfully difficult it was for me to extract a large Philippine *Panesthia* from a shallow chink in a post. Somewhat related to *Panesthia* is the Australian *Geoscapheus,* with several species; large, broad and powerful insects of digging habits, with the fore legs modified somewhat after those of mole crickets (Tepper, Tr. R. S. Austral. XVII, 1893, p. 68).

Still more remarkable in habits are the water-cockroaches of the Indo-Malayan region, that have been studied by Annandale (Entomologist's Record, XII, 1900.) in the Malay Peninsula, and by Shelford (A Naturalist in Borneo; London, 1916) in Borneo. According to Shelford these aquatic insects belong mostly to the genus *Rhicnoda* (Epilamprinae), and while externally they suggest little modification for a life in and about water, dissection reveals the fact that their always deflated tracheal or breathing system does not contain much air so that they

are less boyant than land insects and are thus enabled "to swim and dive with ease", though frequently obliged to renew the supply of oxygen. "The spiracles of the terminal pair in the water-cockroach are situated each at the base of a short tube projecting from the last segment but one, and it is these which are thrust above the surface of the water, and through which the animal draws its air supply".

From certain observations that have been made it is likely that cockroaches are long-lived insects, and Sharp (Cambridge Natural History, V, 1895, p. 229), thinks it is not improbable that the common "black beetle" (*Blatta orientalis* Linn.) of the kitchen may live to be 5 years old.

Apart from being disease carriers the domiciliary blattids are a general nuisance; their odor and appearance do not invite popularity, while an almost omnivorous appetite bring such things as the paste of bookbindings and wall paper, leather, woollens, various foods, eyelashes and finger nails within their menu. Out-of-door species may be injurious in their own environment, for the common *Diploptera dytiscoides* (Serville) in Hawaii, damages the Monterey Cypress trees (*Cupressus macrocarpa* Hartweg), by gnawing off the bark.

Household cockroaches are attacked by enemies also adapted to a domiciliary life, and thus we find the large active spider *Heteropoda regia* Fabr. that eats the young and adults, and wasps whose grubs devour their eggs, quite at home in buildings properly supplied with Blattidae. Among the larger wasps more than one species of the brilliantly blue or green *Ampulex* are known to enter houses in the tropics in search of cockroaches; most of these larger Hymenoptera, however, are forest or open-country insects and hunt their prey on trees and bushes, in hollows, or among the debris of the ground. The Ampulicidae include the several species of *Aphelotoma,* rather small wasps of the Australian region that frequent tree trunks, the handsome *Ampulex* * whose range is both hemispheres, the blue or purplish *Trirhogma* of the Oriental region, the widespread though mainly tropical genus *Dolichurus,* and the slender arboreal *Rhinopsis.* Related to the common black and yellow mud-dauber *Sceliphron,* that is predatory on spiders, is a number of medium-sized to large cockroach wasps of the genera *Podium* and *Trigonopsis* that inhabit tropical America, although *Podium luctuosum* Smith, *Podium rufipes* Fabr. and *Podium carolina* Rohwer are known to occur in southern United States. All of these cockroach wasps of both subfamilies are characterized by a more or less slender and narrow prothorax or neck, in being only sparsely hairy and consequently often very glossy, while their geographical distribution in keeping with that of the insects upon which they prey, is confined mainly to the tropics.

The genus *Trigonopsis* which is sometimes placed under *Podium* is composed of slender wasps whose very elongate necks and large triangular heads give them a grotesque and perhaps giraffe-like appearance (Pl. XVIII, Fig. 184). They are active though deliberate insects, and in my experience, of rare occurrence, that inhabit the forests; they seem to be mainly arboreal, although being mud-daubers are usually captured on the ground gathering nest material. They pur-

* A very interesting account of the habits of *Ampulex assimilis* Kohl in the vicinity of Bagdad, is given by R. W. G. Hingston in his book "Nature at the Desert's Edge," London, 1925.

sue small wood roaches and store them in mud cells which are applied to the trunks of trees, large leaves, etc. *Trigonopsis abdominale* var. *cameroni* Kohl, is a pretty, violet blue and black variety. One was reared October 1, 1922, from a mud-cell nest from Bucay, Western Ecuador, at 1000 feet. The male is about 15 mm. long, with a purplish blue head, black thorax, and steel blue legs and abdomen; the fore wings are twice banded with fuscous and the hind ones tipped with the same color. The remaining two species taken are blackish, with the legs sometimes, and the abdomen reddish and the wings barred. They represent Ecuador, British Guiana and Brazil. Two species were taken in eastern Ecuador. They are *T. abdominale* Perty and *T. affine* Sm. I can find nothing in literature on the life history of any species, and the data secured on *Trignopsis abdominale* (= *rufiventre* Fab.) is very fragmentary. This insect measures about 23 mm. long in the female and is mainly black and red and differs from specimens on hand from Brazil and British Guiana in having the legs redder, and the pubescence golden near the base of the wings and on the propodeum. It occurred sparingly in the forest at Tena, in eastern Ecuador.

Muddy tropical trails in a woodland are always interesting from an entomological standpoint, inasmuch as they are patronized by various species of mud-daubing wasps. It is in such places that the observer hopes to gather much biological data on these insects, but very frequently indeed do they disappoint him, their small size and swiftness often make their flight impossible to follow, while a lull in building activities, due to dull weather or to already completed cells increases the difficulty of trailing them. Fortunately the *Trigonopsis abdominale* under observation were good-sized insects with building sites only a few yards removed from their clay quarry, so that by perseverance, two mud nests were located. On March 4, 1923, I saw one alight on a muddy trail in a broken forest near Tena, and in an alert and gingerly fashion search for a fitting place from which to gather mud; this found, she collected a load with her slender mandibles and took wing. She worked rather slowly but was eventually followed to the site of construction, the underside of a small feather-palm leaf, a short distance off the trail. Here she would apply her load to a couple of streaks of dried mud, emitting a loud rasping buzz the while. The work poked along, rain interrupted, and it was finally abandoned. On March 14, a few days later, on a feebly sunny afternoon, I saw another of these wasps (later captured and identified as *T. abdominale*), a far more intent, active and efficient worker than the first. Her trips to and from the thicket, some 50 feet away were thus at short intervals and her nest was easily located. This, too, was plastered to the underside of a palm leaf and lay across its midrib. Nearby was an old nest with one emergence hole. The new structure consisted of one completed and mud-smeared cell with a second alongside, nearly finished, yet not cemented to the first. They much resemble the cells of some of the Philippine *Sceliphron* wasps. The next morning found *Trigonopsis* working; the bit of mud she gathers is a good deal smaller than her head, and as she applies it delicately held before her long neck and head, on a pair of slender mandibles, she gives the impression of working with dangerous or even explosive materials cautiously held out at arm's length. On March 16, the second cell was finished, except for a temporary cover, and was joined by well-distributed bits of mud to the first, the whole mass measuring

35 mm. long, 27 broad and 20 high. Detaching this mud nest showed two proportionately long and narrow cells (Pl. XVIII, Fig. 181), one containing a smooth brown cocoon with the larva still spinning within, and the other an immature cockroach 7 mm. long and with the comparatively large *Trigonopsis* egg extending from behind one of the fore coxae obliquely across to a hind coxa (Pl. XVIII, Fig. 182). The cockroach had been severely stung, though not quite motionless, and its antennae were intact; this contrasts sharply with the condition of the prey of *Dolichurus* of the Ampulicidae, which retains much of its activity and is usually shorn of full a half length of the antennae. The cell containing the *Trigonopsis* cocoon was stoppered at the far end with a comparatively thick disc of clay, while that containing the single little wood roach, not being completely stored had only a thin overnight cover. It would take several more little roaches to furnish enough food for the wasp grub, hence the temporary precautionary disc. A species whose nest was found at Tumatumari, British Guiana also has this habit, which is probably general for the genus. Thus also acts *Sceliphron conspicillatum* (Costa) in the Philippines; if she has insufficient spiders in a cell by the end of her day she stoppers it with a thin concave disc, to be removed the following morning, and upon enough spiders being stored, replaces this disc with a thick permanent cover (Williams, Philippine Wasp Studies, Bull. 14, H. S. P. A. Experiment Station, Honolulu, Pt. 2, 1919). This habit also holds good for *Sceliphron caementarium* (Drury) in Hawaii, for *S. madraspatanum* (Fabr.) in India (Dutt., Mem. Dept. Agric. India, IV, p. 203, 1912), and doubtless for other Sceliphronini.

The *Podium* cockroach wasps, are larger, less elegant insects than *Trigonopsis* and perhaps more numerous in species. Superficially they resemble certain of the slenderer *Chlorion*. The genus *Dynatus*, which is sometimes included under *Podium* is represented by *D. nigripes*, an immense species with a body length up to 58 mm., or 2¼ inches. It inhabits the warmer portions of the American tropics, and from information gathered by Frederick Smith (Annals and Magazine of natural History, 20, 395, 1847=*Stethorectus ingens*) preys upon very large spiders. Of seven species of *Podium* taken by me, the more slender forms, four in number, were mud-daubers, building mainly on tree trunks, while the more thickset species nested as loose colonies in holes in the ground, although showing some traits of a true cell-making species. These wasps destroyed innumerable Blattidae, which none the less swarmed in their neighborhood, and I must confess from my observations on the various cockroach-catching wasps that the blattid more than holds its own alongside its enemy.

There seems to be little written on the biology of the genus *Podium*. Howes (in "Tropical Wild Life in British Guiana," 1917, part 3, Entomological) gives a good account with illustrations, of the mud-daubing *Podium* (*Parapodium*) *rufipes* (Fabr.) in British Guiana. This wasp builds a mud nest as a single hollow column which she plasters on tree trunks or on buildings. The cells are stored with a variable number of wood roaches. The egg hatches in 2 days, and 5 days later the full-fed grub commences her cocoon which requires about 18 hours for completion; 10 days more and the pupa is formed, and this after a rest of 24 days produces the fully-formed adult.

179

STORED NEST-HOLE OF PODIUM FLAVIPENNE. ABOUT X .66

180

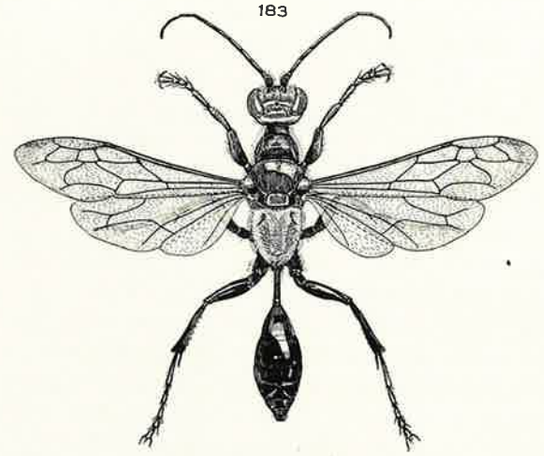
PODIUM FLAVIPENNE, ♂ PUPA. X1.2

181

CELLS OF TRIGONOPSIS ABDOMINALE. ×.53

182

PARASITIZED PREY OF TRIGONOPSIS ABDOMINALE. ×2

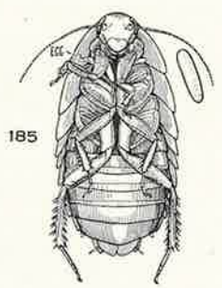


183

PODIUM FLAVIPENNE ♀ X 2 BRITISH GUIANA

184

TRIGONOPSIS ABDOMINALE ♀ X1.7 CATHERING MUD FOR NEST BUILDING. ECUADOR



185

EPILAMPRA SP. THE PARASITIZED PREY OF PODIUM HAEMATOGASTRUM. ×3.3

186

PODIUM FLAVIPENNE LARVA LATERAL VIEW FORE PART.

187

PODIUM FLAVIPENNE, COCOON. X1.1

×.83

THE BRAZILIAN WASP, **PODIUM HAEMATOGASTRUM** IN THE ACT OF GLUING HER EGG TO THE UNDERSIDE OF A SEMI-PARALYZED COCKROACH, **EPILAMPRA**. THE SCENE IS TAKING PLACE UPON THE SIDE OF A TERMITE MOUND IN WHICH MAY BE SEEN THE WASP'S NEST-HOLE AT A.

PLATE XVIII

Poulton (Transactions Entomological Society of London, p. xxxvi, 1917), records a *Podium* sp. captured in its burrow stored with the cockroach, *Epilampra conferta* Walk. at Piracicaba, Sao Paulo, Brazil. The genus *Epilampra* is popular with the ground-nesting *Podium,* as the writer has found *Podium flavipenne, P haematogastrum,* and probably *P. dubium* that store these Blattidae.

Podium flavipenne Latr.

This inch-long, black wasp (Pl. XVIII, Fig. 183) was found to be quite common locally on the low, front lands of British Guiana. My first view of the species was on Plantation Blairmont, in Berbice County, August 18, 1923. While out collecting with Mr. H. E. Box, the plantation entomologist, he flushed a large slender wasp that was immediately identified as a hunter of cockroaches, and which later proved plentiful nesting on well-drained, bare though partly sheltered spots along a canal towing-path bordered on one side by a scrubby forest (Pl. XIX, Fig. 189). It was found also in the rather open, second-growth country and in large gardens. The nest-hole is hardly 2 inches deep with the bottom somewhat enlarged to more conveniently hold the prey (Pl. XVIII, Fig. 179); in level ground it is vertical or nearly so, but when excavated in the side of a bank extends more or less obliquely. Two or more nests probably made in sequence by the same individual may be only a few inches apart, and in suitable ground several wasps are sometimes seen working near one another. *Podium* is not averse to saving herself labor because we often find her clearing of its cocoon-remains and of the hard uneatable portions of cockroaches, a hole from which one of her species has emerged; as a rule, however, we interrupt her at work on an excavation of her own. The hole is dug with the wasp's jaws, although she does occasionally commence operations with a few strokes of her feet, in order to clear the light debris from a contemplated nesting site. The latter is a matter of some consequence; it must be in hard, solid ground, not mined by tiny ants, devoid of vegetation and reasonably sheltered by plant growth from the sun's rays. Water fairly close at hand appears to be another requisite. The wasp in choosing a place, walks about briskly, her antennae to the ground, and inspects here and there until she finds a spot to her liking; she then flies to a convenient ditch, and returning with moistened mouth-parts, applies a little water to the prospective nest site; the ground thus softened is bitten out as little pellets —one drink suffices for a number of gougings and pellets—which are deposited about the deepening hole so as to surround it in a crude square.

The tunnel becomes immediately oval or thickly lenticular in cross section, that is, it has two axes crossing each other at right angles and the longer axis terminates at the rather blunt spherical angles or corners. The bore is large, considering the size of the diggers. But *Podium* is a rangy insect with a large head provided with closely folding mandibles, spreading legs and a thorax at least in the middle, broader than high; then too, the insects with which she provisions her burrow are, even when half-grown, broader than herself and very flat. The lenticular tunnel is therefore justified as more fitting and economical than a round one. Watching *Podium* at her work of excavating, we find that she enters the hole not from any direction but only from two opposite sides, the broad ones,

Nesting site of Podium Flavipenne. Front lands, British Guiana.

As an expression of appreciation for the cooperation extended in entomological work, the Hawaiian Sugar Planters' Association presented the College of Agriculture of the University of the Philippines, this insectary.

PLATE XIX

using one for a spell and then the other, and that in attempting to enter at right angles to the longer axis, as sometimes happens, she finds it too narrow and shifts over to a wide side. Thus the pellets are deposited not evenly in a circle but in four more or less separate heaps from the broad sides, leaving a central space some 2 or 3 inches in diameter (Pl. XX, Fig. 192).*

In about one hour after the commencement of her work, the burrow of *Podium* may be an inch in depth, and in a total of about four hours—depending on weather, soil and abundance of cockroaches—the nest may be stored and sealed. As these wasps work until quite late in the afternoon, two nests are sometimes completed in one day. The cockroach that serves as the prey is a stout brownish species, *Epilampra abdomen-nigrum* (De Geer), an active out-of-doors insect that swarms at the base of thick clumps of grass and under sugar cane trash. Quite young, perhaps quarter-grown specimens to adults are captured, stung to helplessness in the field, and borne back to the nest; the roach while often comparatively heavy is usually carried away in flight, the wasp holding it generally back up beneath her with one or more pairs of legs and its unmutilated antennae grasped near their base in her mandibles. She alights quite near her burrow with it, drags it to the entrance and the enfeebled insect is passed or lowered head down without a struggle. Her captives, however, soon regain much of their activity, so that if a freshly stored burrow be opened, the cockroaches may dart out and even escape. But they lack the power of sustained movement and usually remain quiet, commonly head downwards—as though filled with shame—in the open burrow (Pl. XVIII, Fig. 179). If the prey becomes too active before being stored the wasp grasps it roughly and stings it again. The nest is left unsealed until fully provisioned; it may then contain from one to five or more roaches, according to their size and to cell requirements—the female wasp grub being the larger needs the greater amount of food. Though *Podium* handles dozens of cockroaches during her lifetime, she seldom descends among them in her tunnel and one might conclude, on seeing her merely poke head and shoulders in the doorway, that she disdains to associate with such vulgar provender. She lays her egg on her last, or on the only victim; the process was seen but two or three times, and if we exclude *Larra*, that makes no nest whatever, it differs from that of all other solitary wasps that I have observed in being accomplished *outside* the burrow. Thus the burdened wasp coming in from the field alights near her burrow, and approaching to within perhaps a couple of inches of it, shifts her prey head first beneath her with several of her legs, bends her abdomen down, forward, and recurves the tip, and prying back behind one of the fore coxae with it, glues the rather small and slender egg (2.5 by .6 mm.) in place, as shown in

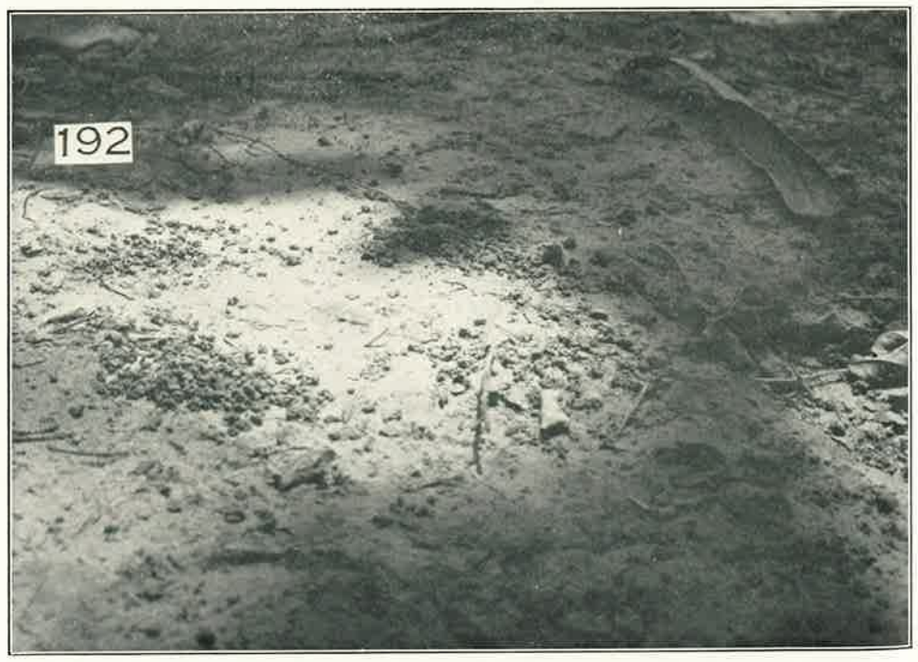
* In this connection it is interesting to compare the tunnel work of this *Podium* and of the following species with that of *Montezumia brunea* (Sauss.), a ground-nesting species of the family Eumenidae that occurs in the same localities as these two sphegids and stores her cells with caterpillars of various skipper butterflies (Hesperidae) that feed upon the leaves of sugar cane and of other grasses. This *Montezumia* is a thickset, almost neckless wasp with long crossing jaws, short antennae, a thorax that at its middle appears deeper than broad, and with closely fitting legs. She is rather cylindrical then, so is her prey, and naturally too, her burrow, whose mouth is then surrounded by a comparatively regular circle of pellets (Pl. XX, fig. 191).

plate XVIII, figures 188 and 185, for the Brazilian *Podium haematogastrum*. The roach thus parasitized is turned about and introduced into its chamber, which is forthwith sealed up. The wasp is very bold towards intruding or passing ants; the chief offenders of these being the brazen though useful ponerine *Ectatomma quadridens,* locally known as the "Kop-kop," and which is often a perfect nuisance in molesting and robbing the nests of the large fly-catching Monedulas, and others; such ants she persistently chases away and nips with angry vigor for a distance of perhaps a foot. In closing up the burrow she chooses a spot only a few inches removed, moistens it with water, gathers up a mouthful of the mud and commencing work from some little distance down the mouth of the tunnel finally plugs it flush with the surface of the ground. The nest site is not disguised in any way, and weather and slope of the ground not interfering, is for days easily recognizable because of its crude circle or square of pellets; the plug when dry is not readily distinguishable from the surrounding earth, while the spot from which she gathered material for sealing up is inconspicuous and perhaps rather distant.

The egg of *Podium* hatches in about 2 days; the larva is at first an external feeder, but soon enters the roach behind the fore coxa, so that perhaps one-half of its body is within; it hollows out its host and at last feeds externally, chewing at the softer parts and leaving some of the heavily chitinized portions as debris in the cell. A full-fed grub varies in size according to sex; an average male is 21 mm. in length—the female considerably longer—the head is comparatively small, nearly white but duller than the body; the mandibles and a few blotches are darkish; the body is well divided, the first segment has two pairs of chitinized convexities, the second has but one pair (Pl. XVIII, Fig. 186). The cocoon (Pl. XVIII, Fig. 187) is spun at the lower end of the cell, its narrow, dark nipple-like base fixed to the bottom and the rest supported, free of the walls, by a scant framework of silk in which are embodied various roach remains. A good sized cocoon is 25 mm. long, and has the crackling delicate paper-like texture of those of *Sceliphron;* it is brown with the base darker. The feeding larval stage is about 4 days, but there is no change into a pupa (Pl. XVIII, Fig. 180) until perhaps two weeks later. The pupa is at first creamy yellow; the head and thorax are unarmed, but segments 2-6 of the abdomen are each provided with a sort of lateral knob, with segments 7 and 8 bearing a smaller one; in addition, there are rather inconspicuous, weak spinules on the back of the abdomen. The adult issues perhaps 10 or 12 days later, making the life cycle rather more than a month; this, however, can be expected to vary considerably. It appears that the adult bursts rather than bites through the thin cocoon; a little pressure from within easily effects this.

Podium flavipenne was plentiful and active from August to December, the commencement of the rainy season when the writer left the district. In common with many other wasps, the females seem to feed at flowers and to recreate mainly during the early morning and rather late in the afternoon; the males, however, appear to spend most of their time at blossoms and have not been observed about the nests. The bush, *Cordia aublettei* (Boraginaceae)

Clay pellets encircling nest-hole of Montezumia brunea



Crude square of pellets enclosing nest-hole of Podium Flavipenne. British Guiana.

PLATE XX

and the semi-vine *Mikania micrantha* H. B. K. (Compositae) bear flowers that are a favorite with such wasps as *Podium, Priononyx, Monedula, Larra,* Psammocharidae and others. Late in the afternoon these wasps seek out their sleeping quarters—which in the case observed consisted of a bunch of dead, yet attached mango leaves—on a branch several feet from the ground. This wasp dormitory was visited a number of times, from September to November 26, and it was always occupied towards nightfall, sometimes by a few and sometimes by over a dozen wasps. Male *Podium flavipenne* predominated, and at times one or more of the large mud-daubing *Trypoxylon albitarse* Fab. were found resting among the others. The habit of passing the night on weeds and trees is common to many species of bees and wasps; numerous such examples are to be found in the United States; I have noted large fly-catching *Monedula surinamensis* wasps of both sexes resting on dead twigs of weeds or bushes or on the crowns of living Compositae weeds at Campinas, Brazil. In the Philippines, the big grasshopper-wasps, *Chlorion aurulentus,* rest night after night on the same bunch of dead leaves, while the iridescent blue *Chalybion violaceum* of the same region was observed perched in small numbers on a loop of brown string hanging under the eaves of a palm and bamboo house.

Several *Podium flavipenne* were kept in a large wire screen cage where they became rather tame and fed readily at sugar. The single female would not attack *Epilampra abdomen-nigrum,* her roach prey, with any degree of seriousness, though when disturbed by one she sometimes made a vicious dig with open mandibles at the terrified creature, even driving it away with some little show of hunting instinct, but never was it stung nor ousted from an inobtrusive hiding place. She at first seemed to resent the introduction into the cage of several male *Podium,* but soon chose the largest and handsomest of these as a partner.

Two lots of roaches parasitized by this wasp were collected and placed in artificial mud cells and shipped in tins of sandy soil to Honolulu, Hawaii, but perhaps due to the cool northern weather encountered none survived. All the material gathered, however, furnished data on the number and instars of the roaches stored per cell, as follows: In all, 153 nests or cells of *Podium flavipenne* were dug up and examined between August 25 and September 10, 1923. There was a total of 331 cockroaches, or an average of 2.164 per cell. Of these cockroaches, 311 were immature and 20 were adults, or 6.04 per cent, and of the latter 6 were males, 12 females, and 2, sex undetermined.

40	cells	contained	1	cockroach	apiece	= 40	cockroaches
66	"	"	2	"	"	= 132	"
33	"	"	3	"	"	= 99	"
10	"	"	4	"	"	= 40	"
4	"	"	5	"	"	= 20	"
						331	

Podium haematogastrum Spin.

As its name implies, this Brazilian wasp has a red abdomen. The legs are also red, the head and thorax black and the wings tinged with a sort of yellowish brown, but tipped with fuscous. It is quite closely related to *Podium flavipenne,* though a trifle more slender and smaller; the females measure up to about 25 mm. or an inch long. The cockroach that serves as food for the young is an undetermined species of *Epilampra,* that at least in the female has short truncate wings that extend barely beyond the middle of the body. It is about 22 mm. long, a sort of pale wood brown streaked and speckled with black, and in proportion is a smaller, somewhat flatter and broader insect than *Epilampra abdomen-nigrum,* the prey of *Podium flavipenne.* All my observations on this wasp were made in May and June, 1924, about Utinga on the outskirts of Belem, the capital of Pará, a warm, steamy part of Brazil that abounds in animal and plant life. In early May, a large termite* mound (Pl. XXI, Fig. 193) in a grassy field that bordered the Utinga forest, attracted my attention because its almost stony sides were perforated here and there with the burrows of several species of bees and wasps. Outstanding among these was a bee, the eumenid wasp, *Montezumia brunea,* with a green chrysidid or cookoo wasp heavily parasitizing it, and *Podium haematogastrum* Spinola. In addition, were a few ants, including a slender one of the genus *Pseudomyrma?* An examination of this nesting site showed a stored roach or two, a couple of cocoons of *Podium,* and several of the active wasps. It was evident that this isolated mound had served these insects for several generations at least; they were fortunate in being only superficial excavators, for the white ants, the true proprietors of the edifice worked close beneath the surface, so that several times when in digging out wasp burrows, I broke through the shell, the warlike soldiers would menace me with big sharp jaws, and workers made haste to repair the damage. Here the writer dug out many stored *Podium* cells during June; among these, however, were some failures—shriveled wasp eggs and dead roaches—and it seems that the sun beat down too fiercely on this unprotected mound. For a time it was the only source of supply of *Podium,* and I had almost decided that termite mounds—of which no others were found in the neighborhood—were the sole habitat of this roach wasp, but a more extended search, aided by the bettering of the season, proved that it nested just about as did its British Guianan relative, on level ground and in banks. Searching a low bank cut for the railroad line promised some results, but when informed by an officer that it lay quite in front of a target range, safer hunting grounds were sought. These were found mainly along the edge of the Utinga forest reserve that guards the city water supply. In order to secure a quantity of stored *Podium* cells, it was necessary to carefully locate their tunnels—lenticular in cross section, as in those of *P. flavipenne*—during the early afternoon, when the work was well under way, mark and describe them, revisit the place on the following afternoon and gather the plunder, which seldom numbered more than 8 units of cockroaches. It was found that many holes—finished or not—were abandoned altogether, and that others because, perhaps, of the frequent rains were completed and stored after a delay of a day or more; or perhaps they were taken over by other indi-

* *Cornitermes* (*Cornitermes*) *pilosus* Holmgren. Determined by T. E. Snyder.

Termite mound, nesting site of Podium Haematogastrum. Brazil.

PLATE XXI

viduals Pl. XVIII, Fig. 188 shows one of these wasps a few inches above her burrow in the termite mound, in the act of laying her egg on a mature female *Epilampra*. The cockroach is head first and partly beneath the thorax of *Podium* that holds it in place by her fore legs and in part by the second pair. The victim has been stung to docility and after oviposition is turned, end for end, brought to the mouth of the tunnel and slipped head first into it, where it could be seen breathing heavily. Small ants were angrily put to flight by a wasp engaged in nest making, but when the huge lone *Dinoponera grandis* lumbers along towards the tunnel the owner gives ground with alacrity. This ant is the largest species in the American tropics, the workers attaining an inch and a quarter in length. The egg of *haematogastrum* is glued for part of its length with the broader head end in the membrane at the base of one of the roach's fore coxae (Pl. XVIII, Fig. 185). The cocoon is also like that of its British Guianan relative, viz., somewhat fusiform delicate, dark brown and not at all silk-like. In finishing off the mud-cell plug, the wasp often makes nice, parallel, little wavy ridges on it, which ornamentation and its somewhat different shade serve to distinguish it from the surrounding soil.

Besides the mould-favoring dampness of the region, this wasp undoubtedly has other enemies that attack her brood. Large "velvet ants" (Mutillidae) occurred in the nesting region of *Podium,* and a little tachinid fly took interest in the wasp's work, perching on a grass stem overlooking the burrow and on one occasion examining the entrance during the wasp's absence. Finally, many species of ants are known to be detrimental to the nests of solitary wasps.

A number of the stored cells of *P. hacmatogastrum* were collected, with the following results: 74 cells contained a total of 121 roaches, or 1.635 per cell. This is less than the average number (2.164) per cell in the case of *Podium flavipenne;* but of the 121 Epilampras, 33, or 27.7 per cent, were adults, as compared with 6.04 per cent in *flavipenne*. The life cycle of this Brazilian wasp varies from about a month to 45 days or more, under rather artificial conditions.

From June 20 to June 30, 1924, the contents of 60 nests were transferred to cells made of sandy mud which were plugged and placed in a rather moist sand in two iron cans and brought back to Honolulu, the voyage occupying 27 days. From this lot were 45 emergences, 30 males and 15 females. On July 15 the first, a male, issued; then followed a hiatus of nearly two weeks. By August 2 the ninth male had issued, and on the following day five more males and the first female came out. August 14 saw the last of the emergences, which all took place in the morning. As they issued they were placed in a large cage where mating readily took place; 29 males and 15 females were liberated in three lots during the first half of August, in the lower portion of Makiki Valley, Honolulu. No Epilamprinae exist in Hawaii, though certain species in other subfamilies of cockroaches are very abundant there, and granting the wasp is no more particular in its choice of prey than *Dolichurus stantoni,* the Philippine roach parasite, these might well serve as hosts. It did not become established, however.

A *Podium* with habits similar to those of *P. flavipenne* and *P. haematogastrum* is *P. dubium* Tasch., which for size, form and color approximates the British Guianan species, was taken in April, 1924, at Nictheroy, near Rio de Janeiro,

Brazil. The wasp lacks the golden hair on the metathorax of *P. flavipenne,* and there are other less obvious differences between the two. Very little was learned of its nesting habits; a few burrows, lenticular in cross-section, were found on a shaded trail and remains of what suggested epilamprine roaches were identified with these tunnels. Two female wasps were taken.

Four species of mud-daubing *Podium* were taken. The largest of these is *P. goryanum* Lep. of Blairmont, British Guiana, and Belem, Para; seemingly a rare species, about 30 millimeters long, black with yellowish-brown wings with some fuscous at and near the apex, and a velvety covering of golden hair on the back part of the metathorax. It is a sylvan species. A specimen each of the smaller *P. aureo-sericeum?* Kohl and *P. brevicolle* Kohl were taken in April, 1923, gathering mud on a trail in Tena, Ecuador. *Podium (Parapodium) rufipes* occurs in British Guiana and Brazil. It nests on tree trunks, banks, etc., and I reared one male from Para, from a cell formed by a plastered-over hollow in a termite mound, while a partially stored, thinly capped cell in the same mound contained a single little cockroach with the comparatively large wasp egg protruding from behind one of the fore coxae.

An excellent monograph of the genus *Podium* (including *Dynatus, Trigonopsis* and *Parapodium*) has been written by Dr. F. F. Kohl (Abhandl. d. K. K. Zool-Botan. Gesellsch. in Wien. Bd. I, Heft 4, 1-101, Pl. I-VII, 1902.)

V

HABITS OF SOME SPIDER WASPS OF THE FAMILY PSAMMOCHARIDAE OR POMPILIDAE

It is no uncommon thing to see a wasp of this family laboriously dragging away a paralyzed spider to her nest. For the Psammocharidae are to be found almost everywhere that spiders exist, and appear usually to outnumber, both as regards species and individuals, any other groups of solitary wasps. Furthermore, they are generally hardy insects and for that reason may be active in rather unfavorable weather, when other wasps—except the Vespidae or social kind—are content to remain in hiding.

Though represented by a large number of species they are a compact and well-defined family of insects, broadly characterized by the comparatively small head sunken into the well-rounded thorax, giving them a hunchback appearance; the first portion of the thorax above is well developed and extends as an arch as far back as the base of the forewings, while the legs are usually long and swift. Comparatively few are of minute size, while others number among the giants of the wasp world. Some of the smallest kinds belong to the genus *Aporinellus,* commonly steel greyish insects that prefer a dry environment; the big spider hunters are conspicuously represented by the genus *Pepsis,* often with tawny or particolored wings, and that inhabit the Americas, both on the temperate plains and within the tropical jungle. In the Old World are found immense species of *Salius.*

As their common name implies, nearly all of the species whose habits are known prey upon spiders. A few store cockroaches, crickets and beetles (Bingham, Fauna Br. Ind. I, 103, 1897). Neither great size, speed, ferocity, nor skillfully hidden retreat in the realm of spiderdom seems proof against the attacks of the Psammocharidae. Some of these wasps are rather catholic in their tastes, but others appear to select one species or a genus of spiders as food for their young. Thus it is that as spiders may vary greatly in size, according to sex and kind, so also do these persecuters range. The so-called "tarantulas" of the southwestern United States, the related monster spiders (Avicularиidae) of tropical America and elsewhere, as well as the immense and even more repulsive *Galeodes* (Solifugae) of India, have their conquerors among these wasps. The home of the trap-door spider *Cteniza* (Avicularиidae) protected by a strong lid that resembles the surrounding soil to a remarkable degree and that of a smaller *Aptostichus* which lives in a silken tube embedded in the sand but connected with the surface by a collapsible flap-like mouth, are invaded by wasps modified by nature to cope with these difficult situations. *Heteropoda regia* Fab., the "Nancy spider" of British Guiana, a well known tropical species, with a wide spread of legs and almost lightning like in its movement, succumbs to the attacks of the handsome Indo-Malayan *Macromeris* wasps. Other sorts of spiders, glowering from funnel-like retreats, are enticed out into the open and fatal danger zone by their crafty foe, and bulky orb-spinners are themselves not secure on their ample discs of thread, from certain Psammocharidae.

For an interesting account of the behavior of the large Porto Rican *Pepsis marginata* and *Cyrtopholis portoricae,* her tarantula prey, see Petrunkevich (Journ. Exp. Zool., v. 45, No. 2, July 5, 1926). See also "Nature at the Desert's Edge," by Hingston, for the habits of other Psammocharidae and their spider prey.

While a large proportion of these wasps dig their own nest-holes in the ground, some making shallow and others deep burrows, not a few utilize the retreats of their victims as a nidus, while others still fashion cells of diverse shapes, situation, and materials, according to species. Most of these cells, which are arranged in groups, are composed of clay or clay-like substances, sometimes varnished over with the gummy exudation of trees, and otherwise finished off; but there are at least two South American species of the subfamily Ageniinae that construct their cells within hollows and use nothing more than dry bits of leaves of grasses or of palms for this purpose. Still other Psammocharidae are parasitic, making no nests but laying their own eggs on the prey of their fellows.

Again, according to wasp group the spider victim is stung to a degree ranging from complete immobility to one in which when disturbed it can run about rather briskly, though otherwise loath to leave its retreat.

Bulletin 14 (1919) of this Experiment Station treats of fragments of the life histories of some of the Philippine Psammocharidae, while it is my purpose here to set forth a few details of the biology of several American forms.

Some Giant South American Spiders and the Wasp **Notocyphus** That Preys Upon One of Them

One cannot remain long in the American tropics without becoming familiar with some of her huge spiders. Of these there are many kinds and with diverse habitats; but among those most frequently met with are certain Avicularиidae; bristly hairy fellows, velvety grey, brown to black, often with a beautiful bluish or purplish iridescence on the cephalothorax that to a great extent dwell within the crevices of tree trunks. As youngsters, and often too when grown up, they may make their separate homes by fastening a few leaves together with white silk or merely by turning over and securing a single leaf upon itself so that one may find these spiders thus ensconced on bushes or trees. Usually the retreats of the adults in tree trunks are not difficult to locate because of the white silken sheet that overlies the cavity. A number of these spider retreats were examined. The sheet is at first a sort of bag with a collapsible aperture at one or more of its corners and is continued, often far into the bowels of the tree, as a more or less well-defined tube. It is within this often inaccessible hollow that the spider casts its skin and probably also lays her eggs. Most of the nests were found at Tena, eastern Ecuador, where some grazing lands tolerated a number of decrepit trees with suitable cracks in them. The silk spun by these spiders is not very strong and seems to be employed mainly in travel and for the construction of their nests; it appears unsuited in its quality and generally in its disposition for ensnaring insects or other prey. Undoubtedly the spider depends chiefly upon its sudden swiftness and strength to secure provender. This, in parts of Ecuador, I suspect, consists to some degree of certain giant cockroaches (*Blaberus*) that favor an arboreal environment very similar to that of the spider. Near Belem,

Pará, Brazil, in a district subject to floods, I once observed several of these big spiders on the trunks of trees, and one of them was devouring a small land crab, a crustacean so abundant in the locality as undoubtedly to furnish a good part of the arachnid's menu. Simon (Histoire Naturelle des Araigneés, 1892) attributes large beetles as the main food. Bates (The Naturalist on the River Amazon,

Giant spider (Theraphroseae) from Ecuador. X½.

PLATE XXII

1864) found a large species that had attacked and killed two small birds; this is perhaps an unusual habit, although the family name, Avicularíidae, for these spiders would imply that at least some of its members are bird catchers, J. H. Emerton (Psyche, XXXIII, p. 60, 1926) writes in part as follows: "In a communication to the Biological Society of Sao Paulo, Brazil, July 8, 1925, Drs. Brazil and Vellard give an account of a spider which eats snakes, frogs and lizards in preference to insects. . . . The spider *Grammostola acteon* Pocock, is

one of the large Avicularíidae commonly known as "tarantula." The body of a male is 60 mm. (nearly 2½ inches) in length . . . . The female is somewhat larger with shorter legs. . . . In a large cage with snakes 24 to 45 centimeters (about 8 to 10 inches) long, frogs and insects, the spiders will generally neglect the insects." Petrunkevitch (Journ. Exp. Zool., v. 45, No. 2, July 5, 1926) found that a large ground-inhabiting tarantula, *Cyrtopholis portoricae*, common in Porto Rico, fed to a considerable extent upon large millipedes.

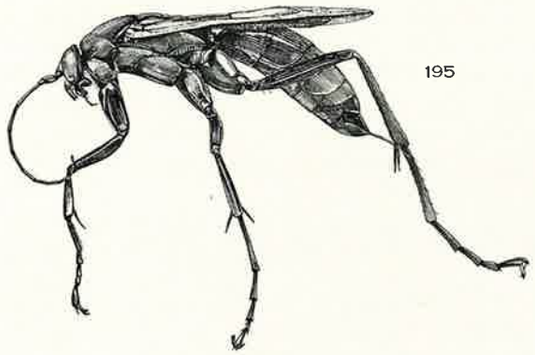
Spiders of the tree-dwelling group (Avicularieae) as came under my limited observation measured up to about 2⅛ inches in body length and with a diagonal spread of legs of slightly more than 6 inches. That these creatures are fitted for an arboreal life is shown by the modification of the last two joints (tarsus and metartarsus) of the legs, especially the anterior ones, as broad pads beneath, of close-set, fine short hairs which are swollen towards the tip, somewhat roughened there and terminate in more or less of a hook (Pl. XXIII, Fig. 196). These pads suggest a glandular function and when one passes the finger over their iridescent surface, exert a decidedly retarding, adhesively pulling effect on it. Thus provided, such spiders may safely climb even comparatively smooth surfaces.

There are other kinds of giant spiders (Theraphroseae) that seem addicted to a life on the forest floor. They are not so bristly hairy as the Avicularieae, and naturally have the foot pads much less developed. They constitute probably the largest of spiders, and well favored individuals may have a body length of over 3, and a leg expanse of between 8 and 9 inches (Pl. XXII, Fig. 194). As observed in a large living specimen from eastern Ecuador, the deep pit or depression (median fossa) on the top of the thorax furnishes a breeding place for a minute fly, which I suspect belongs to the family Phoridae. Two pupal cases were scraped out of this pit and one yielded a fly. The hairs on all these big creatures are sometimes very irritating to the skin. Uninviting as such spiders may appear, their curved and polished fangs are said to be used among certain of the South Americans for making necklaces.

The age attained by some of these giant spiders may be very great, although I suspect little research has been done along this line. However, W. J. Baerg has kept *Eurypelma californica* Ausserer, the large Californian "tarantula," in captivity for over seven years and he estimates, no doubt with considerable accuracy, that it may live to be sixteen years old. He concludes that this species is able to regenerate lost appendages at maturity and that they apparently moult as long as they live (See Ann. Ent. Soc. America, XIX, p. 512-513, 1926).

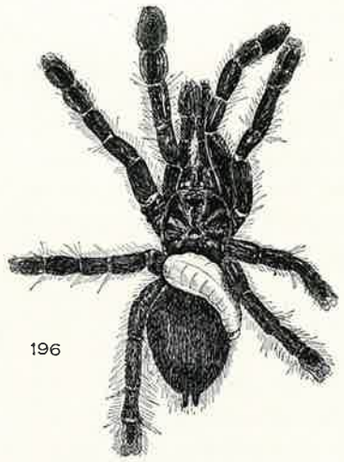
While spiders are not generally harmful, those of the genus *Latrodectes* ("Black Widow," "Hour-Glass Spider," "Shoe Button Spider," "Katipo" of New Zealand) may bite with serious results. Ferton (Ann. Soc. Ent., France, LXXIX, p. 164-165, 1910) speaks of the ill-famed "Malmignata" (*Latrodectes 13-guttatus*) as being very numerous locally in Corsica, where he observed the wasp, *Pompilus rytiphorus* Kohl (Psammocharidae) preying upon it.

For a contribution upon the venom of spiders, see Drs. Brazil and Vellard (Contribucao ao Estudo do Veneno das Aranhas, Memoiras do Instituto de Butantan, Tomo II, Fasc. Unico, p. 5-77, Pls. 1-14, 1925).



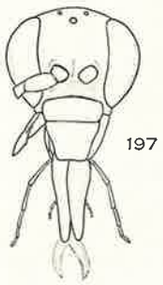
195

NOTOCYPHUS TYRANNICUS ♀. ×2.1
BRITISH GUIANA



196

AVICULARIID SPIDER BEARING LARVA OF NOTOCYPHUS TYRANNICUS. ×.83
ECUADOR

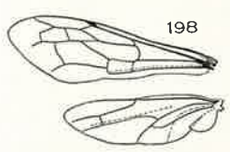


197

199

200

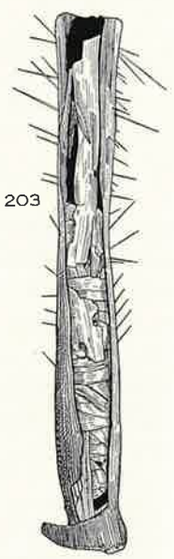
PUPA OF N. TYRANNICUS ♀. ×1



198

NOTOCYPHUS TYRANNICUS ♀.
HEAD AND WINGS
ECUADOR

FULL-FED LARVA OF NOTOCYPHUS TYRANNICUS ON SPIDER'S WEB IN A GLASS, AND FEEDING ON REMNANT OF SPIDER. ×.8



203

201

PLANICEPS HIRSUTUS ♀. ×3.3
CALIFORNIA

202

CLAWS OF N. TYRANNICUS ♀

LEAF-BIT NEST OF PSEUDAGENIA NOBILIS. ×.33

PLATE XXIII

Notocyphus F. Smith (1855)

The American genus *Notocyphus* contains over 40 described species, and like the avicularíid spiders which are probably its most common prey, is best represented in the tropics. Among the more salient characters of this group are an exceptionally elongate upper lip (labrum) and an abdomen strongly compressed for its apical portion. For a monograph of the genus see R. Lucas (Ent. Nachr. XXIII, 65-96, 1 fig., and 134-144, 1897).

The black wasp *Notocyphus tyrannicus* Sm. (Pl. XXIII, Figs. 195-200, and 202), while attacking a large arboreal avicularíid spider, probably of the genus *Tapinauchenius,* is itself scarcely an inch in length. It is hardly to be compared then with certain wasps of the genus *Pepsis,* that may reach a length of two inches and that form a conspicuous element in the wasp fauna of tropical America.

Notocyphinid wasps are usually considered rather uncommon, and as Ashmead in speaking of this group, in his classification of wasps (Canadian Entomologist, 34, p. 134, 1902) rightly concluded "the structural characters of these wasps clearly show that they have different habits from those in the other subfamilies." They are not, however, parasitic or inquilinous in the nests of other wasps, as he suspects, so far as my meager observations attest, but seek out spiders for themselves, much after the fashion, it seems, of the somewhat similarly formed wasps of the subfamily Planicepinae, members of which are known to attack tube-building spiders of the genera *Aptostichus, Cteniza,* and *Lycosa.* The tendency of such wasps engaged in the dangerous work of attacking the spider in, or of ousting it from its silk-lined burrow, usually closed by a lid, by entering it themselves, has been to so modify their form of body as to lessen any bulge, angle or notch that would interfere with quick turns and with forcing themselves in or out of narrow spaces. Thus we see in the side view of *Notocyphus* (Pl. XXIII, Fig. 195), the fittingly-curved, short head connected with the rather evenly arched thorax by a very short neck, with the abdomen compressed apically and sustaining the curve of the preceding portion with which it is very shortly joined and in a manner to make the whole body a gentle arch. In the Planicepinae this modification has gone much further, as seen in the even more closely fitting and posteriorly concave head, the lengthened thorax, shorter legs and antennae, and generally smoother and more elongate body. But a single specimen of *Notocyphus tyrannicus* was reared in Ecuador, where my observations on it commenced only from its early stages as a small grub upon its spider host. One female example of this species was subsequently captured in British Guiana. Other species were taken in Brazil.

In the cut-over forest near the tiny village of Tena, in eastern Ecuador, the writer found on the branch of a tree at a height of 5 or 6 feet, what was evidently a spider's nest but of such size that he paused to examine it. The affair was simply a folded green leaf supplemented by a white sheet of silk, and in pulling it down for a closer inspection the occupant, a large, hairy, nearly black spider of the group Avicularieae and close to an inch and a half in length of body, was disturbed and came out. Something white on its back made me capture this spider and it was found to be parasitized by the grub of a wasp that lay extended obliquely across the dorsum of its abdomen and with the head to one side and

tailwards to its host (Pl. XXIII, Fig. 196). This was on February 18, 1923. While the spider could be urged into activity, it was probably not its normal self and doubtless the wasp had stung it. It refused a couple of grasshoppers that were offered it, but spun a neat and commodious cup of silk in the diameter of the jelly tumbler, its prison. The *Notocyphus* larva rests firmly on the hairy back, and in some measure is glued thereto, for it endures successfully the chafing movement of the spider's hind legs, should it take a notion to walk about. It is quite motionless and feeds at one spot in a sucking manner. As the hours pass, the abdomen of the weakening victim shrinks while that of the lusty young wasp grub swells to greater turgidity. On the morning of February 21, the spider perished, although the parasite had not yet cast its final feeding moult skin and was still feeding in its original manner. However, by 1:30 P. M. of the same day it had nearly rid itself of the old skin, the shrivelled remains of which gather up beneath it. It is at this last larval stage—when the young of most solitary wasps are comparatively active—that by its moult it has acquired a larger pair of jaws which are fitted for chewing and biting, and *Notocyphus,* now a loosely filled out and deeply segmented larva with a well-marked crease along its side, bites into its victim, gently at first but finally in crude mouthfuls until the whole carcass is reduced to a comparatively small homogeneous wet mass of finely chewed material, placed upon its lap and into which it delves in an unsatisfied manner (Pl. XXIII, Fig. 199). This was the development by 6:00 P. M., February 22, with the full-grown larva, more loose skinned than in the preceding quiet stages and with its fore part quite extensile. Straightened out normally it is a good inch and a half long and thus would seem to give promise of becoming quite a large wasp. The dark mess on its lap is ultimately sucked or chewed almost dry. No other trace of the big hairy spider except an odd hair or two remains, and we must give credit to the soft white grub's powerful dark-tipped mandibles for reducing almost to dust such hard parts of its vicitim's anatomy as the fangs and eye plate. While at length totally deprived of nourishment, this powdered material does not go to waste, for the larva incorporates much of it in loose outer part of its strong silken cocoon. It was first noticed spinning in the early morning of February 23. To begin with, only the crude framework is made, the operator still on its back with its lower thread-bearing lip prominent, heaves and twists about and reaches out for some wall or other object on which to fasten its silk—if it cannot thus attain the desired point, an undulation of the body will bring it near enough. A few strips of paper helped it in this work. Threads are fastened alongside or to each other, or elsewhere often by a pinch of the active mandibles, the grub shifts its position from time to time and soon a silken framework comes into being. Still to be seen is the dark earth-like lump well down on the broad part of the venter where the strong lateral folds help to keep it in place, and into which, every now and then, the grub reaches down, bites into the mass, carries a mouthful to some point in the structure and loosely deposits it there. At first the silk is silvery transparent, later it turns, or is made brown. The inner, more compact cocoon soon becomes thinly outlined and by evening of the spinning day is dense enough to appear rather opaque, of a dark brown color and plentifully sprinkled with the cinder-like dust remains of the

spider. On the morning of February 24, the cocoon is quite opaque though by no means complete, for it later assumes a very firm texture within.

The pupae of psammocharid wasps are remarkable for the great development of the lateral abdominal processes which assist in holding them snugly in place in the smooth-walled interior of the cocoon. Desirous of seeing if possible the pupa of *Notocyphus,* I carefully cut through the tough inner envelope on April 13, and thus revealed a well-developed pupa (Pl. XXIII, Fig. 200). The cut also showed the cocoon in longitudinal section, the inner envelope is very strong and of a leathery structure and comparatively thick; within it is very smooth, and much darkened at the base by the more or less absorbed fecal matter; surrounding this inner shell are rather close-set, irregular layers of light brown silk, and finally the coarse loose reddish brown outer framework. The whole of the firmer structure measures about 35 millimeters long by 13 or 14 broad, it being more narrowly rounded at its basal or tail end. Since the material used in forming this large and dense cocoon is derived mainly from the wasp grub's body, the latter finally becomes considerably reduced in size so that one can readily understand the comparatively small bulk of the adult it develops into. The pupa is about 25 millimeters long and can wiggle its abdomen actively. The development of the lateral processes supplements the curvature and dimensions of the rest of the body and enables all to conform snugly to the even bend within the cocoon. The lateral processes in the pupa of a British Guianan *Pseudagenia* and of the Philippine *Macromeris,* mud-daubing wasps of the psammocharid family, while quite as elongate are far more slender and delicate (see Howes in Tropical Wild Life in British Guiana, 1917, and Williams in Philippine Wasp Studies, 1919). The pupa of *Pompilus holomelas* (Psammocharidae) is also rather similarly armed (see Ferton, Ann. Soc. Ent. France, LXX, Pl. III, Fig. 5, 1901).

On April 17, P. M., the wasp had practically freed herself of the pupal envelope and although fully formed was yet quite soft, especially the abdomen. Later it was preserved piece-meal.

A hunt for other specimens among the dwellings of the big hairy *Tapinauchenius* spiders (Aviculariеae) revealed two *Notocyphus* cocoons, neither far within the retreat in the tree trunk, one of these although unopened was without living content; from the second the wasp had already made its escape by cutting off a very neat circular cap at the top of the cocoon.

Planiceps hirsutus Banks, a Spider Wasp of the Sand Dunes

Of the sand dunes that once covered the greater part of the site of San Francisco, California, only along portions of the western fringe of the city do we now find their poor remnants. With the complete effacement in the near future of these wind-piled hillocks and ridges will disappear from the locality most of the interesting fauna and flora attached to them. Hence it may be inferred that the San Francisco sand-dune area is (or better, was) not all a desert, for the soil remains moist from a short distance beneath the surface; hollows are rather well interspersed with miniature oases, perhaps graced with a tiny pond, and small thickets of low trees and areas of other plant growth are still to be found. Notwithstanding the characteristic summer fogs blowing in

from the ocean and the frequent strong westerly winds that sometimes blanket the dunes in a haze of sand, there is enough mild sunny weather and sheltered depressions and detached hills to justify the existence of a very considerable variety of insects and other invertebrates. Of the more than fifty species of stinging wasps that are still found (1925) within the city limits, by far the greater proportion are diggers in sand. The family Psammocharidae or typical spider-wasps constitutes at least 25 per cent of this number, and all but two, a parasite (*Ceropales*) and a mud-dauber (*Ageniella*), are diggers. These diggers fall naturally into two groups; those that excavate their own nest-holes and those that use the burrows of their prey for that purpose. It is in the latter group that the several species of San Franciscan Planicepinae belong; one or two very tiny forms about 3.5 mm. long and among the smallest members of the family, and two species of *Planiceps,* both purplish blue-black insects; *P. luxus* Banks measuring up to 15 mm. in length is very inconspicuously hairy, while *P. hirsutus* Banks, (Pl. XXIII, Fig. 201) slightly less in size, is noticeably though not densely covered with rather long erect hair. The genus has among other characters, an elongate body, short head closely fitting into the thorax, stout, rather abbreviated antennae placed low down on the face, and comparatively short thickened legs, altogether a sturdy form admirably fitted for its specialized habits. While both of these San Franciscan *Planiceps* probably have a very similar life history, that of *P. hirsutus* alone was studied. This wasp is found in suitable places in several parts of the city; at Point Lobos, along the Straits of the Golden Gate; on Lone Mountain, a sandy hill sorely hemmed in by civilization, though still rich in insect life; and in the sand-dune area that lies to the south of Golden Gate Park (Pl. XXIV, Fig. 204) and where nearly all the data was secured. *Planiceps* feeds readily at flowers, being very fond of the blossoms of the wild buckwheat, *Eriogonum latifolium* Smith (Polygonaceae), the most popular wasp plant native to San Francisco.

One might well wonder what the wasp is about as she runs over the bare sand, her purplish blue wings quivering in the sunlight, her head nosing the ground, and occasionally digging in it for perhaps half her length. She is probably using her sense of smell, or of touch, located in the antennae, as much as her eyes, for these are constantly on the sand. You might watch her for an hour or more and grow impatient because the time thereby consumed could have been applied to other investigations, and sunny weather in the summer time is not too frequent on the sand dunes near the sea; sooner or later, however, she may disclose the object of her search—a spider, of course, but one of rather unusual habitat. This proved to be *Aptostichus,* species most probably *stanfordianus** Smith (Ann. Ent. Soc. Am., I, pp. 221-223, 1908) of the family Avicularíidae, subfamily Ctenizinae or trapdoor spiders. My largest specimen measured 15 mm. in length of body and the series studied by Smith ranged from 10 to 21 mm. long. The spider is of low, stout build, pale brown and moderately short hairy. Its sand-dune home is a delicate silk-and-sand grain tube, whose trapdoor is a limp,

* An immature specimen of this spider was sent to Mr. Nathan Banks, who identified it as *Aptostichus*, probably *stanfordianus* Smith. C. P. Smith, its describer, had specimens of this species from Monterey Bay, California, to as far north as San Francisco.

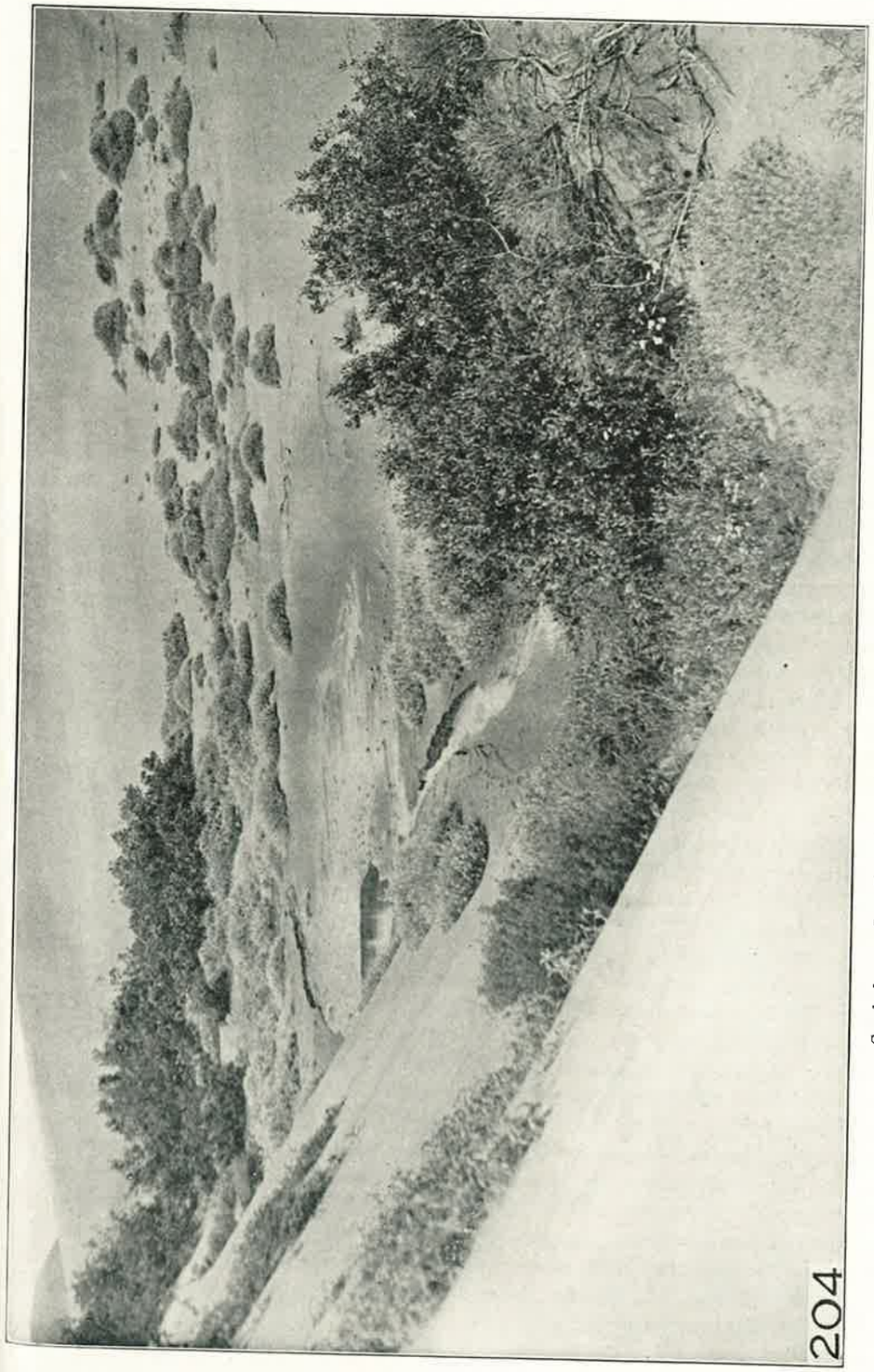


PLATE XXIV

Sand dunes, San Francisco, California. Home of the Spider Wasp, Planiceps Hirsutus.

horizontal sort of flap that rests in an almost imperceptible semicircle of silk-bound-sand, on the sand; the tube that follows being at first just beneath the loose sand is probably in part collapsed; it soon slopes considerably and may penetrate to a depth of 2½ inches or more. One of the few nests examined had two entrances soon converging to form a Y, though owing to their delicacy little of their structural detail was ascertained. Nothing was learned of the habits of this spider, but as in related forms it is most probably nocturnal and stays at the flap mouth of, or close to its tube capturing what suitable insect prey ventures sufficiently near it. It is a common species and while its tube may be found in the sand at some little distance from any vegetation, it likes to nest in the shelter of a slope or small hillock where perhaps such dune plants as the blue lupine (*Lupinus Chamissonis* Esch.), the Composite, *Franseria Chamissonis Less.* with its prickly seeds; the prostrate and radiating little *Oenothera spiralis* Hook. of the Evening Primrose family, and a few others, grow.

Planiceps then, preys on this sand-inhabiting spider. The calm sunny afternoon of June 7, 1925, witnessed one of her successful hunting expeditions. Two of these wasps, about 40 feet apart were each exploring an area of sand. Finally, one of them discovered a flap door, an affair hardly to be distinguished from its surroundings; she made haste to peek within, using as always, a characteristic method of entering, for instead of going straight into the tube in an upright position, she gets on top of the flap, turns around, grasps the edge with her stout fore legs, standing nearly on her head, and then turning over yet more, as though about to sommersault, almost dives into the slit that she has pulled and forced open; in this inverted position she enters for less than her body length and immediately backs out. The whole procedure is done with great rapidity and her exact methods are thus difficult to follow. This, of a certainty, is the most effective manner of entering by such a door; one could not expect to see her raise the limp flap over her head with the forelegs and then run inside.

The change that comes over *Planiceps* on discovering that the spider is at home is very obvious. Immediately greatly excited she buzzes her wings right over or very near the flap door, as if attempting to irritate the spider and coax her without. She is evidently loath to encounter *Aptostichus* face to face in the tube and several times she plunges part ways through the trapdoor and withdraws; after each essay buzzing her wings as before. But perhaps she has enticed the spider sufficiently near her doorway, for she now tries other tactics. Her object is to get to the rear of this formidable prey and to drive her out of the tube and into the friendless daylight and open spaces. She now runs about an inch and a half behind the tube's entrance and there penetrates the yielding sand, burrowing, or rather sinking out of sight in it; she is quickly out again but repeats the performance, which very soon brings the desired results, for out of the flap door rushes the thoroughly frightened spider closely followed by *Planiceps,* that almost immediately overtakes and grapples with her; the fugitive shakes free and hurries on apparently unhurt and gains a bushy slope, the wasp far behind her, hunting in a frenzy of curves. Probably after an extended search the huntress should find her, but to ensure a more rapid performance, the spider was tossed on the sand near her foe; the latter spies the immoveable spider, then as she attempts to flee, pounces upon her. Quite a scuffle follows, although there

is really only one aggressor, the spider tries to run off but the wasp clinging to the back of her abdomen curves her body beneath her, and forward and administers one or more stings, presumably under the cephalothorax, so that the spider is soon reduced to a state of coma. Very little delay ensues; *Planiceps* now grabs the comparatively large *Aptostichus* by a fore leg and attempts to back off with her towards the vacated tube nest, but the great weight of her prey and the loose, dry sand makes locomotion very slow, the wasp slipping almost altogether; she frequently lets go her burden to inspect the flap hole and make some longer, purposeless? excursions. She enters the tube once at the puncture, an inch and a half behind the door, to come out from the latter; but now and several times uses the flap door for both entering and leaving, always entering in the orthodox manner. So tedious is the progress of wasp and so heavy the spider, that to expedite matters I cautiously push while *Planiceps* pulls; finally the load is dragged to within a third of an inch of the flap door, the wasp lets go, dives in, emerges sufficiently to reach her prey, whose legs she so manipulates as to swing the body tail to her, and thus the twain disappear within. The horizontal flap door, very slightly ajar is now closed from within by the wasp, for we can see it being thoroughly pinched to the lower part, the jaws evidently being used for the purpose. Certainly she does not wish any other wasp to enter here and disturb her provender. Thirteen minutes after entering *Planiceps* is on the surface again, having issued from the puncture, one and a half inches behind the entrance and over which she brushes ever so little sand. Now she cleans herself and is ready for the cyanide bottle. The frail tube of silk and sand forks forward in the beginning, farther within is a cast skin of *Aptostichus,* herself still deeper down, paralyzed and almost without power of movement. Glued to her abdomen between the back and side is the elongate and pearly wasp egg. Unfortunately this egg and one from another paralyzed spider were disturbed and so these limit the observations on the early stages of *Planiceps hirsutus.* The proper way to obtain cocoons of this wasp, time being no object, would be to mark the nest tubes within which she drags the paralyzed owner, and to exhume them several weeks later.

Additional studies on the habits of the adult wasp tend to confirm that her methods vary little, if at all. An earlier observation, May 31, 1925, in the middle of the afternoon, describes one of these *Planiceps,* as engaged in dragging an *Aptostichus* spider towards a small sandy hummock held in place by the root system of a dune plant. The victim had evidently made a race of over four feet for her life and proved a heavy burden. I aided the wasp as before, pushing the spider warily now and then. After several nest inspections the spider was brought before the flap door, *Planiceps* entered, heels over head, as usual, came out a little and dragged her in tail first. The spider, one might say, was pulled up in front of nothing, so well hidden was the flap door; the latter was pinched and mouthed into the opposing edge of the tube, at first and also a short time before *Planiceps* issued, which was in 15 or 20 minutes, and as with the wasp of June 7, through the sand about two inches below the mouth. The thoroughly paralyzed spider was in the tube at a depth of about 2½ inches and with the wasp's egg latero-dorsal on the abdomen.

Deserted tubes of *Aptostichus* are also investigated by these wasps, and sometimes stir up considerable excitement, the huntress carrying on as though a spider

should soon rush out. The finding on the sand of a comparatively large tube-making spider, apparently recently stung indicates that the wasps may conquer a greater burden than they are able to carry—a mistake not at all uncommon among solitary wasps.

It is probable that the *Planiceps* are here two brooded—the summer is long and the annual variation in temperature not great.

Ferton (Ann. Soc. Ent. France, LXX, p. 121-122, 1901, and LXXIV, p. 76, 1905), and Davidson (Ent. News, XVI, p. 233-234, 1905) have found more or less similar habits in other *Planiceps*. In speaking of *Planiceps fulviventris* Costa, and its prey *Nemesia badia* Auss., studied in Corsica, Ferton (l. c., LXX, p. 122) has observed that in autumn the spider adds a second exit door to her nest and is thus frequently enabled to outwit her enemy, taking refuge upon a stone or tuft of vegetation.

Two ~~Pseudagenia~~ Wasps from British Guiana

The subfamily Ageniinae may be described with a fair degree of accuracy, as including all and only those wasps of the family Psammocharidae that build cells. Thus we have no true diggers among them, none of the parasitic kind, and none that simply use the spider's retreat in lieu of a nest. This biological definition, which may suffer modification following a more extended knowledge of the habits of these wasps, might be supplemented by the statement that few of the family outside the Ageniinae have the custom of snipping off the legs of their victims. A large Indian *Salius*, a genus that is closely related to this subfamily is known to be a leg-cutter (Bingham, C. T. Journal Bombay Natural History Society, XIII, 1900), and the Peckhams (Instincts and Habits of the Solitary Wasps, Madison, Wis., 1898, p. 141-144) have observed that *Pompilus fuscipennis* St. Farg. very frequently bites off one or two of her victim's legs.* The reason for removing the limbs of the spider, wholly or in part, is probably an attempt to make it better fit the cell. No other psammocharid wasp, as far as known by the writer, carry their prey beneath them and walk forward with it, as generally seem to do the Ageniinae, but drag it backwards or sideways.

Associated with the habits of these cell-makers is a difference in structure—more easily seen than described—from the other psammocharids; and in general, we may say that the head is comparatively large, wide and free, the back not so hunched, the legs long, slender and only feebly spinose, while the abdomen to be more flexible, joins the thorax as a rather narrow and well-defined stem, with its other extremity often fitted as a sort of mason's tool with which to shape its cells. The males have less distinctive characters. The group contains some forms with brilliantly metallic bodies. Many of these wasps have arboreal habits, building their cells and hunting their prey on bushes or trees, some are

* Several sphecid wasps may mutilate their prey; one of these is an *Ampulex* (Sharp, Camb. Nat. Hist. Ins. VI, Pt. II, 115, 1901), *Notogonidea pompiliformis* Panz. often cuts off the legs of the gryllid crickets it stores in its cells (Ferton, Ann. Soc. Ent. France, LXXVIII, p. 413, 1909), while Jansson (Ark. Zool., XII, No. 12, 1909), in Sweden captured a specimen of *Blepharipus vagabundus* Panz. which had bitten off all the legs of its prey, a tipulid fly. In the Hawaiian Islands the writer has observed *Hylocrabro tumidoventris* P. carrying off a legless tipulid fly.

fond of building in dark hollows, and even construct cells in holes in the ground, in logs, or utilize hollow twigs, making partitions of mud. Their architecture is often topped off by curious protective (?) disguises, as tree gum, bits of lichens, etc. For example, the pretty woodland *Pseudagenia chrysosoma* Rohwer, of the Philippines, was noted building in a hollow twig, dividing off the cells and depositing a bit of snowy white fungus on the outer mud partition.

The material most frequently employed in cell-making is mud or other earth-like materials, but there are at least two, and probably a number of South American Angeniinae that use strips of the leaves of large grasses and of palms to meet these requirements. In this category fall the rather large species, *P. regius* (F.) and *P. nobilis* (F.)* My observations on these wasps are exceedingly limited and it is mainly because of the employment of such unusual nest-building material that they are made note of. Many social wasps masticate bits of dead wood, and possibly old leaves to make into a paste for the construction of their homes, and some of the Zethinae, handsome insects best developed in the American tropics, use bits of netted-vein leaves (dicotoledons) often more or less reduced to small pieces or to a pulp, which they glue together to form cells and their accessories, but these two spider wasps use no adhesive materials whatever in forming their cells, skillfully bending and squeezing their comparatively large leaf sheets into some appropriate hollow. Considerable strength must be employed in this work.

In a grove a few miles up the Berbice river in British Guiana, on October 17, 1923, I observed a dusky winged *Pseudagenia* (*P. regius* (F.)) about 13 millimeters long and with areas of silvery on her thorax and abdomen, laden with a pale conspicuous object alight on the trunk of a mango tree. She went under a piece of loose bark, which I detached from the trunk thus exposing a large unfinished cell of broad strips of dead grass leaves, of which one piece measured 25 millimeters long by 5.5 wide; they were curved and thus held in the cavity in a more or less vertical plane. The architect was captured and preserved.

Pseudagenia nobilis (F.) (Text fig. 13, ♀), a larger and more handsome insect measures 16 to 18 mm. long; she likewise is adorned with silvery velvet and her wings each bear two conspicuous dark blotches. This insect occurs in the Guianas, in Brazil, and probably elsewhere.

A short distance from Plantation Blairmont, on the low front lands of British Guiana is an attractive piece of forest land whose chief characteristic is the predominance of a huge species of euphorbiaceous tree, known scientifically as *Hura crepitans* but otherwise and locally as the "Sandbox Tree", a quick-growing giant of little commercial value whose trunk and limbs are cruelly armed with thorns. It was to this, the "*Hura crepitans* bush" that Mr. H. E. Box, plantation entomologist and myself made several interesting entomological excursions. The locality was rich in wasp life, and besides *Podium, Trigonopsis, Ampulex, Trypoxylon* and several others, this large *Pseudagenia* nested. On December 1,

* These two species may belong better to *Cryptocheilus;* they have the last joint of the hind tarsi spinose beneath, in the hind wings the transverse median vein ends before the cubitus, and the second ventral segment is transversely depressed. The Psammocharidae of the world need revision badly.

1923, the only nest of this species was found, the architect being caught in the act of flying with a conspicuous piece of dry palm? leaf held beneath and behind her, and alighting on the butt end of a dead and fallen leaf sheath of a spiny palm or "pimpler" (*Bactris* species) that had rolled up as a cylinder. This she entered. An examination of the cylinder showed it to contain a leaf-bit nest, 100 mm. or approximately 4 inches long, and about 17 mm. in diameter (Pl. XXIII, Fig. 203). The accompanying figure shows this palm sheath with portion of its length cut away, exposing the plan of *Pseudagenia's* work. First, long strips are brought in and arranged in a longitudinal manner; they evidently serve to smooth over any undesirable unevenness in the bore of the cylinder and form a sort of superstructure on which to build the cells proper; these are composed of pieces of leaf curled mainly at right angles to the tube, and of others domed over so as to form the convex base of one cell as well as the concave cover of the one back of it. This nest was composed of two complete and one unfinished cell, the last towards the bottom of the picture. The cutting and curling of these strips forms a neat piece of work and denotes considerable strength and skill on the part of the wasp. The two completed cells each contained a good-sized spider with long unsnipped legs; that of the innermost had a young wasp larva adhering to one side beneath on the spider's abdomen, the middle cell with an egg, also latero-ventral on the victim's abdomen. This egg measured about 3.5 by 0.7 mm.

FIGURE 13

Cryptocheilus (?) sp.* whose habits have been aptly described by Howes in "Tropical Wild Life in British Guiana" is a fine black wasp with iridescent violet blue wings that builds heavy mud cells in protected places on tree trunks and elsewhere. It is common about Plantation Bairmont.

* Referred to by Howes as *Chlorion neotropicus* Kohl. In this insect the last joint of the hind tarsus is spinose beneath, and in the hind wings the transverse median vein ends beyond the cubitus, and the second ventral segment is transversely depressed.

In concluding the section on the habits of the Psammocharidae, it is perhaps worth mention that a small parasitic fly (Tachinidae?) sometimes follows close after a flying wasp, as observed at Rezende, Brazil, and obviously for long distances, presumably in the hopes of ultimately laying her young on the carcass of the spider that the wasp is expected to catch. Examples of this patience and persistence are characteristic of parasitic insects.

A note on a very large *Pepsis* spider wasp (Psammocharidae) in the environs of Guayaquil, Ecuador, is as follows: "December 9, 1922. On a small flat at the base of the Salado hills the ground is cracked by the heat of the sun, and the vegetation at this season of the year is mainly sparse and scrubby; nevertheless, it is even now fairly rich in insect life and I was particularly interested late this afternoon between 5:45 and 6:10, in watching several huge *Pepsis* wasps with orange wings and black antennae, attempting to settle down for the night. It seems frequently to hold true that the bigger the insect the more wary it is, and these giants, conscious of my presence were very loath to roost in the neighborhood. As a rule, such wasps are low and apparently leisurely flyers but not at all easy to net, for they give evidence of very fair eyesight and swerve skillfully away from your too near approach. I carefully followed one of the trio; it would fly about a certain spot and eventually alight on the ground, but very alert, for it flew off at my coming, going perhaps 250 feet away though in the end swung back and settled in practically the same place. On my creeping up it again took wing but eventually returned, as before. In all, this was repeated three or four times. Another large *Pepsis*, after careful scouting, settled on the ground about 30 feet away from the first, but her actions startled this one and both took flight. I was unable to capture either wasp, which I think were females, but finally netted a fine big male that settled on a small bush in this thirty-foot area. These wasps seem to exhibit a sort of communal instinct for resting, just as do to a more marked degree many other species that gather in numbers on selected weeds or on suspended bunches of dry leaves.

It has been several times observed that certain large predaceous bugs (Reduviidae) in South America are when in flight very like, in color and appearance to some of the psammocharid wasps, and I was quite deceived for a moment by this mimicry? as practiced by a large yellowish brown bug, in the environs of Belem, Pará."

VI

PTEROMBUS, A WASP-ENEMY OF THE LARVA OF TIGER-BEETLES

Many of us know the ordinary tiger-beetle as an insect of great activity that frequents the sandy margins of streams and lakes or roadsides and races away on slender legs at our approach, to gain final safety by a low and rapid flight. Fewer have observed the neatly cylindrical burrows in which the curiously formed—one might almost say, deformed—larvae dwell. The life history of such a beetle is obtained only by patient observation, and Mr. V. E. Shelford (Journal of the Linnean Society, XXX, March, 1908, p. 157-182, Pls. 23-26) is one who has given us excellent biologies of several species of *Cicindela* that occur near Chicago, Illinois. Very briefly stated: the eggs are laid at a depth of some millimeters in open holes drilled in the soil by the female; the larvae hatch usually in about two weeks, enlarge and deepen these holes, pass through three stages and transform into pupae in cells in the ground, and finally emerge as adults. In *Cicindela purpurea* Ol., the larval life occupies about a year, and that of the adult ten months, making altogether two years between generations.

These beetles are very carnivorous, the adults securing their prey, which consists of other insects, in actively prowling about; the grubs, on the other hand, patiently await until some unwary creature passes over or near their burrows, when it is snatched up in their jaws and dragged down to be devoured. The family is adapted to a wide range of environment, and some are so modified in shape as to bear little resemblance to the ordinary type, known as *Cicindela*. The larvae show less modification among themselves than the adults, for they all appear to live in holes and to capture their prey in about the same manner.

Many Cicindelidae are brilliantly colored, some inhabit open country, while others prefer forest paths. The genera *Megacephala, Omus* and *Amblychila* are mainly nocturnal. Particularly in the tropics do we find species that live in the foliage of trees, with some that frequent the trunk itself, while certain others are said to be partial to the mounds of white ants.

Amblychila of the United States of America, and *Manticora* of Africa represent the largest members of the family; both are flightless, but *Manticora* is a very fast runner, and measures over 40 mm. in length, while *Amblychila cylindriformis* Say, is about 37 mm. long.

The larvae of tiger beetles are elongate, with the thoracic legs well developed; the head and upper side of the first segment are heavily armored and flattened above, and fitting together form a sort of circular disc that is held horizontally so as to block the mouth of the burrow; a pair (in the arboreal *Collyris* and probably others, a series) of hooks upon a hump on the back of the eighth segment helps keep the insect in place, aids in locomotion, and enables it to resist the struggles of a powerful insect it may seize in its sickle-like jaws. The tunnels which are usually very steep, may be 30 inches or more in length, as in *Amblychila cylindriformis* (Hungerford and Williams, Ent. News, 25, p. 1-9, Pl. 2, 1914); the larvae of the slender tree-inhabiting *Collyris* of the Orient are known to live in short burrows which they make in the pith of slender coffee

etc. twigs, and to dart out a short distance to capture their prey (Shelford, R., The larva of *Collyris emarginatus* Dej., Trans. Ent. Soc. London, 1907, Pt. 1, p. 83-90, Pl. No. 111.)

The enemies of the tiger-beetle larvae considered in this paper are solitary wasps that on biological grounds fit best among the Scoliidae. As far as known all the Scoliidae attack the larvae of beetles. The genus *Methoca* is wingless, slender, and ant-like in the female, and very active, but the American *Pterombus* Smith (=*Engycystis* Fox) while rather short-winged is quite similar in both sexes. Both *Methoca* and *Pterombus* attack the grubs of Cicindelidae in a similar manner and their larvae spin similar cocoons. From a standpoint of habits these two genera of wasps should be alloted to the same family, but the one has been placed sometimes with the Mutillidae, and sometimes with the Thynnidae, and the other among the Scoliidae and the Tiphiidae. If less stress were laid on the wingless condition of one sex, as occurs in the Thynnidae and Mutillidae, a more natural classification should result, inasmuch as the winged form is really the more normal and less modified of the two and therefore best suited for study from a standpoint of broad relationships.

Adlerz (La Proie de *Methoca ichneumonides* Latr. Arkiv. för Zoologi, 1903, Bd. 1, 255-258) was first to discover that *Methoca* parasitized the grubs of *Cicindela*. The writer has found other species in the Philippine Islands and in eastern and western United States that have similar prey, though the severity with which they paralyze the cicindelid and the position of the wasp's egg upon it may vary with the species. Obviously, the unusually slender forms of both *Methoca* and *Pterombus*, as well as their activity, are best adapted for attacking so well armed an insect as the larva of Cicindelidae.

Fewer than a dozen species of the rare genus *Pterombus* have been described.* They are American insects that are mainly tropical, though also occurring sparsely both north and south of the tropics—as in southern Brazil, Argentina and southern United States. They are comparatively small, shining wasps, whose rather short wings are usually barred with dusky, at least in the ♀, and with the abdomen often more or less red. Three species were taken by the writer in Brazil and one in eastern Ecuador. The habits of the Brazilian *Pterombus cicindelicidus* and *P. iheringi* were studied at some length.

Pterombus cicindelicidus F. X. Williams

The small city of Rezende is about 114 miles inland from Rio de Jeneiro and lies at an altitude of nearly 1300 feet above sea level. Less than half a mile away, situated on a little eminence, is a Government Agricultural Station. It was here on a warm sunny morning, on March 1, 1924, on bare clayey soil that *Pterombus* was first seen hunting her prey. She is a slender insect about 7 mm. long, shining black and red with the wings in fully matured ♀ specimens, marked with dusky. She runs over the ground in jerky fashion hunting for the occupied tunnels of larvae of *Cicindela,* two small species of which, 6.5 to 8 mm. long were present in the locality. She is a good flyer but does not appear to favor

*An excellent revision of the species of *Pterombus* has been published by Ducke (Revista do Museu Paulista, IX, 107-122, and Pl. III, Fig. 5, 1914).

that mode of locomotion, except in case of danger, when like some bethylid wasps she requires a moment to spread her wings before "taking off." Several females were captured that morning, and in the early afternoon the spot was again visited. A female was soon found diligently hunting. Almost immediately she discovered a cicindelid tunnel, and without premeditation plunged in until only the tip of her body protruded from the ground; perhaps she was appraising her prospective victim, at all events she soon disappeared below. After watching the tunnel for twenty minutes a small vial was placed over it and on my return a half hour later *Pterombus* was found therein. The tunnel was carefully dug up; it soon widened to perhaps twice its upper diameter and there, in upright position, at a little less than two inches below ground was a small immobile *Cicindela* larva about 11 mm. long, with the longitudinally-glued wasp egg stretching, a little to one side of the middle line, from the fifth to sixth segements beneath, as illustrated in Plate XXV, Fig. 211, for *P. iheringi.* The tiger-beetle larva eventually recovered very slightly so that it would flinch a little when touched. The duration of the egg stage was approximately 2 days and 8 hours, the larva crawling forward nearly out of the egg shell. As usual among solitary wasp larvae, it at first feeds externally (probably through a fine puncture) and its sucking efforts appear as concave movements of its soft head. An undulatory intestinal movement is also apparent. It soon assumes a salmon pink color, the head and thorax remaining much paler and glassy (Pl. XXV, Fig. 206). At the end of the third day the beetle larva is still alive and every now and again moves its thoracic portion complainingly. Shortly thereafter the wasp grub bites through the skin of its prey, inserts the thoracic portion within, where reaching about, rapidly sucks and chews it into a shrivelled skin, with the head and perhaps some other hard portions uneaten. The feeding stage is about 4 1/3 days, after which it spins a cocoon (Pl. XXV, Fig. 213) nearly 9 mm. in length that quickly turns to a light brown color and very much resembles the cocoon of *Methoca,* having the same flaring structure at its cephalic end, where likewise may be supported the hollowed-out head of the cicindelid. 22 days later this cocoon produced a female *Pterombus,* making the time from the laying of the egg to the eclosion of the adult, 29 days.

A further hunt on March 3, in the same locality revealed no more adults. It had rained heavily the night previous and the *Cicindela* burrows were nearly all stoppered up. By careful digging and chipping off a tiny earthen bank a number of tunnels were exposed. Several of these contained naked beetle pupae, as many, still immature adults, more with larvae in various stages of growth, and two were occupied by a cocoon of *Pterombus.* The burrows were but a few inches in depth and the wasp cocoons fastened to the walls, chiefly at the upper flaring end were about 1¼ inches below the surface; one had already hatched while the second produced a male on the following day.

Pterombus iheringi Ducke

The district about the city of Campinas, Sao Paulo, Brazil, is in a rolling prairie country two thousand feet or more above sea level, on the Serra do Mar (Sierra of the Sea). The soil is distinctly red (*Terra roxa*) and in large areas

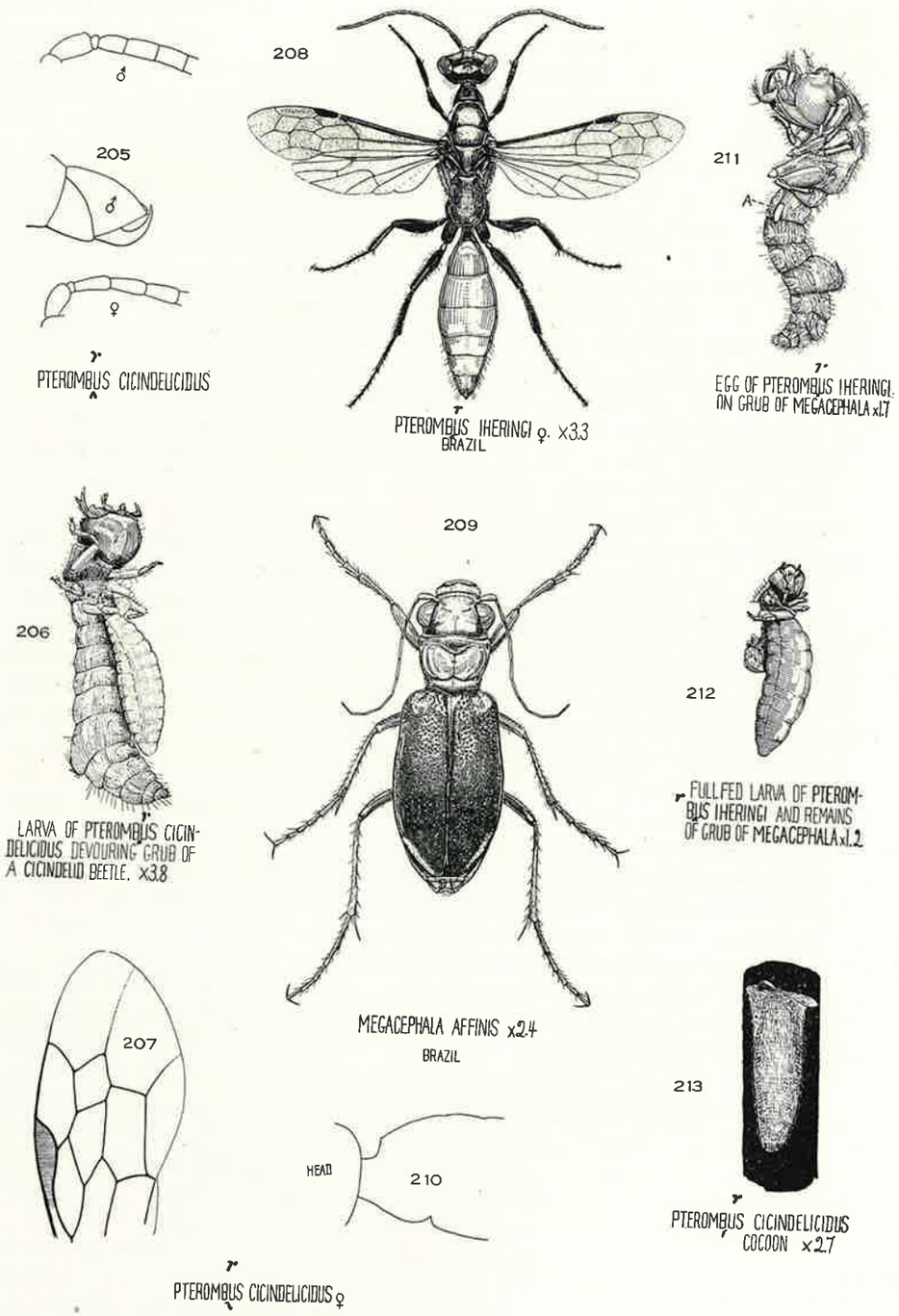


PLATE XXV

clothed with grass, shrubs, here and there a forest, and what is more important, with thriving coffee "fazendas" or estates. It lies but a short distance within the Tropic of Capricorn, although by reason of the elevation is in a temperate region. It is eminently suited to insects of many kinds, such as flies, bees and wasps, that are to be found chiefly along the growth fringing small water courses, in rather open forest paths, and on the various weed-flowers of the fields. Nearly all my work was confined to the Fazenda Santa Eliza, that belongs to the Government Agricultural Experiment Station. Two visits, one in February and the other in March, 1924, were made to this district.

Shortly after 9:00 A. M., March 17, I saw a large specimen of *Pterombus* (Pl. XXV, Fig. 208). She proved to be slightly over 15 mm. in length, with comparatively short though capable wings extending a little more than half ways down her polished red abdomen. She was running along a patch of hard red soil, evidently seeking her cicindelid prey. After nearly bottling her she took wing and was not seen here again for several hours. Then she approached a tunnel, felt over or near it with her antennae, but an active spider was within and she quickly drew back.

At 9:20 A. M. the following day a rather smaller *Pterombus iheringi* was found very near the locality of the first. She was a fast walker exploring the path and then a cleared space off to the side, but not entering weedy growth nor using her wings. Soon she came upon two or three holes, and with quickening antennae inspected them; then she located—it seemed through the sense of smell—a couple of cicindelid dwellings about 2½ inches apart. One of these was open, the second was filled almost or quite flush with the surface of the ground and their size showed that they were the work of large larvae, very probably that of *Megacephala* (*Tetracha*) *affinis** Dej. (Pl. XXV, Fig. 209), a nocturnal beetle about 18 mm. long with a green and black body and pale legs, and that could be found hiding during the day under the heaps of plant trash along the path. After cautiously inspecting the mouth of the open hole, she came over to the plugged one and commenced digging it out, but, as might have been expected at this critical time, along came an impudent *Ectatomma* ant** (Ponerinae) and frightened her away. It was then found necessary to drive off or kill these wandering ants so that the wary wasp might work undisturbed. *Pterombus* resumed operations, excavating steadily though rather slowly, evidently biting out the earth and backing up with a grain or two held in her mouth, aided perhaps by the fore legs. Thus she does not, like some of the more expert wasp diggers, throw out a stream of soil behind her with her feet. At the end of a half hour she had dug in 2/3 of her length; at this point I left, and on returning some 15 minutes later, saw that the wasp had already reached her prey and that a desperate struggle had ensued and was perhaps still going on, for in place of the excavation there was a small, and occasionally heaving heap of dark moister earth containing rejected portions of the prey of the beetle larva, now herself a prey of the agile wasp. The heaving motions presently subsided, but *Pterombus* was a long time at work below, and so the tunnel was dug out. It was plugged down to several inches; at 6 or 8 inches the wasp was found, and still a little

* Adult beetle identified by Dr. E. C. Van Dyke.
** Probably *Ectatomma quadridens* (Fabr.).

deeper, the nearly motionless *Megacephala* larva. This was 23 mm. long and bore no wasp egg, though it might well have been brushed off in the digging. Both wasp and prey were brought to the laboratory and the latter inserted into a crudely made hole in soil in a jelly tumbler. *Pterombus* again readily attacked the helpless larva, grasping it and administering several stings. This she repeated when her prey was placed in another hole. An egg was laid upon it and a cell formed; the poor *Megacephala* however, did not survive the numerous stings and soon decomposed. But other *Megacephala* larvae were available at the fazenda, where they dwelt in nearly vertical burrows, 8 or 9 inches deep, that bore a great likeness to the neat holes of the *Ectatomma* ant. *Pterombus* works well in captivity, and by placing the beetle grub in a hole made alongside the glass of the jelly tumbler, her methods could be easily watched. She enters the tunnel with or without noticeable caution, suddenly grasps the head end of her victim in her mandibles and immediately curves the abdomen under its throat or thorax and stings it to immobility. This procedure is similar to that of the wingless *Methoca*, though the latter may use more caution in her attack. Both wasps are provided with needfully long stings, for they have far to reach. *Pterombus* may now rest a moment, then she grasps the underside of her heavy prey in her mandibles pushing it upwards to near the top, in one case to the top, of the burrow so that perhaps after a failure or two it naturally suspends itself, limp and straight and out of the way of the wasp below that immediately sets about making the lower part of the cell. Bits of earth are gouged out from the sides and tamped down into the bottom with the extremity of her flexible abdomen. This requires but a short time, and soon she crawls on the venter of the *Megacephala* larva, pinches and arranges it, gets into position for egg laying; she feels about carefully with the sheath of her ovipositor, finds the proper spot and slowly walking forwards towards the top of the burrow and literally pulls away from the egg, which issues tail first. The wasp has squeezed herself past the head and thorax of her prey and now commences to plug up the burrow, biting off soil from the walls and tamping it down upon the armored part of *Megacephala*. This tamping is done not so much after the manner of certain Larridae, notably *Tachysphex*, which wriggles the abdomen, and vibrates the length of her body as a steam hammer; the process in the main is relatively slow, the abdomen of *Pterombus* elongates and telescopes, reaching out sideways and pushes and packs the soil almost as one might use the hand for that purpose. She also turns about, works the soil in her mandibles and pushes in with her head; her forelegs scrape off a little earth, but biting is the chief means of detaching it, and as the hole becomes more shallow she deposits pieces at the bottom but does not tamp down at the last. One such cell measured 20 mm. long, the plug 13, and the unfilled top 9 mm.

The paralyzed grubs, save for an occasional slight leg movement when disturbed, are quite motionless. Paralysis has retarded the metabolic processes, for the great, valved blood vessel along the back of the body that corresponds to the heart in vertebrates, pulsates on an average of only 12½ times per minute as compared to 30 beats per minute for a normal *Megacephala* larva. This greatly retarded metabolism is what makes the victim "keep" and thus in some measure it may be compared to a hibernating animal that never awakens.

The egg (Pl. XXV, Fig. 211), is glued near the middle line of the underside; it has a pale lemon yellow tinge, is moderately polished, slightly curved along its length, and thickest at the head end. It measures about 1.33 mm. long. It hatches in between three and four days; the larva feeds for nearly six more and is immediately well segmented; it moults several times and almost imperceptibly; on the morning of the fourth day it penetrates the body of its very feeble host, and later we may see its slender fore-part within, greedily snapping its jaws in devouring the tissues. The thoracic portion of the *Megacephala* soon becomes much shrunken and little food remains there, so the voracious grub attacks the other end, still plump, and devours nearly all the interior. She returns to the thoracic portion and at last can be seen with her head inside that of its host so that it appears to belong to her own body (Pl. XXV, Fig. 212). The full-fed larva is about 16 mm. in length; it spins a delicate web frame in which the cocoon proper is made; this is brown and also about 16 mm. long and in this unique individual lacks the flaring head end made from the looser outer structure, but is rounded at both extremities. Unfortunately the pupa was attacked by mould.

No further wasps of this species were obtained; but a single example of the smaller *Pterombus pilicollis* Ducke was captured May 26, 1924, some sixty miles from Belem, Pará, along the Bragança Railroad, whose sandy bed she was inspecting for cicindelid larvae. A single ♀ of *P. clavicornis* Ducke, was taken April, 1923, at Tena, eastern Ecuador.

Before concluding on the enemies of these beetle larvae, it would be well to mention the bee-fly (*Spogostylum anale* Say, Bombyliidae) parasitic on the larva of *Cicindela scutellaris* Say var. *lecontei* Hald., that has been studied near Chicago by Shelford (Annals Entomological Society of America, VI, 1913, pp. 213-225, 17 figs.). This fly has a shining velvety black body, with the wings partly blackish. The female oviposits when on the wing, touching the sand at 5 to 10 mm. from the burrow of the tiger beetle larva, the egg-laying thrusts being repeated a number of times. The young fly larva in some way reaches its host and attaches itself thereto, to the number of one or more and thus passes the winter. It moults three times on its active host, but does not make rapid growth until the latter has been in the pupal chamber for some time, and because of the disintegrating and building up process within its body, is almost motionless; the fly larva now casts its skin for the fourth time, moves lower down on the *Cicindela* and very quickly devours it and becomes full-fed. It soon casts its skin again to turn into an active bristly pupa with curved hooks on its crown. In due time it easily works its way out of the soil by means of these head hooks, its skin splits and the adult fly comes forth. Similarly parasitized *Cicindela* larvae are not uncommon about Boston, Mass.

Family Scoliidae

Pterombus cicindelicidus n. sp.

(Pl. XXV, Figs. 207 and 210, venation and profile of prothorax, ♀ paratype; 205 ♂ ♀ antennae and tip of ♂ abdomen.)

Female, type: Length, 8 mm. Moderately slender. Black; apex of scape and first portion of flagellum reddish, mandibles reddish, but pale creamy yellow exteriorly at

base, with a spot of similar color above their base on lower part of inner eye margin; apical portion of legs more or less reddish, abdomen except extreme base of first segment red, tegulae testaceous, venation brown. Clypeus well rounded out, polished and sparsely punctured except at the thin, finely opaque margin; antennal joints 3 and 4 subequal, antennal tubercles (sockets) rounded, a median line extending between them; eyes widely separated and gently converging above; frons polished, very sparsely punctured (as irregular lines of punctures); ocelli forming nearly a right-angle triangle; vertex sparsely punctured; neck of pronotum with some very fine transverse wrinkles, which are also present anteriorly and mesially on the disc of the pronotum just before the sharply raised margin; dorsum of thorax polished, with strong though sparse punctures; mesopleura duller and with separate punctures in a horizontally aciculate ground; disc of propodeum rather finely reticulate, excepting a basal area each side of aborted median carina, these areas being smoother and aciculate; pleura obliquely and irregularly wrinkled; posterior face separated from the dorsal by a sharp transverse carina, the face with coarser reticulations; wings bifasciate; third submarginal cell the smallest, the two recurrents received in each case well before the middle of the cells; abdomen rather depressed, petiole short and with remainder of abdomen shining, practically impunctate, pygidium with sides gently outbowed and delicately margined, the fovea just within the margins piliferous. Vestiture: rather sparse, silvery pile, with darker erect hairs on dorsum.

Male, allotype: Length, 8 mm.; rather like the female but more slender, hairy, and coarsely sculptured; antennae with shorter joints, wings clear, abdomen red from apex of second segment, antennae blackish, pilose, joint 3 much shorter than 4; clypeus gently bilobed at apex, rather heavily punctured to margin; frons with strong, rather sparse punctures; vertex almost impunctate; thorax with sparse though large punctures; pronotum without median sulcus before margin; disc of propodeum with some very large, irregular and well margined reticulations, a basal fovea, the area to either side with fine oblique striae, pleura with irregular and far less coarse reticulations and indications of oblique basal wrinkles, posterior face coarsely reticulate, separated from the dorsal face. Venation as in ♀; abdomen slender, aculeus rather stout.

Type and allotype reared; paratypes, 4 ♀ ♀, all from Rezende, Estado do Rio de Janeiro, Brazil, 1300 feet, March, 1924, (F. X. Williams). Apparently related to *Pterombus williamsi* Turner (1917), from British Guiana and which it resembles in color but differing in sculpture, etc.

VII

OBSERVATIONS ON SOME SOCIAL AND SOLITARY WASPS, AND ANTS

Gorytes brasiliensis Schuck.

There are many species of wasps that prey upon homopterous bugs. One such is *Gorytes brasiliensis*, a rather small blackish insect with the wings partly tinged with smoky and the abdomen narrowly banded with yellow. It is abundant in the environs of Belem, Para, nesting in banks of rich soil along the margin of the jungle. At Jabaty, some 100 kilometers from Belem, its short burrows were not uncommon in the masses of earth adhering to the roots of trees that had lost their balance in some storm and lay prone on the ground. Here a single *Gorytes* was observed flying to her cell carrying under her and rather astern an immature fulgoroid bug, with quite a snout and probably belonging to the genus *Dictyophora* (Dictyophoridae). A freshly stored burrow contained four of these young bugs and two issid bugs, also immature, and of, or near the genus *Thionia*, one of which bore the wasp's egg. Another cell previously examined was stored with five adult and one immature Issidae representing 2 genera, and 3 species. A species of Flatidae is also stored by this wasp. The prey was limp and sometimes capable of very slight movement. The single wasp egg was secured alongside the thorax so that it margined the basal portion of the forewings.* One of the bugs had upon it the white, mealybug-like larva of an epipyropid moth; the caterpillars of which are known to live externally upon various Fulgoroidea, feeding presumably upon their honeydew-like excretion or glandular products. A number of hatched and several unhatched cocoons of *Gorytes brasiliensis* were unearthed; these were more or less enveloped by the remains of the homopterous victims and consisted of a soil cask that was gently rounded at the fore end and more narrowed and drawn out a little, nipple-like at the base.

Cerceris eustylicida Williams,

A Weevil Enemy in British Guiana

There is much variation among the burrows of solitary wasps. Some dig holes that are nearly vertical, while other species make them with a very gradual slope. Then again we find large wasps like *Podium* excavating to a depth not exceeding two inches, or certain others going down as deep as four or five feet. *Cerceris eustylicida* is one of the profound burrowers. She is about 13 millimeters in length, dull black, with yellow marks, or the abdomen may be quite reddish. Like other species of this beetle-catching genus she lives in compact colonies, only one of which was found. This colony was discovered in late November, 1923, on Plantation Blairmont, one of the sugar estates on the coast lands of Berbice County, when a heavily laden *Cerceris* was observed flying to a shaded clay-and-sand slope adjoining a trench. The insect, which she grasped head-to-head beneath her, with its antennae in her mandibles, and some of the legs supporting its body, was *Eustylus puber* Heller, a pretty weevil about 8 millimeters long, with well developed wings, and a large part of its armor covered with metallic green scales. This weevil always occurred on a certain shrub, probably of the genus *Cassia* (Leguminosae), growing here and there in the open country along the trenches. It devours the tenderer foliage of the plant and deposits its flattish eggs in small batches in a neatly formed little pleat that extends to the margin of one of the young leaves. The egg stage was ascertained to be about 9 days, the grub on hatching doubtless falling to the ground, wherein it certainly passes the larval and pupal stages. The *Cerceris* colony was indicated by four or five considerable little mounds of soil heaps pierced by the burrows. The proprietresses were seen from time to time storing their burrows, rushing into its mouth with the weevil held beneath them. Following down the steep burrows gave unsatisfactory results; after digging to a depth of about 2 feet, the grass stem guide inserted in the *Cerceris* burrow was found to penetrate to the depth of a foot and a half more. Old cells and cocoons of *Cerceris* were found from a depth of about 2½ feet, but one burrow extended to a depth of 4 feet or more. The hard remains of weevils in the cells showed that in addition to *Eustylus*, a smaller brownish species was also stored and that this species and *Eustylus* were found sometimes to a total of 15 individuals per cell. The slender rather delicate cocoons have some loose outer silk and may be 21 millimeters long.

* Other species of Gorytidae prey upon bugs that make equally or more clumsy burdens; a larger species found in eastern Ecuador provisioned its cells in the sandy river shore with a large undetermined membracid or tree-hopper; while in North America, an Arizonan *Gorytes* preys upon *Cyrtobolus* sp., a membracid, shown in plate XXIX, fig. 219, bearing the wasp's egg, latero-dorsally upon the thorax.

Only female *Cerceris* were secured, being taken at large near the burrows and in the latter. The "Kop-kop" ant (*Ectatomma quadridens* (Fab.)) is the enemy of this and of other fossorial wasps of the neighborhood, in fact, I saw not far from this colony a species of *Cerceris* still feebly alive, whose antenna was grasped in the jaws of this bold ponerine ant.

This *Cerceris* settlement was investigated with the purpose of securing good cocoons to ship to the Hawaiian Islands, in hopes that the wasp might prey upon Fuller rose beetle, *Pantomorus godmani*, so common in the Archipelago.

The Architecture of Some Spider-Catching Wasps of the Genus **Trypoxylon**

These slender wasps all appear to be mud-daubers. A number of species utilize hollows in twigs, tree trunks, deserted mud nests of larger wasps, etc., which they partition off into cells. Other kinds, as many American forms exhibit more skill in nest building. Some of the larger black species make elongate mud tubes by building against stems, suitable rocky banks, walls, etc. Plate XXVI, Fig. 214, is from a photograph taken at Bucay, Ecuador, and shows a large colony of these mud nests, probably those of *Trypoxylon leucotrichum* Roh., obviously the work of many generations, on a rocky bank. = buchwaldi, see Richards, 1934: 351.

Trypoxylon fabricator Sm. builds a number of thin-walled little tubes set obliquely upon some surface, giving the whole group a communal aspect (Pl. XXXI, Fig. 224). Another small species constructs a nest often having a stalac-

titic effect; plate XXVII showing such an one (enlarged) depending from the trunk of a tree at Tumatumari, British Guiana.

Rhipiphoridae (parasitic beetles) were reared from the cells of a tube-making *Trypoxylon* in British Guiana.

Many species of *Trypoxylon* may build in houses.

A Few Social Wasps from Tropical South America

It must be admitted that a large percentage of the South American social wasps, particularly those of lesser size, or such as live in smaller communities, have a very considerate disposition, inasmuch as the naturalist in passing through the more open forest land may constantly disturb their nests or approach exceedingly near to them and still remain unpunctured. And so great is the number of species of these social wasps and so striking the variation among many of them that it has proved a rich though almost pardonable field for hymenopterological confusion. Nevertheless, a great deal of very excellent work has been done in the American Vespidae, both as regards the structure of the wasps themselves and in the plan of their nests.

The few notes that follow upon South American social wasps have been worked up from literature, particularly that of Ducke, Von Ihering and Saussure, and from materials gathered chiefly in Ecuador.

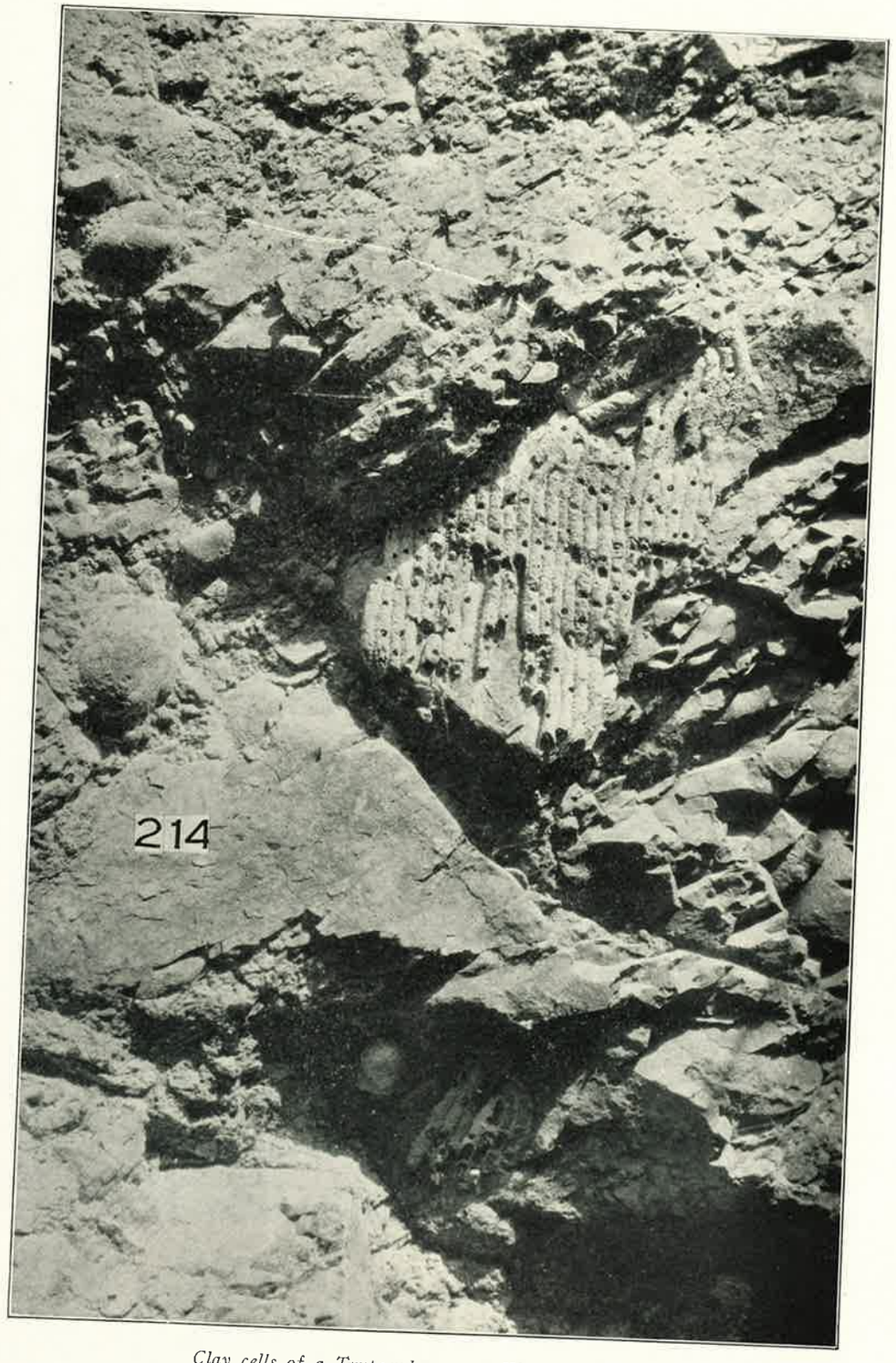
Plate XXVIII, Fig. 216, is a photograph of the nest of *Stelopolybia infernalis* (Sauss.),* a rather plain brownish species, 9-10 millimeters in length. The funnel-shaped nest-envelope which encloses two freely hanging, well-pedicelled tiers of hexagonal cells, 206 in this case, is thin and greyish white. I surreptitiously chloroformed what appeared to be the entire brood (249 wasps) but three or four individuals; however, some weeks later upon examining the *Heliconia* plant, whose particular leaf had borne the nest, it was observed that on the underside of another leaf about 2 feet away was a replica of the destroyed nest and with a good swarm of wasps upon it. This rebuilding of destroyed nests in practically the same spot is a common feature among many species of social wasps.

A nest, probably of *Stelopolybia,* figured (reduced) as unidentified, is to be found in De Saussure's monograph of Social Wasps (Atlas, Pl. XXVIII, Fig. 3, 1858).

Plate XXIX, Fig. 218, shows a small nest of *Polybia occidentalis** Oliv., a little wasp abundant in Ecuador. Here the paper covering also forms the outer side of the comb, whose cells except naturally these peripheral ones, are quite hexagonal. H. W. B. Moore (Timehri, III, 3rd Ser., p. 310, 1915, Georgetown, B. G.), records *P. occidentalis* as attacking *Eutermes costaricensis* Holmg., the common sugar-cane termite in British Guiana.

Plate XXIX, Fig. 221, shows a remarkable type, likewise from Tena, Ecuador. It consists of several small combs secured along the midrib of the underside of a leaf, with an extensive, flattish paper cover having the opening towards the apex of the leaf and whose margins approach that of said leaf.

* Identified by Dr. J. Bequaert.



Clay cells of a Trypoxylon wasp, Western Ecuador.

PLATE XXVI

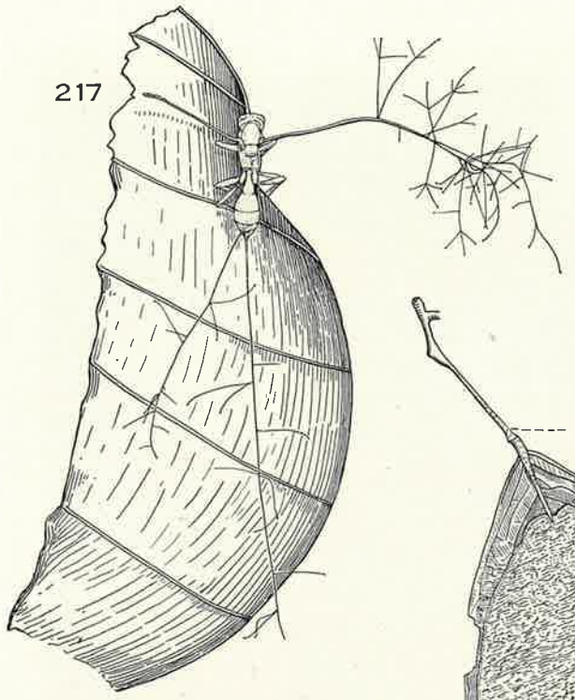
TRYPOXYLON NEST FROM BACKWOODS OF BRITISH GUIANA.

PLATE XXVII

Nest of Stelopolybia Infernalis, under Heliconia leaf, Eastern Ecuador. × .417

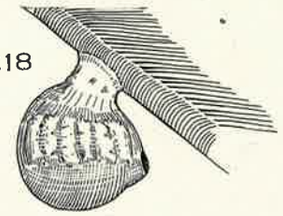
PLATE XXVIII

217



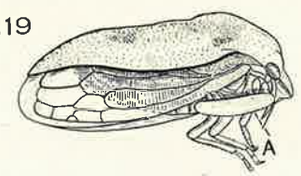
POLYBIA WASP KILLED BY A FUNGUS.
ABOUT X .83

218



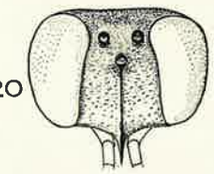
NEST OF POLYBIA OCCIDENTALIS
x 1.

219



MEMBRACID BUG CYRTOBOLUS SP. BEARING THE EGG OF A GORYTID WASP AT A. X 5.

220

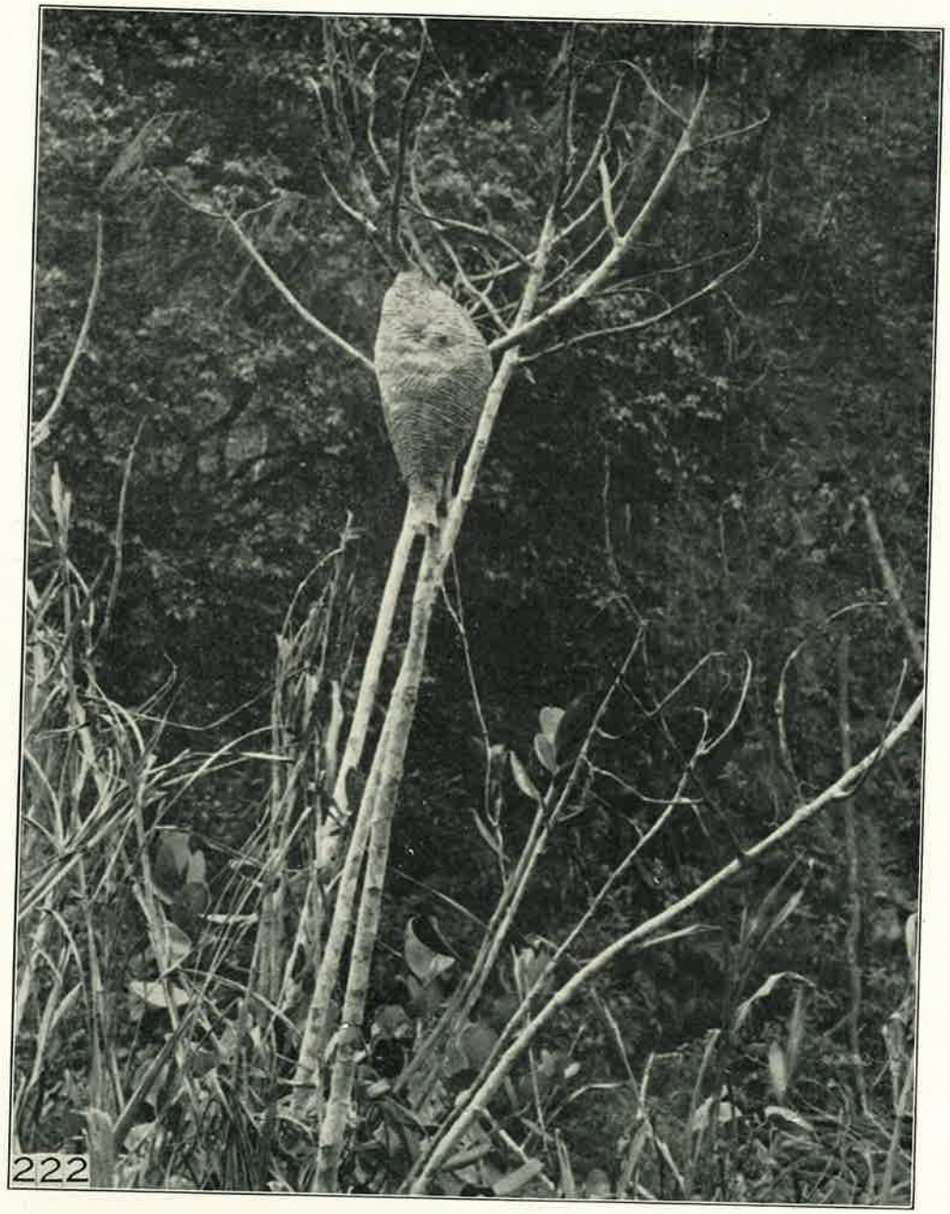


RHINONITELA GUIANA
VERTEX INCLINED FORWARD.

221

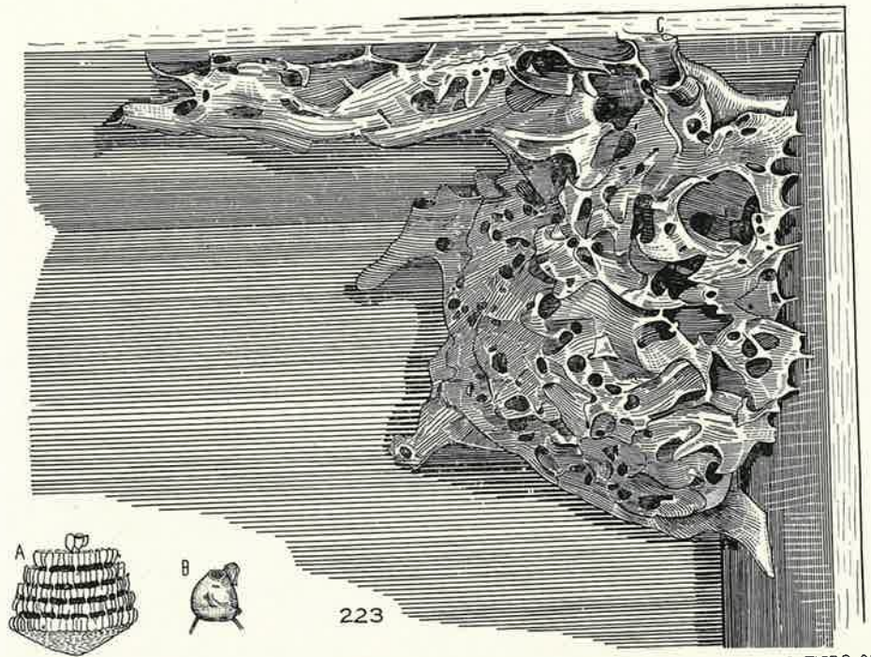
NEST OF LEIPOMELES LAMELLARIA WITH FOUR GROUPS OF CELLS. CELL GROUP AT A.
$\times \frac{1}{2}$

PLATE XXIX

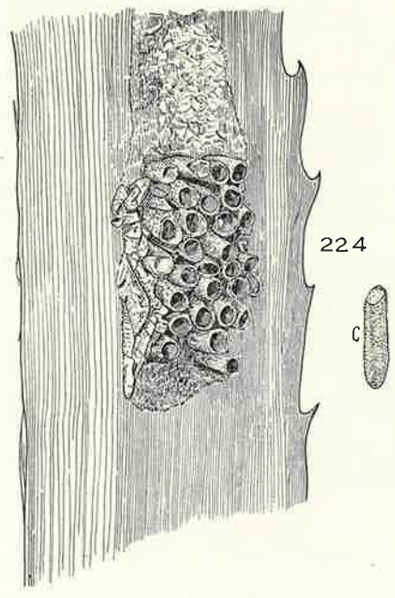


Paper nest of Parachartergus Apicalis. Western Ecuador.

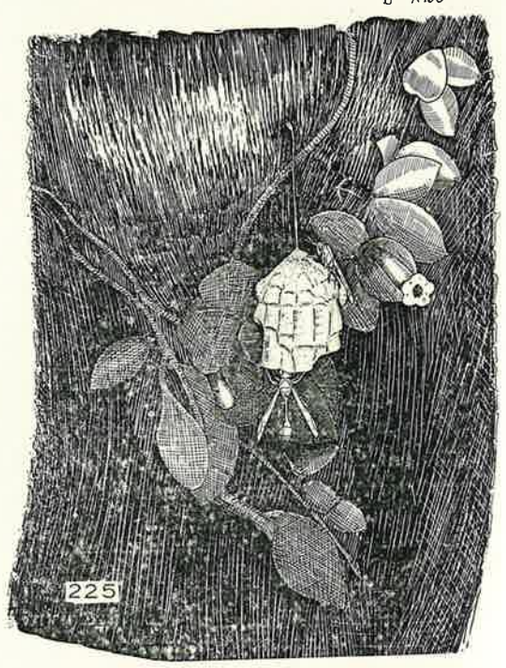
PLATE XXX



WAX NEST OF THE SOCIAL BEE, TRIGONA JATY. A, UPPER TIERS OF BROOD-CELL COLUMN; B, POLLEN POT; C, NEST APERTURE. ABOUT X .42, B- X .60

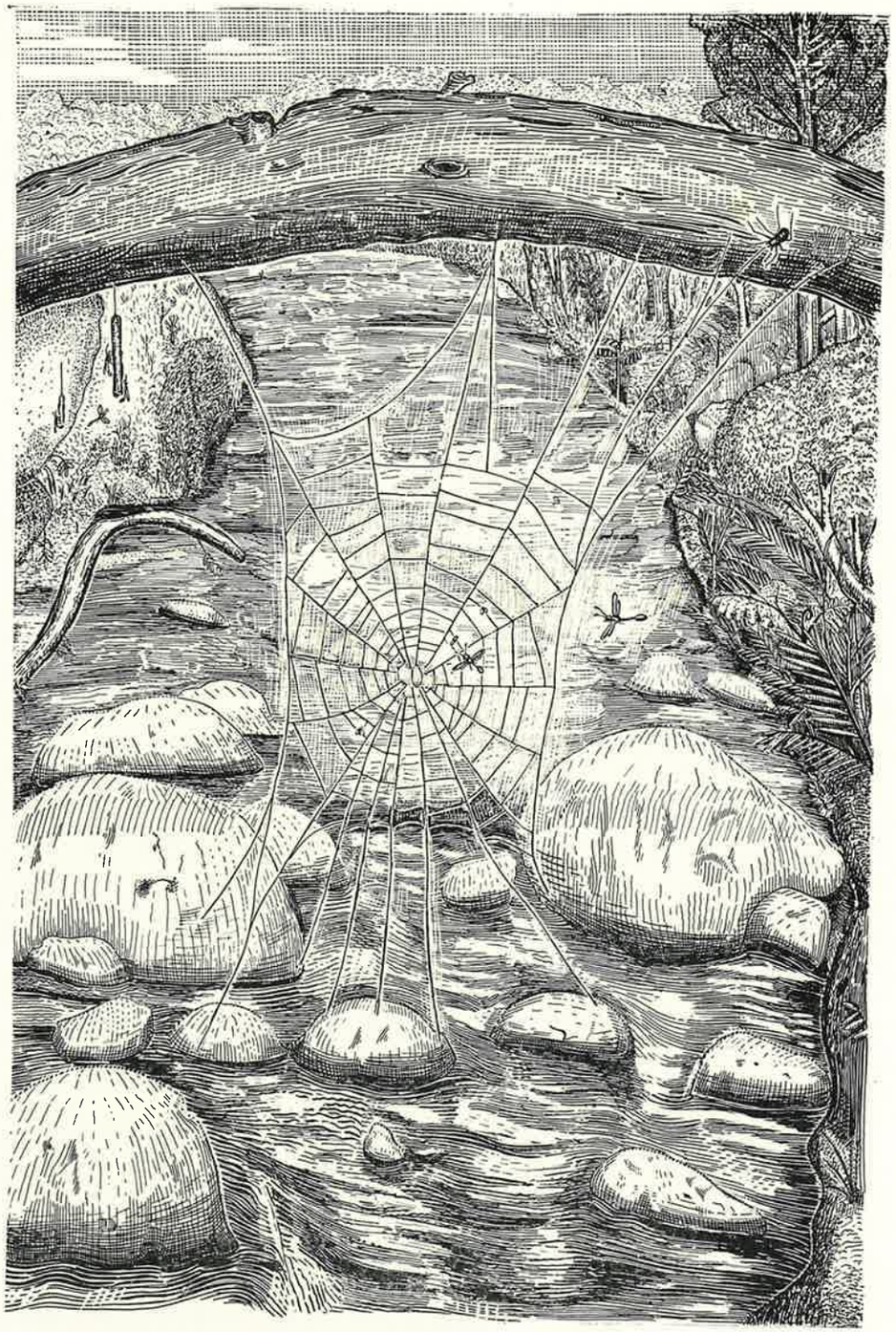


MUD CELLS OF TRYPOXYLON FABRICATOR ON UNDERSIDE OF AN AGAVE PLANT LEAF. DETACHED CELL AT c. x.83



NEST OF MISCHOCYTTARUS LABIATUS ON TREE TRUNK. x .60

PLATE XXXI



226

STENOGASTER DEPRESSIGASTER

TWO OF THESE PHILIPPINE WASPS ARE ROBBING THE SPIDER'S WEB OF THE LITTLE GNATS ENTANGLED IN IT. AT THE UPPER LEFT ARE TWO OF THE WASPS' NESTS.

PLATE XXXII

Several more or less complete oblique streaks of darker shade suggest that the diminutive architects, *Leipomeles lamellaria** Moeb. endeavored to imitate the venation of the leaf. The shrub upon which this nest was found had a number of leaves but only that one under whose surface the nest was appressed was the petiole covered with a sticky substance, making an efficient ant guard. R. von Ihering (Revista do Museu Paulista, VI, Pl. VI, Fig. 8, 1904), in "As Vespas do Brazil", figures a nest of this species.

Plate XXX, Fig. 222, shows the handsome, transversely-ribbed paper nest of *Parachartergus apicalis* Fab., a stoutly-made black *Odynerus*-like wasp with white-tipped wings. The locality is Naranjapata, Ecuador, 1850 ft. on the western slopes of the Andes. Upon this nest a large chalcidoid (?) wasp was noted walking about and probing through the paper with its long ovipositor. Nearby many *Parachartergus apicalis* were observed thickly gathered on twigs that were infested with numerous young tree-hoppers (Membracidae). The honey dew secreted by these bugs was evidently the attraction.

Plate XXIX, Fig. 217, shows a large species of *Polybia* that has been killed by a fungus, the latter branching out fantastically from its host which in its death pose holds desperately by legs and jaws to the leaf upon which it is pictured. Saussure, 1858, Pl. V and XI, figures two social wasps, one an *Icaria* and the other a *Polistes* that have succumbed to an ailment quite comparable to the above.

Mischocyttarus labiatus Fab.

We find in *Mischocyttarus,* a slender, reddish brown wasp about three-fourths of an inch long, that according to my observations, is possessed of a very gentle though unafraid disposition. In some ways it suggests a relationship with the dainty *Stenogaster* of the Oriental regions, but this is a mere parallelism of habits and of architecture, for structurally the two genera are well removed. Rather is it related to the *Megacanthopus* and to the Ethiopian genus *Belonogaster,* belonging to the subfamily Epiponinae. The wasp is widely spread in tropical America and as far as noted inhabits the more open country where the trees have been thinned out and it even ventures to construct its nest on the outer parts of buildings. It is probable that a single female commences the original nest (monogamous species); the pedicel by which it is hung is slender, almost thread-like, and sticky, and made of a brown gum-like material; it may be only three or four millimeters long, as when the nest is suspended from the tip of a spine on the stem of a palm tree, or twenty-five millimeters or more in length as when fastened to the underhanging part of a tree trunk (Plate XXXI, Fig. 225), or under a fence rail, beam, etc.; the cells are hexagonal, often imperfectly so, and made of fine bits of old wood, bark, material used by termites in constructing their runways, etc., chewed up and fastened together with a salivary fluid. The full-fed larva caps its cell with a bulging hemisphere of whitish silk. The nests are never large and could not be, as built; I have seen twelve individuals at one time on a good-sized nest which may be made up of 50 or more cells. It may be that there are several fertile females on the larger nests. Very little was

* Identified by Dr. J. Bequaert.

observed concerning the food habits of *Mischocyttarus*, but near the city of Rio de Janeiro, Brazil, it was found to have much the same hunting habits as the Philippine *Stenogaster,* in examining the orbs of spiders and robbing them of their smaller entangled prey. Their nests recall in the slender pedicel and slight form, that of *Stenogaster;* the flight of *Mischocyttarus* however, is very different, lacking the dart and poise of the Oriental genus. They are very mild insects and when on the nest may be poked with the finger, upon which one will sometimes leisurely crawl. In common with many other species of social wasps they will rebuild in, or nearly in the same spot when their nest is destroyed.

An excellent colored figure of *Mischocyttarus labiatus* and its nest is given by Saussure (Monographie des Guepes Sociales, Pl. III, Atlas, 1853-58.)

Stenogaster (Ischnogaster); from the Philippines

These wasps are par excellence dwellers in the forest. Of slender and graceful form and possessed of an architectural ability perhaps unexcelled among other insects, their shy and retiring habits seldom bring them within the ken of the layman; yet they are abundant in their proper environment and offer a study of habits and relationships replete with interest—their frail and exquisite nests, the gathering of food, and the apparently intermediate position they occupy between the social and solitary wasps. For so compact a genus their nests are rather varied; all have thin walls and seem to be composed of fine particles of decayed wood or of soil glued together by the wasp's saliva; for the most part they are suspended, as very slender structures of few to many cells (*Stenogaster timidus* Williams, *S. depressigaster* Rohwer, etc.), or as a pear-shaped nest (*S. micans* and var.), from some bank or boulder, by a delicate fern frond, slender rootlet, or by one of the thread-like "horsehair blights", *Marasmius* sp. of the Agaricales; at least one species (*S. varipictus* Rohwer), however, pastes her cells for their length to a properly inclined leaf, tree trunk or rock. Elsewhere (Bull. 14, Ent. Ser. Exp. Sta., Hawaiian Sugar Planters' Association, p. 166-176, 8 figs., 1919), are given a few details on the habits of four species occurring on Mount Makiling; to these are appended further notes from observations made in 1920-1922.

Collecting food for the young grubs. Most wasps of our acquaintance that feed their young from day to day, and this includes social wasps and a comparatively small number of solitary ones, use rather gross victims, such as houseflies and larger flies and caterpillars, usually chewed up into a palatable pulp, for this purpose; it seems however, as if nature had ordained that the dainty *Stenogaster* should feed her offspring on a food of dainty character, the fragile and tiny midges that sometimes attracted to the decaying prey in a spider's orb are themselves ensnared among the threads, but because of their diminutive size fail to draw the spider's attention. An orb-web stretching perhaps just over the turbulent waters of a mountain stream (Pl. XXXII, Fig. 226), with the fine guy ropes secured to convenient boulders, branches, etc., and the spinner herself in the center of her web or off to one side of it, is quite likely to be visited by one or more species of *Stenogaster.* Such a wasp in quest of food carefully goes over the web, alighting thereon not at all; if it is inclined from the vertical she

examines it from beneath, picking out with her mouth and feet the tiny morsels, which are detached from the web, with a jerk that often arouses the spider. Two larger flies that I threw in a web failed to interest the wasps. This midge-picking habit is true of several species of *Stenogaster,* and was observed on Mount Makiling and many miles east of it, in the Tayabas forest. Not being so dependent as many other wasps upon the sunlight, these insects make the most of the day, for they were noticed in early March, at 6:25 A. M., and then again at 5:30 P. M., in a canyon examining spider webs.

The *Stenogaster* grub is fed from day to day—indeed a bountiful supply of food awaits its birth from the egg, being heaped upon the latter as a globule of semi-transparent milky white jelly. The egg is gently curved and in the case of *S. varipictus* measures about 3 millimeters long by 1 thick, and is secured to, and even raised a trifle from the bottom of the cell at the middle of its outcurved surface, with a little adhesive matter. This food globule it will be noticed, is of a slightly different shade nearest the egg, suggesting that the new-born larva requires at first, nourishment of a finer quality; it is otherwise quite uniform in consistency and color and rather difficult to reconcile with masticated and probably regurgitated midges. A fair-sized globule is of course, the result of several collecting trips by the mother. The bringing in of the food was observed with the semi-social *S. varipictus* that for many years have constructed their cells against the buttressed side of a large "Dao" tree (*Dracontomelum dao*) growing alongside the excellent trail leading to the summit of Mount Makiling. Small groups of cells were pasted about an area, mostly out of reach, on this tree, and presently to one of these cell-groups upon which was perched a single wasp, I saw a laden *varipictus* fly. She carried in her mandibles a conspicuous load of whitish substance, and on alighting with it was approached by the second wasp that grasped the load so that it divided, each wasp now choosing an open cell and inserted head and fore part of the thorax therein and in a short time backed out disburdened. The food material as found upon the lap of a large *varipictus* grub was an aggregate of sticky little white spheres reminding one somewhat of snail's eggs. But it was usually found to be a solid mass so that the newly hatched larva partly imbeds and curls itself about its periphery and devours it. At full growth the larva spins no cocoon.

The species of *Stenogaster* may be quite heavily parasitized in the larval state by ichneumonids of the genus *Theronia,* which genus also may be bred from the cells of large Philippine *Eumenes.* The wasps of the genus *Theronia* seem to have a wide range of hosts—many preying upon lepidopterous caterpillars, *Theronia fulvescens* Cress. for example, is an important check on the Pine Butterfly (*Neophasia menapia* Felder) that sometimes severely damages pine forests of the Northwestern United States (Evenden, J. C., The Pine Butterfly, *Neophasia menapia* Felder, Journ. Agric. Research, XXXIII, No. 4, 1926).

The Ponerine Ant, **Odontoponera transversa** Smith, in the Philippines, Preying upon Termites or "White Ants"

Odontoponera transversa Smith, is a large reddish brown and black ant 8 or 9 millimeters long and with the head and thorax beautifully sculptured in fine, close-set parallel striae, that nests as rather small colonies in neat, more or less

vertical and often exposed holes in the ground. It is a common insect about the College of Agriculture at Los Baños, and although possessed of a rather powerful sting has a timid rather than an aggressive nature. Its fondness for termites or white ants soon becomes evident to those who study its habits. Wheeler and Chapman (Philippine Journal of Science, XXVIII, p. 62, 1925) state of this species that: "It is especially fond of termites and is often seen raiding their colonies."

During February and March, 1921, a few observations were made on this ant at the Los Baños College of Agriculture. Some termites had built covered runways of frass along a tree trunk to the ground; at the top, however, they had met with an accident for workers were busily engaged in repairing these tubes. Several species of ants were present on and about the tree trunk, but only one species, *Odontoponera transversa,* was really interested in the termites; these they would seize without any preliminaries, at the broken coverway, grasping them about amidships—as they faced forwards or backwards—and bear them away to their tunnel. Frequently coming upon a closed coverway the ant would bite a hole through the roof and entering at times quite out of sight would back out with a termite in its jaws. But one is impressed with the fact that *Odontoponera* strives to grasp its prey suddenly and thus by surprise, so that it may have no opportunity of defending itself; this defense under timely warning is done with telling effect; the termite becoming aware of its enemy faces it and jerks its body longitudinally back and forth and expels from its head a secretion of evidently very repugnant nature, for the ant that has faced this attack retires thoroughly beaten and indeed, at times and in some manner, quite crippled. Under favorable conditions, however, *Odontoponera* successfully grasps both soldiers and workers. An unbroken coverway may nevertheless form a fairly effective barrier against *Odontoponera transversa,* whose small colonies do not seem equal to the task of holding any of these exceedingly numerous termites in check. When a flight of termites takes place, as was noticed late one afternoon in the case of *Microcerotermes, Odontoponera* captures many winged forms about their carton nest.

Dr. Bequaert (Ent. News, XXXVI, p. 294, 1925) in reference to two large termites, *Syntermes grandis* (Rambur) and *Syntermes braziliensis* Holmgren, Brazilian species, writes as follows: "I also observed a column of the large ponerine ant, *Neoponera commutata* (Roger) (Identified by Prof. W. M. Wheeler) preying upon these termites, apparently attacking the workers only, of which they carried off many individuals. Soon after the ants appeared on the scene, the termites withdrew completely under the ground."

Ectatomma quadridens (Fabr.), a bold inquisitive ponerine ant, the "Kop-kop" of British Guiana is recorded by H. W. B. Moore (Timehri, III, 3rd Ser., p. 310, 1915, Georgetown, B. G.) as preying upon *Eutermes costaricensis* Holmg., the common sugar-cane termite, when the latter is swarming.

Megaponera foetens F. is a redoubtable termite raider in Africa.

Notogonidea lutusator n. sp.

(Plate XXXIII, Fig. 233, clypeus, ♀; 234, venation, forewing; 232, pygidium, type; 236, armature and last visible ventral segment, ♂ allotype.)

Female, type: Length 10.25 mm. Black; the mesonotum well polished; wings rather infuscate, with violet reflections; produced portion of the clypeus emarginate mesially, and from this emargination sloping almost as straight lines to the obtuse lateral angles, whence and towards the eyes it is shallowly transversely grooved; the edge of the clypeus is rather widely polished, with a few scattered punctures and is not beveled; before this polished part there are some sparse punctures of large size, while the main disc is rather closely punctured before this; mandibles unidentate within before middle; antennal joints 3 and 4 subequal; interocular space at vertex a little greater than antennal joint 3; face and vertex with very fine punctures; mesonotum with fine, well separated punctures, somewhat sparser on the polished pleura; disc of propodeum rather dull, with a combination of very fine transverse wrinkles and shallow punctures; median carina nearly or quite obsolete (to quite strong in some paratypes, though not extending to apex) and more or less replaced by a shallow sulcus, pleura polished and with very fine, well separated punctures, posterior face with a rather deep sulcus without differentiated margins and narrowly V-shaped at upper end, the face with fine punctures and fine side wrinkles; metatarsus not strongly carinate for the genus; wings with abcissae in the following order of increasing length: 2, 5 and 3 (more or less equal), 1 and 4; the marginal cell (=5th abcissa) squarely truncate, the two recurrent veins very proximate on cubitus; abdomen with a moderate carina on basal part of second ventral segment. Three rather dull and incomplete silvery sericeous bands on abdomen, pygidium rather dull, 1½ times or more longer than its greatest width, its margins gently arcuate; the disc mostly naked and punctured mainly at the sides and apical half, where it is rather thinly clothed with some appressed golden pubescence and sparser erect hairs. Vestiture elsewhere: silvery pubescence on face, thorax and legs, but only somewhat conspicuous on face, and with a faint golden tinge.

Male, allotype: Length 8 mm. Much like the ♀, though slightly more pilose; mandibles not toothed within; produced portion of clypeus rather narrow, well rounded out and entire, transversely grooved or depressed on either side to margin and not beveled and with but few punctures for its lobate part; before the lobe it is closely punctured; third antennal joint short, noticeably shorter than fourth; interocular space at vertex about equalling antennal joints 3+4; disc of propodeum polished, with the transverse wrinkles stronger than in ♀, with no median carina and hardly a sulcus, the pleura polished and with very fine scattered punctures; abcissae of wings in following order of increasing length: 5 and 2 subequal, 3, 1 and 4; abdomen with last visible ventral segment rounded out at apex; armature somewhat like that of *Larra;* sagittae long, delicate and strap-like.

Type, Tena, Oriente Province, Ecuador, 1,850 feet, February, 1923; allotype Naranjapata, Occidental Ecuador, 1850 feet, December, 1922; paratypes 6 ♀♀, 2 from Bucay, Occidental Ecuador, 1,000 feet; October, 1922, and 3 from Tena, Oriente, 1850 feet, February, March, April (F. X. Williams).

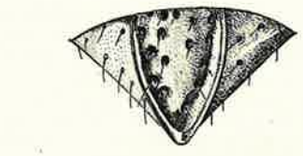
There is some variation in size, i. e., ♀♀ from 8.75 to 10.50 mm., and the disc of the propodeum is more coarsely wrinkled in some cases and also may be carinate for 2/3 its length in the paratypes.

Named for its mud-daubing habit; and while it was not an infrequent visitor to a certain forest trail, I could not follow its swift flight to the nesting site.

Tachysphex vitiensis n. sp.

(Pl. XXXIII, Fig. 231, pygidium)

Female, type: Length, 10 mm. Black; mandibles somewhat reddish at apex, wings rather infuscate; produced portion of clypeus subtruncate, gently notched mesially; two low lateral teeth, including the angle, a strong, polished though rugulose bevel; extending to the thin marginal strip, the disc of clypeus sparsely punctate, the punctures near the bevel large; antennal joints 3 and 4 subequal, 2 + 3 very little less than interocular space at vertex; face and vertex with fine, well-spaced punctures and an exceedingly fine interreticulate effect; scutum with an anterior median depression, rather sparsely punctured in the middle of disc; scutellum with fewer punc-



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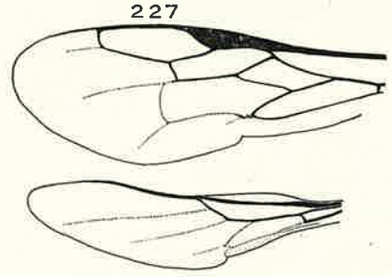
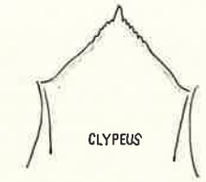


ANACRABRO CIMICIRAPTOR ♀



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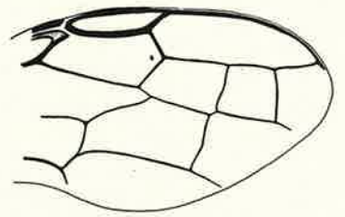

STENOGASTER TIMIDUS ♀TYPE

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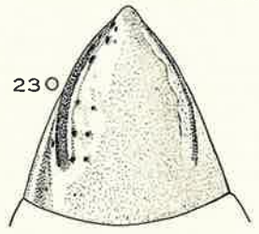
CERCERIS EUSTYLICIDA ♀



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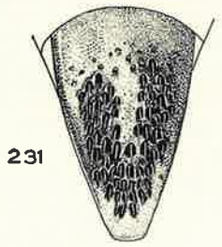
LARRA ALTAMAZONICA ♀ TYPE



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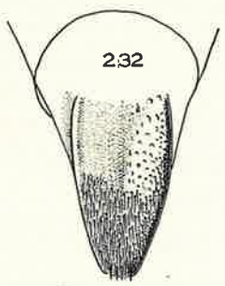
TACHYSPHEX VITIENSIS ♀ TYPE



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NOTOGONIDEA LUTUSATOR ♀

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NOTOGONIDEA LUTUSATOR ♀ TYPE

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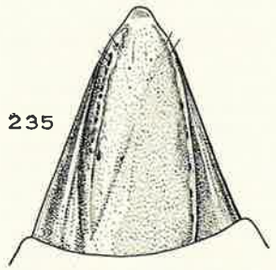
NOTOGONIDEA LUTUSATOR ♀ TYPE



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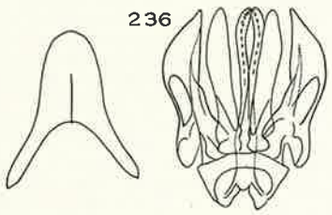
LARRA AETHIOPS ♀



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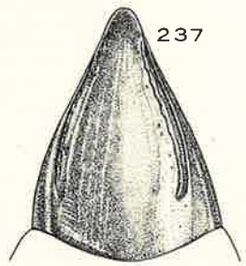
NOTOGONIDEA LUTUSATOR, ♂ ALLOTYPE



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LARRA SCAPTERISCICA ♀ PARATYPE

PLATE XXXIII

tures, pleura mainly with an exceedingly fine reticulate effect; disc of propodeum wrinkled-reticulate, pleura with fine and close subvertical wrinkles; posterior face transversely wrinkled-reticulate and with a median fovea; tarsal comb (on basal joint of six or more bristles—the specimen is somewhat worn—; wings with a narrowly truncate marginal cell and with the abcissae in the following order of increasing length: 5, 3, 1, 2 and 4; 1 and 2 being nearly equal, and 4 equal to 2 + 3; abdomen shining, pygidium about 1½ times as long as greatest width, the margins slightly outbowed, the apex subtruncate, the disc shining and with coarse piliferous punctures, the pile rather coarse and brown. Vestiture: a little silvery pile on lower part of face, sparse and fine erect hair on head and thorax and legs, this often as long as greatest width of first antennal joint.

Type 1 ♀, Suva Bay, Viti Levu, Fiji Islands, July 13, 1923 (O. H. Swezey). In the collection of the Bishop Museum, Honolulu.

This species is noteworthy in that the disc of the pygidium is provided with fine bristles.

Rhinonitela guiana n. sp.

(Pl. XXIX, Fig. 220, head, obliquely from above to show fronto-clypeal carina.)

Female, type: Length, 3.5 mm. Rather slender, and dull except for the shining abdomen. Head black, with the antennae, apex of rostrum, clypeus and mandibles mainly pale yellowish brown, the slender palps still paler; pronotum and first pair of legs pale yellowish brown, mesothorax deeper brown but broadly blackish mesially and on hind edge of scutum and beneath; tegulae, scutellum and metanotum pale yellowish brown, meso-and metacoxae, trochanters and tarsi almost whitish, the femora and a portion of the tibiae smoky brown; wings with the venation pale and with a couple of very approximate brown blotches, the upper centering on the interrupted cubitus of the first submarginal cell; propodeum black except stigmal areas; abdomen black and brown. Clypeus produced into a beak or raised lamellate carina which thickens out lobe-like along the front margin and is continued on the frons as a single elevated line to the fore ocellus; no carinate inner eye margins nor transverse frontal carina as in *R. domestica* of the Philippines; antennae with joints 2, 3 and 4 subequal and individually longer than the following; and together a little more than interocular space at vertex; ocelli practically in an equilateral triangle; head delicately reticulate, thorax finely roughened except portion of the pleura; disc of propodeum rather coarsely reticulate, the sides and posterior face more irregularly so; wings rather short; venation much as figured for *R. domestica;* marginal cell quite narrowly truncate at tip and weakly appendiculate; abdomen smooth and polished, apex pale brown, no defined pygidial area. Vestiture: mainly sparse pale pile.

Type 1 ♀, Blairmont, British Guiana, October, 1923 (F. X. Williams).

Anacrabro cimiciraptor n. sp.

(Pl. XXXIII, Fig. 227. pygidium and venation)

Female, type: Length, 7 mm. Stout; coarsely punctured. Head not as wide as mesothorax. Black, with yellowish as follows: upper part of scape, apex of fore femora, fore tibiae and part of middle and hind tibiae, fore tarsi, more or less, posterior (raised) part of pronotum, except mesially, metanotum, four spots near apex of first tergite of abdomen and a spot laterally from 2-5 inclusive; mandibles brownish in the middle, tegulae in part brownish yellow. Clypeus with its sharp margin gently rounded out, a little notch on each side formed by a tooth and the lateral angle, the beveled part to margin smooth, polished and impunctate, raised and broadly wedge-shaped towards its base; mandibles not toothed at apex; antennae well separated at the base, clavate; joint 2 longer than 3 which is about as long as 4; eyes diverging towards vertex; ocelli in a low triangle, the anterior separated from the posterior by a little less than its diameter, and with a grooved line from it posteriorly; frons grooved down the middle, upper portion moderately and the vertex coarsely punctured, a strong occipital margin and another carina just behind eyes, and a shorter one posterior to this from the base of the mandibles; pronotum exceedingly fine reticulate, mesothorax coarsely and irregularly but separately punctured; metanotum smooth; propodeum short, dorsally with a transverse row of cell-like reticulations, posterior face with fine recticulation above and with a smooth median V-shaped fovea; venation (Fig. 227); fore femora flattened, broadest in repose fitting into the smooth and well margined

mesopleural area (epicnemium); abdominal tergites for the most part strongly though separately punctured; pygidium (Fig. 227) polished with a few strong punctures chiefly towards the sides. Vestiture very sparse silvery pile.

Type and 2 paratypes ♀ ♀ from Campinas, Sáo Paulo, Brazil, March, 1924 (F. X. Williams). Stores bugs of the family Miridae (= Capsidae).

Cerceris eustylicida n. sp.

(Pl. XXXIII, Fig. 229, clypeus and pygidium, ♀)

Female, type: Length, 14 mm. Black, with yellow as follows: a wedge between the antennae, large spot on disc of clypeus and on either side, small one on outer base of mandibles, spot on each side of scutellum, the metanotum, spot each side posterior face of propodeum, apical margin of fore trochanters, middle coxae in part, stripe at apex of middle femora outside, posterior coxae, trochanters and femora in part, wide median pre-apical spot on each side (but often fused as a band) on first abdominal tergite, and one on side, and yellow also on venter (sternite) of 1 and 2. Reddish brown as follows: extreme tip of antennae, discal apex of posterior femora, a faint pre-apical band on tergites 2 and 3, and the margin of the dorsal tergites in part and the disc of the well-margined pygidium. Fore wings strongly and broadly infuscate on costal margin. Puncturation of rather large, close-set, often confluent (on head) deep punctures. Clypeus with a moderate median tubercle, raised slightly before the anterior margin, which is tridenticulate mesially and with a lateral, obliquely truncate tooth; mandibles crenulate on inner border into three low teeth; antennal joint 3 longer than 4; eyes slightly converging towards vertex; ocelli forming a low triangle, the anterior a little less than its diameter from the others; a frontal carina between the antennae not extending to clypeus, scutellum with sparse large punctures; disc of propodeum with a smooth triangular area obliquely carinulate on either margin and with a median impressed line faintly continued into the impressed line of the posterior face; apex of posterior femora with its disc delicately rugulose; wings with first recurrent joining the second submarginal cell very near its middle, the second recurrent near the base of the third submarginal; pygidium very shallowly emarginate at apex, the disc closely and rather coarsely and irregularly punctured except along apical margin where there are some more or less ill-defined preapical parallel wrinkles.

Type and 12 ♀ ♀ paratypes, from one colony storing *Eustylus puber* and another weevil; Blairmont, Berbice Co., British Guiana (F. X. Williams). The red phase and some of the black ones have a pair of wide pronotal spots, one each side of mesopleura, a small superior one on posterior face of propodeum, and the abdomen mainly reddish with a preapical yellow band on tergites 3 and 4 and partly on 5.

Methoca debilis Williams

(Text fig. 14, head from above)

Williams, F. X., Ent. Bull. No. 14, Experiment Station, Hawaiian Sugar Planters' Association, p. 41 and 42, Fig. 11, ♂, 1919.

Female: Length 4 mm. Polished black; antennae, mandibles, first thoracic node very slightly, and nodes 2 and 3 (3 = propodeum) mainly brownish, tip of abodmen pale brown. Slender and almost without punctures, of which there are a few rather large ones on head and thorax; head about twice as wide as thorax and moderately extended though not gibbous behind the eyes. Mandibles with the inner tooth the shorter; clypeus with the produced portion subtruncate, brownish and not thin nor differentiated from rest, gently and transversely arched; frons without bituberculation near base of antennae, and well furrowed by a line from the clypeus to the anterior ocellus; eyes large and rather proximate, slightly diverging towards clypeus; ocelli forming nearly an equilateral triangle, the fore ocellus slightly the remotest; antennae subclavate, hairy; joint 2 shorter than 3, which is about equal to 4; 3 about twice the length of its widest diameter; neck of pronotum slightly rugulose and with a few longitudinal carinulae at base; propodeum as seen from above nearly fusiform, widest at about middle; legs with bifid claws; vestiture sparse, rather long, mainly pale erect hair.

Described from a single female collected in the Makiling forest, Los Baños, Philippines, January, 1922 (F. X. Williams). Related to *Methoca formosana* Williams (Ent. Bull. No. 14, Experiment Station, Hawaiian Sugar Planters'

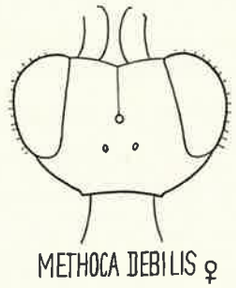

FIGURE 14

Association, p. 37-38, fig. 8 ♀, 1919), in being almost unsculptured, lacking any frontal process and in the undifferentiated clypeus; but the head is much shorter than in that species, and the whole insect is not so dark, etc.

Stenogaster timidus n. sp.

(Pl. XXXIII, Fig. 228, clypeus and venation ♀.)

During July and August, 1917, I made observations on the nest of a small species of *Stenogaster* occurring on Mt. Makiling, Los Baños, Philippines. (Williams, F. X., Ent. Bull. No. 14, Experiment Station, Hawaiian Sugar Planters' Association, p. 172-173, fig. 103, 1919). Failing to capture the wasp at the time, I succeeded in getting a single female and her nest nearly four years later on my second visit to the islands.

Female, type: Length, 11.75 mm. Black; head and thorax rather dull, abdomen polished, mandibles mainly, and first 3 joints of antennae brownish, legs brownish except apices of femora, most of fore tibiae and part of first tarsal joint of fore legs and knees of second and third pairs of legs, which are here yellowish, apex of second and third tibiae with a small pale spot; wings semi-transparent, marginal cell slightly infuscate; prothorax brownish with a thin yellowish marginal band fore and aft; mesopleura with two large nearly united yellow spots; metanotum and near apex of propodeum with a pair of yellow spots, that on the metanotum nearly fused; a large yellow spot on side of second abdominal segment; pedicel of abdomen brown and black. Head and thorax very closely punctured, in fact granulate in appearance; propodeum with a combination of large punctures and wrinkles diverging on disc towards apex, longitudinal on pleura. Face rather short; clypeus terminating as a wedge which, excluding the apical tooth, is of about 90°, the sides except towards apex slightly outbowed, finely separated for apical half of wedge; antennae clavate, joint 3 not equalling 4 plus 5; ocelli large, forming a nearly equilateral triangle, not separated from one another by as much as the diameter of any of them; scutum with no outer pair of furrows, the inner ones inconspicuous; posterior face of propodeum with an impressed line, widening at apex (origin of pedicel of abdomen), wings with dark brown stigma and venation; abdomen with very fine and separate piliferous punctures, the pile dark. Vestiture: sparse erect brownish hairs and appressed silvery pubescence on face and cheeks, and small portion of pleura; brownish suberect pile on mesonotum.

Smaller than the other *Stenogaster* that I have seen in the Philippines, lacking the outer mesonotal furrows of *S. depressigaster* Rohwer, and the comparatively smooth notum of the other Philippine species.

Described from one ♀ secured at Molawin Falls, Mt. Makiling, Los Baños, March 12, 1921 (F. X. Williams).

The nest of this species is figured in Bull. No. 14, H.S.P.A. Experiment Station, p. 172, fig. 103, 1919.

VIII

THE NEST OF TRIGONA JATY SM., A SOCIAL BEE OF THE NEOTROPICS

Small though nevertheless conspicuous by their great variety and abundance are the Meliponinae or stingless social bees of the American tropics. The more minute species have aptly earned the name of "mosquito bees"; Latin Americans call them "angelitos" because so many are harmless, while on the other hand the more aggressive kinds, such as get into one's hair and daub it with their gummy legs are often referred to in Trinidad, B. W. I., as "tar babies". Their colonies are frequently large, numbering well into thousands of individuals and are variously situated; some nest in holes in the ground, others inhabit the large ball-like termite nests on forest trees, others still make free nests on trees, etc., while perhaps the majority prefer hollows in tree trunks. The nest consists of an aggregate of brood, pollen, and honey cells, made of wax and more or less enveloped in sheets or lamellae of the same material. Gum and mud are also employed in nest building. The entrance to the bees' nest is usually a tube of some sort, variously shaped according to species and often covered with a sticky material. As in the ordinary honey bee (*Apis mellifera*), there are three castes; the queens become very obese and incapable of flight and are quite tolerant of young queens. The young are not fed from day to day by the workers as in *Apis,* but a cell is stored with pollen and honey, upon which the queen lays an egg and the receptacle is then sealed.

In Ecuador, I have seen meliponine bees feeding in numbers at flowers of an araceous plant, they also patronize the long tubular flowers of the banana (*Musa*), and many other kinds. Their habits are not always cleanly, for they often visit faecal matter, and once along a forest trail I saw a small dead mammal perforated, collander-like, by a swarm of these bees, that were feeding upon it. Occasionally they may be seen gathering the resinous material exuding from some tree trunk. This substance is bitten off with the mandibles, to be gathered up in the fore paws; next it is transferred, by a slight movement of one of the fore legs, to one of the active middle ones that receives the load from the inner side, at the articulation between the tibia and tarsus, and immediately transfers it to the broad outer modified surface or corbicula of the hind tibia. Neither hind leg seems to be loaded by turn; finally, however, each presents a shining gummy mass. When the material is not very adhesive, as muddy sand, it is the fore and not the third pair of legs that braces the bee, the middle pair gathering up the sand and placing it on the corbicula of the third.

The little brownish *Trigona jaty* F. Smith (1863)*, measuring about 4 mm. long is common about Tena, in the eastern part of Ecuador. It is widespread in Central and South America. It nests in tree hollows and builds a whitish perforated tube for the entrance to the nest, about which during the day are always poised a number of individuals, with a few others at the mouth of the tube itself.

* Identified by Prof. T. D. A. Cockerell.

A small colony of these very mild insects for some time dwelt within an idle letter box at the Post Office, and with the kind permission of the officials I was able to examine the domicile and make sketches of it. It occupied the corner of said box (Pl. XXXI, Fig. 223), extending in places to the top, the slot for the insertion of letters being sealing up except for the perforated tube (Fig. 223c), here more or less appressed and connecting the nest with the exterior. The wax, which seemed of good quality is soft and pale brown and forms an amorphous, much perforated, lamellate and curved cover to the cells that rest in a small open space. Here a neat brown pile of brood cells consisting of about 15 concave and circular tiers of cells meets the eye. The aggregate is several inches tall and the tiers are connected with their neighbors by means of waxen stanchions leaving thus sufficient space between for the bees to pass; the cells are not angulate in this species, and as usual, stored with a mixture of pollen and honey that is sharp and biting to the tongue. Fig. 223A, shows the six upper stories of these discs of cells, the first story is the newest and consists of three open and one sealed cell, one of the first having an egg floating on the food. Cells were studied down as far as the ninth story from the top; all were sealed, and the young bees of increasing age towards the ninth or base; for example, tier 3 from the top contained cells with quite small larvae floating upon the liquid provender; tier 6 showed many full-fed arcuate larvae in dry cells—or cells with a little unconsumed food, and tier 9 had cells containing fat little whitish bee pupae. Issuance is from the top side of the cells.

Except for the incomplete tier No. 1, the rest consist of several hundreds of cells each, making a total of at least 6,000 brood-cells. Occupying far less space than the brood-cells and off to one side within the envelope to which they are attached directly or by rods and thus to one another, are two groups of comparatively very large, thin-walled cells, the pollen- and the honey-pots. Not more than a half a dozen pollen-pots (Fig. 223B) were seen; when filled they are sealed. The honey-pots are more numerous than those containing pollen, and occupy an elongate vertical space; their honey is quite clear but rather queerly tasting, and in quantity that would seem quite insufficient for a winter supply, did that season exist in this equatorial region.

Among the enemies of South American meliponine bees are the philanthid wasps of the genus *Trachypus*, *T. gomesii* Klug having been observed near Rio de Janeiro storing its nest with *Melipona* (See Bristowe, Notes on the Habits of Insects and Spiders in Brazil. Trans. Ent. Soc. London, 1924, p. 475-504, 1 Pl.).

A very excellent account of the Meliponinae is given by Wheeler (Social Life Among the Insects, 1923, New York). These insects have been much studied; among other investigators by Ducke and Von Ihering, in South America. Von Ihering (Biologie der Stachellosen Honigbienen Brasiliens, Zool. Jahrb. Abt. F, Syst. XIX, p. 179-287, Pl. 10-22, 1904) on p. 220-223, Pl. 17, Fig. 2, treats of *Trigona jaty* or the "Jatahy amarello" as it is often known in Brazil. Jose Marianno (Ensaio sobre as Meliponidas do Brazil (Rio de Janeiro, 1911) p. 111) also writes at length on the biology of this insect.

The foregoing papers show to some extent that there are more or less fixed hosts and habits among insects, this depending largely upon the degree of specialization and upon the group to which the insects belong.

The fruit of the fig is a world in itself, supporting many kinds of insects and specialized to the extent that a particular species of fig requires a particular species of fig-pollinating wasp for its development, the two-co-adapted parties being thus mutually indispensible. The fig-pollinating wasp in its native habitat is parasitized or otherwise interfered with by a series of specialized wasps and by other insects, so that the association becomes very complex.

The interesting assemblage of Solitary Wasps is classified mainly on structural characters of the adult, although a classification based on habits and larval food will correspond in a rough manner to the other. The Social Wasps make characteristic communal nests, are generally less specialized in structure than the Solitary species and are not usually particularly fitted for preying upon one or a few kinds of insects, but feed their young from day to day upon what prey is most suitable and available at the time, and delivering it to their offspring in a more or less masticated condition.

To some extent, one may notice individualities among insects of the same species; in wasps, this one exhibiting a preference for mole crickets of a certain size, that one working more steadily at her nest than her neighbor; while insects as species, may be characterized in one case, as among wasps, by a tameness of disposition, others are timorous, and others still even vindictive. This also applies to bees and to ants.

While one may think of the tropics as far surpassing the temperate regions in the diversity and number of its insects this does not hold true in a great many cases; to narrow down to a single order, the bumble bees (*Bremus*) are preeminently temperate and even boreal in habitat, the larrid wasps of the genus *Tachysphex* prevail in semi-arid, temperate regions, while the family Crabronidae appears better developed outside the tropics. On the other hand, however, where else than in the tropics do we find the immense number and diversity of social bees and wasps, and the hosts of other insects that are at their best in a warm humid country that brings them no sudden nor severe change of climate?

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