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Larvae of Three *Polistes* Species from the Philippines
and *Ropalidia maculiventris* from New Guinea
(Hymenoptera, Vespidae)

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Abstract Larvae of *Polistes* (*Nygmopolistes*) *tenebricosus nigrosericans*, *P. (Polistella) sagittarius funebris*, *P. (Polistella) manillensis* from the Philippines and of *Ropalidia (Ropalidia) maculiventris* from New Guinea are described. The present study gives the first description of larvae of subgenera *Nygmopolistes* and *Ropalidia* s. str.

Although the larval characters are considered to be useful for the taxonomic and phylogenetic studies of the subfamily Polistinae (NELSON, 1982; REID, 1942; RICHARDS, 1978; YAMANE & OKAZAWA, 1981), the accumulation of knowledge about the larval morphology is still restricted that we cannot use them as well established supplement to the phylogenetic studies of Polistinae (CARPENTER, 1980; YAMANE & OKAZAWA, 1981). Especially, only a part of the Old World and Oceanian polistine wasps has been known as to their larvae.

In the present paper, larvae of *Polistes (Nygmopolistes) tenebricosus nigrosericans* BEQUAERT and *Ropalidia (Ropalidia) maculiventris* GUÉRIN are described for the first time for each subgenus. In addition, two species of the subgenus *Polistella* of the genus *Polistes* from the Philippines are described and compared with those of the members of this subgenus so far described.

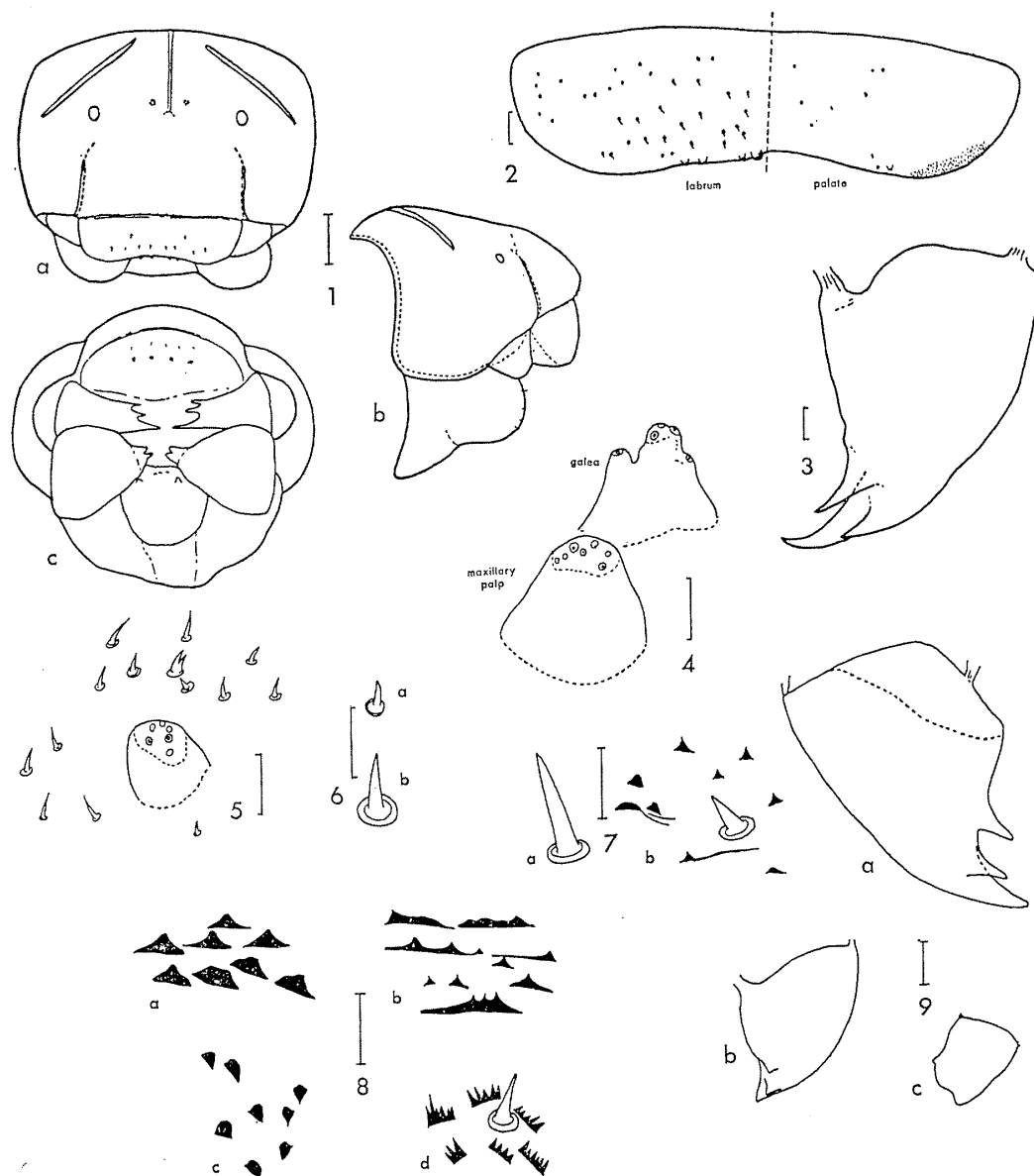
Materials and Methods

Larvae of three *Polistes* species were obtained from 8 nests which I collected during the stay in the Philippines in 1980. They were preserved in 80% ethanol after being fixed in Kahle's solution. Color pattern and degree of sclerotization were observed under the stereoscopic microscope. After being cleaned in hot KOH, specimens were mounted in order to observe the microscopic structures, such as punctures, sensilla and setae. Some of mature larvae were heavily stained with acid fucsin before mounting for more detailed observation. A dried mature larva of *Ropalidia maculiventris* here examined was received from the Rijksmuseum van Natuurlijke Historie, Leiden by the courtesy of Dr. J. VAN DER VECHT. It is observed after being cleaned in hot KOH and heavily stained with acid fucsin. The terminology follows NELSON (1982).

Polistes (*Nygmopolistes*) *tenebricosus nigrosericans* BEQUAERT

(Figs. 1-9)

Specimens examined: 9 (5th-1, 4th, 3rd-each 2, 1st-4) from a nest, Claveria, Cagayan, Luzon I., 16 May 1980, J. KOJIMA leg.



Figs. 1-9. Larvae of *Polistes* (*Nygmopolistes*) *tenebricosus nigrosericans* BEQUAERT. 1-8, mature larva. 1, head in frontal view (a), lateral view (b) and ventral view (c); 2, labrum and palate; 3, mandible; 4, maxillary palp and galea; 5, labial palp and setae around it; 6, setae on cranium (a) and labrum (b); 7, seta on venter of thoracic segment I (a) and microscopic spicules on venter of thoracic segment II (b); 8, seta and spicules on dorsum of thoracic segment I (a), and of abdominal segment I (b), III-VIII (c) and X (d). 9, mandibles of fourth (a), third (b) and first (c) instar larvae. Scale lines: 1, 0.5 mm; 2, 3, 9, 0.1 mm; 4, 5, 0.05 mm; 6-8, 0.02 mm.

Mature larva. Head: Cranium blackish brown (ecdysial sulcus, parietal band mostly, antenna, lower margin of clypeus and small spot at ventral margin of gena, pale), strongly transverse in frontal view, about 1.5 times as wide as high; posterior margin concave; as long as high in profile. Integument strongly sclerotized, weakly granulate; frons, clypeus and lower margin of gena with sparse small punctures associated with very minute setae. Ecdysial sulcus distinct, narrow. Parietal band narrow, rather long, not reticulate. Frons not separated from epicranium and clypeus by suture. Antenna moderate in size, surrounded with a strongly sclerotized ring, with three minute sensilla. Clypeus transverse, defined laterally by epistomal sulcus, not emarginate ventrally. Anterior tentorial pit distinct, located on epistomal sulcus and ventrally to antenna. Postoccipital and hypostomal sulci not very developed; pleurostomal sulcus weak; epistomal sulcus developed and its upper portion disappearing. Labrum brown in color with large median pale spot, transverse, slightly emarginate ventrally, with sparse small punctures on whole area, which are often associated with minute setae, ventral margin with a few conical papillae; palate with small punctures associated with quite minute setae, laterally with dense microscopic denticles. Mouth part dark brown; mandible wide at base, apically pointed, with two subsidiary teeth, which are rather long, subequal in length to each other and well set back from apex. Maxilla spherical in shape, not very developed, and as wide as the width between the mandibular bases in frontal view, with several setae; maxillary palp thick, with 7 minute sensilla at top; galea rather thick, asymmetrically bilobed, larger lobe with 4 sensilla (3 at apex, 1 on the inner side), smaller lobe with a single sensillum at apex. Prementum subcircular in shape, with a pair of palps, each palp with 6 or 8 minute sensilla at apex; around each labial palp more than 15 setae, one of which dorsal to the palp is bifid; remaining portion of prementum with sparse setae. Postmentum small, with very sparse setae.

Body: Integument pale in color (postero-ventral portion of thoracic segment I brown), not granulate. Venter of thoracic segment I with sparse somewhat strong setae anteriorly, bare posteriorly; venter of the remaining thoracic segments and of abdominal segments I and II with very sparse setae and rather dense microscopic spicules, some of which are rounded apically. Spicules on the further posterior ventral area much sparser. Dorsum of thoracic segment I with sparse setae and densely covered with microscopic spicules, all of which are rounded apically; that of segments II and III with sparse minute setae and dense transverse (ridge-like) spicules. Dorsum of abdominal segments I and II with sparse very minute setae at lateral portion and on dorsal lobes, posteriorly with dense spicules (both apically pointed and rounded), which are sometimes contiguous to form rows; setae on dorsum of abdominal segments III–VIII as in I, while most spicules rounded apically; IX with sparse setae and rather dense apically pointed spicules which are often contiguous to form rows; X with sparse setae and more frequently contiguous spicules. Limb and wing bud plates rather distinct before being stained. First spiracle

somewhat larger than the rest: atrium bare.

4th instar. Much as in mature larva, but pigmentation slightly weaker, mandibular teeth shorter and brownish patch on ventral area of thoracic segment I absent.

3rd instar. Cranium much less pigmented and weakly sclerotized. Mandible tridentate, but teeth much shorter and not strongly pointed apically.

2nd instar. Not available.

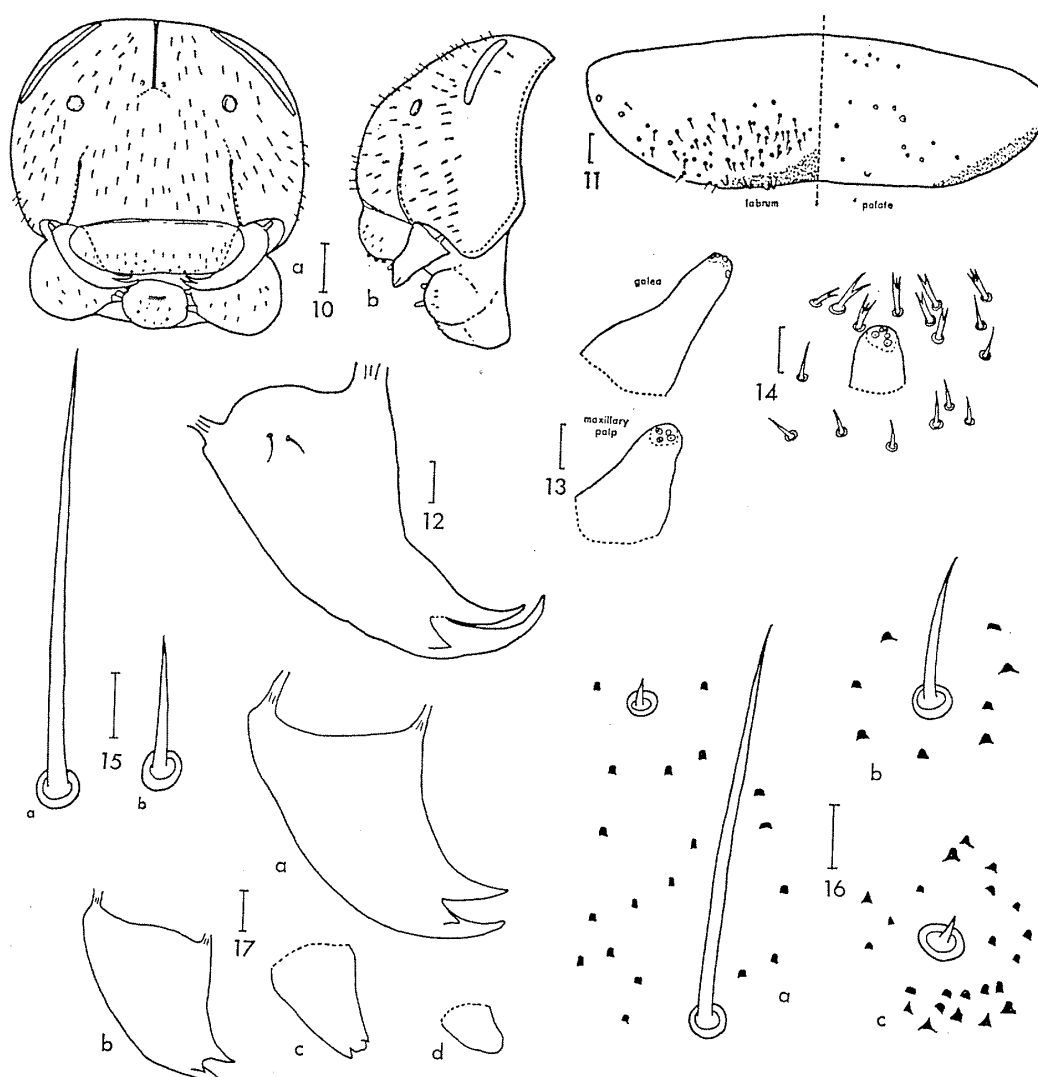
1st instar. Cranium very weakly sclerotized, mostly whitish yellow in color with brownish patches near the parietal bands. Mandible very weakly divided into three teeth which are apically rounded. Maxillary palps, labial palps, galeae and setae on integument invisible.

Polistes (Polistella) sagittarius funebris BEQUAERT

(Figs. 10–17)

Specimens examined: 13 (5th-5, 4th to 1st-each 2) from a nest, Campus of the University of the Philippines at Los Baños, Laguna, Luzon I. (abbreviated as "UPLB"), 18 Mar. 1980, J. KOJIMA leg.; 14 (5th-6, 4th to 1st-each 2) from 2 nests, UPLB, 6 Mar. 1980, J. KOJIMA leg.

Mature larva. Head: Cranium dark brown with a large yellowish rounded-triangular marking, of which upper margin runs along the line from the anterior edge of ecdysial sulcus, down to just below the antenna, then back to the ventral margin of occiput (lower margin of clypeus dark brown); other yellowish parts are as follows: an irregular spot on vertex (sometimes absent), ecdysial sulcus, parietal band and antenna. Outline of cranium rounded-quadrate in frontal view, posterior margin emarginate at the level of antenna. Integument strongly sclerotized, weakly granulate; covered with sparse rather long hairs except vertex and genae where it is almost bare. Ecdysial sulcus relatively weak, but distinctly visible, narrow. Parietal band not very long, rather wide, its outer half reticulate. Antenna moderate in size, defined by strongly sclerotized ring which is heavily pigmented, with 2 to 4 minute sensilla (most often 3). Frons not defined. Anterior tentorial pit distinct, located on epistomal sulcus, and ventrally to antenna. Clypeus transverse, defined laterally by epistomal sulcus, weakly emarginate ventrally. Postoccipital and hypostomal sulci developed; pleurostomal sulcus very weak; epistomal sulcus developed, and its upper portion disappearing. Labrum pale in color, with brownish patches on dorsal lateral corners, transverse, weakly emarginate ventrally; lower half with sparse setae; lower margin with a few conical papillae and dense microscopic denticles; laterally with a few conical papillae; palate with several punctures and dense microscopic denticles on lateral portion. Mouth part pale brown, with following parts brownish: base and teeth of mandible, large spot on maxilla, small spots on lower half of prementum, irregular markings on postmentum. Mandible wide at base, apically pointed, with two subsidiary teeth,



Figs. 10-17. Larvae of *Polistes (Polistella) sagittarius funebris* BEQUAERT. 10-16, mature larva. 10, head in frontal view (a) and profile (b); 11, labrum and palate; 12, mandible; 13, maxillary palp and galea; 14, labial palp and setae around it; 15, seta on cranium (a) and labrum (b); 16, setae and spicules on venter of abdominal segment I (a), III (b) and dorsum of thoracic segment I (c). 17, mandibles of fourth (a) to first (d) instar larvae. Scale lines: 10, 0.5 mm; 11, 12, 17, 0.1 mm; 13, 14, 0.05 mm; 15, 16, 0.02 mm.

both well set back from apex; inner subsidiary tooth long, subequal to the main tooth in length, outer one much shorter; often with 1 or 2 setae near base. Maxilla developed, spherical in shape, about as wide as cranium in frontal view, with several setae; maxillary palp dark brown, rather slender, with 4 to 5 small sensilla at top; galea similar to maxillary palp, but some of the sensilla often situated on the sides. Prementum subcircular in shape; labial palp with 4 to 5 minute sensilla at top; around palp 15 to 20 setae, most of which dorsal to the palp are bifid or some-

times trifold; remaining portion of prementum with sparse setae. Postmentum not developed, with a few setae.

Body: Integument pale in color (venter of thoracic segment I laterally with brownish large spots), not granulate. Venter of thoracic segments with sparse, small punctures associated with small setae; that of abdominal segments I and II with sparse setae and somewhat dense apically-rounded spicules, some of setae as long as those on cranium; venter of abdominal segments III-VII similar to I, but setae shorter; VIII-X with sparse small setae, without spicules. Dorsum of thoracic segments with relatively dense transverse spicules and sparse, very small setae at the middle; dorsum of abdominal segments I-VII similar to that of thoracic segments, spicules being sparser toward the posterior segment; dorsal lobes bare; dorsum of abdominal segments VIII-X with sparse setae, VIII and IX with transverse spicules only anteriorly, X without spicules. Limb and wing bud plates hardly visible before staining, more or less distinct in stained specimens. First spiracle slightly larger than the rest; atrium bare.

4th instar. Similar to mature larva, but less pigmented and less sclerotized; lower pale marking on cranium not well defined, dark spots on venter of thoracic segment I absent. Setae on cranium and ventral area of abdominal segments I and II not distinctly longer than those on remaining part. Mandible less developed with shorter teeth.

3rd instar. Cranium uniformly brown in color, microscopic structures much less developed; mandible apically tridentate, but each tooth much shorter than mature and 4th instar larvae.

2nd instar. Cranium pale brown with whitish large spots outside the antennae. Mandible weakly tridentate; central tooth broadly rounded apically, lateral teeth more or less apically pointed.

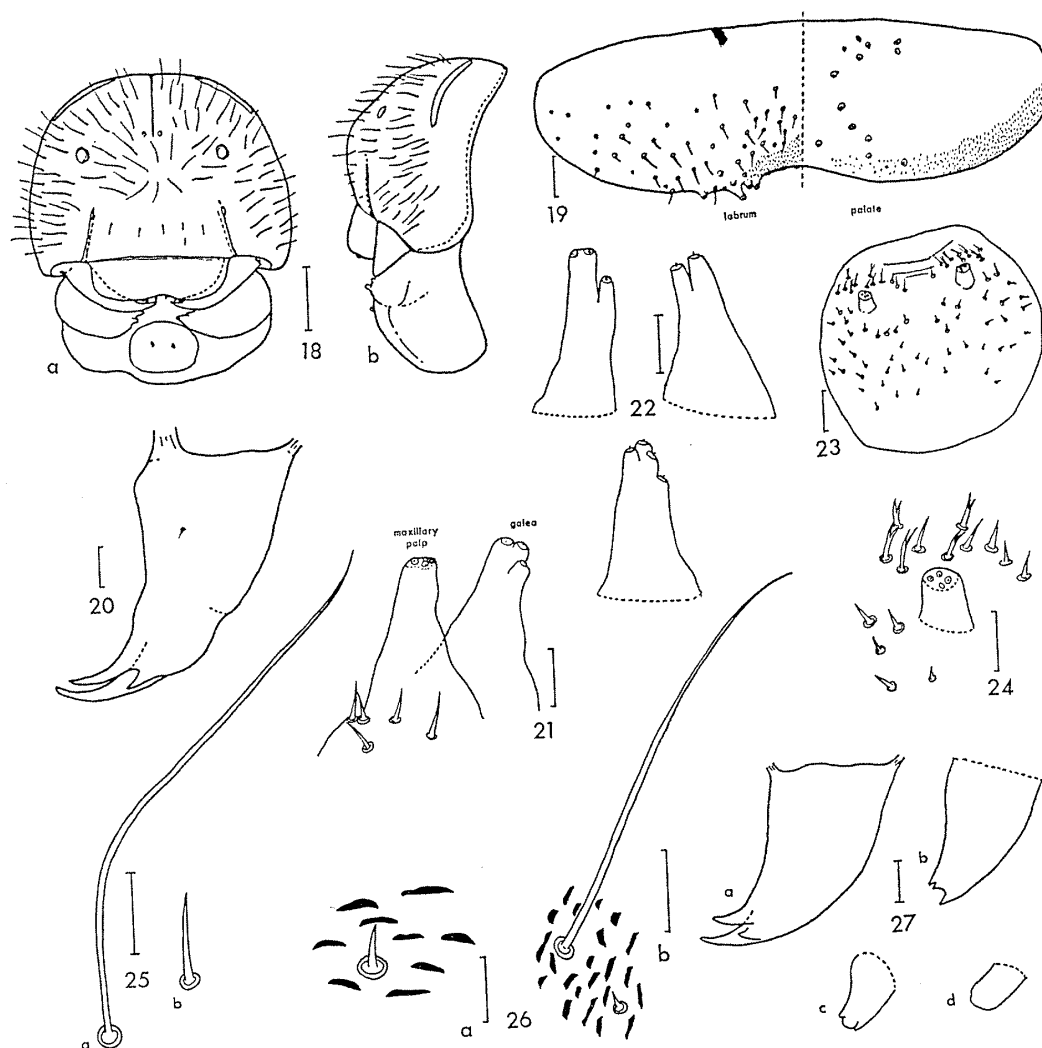
1st instar. Cranium mostly whitish yellow, with brownish patches around antennae. Mandible not divided, broadly rounded apically; microscopic structures hardly visible.

Polistes (Polistella) manillensis SAUSSURE

(Figs. 18-27)

Specimens examined: 11 (5th-5, 4th to 2nd-each 2) from a nest, UPLB, 17 Mar. 1980, J. KOJIMA leg.; 23 (5th-10, 4th-3, 3rd, 2nd-each 4, 1st-2) from a nest, UPLB, 19 Mar. 1980, J. KOJIMA leg.; 13 (5th-5, 4th to 1st-each 2) from a nest, UPLB, 24 Mar. 1980, J. KOJIMA leg.; 5 (5th only) from a nest, Muñoz, Nueva Ecija, Luzon I., 17 Apr. 1980, J. KOJIMA leg.

Mature larva. Head: Cranium dark brown, with following parts yellowish: large spot on gena with branch, which narrowly extends to just below the antenna or sometimes forms a complete band transversely acrossing the cranium, ecdysial sulcus, small spot at the anterior edge of ecdysial sulcus (sometimes absent), outer



Figs. 18–27. Larvae of *Polistes (Polistella) manillensis* SAUSSURE. 18–26, mature larva. 18, head in frontal view (a) and profile (b); 19, labrum and palate; 20, mandible; 21, maxillary palp and galea; 22, some various shapes of galeae; 23, prementum; 24, labial palp and setae around it; 25, setae on cranium (a) and clypeus (b); 26, setae and spicules on venter of thoracic segment III (a), and of abdominal segment I (b). 27, mandibles of fourth (a) to first (d) instar larvae. Scale lines: 18, 0.5 mm; 19, 20, 23, 27, 0.1 mm; 21, 22, 24, 25, 26b, 0.05 mm; 26a, 0.02 mm.

half of parietal band, antenna, clypeus. Outline of cranium rounded-quadrate in frontal view; posterior margin weakly emarginate, not thick, about 1.5 times as high as long in profile. Integument rather strongly sclerotized, not distinctly granulate, with sparse punctures associated with conspicuously long hairs. Ecdysial sulcus distinct, narrow. Parietal band rather wide; outer one-third to half reticulate. Antenna moderate in size, with 3 or 4 minute sensilla. Frons not defined. Anterior tentorial pit distinct, located on epistomal sulcus and ventrally to antenna. Clypeus transverse, defined laterally by epistomal sulcus, weakly emarginate ventrally.

Postoccipital and hypostomal sulci developed; pleurostomal sulcus weak; epistomal sulcus moderately developed and its upper portion disappearing. Labrum yellowish brown, transverse, weakly emarginate ventrally, lower half with sparse punctures, most of which are associated with setae, lower margin with a few conical papillae and dense microscopic denticles; palate with sparse punctures at the middle and dense microscopic denticles near the lower margin. Mouth part yellowish brown; mandible wide at base, pointed apically, with two subsidiary teeth well set back from apex; inner subsidiary tooth long, subequal to the main one in size, the outer one much shorter; mandible often with one or two setae near base. Maxilla well developed, spherical in shape, slightly narrower than the width of cranium in frontal view, with several setae; maxillary palp slender and simple in shape, with 4 or 5 minute sensilla at apex; galea variable in shape (often different between right and left ones in a single individual), most often weakly trilobed, sometimes rather deeply bilobed or weakly divided into four lobes, in most cases each lobe with a single minute sensillum at apex (rarely 2). Prementum subcircular in shape, with a pair of palps, each palp with 3 or 4 minute sensilla at apex (most often 4); around each labial palp more than 20 setae, most of which dorsal to the palp are bifid; the remaining portion of prementum with sparse setae or punctures alone. Postmentum rather developed, sometimes weakly concave below, with very sparse minute setae.

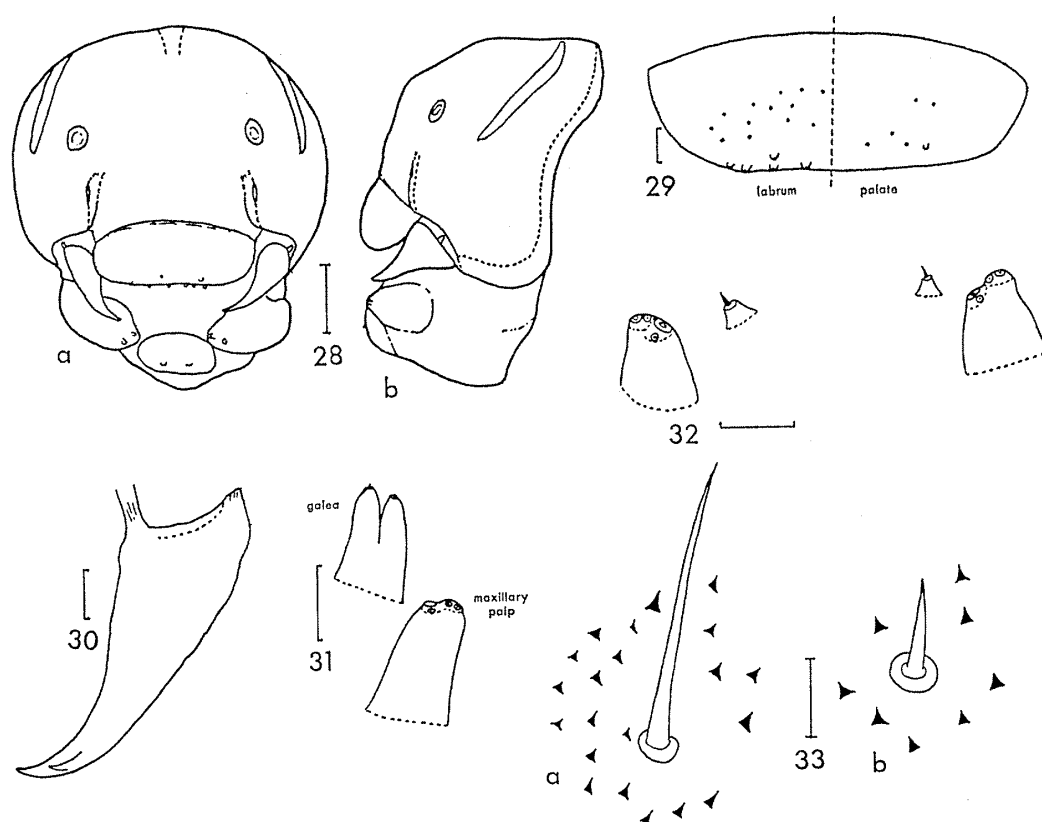
Body: Integument pale in color, not granulate. Venter of thoracic segments with sparse punctures which are associated with minute setae (slightly longer on III), and somewhat dense strongly transverse (ridge-like) spicules; venter of abdominal segment I similar to that of thoracic segments, but some setae very long, as long as those on cranium; II–VIII like venter of thoracic segments, setae and spicules becoming sparse toward the posterior segment; IX and X with a few setae, without spicules. Dorsum of thoracic segments and of abdominal segments I–VII like venter of thoracic segments, VIII–X with much sparse setae; dorsal lobes almost bare. Limb and wing bud plates visible before staining. First spiracle slightly larger than the second which is about 1.5 times as large in diameter as the rest.

4th–1st instars. Amount of pigment and degree of sclerotization of cranium less in younger larvae; in 1st instar, cranium nearly whitish yellow. Long hairs on cranium and venter of abdominal segment I seen in mature larvae absent. Microscopic structures (sensilla, galea, maxillary and labial palps) less developed in younger larvae, hardly seen in 1st instar. Mandible distinctly tridentate in 4th instar but each tooth shorter than in mature larva, more weakly tridentate in 3rd, much more weakly tridentate and each tooth apically rounded in 2nd instar; broadly rounded and not divided in 1st instar larva.

Ropalidia (Ropalidia) maculiventris GUÉRIN

(Figs. 28–33)

Specimen examined: 1 mature larva, Mindiptana, South New Guinea, 1959, P. BENNO leg.



Figs. 28–33. Mature larva of *Ropalidia* (*Ropalidia*) *maculiventris* GUÉRIN. 28, head in frontal view (a) and profile (b); 29, labrum and palate; 30, mandible; 31, maxillary palp and galea; 32, labial palps and paired setae; 33, setae and spicules on venter of thoracic segment I (a) and of abdominal segment II (b). Scale lines: 28, 0.5 mm; 29, 30, 0.1 mm; 31, 32, 0.05 mm; 33, 0.02 mm.

Head: Cranium whitish yellow in color; nearly circular in frontal view, posterior margin weakly concave at the level of antenna in profile. Integument moderately sclerotized, weakly granulate; frons and clypeus with sparse punctures, each puncture with very minute seta. Ecdysial sulcus very weak, shallow and wide, present only in upper portion. Parietal band relatively long, its outer half reticulate. Frons not separated from epicranium and clypeus by sutures. Clypeus strongly transverse, weakly concave ventrally, defined laterally by epistomal sulcus. Antenna relatively large, with 3 minute sensilla. Postoccipital and hypostomal sulci developed; pleurostomal sulcus very weak; epistomal sulcus not much developed and its upper portion disappearing. Labrum pale in color, transverse, not emarginate ventrally, with sparse punctures and a few conical papillae near ventral margin; palate with a few conical papillae. Mandible slender, sharply pointed apically, with an acute subsidiary tooth near apex. Maxilla not very developed, with a sclerotized basal ring, upper margin with dense microscopic denticles, no setae; maxillary palp with 4 very small sensilla at apex; galea divided

into two lobes, each with a single minute sensillum at apex. Prementum subcircular in shape, lower half with sparse punctures associated with minute setae; labial palp with 4 minute sensilla, two of which are situated on very slightly produced half of the palp; paired setae behind labial palps arising from distinctly raised sockets. Postmentum relatively small, not distinctly concave below, with dense microscopic denticles and sparse minute setae.

Body: Integument not granulate, with sparse setae and densely set microscopic spicules, all of which are pointed apically and isolated. Venter of thoracic segment I lacking spicules; setae on ventral surface of thoracic segments II and III and of abdominal segment I relatively long. Spicules on dorsal surface becoming sparse toward the posterior segment and dorsum of abdominal segment X without them; dorsal lobes almost bare. Limb and wing bud plates distinct at least in the stained specimen. First spiracle about twice as large in diameter as the rest; atrium bare.

Remarks

Discussing the importance of some of larval characters in the taxonomy and phylogeny of Old World and Oceanian Polistinae, YAMANE & OKAZAWA (1981) enumerated six characters (lack of setae on upper surface of maxilla, basal sclerotized ring of maxilla, apically bilobed galea, stability in the number of sensilla at the top of maxillary palp (4 sensilla), raised socket for the paired setae behind labial palps, and contiguous apically pointed spicules on body integument), which may be held in common in the genus *Ropalidia*. All of them except contiguous spicules are observed also in the larva of *R. maculiventris*. The lack of contiguous spicules, on the other hand, opposes to YAMANE & OKAZAWA's (1981) view that the presence of contiguous spicules may be a derived condition and associates *Ropalidia* with *Belonogaster*. It is not yet certain, however, whether the lack of contiguous spicules is one of the diagnostic characters which define the subgenus *Ropalidia* s. str. from remaining subgenera of the genus. The occurrence of contiguous spicules in *Polistes tenebricosus* also opposes to YAMANE & OKAZAWA's (1981) view.

Polistes tenebricosus is, based on adult morphology, considered to be closely allied species of the subgenus *Megapolistes* (RICHARDS, 1973; YAMANE & YAMANE, 1979). In the larval characters, it differs distinctly from *Megapolistes* in having a strongly transverse head capsule, complicated galea and presense of apically pointed spicules which are sometimes contiguous to form rows (in *Megapolistes*, the head capsule more or less rounded-quadrate in frontal view, galea simple, and spicules isolated and apically rounded (YAMANE & OKAZAWA, 1981)).

The spicules on body integument of *P. sagittarius* larva are also sometimes pointed apically, although the subgenus *Polistella* has been considered to be characterized by the spicules, which are all rounded apically or tubercle-like (YAMANE &

OKAZAWA, 1982). Even with the extent of species of which larvae are known, the subgenus *Polistella* is heterogeneous in some of larval characters not only in the shape of spicules, i.e., setae on cranium and venter of first abdominal segment (distinctly long in *manillensis*, *sagittarius* (both present study) and in a species from New Guinea (YAMANE & OKAZAWA, 1981), while minute in *adustus* BINGHAM (YAMANE & YAMANE, 1979)), and shape of galea (simple in *sagittarius* (present study), a species from New Guinea (YAMANE & OKAZAWA, 1981), and *adustus* (YAMANE & YAMANE, 1979), while complicated in *manillensis* (present study)). These facts may support RICHARDS' (1973) view that *Polistella* is a subgenus defined by negative characters and would be further subdivided.

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