

Systematic Position of the Tribe
Phylloplaypodini, with Remarks on the
Definitions of the Families
Scolytidae, Platypodidae, Dryophthridae and
Curculionidae (Coleoptera: Curculionoidea)

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**Systematic Position of the Tribe Phylloplatypodini, with
Remarks on the Definitions of the Families Scolytidae,
Platypodidae, Dryophthoridae and Curculionidae
(Coleoptera: Curculionoidea)**

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Abstract. Phylloplatypodini was established in Platypodidae at first by Kato (1998) and synonymized with Proecini of Cossoninae by Alonso-Zarazaga & Lyal (1999). Upon our detailed examination of adults and larvae, the systematic position of Phylloplatypodini is concluded to have a sister relationship with Cossoninae on the adult characters, and provisionally raised its rank to a subfamily, Phylloplatypodinae in Curculionidae. But, the true position is still pending, because the larva has unique head and definitely different from all the known taxa in Curculionoidea in our present knowledge. Family relationships of Scolytidae, Platypodidae, Dryophthoridae and Curculionidae are compared and a key to these families was provided.

Key words: Morphology, Higher classification, Phylloplatypodinae

It is with our great pleasure that we dedicate this paper to Prof. Junichi Yukawa, Professor of Entomology and Director of the Kyushu University Museum, Kyushu University on the occasion of his retirement in token of the memory of his great contribution to the entomology and of our thanks for his kind support for our study in various ways.

The tribe Phylloplatypodini was first established in the family Platypodidae based on

Phylloplatypus pandani gen. et sp. nov. by Kato (1998). After that, the tribe Phylloplatypodini was synonymized with the tribe Proecini of the Cossoninae without any comment by Alonso-Zarazaga & Lyal (1999), and the genus was transferred to the subfamily Cossoninae of the family Curculionidae by Kuschel et al. (2000). In the phylogenetic trees of the Curculionoidea inferred on the analyses of the morphological data set, the 18S rDNA data set only, or the combination of the 18S rDNA with morphological data set by Marvaldi et al. (2002), *Phylloplatypus* was arranged in two different places, namely, in the Cossoninae as a sister taxon of *Araucarius* on the morphological data set or its combination with the 18S rDNA data set, or a sister taxon of *Camarotus* (Camarotinae) from the molecular parsimony analysis.

Present paper is aimed to reassess the systematic position of the tribe Phylloplatypodini on the morphological characters newly obtained in this study from the adult and larva, because the previous analyses upon the morphological characters adopted were apparently insufficient for the purpose of phylogeny of this taxon.

Materials and Methods

Materials. Adults were collected on Chichijima and Hahajima Isls. by Prof. Osamu Tadauchi and Dr. Masatoshi Takakuwa, and both adults and larvae were also taken on the named islands and Iwojima Is. by the senior author, all from the leaves of *Pandanus boninensis*.

Methods. As this weevil is minute, observations were made mostly under the stereoscopic and compound microscopes on the prepared specimens after dissection of eleven adults and five larvae, and partly through a scanning electronic microscope. Drawings were made by the senior author with the aid of an attached drawing tube and a calibrated eyepiece. Photographs by the SEM were taken by the junior author. Terms adopted in this paper are followed after Anderson (1947) and May (1994) for the larva, and Kuschel (1995), Morimoto (1962), Morimoto & Kojima (2003) and Thompson (1992) for the adult.

Redescription of *Phylloplatypus pandani* Kato, 1998

Phylloplatypus pandani Kato, 1998, Ann. ent. Soc. Amer., 91: 72 (Hahajima Is.; Platypodidae: Phylloplatypodini). –Alonso-Zarazaga & Lyal, 1999, World Cat. Fam. Gen. Curc.: 121 (Cossoninae: Proecini) –Kuschel et al., 2000, Invertebrate Taxonomy, 14: 771, 785 (Cossoninae, figs. of antenna, aedeagus, prothorax,

mandible, spermatheca).

Adult (figs. 1-26).

Length: 1.6-1.9 mm including rostrum, maximum width: 0.29-0.32mm. Head blackish on dorsal and lateral sides, rostrum dark brownish to brownish, underside of head and rostrum brownish, mouth parts brownish, antennae, pronotum and scutellum yellowish, elytra yellowish except blackish basal margin and posterior three-fifths, legs and thoraces yellowish, venter blackish with brownish fifth ventrite.

Body cylindrical from apex of elytra to prothorax, weakly bent from vertex to rostrum (fig. 1). Head (figs. 8, 9) including rostrum 1.8 times as long as wide, micromesh on dorsal and lateral surfaces, sparsely with fine punctures and long fine setae; vertex with short median line; temples almost parallel-sided, 1.6 times as long as eye, not constricted; eyes ovate, weakly convex, lateral; rostrum transverse, flattened dorsally, arcuate anteriorly, with a notch at the anterior margin in the middle, without any special setae along clypeal margin; antennal scrobes oblique close to eye and extending to latero-ventral edge of rostrum. Antennae (fig.16) with scape reaching posteriorly a little beyond the middle of eye, lying on the lower part of eye in repose, funicle 6-segmented, first segment large, second to sixth segments gradually becoming wider, club oblong-ovate, first segment much longer than the rest. Mandibles (fig.10) of the typical type of Curculionidae (vide Morimoto & Kojima, 2003), bi-notches and three toothed, with two setae. Maxillae (figs. 8,11) move in a steep diagonal plane, cardo normal in position as in Curculionidae. Postmentum narrow, pedunculate, declivitous; prementum with a pair of setae on the ventral side, labial palpi three-segmented; hypostomal process (figs. 2, 3) conspicuous, sharp triangular; strengthening structures on the underside of cranium (fig. 8) with a ridge along hypostomal margins across the base of postmentum, sclerotized paracoilae, and a broad U-shaped ridge between pleurostomata. Gular sutures (fig. 8) completely coalescent to form a linear sulcus; tentorium parallel-sided when viewed dorsally, tentorial bridge absent, anterior tentorial arms absent, dorsal tentorial arms complete inserting into dorsal tentorial pits on frons (fig. 9, arrow), the pits small and equal to median fovea in size.

Prothorax 1.8 times as long as wide, widest in front of base, weakly narrowing anteriorly, 0.8 times as wide at apex as base, shallowly concave in a broad curve at apical margin, truncate at base, dorsal and lateral surfaces with microsculpture like on head, with scattered fine punctures, each puncture with a long, fine and pale seta.

Scutellum triangular, with microsculpture, with a few minute setae.

Elytra parallel-sided from humeri to close apex, broadly rounded at conjoint apex,

weakly depressed along hind margin of blackish base, lateral margin weakly sinuate above hind coxa; sutural margin lobate at apex on left elytron for folding the right, without any locking mechanism on epipleuron between marginal and submarginal ridges, when observed in preparation under high magnification, each elytron with nine punctured striae, the third row short and present on basal fifth, the 6th and 7th obsolete at base, 8th and 9th striae evident, all striae obsolete at apex, interval with a row of minute punctures. Hind wings (figs. 12-15) with so obliterated anal field that hind margin parallel to *Cu*; fore margin concave, with short microsetae up to stigma from near base; hind margin straight from the widest point to base, with very long microsetae from apex to near base; apical field 0.6 of total wing length; *C* and *Sc* short, *R* strong, radial window absent, stigmal patch (fig. 15) simple, nearly truncate at apex, without apical setae, mediocubital sclerite a little smaller than stigma, *M1* well marked, *Cu* strongest, mediocubital arc absent, *Cu1* short. Wing-folding pattern (figs. 13, 14) of the Curculionid type in spite of obliteration of anal field, wings folded from medial fold first, then apical part Z-folded.

Pygidium partly exposed.

Legs (figs. 19-23) with femora edentate, clavate, fore femora stouter than the others; tibiae prominent at dorsal and ventral corners at apex, dorsal prominence without accompanying setal fringe, inner setose fringe along tarsal groove oblique, not on the inner edge; fore tibiae (figs. 19, 20) with two conspicuous conical spines born in respective socket, strongly sclerotized, one near dorsal prominence, the other near ventral apex, another strongly sclerotized prominence present near the ventral prominence, which does not born in socket and quadrate; tarsi robust, with long setae but not spongy beneath, third segment bilobate; claws simple, free.

Fore coxal cavities separated externally and internally. Pro-, meso-, and metasterna lying on the same plane, flat; prosternum on each side before procoxae and metasternum behind mesocoxae shallowly depressed for receiving legs; mesocoxae narrowly separated, mesepisterna much broader than mesepimera; metasternum almost as long as basal four ventrites combined, metepisterna linear; metacoxae close to each other. Venter visibly four-segmented by complete fusion of basal two ventrites in entire width, without any trace of suture, 3rd and 4th ventrites of the same length, 5th ventrite (7th sternite) longer; 1st to 6th tergites membranous, 4th to 6th tergites with spicule patches, 7th tergite sclerotized, without spicule patches, serrate at apical margin in both sexes.

Hind gut with long loop (fig. 26, arrow).

In male genitalia (fig. 24), 8th sternite paired, 9th sternite asymmetrical, with

spiculum gastrale J-shaped, aedeagal body about 1.5 times as long as wide, almost parallel-sided, evenly narrowing apically at sides of ostium in a weak curve and bluntly angulate at apex, aedeagal apodemes 1.4 times as long as aedeagal body, internal sac shortly exposed from aedeagal body, with a [-shape sclerite. In female (figs. 25, 26), spiculum ventrale Y-shaped, its arms slightly bent inwards; ovipositor obliterated, without any sclerotized structures; bursa copulatrix shagreened; spermatheca comma-shaped, ramus and collum conjoined into a small bulb; spermathecal duct sclerotized tubular for a short distance from the junction into vagina.

Mature larva (figs. 27-35).

Head brownish, pronotum to anus milky white. Head free, shortly retracted at base, flattened dorso-ventrally, porrect, tentorial bridge lying behind the middle, cranium evenly brownish, weakly concave at hind margin, frontal sutures reaching the dorsal end of coronal suture, unpigmented and broad lined from dorsal end to near middle, frons divided into three sclerites by transverse unpigmented line behind the middle and coronal suture, *des* 1 and *des* 3 born on suture, *des* 4 absent, frons with three sensilla and two setae, *pes* visible as sockets, four in a row and a pair on the side of most dorsal *pes*, *les* 1 longer than *les* 2, *ves* 1 shorter than *ves* 2. Antennae on anterior face, oblong-ovate. Postclypeal sclerites merged with frontoclypeal band, *cls* 1, *cls* 2 and sensillum close in position. Labrum transverse, evenly rounded at apical margin, *mst* and *lst* lying on a transverse line close to basal margin. Epipharynx with *als* short, close to the middle, *ams* arranged antero-posteriorly; labral rods sinuate, converging anteriorly. Mandibles dentate at apical part, three notched and four teeth, with two setae and one sensillum. Postmentum pale brownish, parallel-sided, *pms* 1 moderately long, *pms* 2 long, *pms* 3 short, premental sclerite not bridged but widely distant as a pair of lateral small sclerites, and no seta and sensillum, prementum with a seta and sensillum, sclerotized at each side, labial palpi two segmented, each segment with sensillum. Maxillae pale brownish, stipes parallel-sided, 1.2 times as wide as postmentum when viewed ventrally, with three setae and a sensillum, mala with setae near apex, with four *vesma* and five *desma*; maxillary palpi two-segmented, apical segment slender, with a digitiform appendage.

Pronotum with six setae and a sensillum; meso- and metathoraces with following setae: *prs* minute, *pds* 1 and *pds* 3 long, *pds* 2 and *pds* 4 short, alar setae absent, spiracular area with two minute setae, epipleurum with a long seta, pleurum with a long seta, pedal area with five setae, sternum with a seta on each side. Typical abdominal segment (fig. 35) with three dorsal folds and following setae: *prs* minute, *pds* 1 and *pds* 3 short, *pds* 2, *pds* 4 and *pds* 5 long, spiracular area with a seta, epipleurum with a short and a long setae, pleurum with a short and a long setae, pedal area with a long seta,

sternum with two setae on each side; eighth segment with three postdorsal setae, ninth segment with two postdorsal setae. Spiracles (fig. 29) all with two air tubes directing postero-ventrally, each tube as long as long diameter of peritreme, abdomen with eight pairs of spiracles, all lateral and nearly of the same size.

Comparisons

Since the tribe Phylloplatypodini was first proposed in the family Platypodidae and transferred later to the subfamily Cossoninae, and great similarity of *Phylloplatypus pandani* to *Protoplatypus vetulus* in general shape in addition (vide Kuschel et al., 2000, figs. 115-117), comparisons must be made with these taxa at first.

Wood-boring weevils have more or less similar cylindrical body and robust legs for the adaptation of their lives. These are the weevils mostly in the families Platypodidae, Scolytidae, the subfamily Cossoninae, some genera in the tribes Phaenomerini of the Curculionidae, and the subfamilies Dryophthorinae and Stromboscerinae of the family Dryophthoridae. These weevils are also analogous with some species of the families Ciidae and Bostrychidae in general appearance owing to the morphological convergence to the mode of life. These families in Curculionoidea are defined upon the characters as in the following key (vide Morimoto & Kojima, 2003, for head structures).

- 1 (4) Adults: Rostrum with pleurostomal sinus shallow; postcoila shallow and simply lying on the anterior margin of the hypostoma for receiving conical postartis; hypostomal process absent; mandibles not produced nor laminate at laterobasal corner, with lateral depression or sulcus for receiving the prominence of pleurostomal margin; gular sutures Y-shaped in general or paired in the primitive condition, posterior tentorial arms broadly conglutinate anteriorly to the divaricated part of gular sutures. Larvae: Cervical plates absent, head straight at postoccipital margin in lateral view.
- 2 (3) Adults: Gula with posterior tentorial arms broadly conglutinate to the divaricated part of gular sutures (pregular sutures of wood, 1986), which extending anteriorly and continued to subgenal (hypostomal) sulci in parallel to exterior margin of hypostomal sinus when viewed ventrally; paracoila located at the bottom of hypostomal sinus; cardo vertical; strengthening sclerotization developed at and behind paracoila at apex of rostrum on the inside. Larvae: Clypeus distinct, separated from frons; pleurum not subdivided, spiracles nine-paired. (see Wood, 1986, Kuschel, 1995, and Kuschel et al., 2000 for the other

- characters). Family Scolytidae
- 3 (2) Adults: Gula with posterior tentorial arms broadly conglutinate with sheet-like extension of hypostoma from paracoila, and thus the “pregular sutures” continued anteriorly to hypostomal margin at the bottom of hypostomal sinus on each side of postmentum when viewed ventrally; paracoila translocated interiorly from bottom of hypostomal sinus; cardo almost rectangular outward to stipes; strengthening sclerotization undeveloped at and behind paracoila at apex of rostrum on the inside. Larvae: Clypeus fused to frons; pleurum subdivided, first instar larva with two pairs of spiracles, one pair on thorax and the other pair on 8th abdomen. (see above-mentioned authors for the other characters). Family Platypodidae
- 4 (1) Adults: Rostrum with pleurostomal sinus deep; postcoila deep bowl-like or ring-like lying behind the anterior margin of hypostoma on the interior surface for receiving ball-like condyle of mandible; hypostomal process present; mandibles with lamellar extension from latero-basal corner, which is visibly smooth curved surface exterior to the subbasal depression when viewed exteriorly, without lateral depression in general or at most with a small depression on the apex of lamellar extension in a few cases for receiving prominence of pleurostomal margin; gular sutures completely coalescent to form a linear sulcus on the underside of head cranium, so that posterior arms of tentorium triangular or quadrangular trough-like when viewed internally, linear gular sutures widely distant from hypostomata. Larvae: Cervical plates present, head more or less convex at postoccipital margin in lateral view.
- 5 (6) Adults: Prementum very small, deeply retracted into oral cavity and invisible externally; antennae inserted close to the base of rostrum, funicle with 6 or fewer segments, distal segment of funicle enlarged, added to club and constituent the basal segment of club; claw segment of tarsi produced at dorsal and ventral apices and so curved between claws as to embrace the base of claws (Zimmerman, 1993). Larvae: Abdominal pleurum subdivided into two or more lobes, one superposed upon or dorso-posterior to the other; first instar larva with two pairs of spiracles, one pair on prothorax and the other on 8th abdomen; some dorsal setae of mala commonly branched.
..... Family Dryophthoridae
- 6 (5) Adults: Prementum of normal size and freely visible from the underside in front of postmentum; antennae inserted elsewhere between base and apex, funicle often 7-segmented and distal segment of funicle free from club in most

cases; claw segment of tarsi not produced at apex. Larvae: Pleurum not subdivided; larvae in all instar with nine pairs of spiracles, one pair on prothorax and eight pairs on abdomen; mala without branched setae.

..... Family Curculionidae

The Cossonine-lineage defined by Kuschel et al. (2000) is certainly polyphyletic because they included the Scolytidae, Platypodidae and some Dryophthoridae in spite of the fundamental difference among these families on the head structures as noted in the above key (also refer Morimoto & Kojima, 2003). This lineage in our present sense can be redefined on the adult and larval features by the following synapomorphies: (1) Hind gut with rectal loop, (2) hind wings with reduced anal field, (3) spermathecal duct and gland close at base, (4) body cylindrical, with anteriorly or antero-ventrally directing rostrum, (5) tibiae more or less cuneiform, uncinata and mucronate at apices, (6) Larvae with anterolateral setae of epipharynx close to the middle in position.

According to the above-mentioned key, *Protoplatypus* may have the same characters in the head structures as the Platypodidae as far as we judge from the photograph in Kuschel et al. (2000; fig. 117).

The flat mesosternum was adopted for the definition by Kuschel (1995), but it is strongly depressed in the tribe Rhyncolini (Marshall, 1937; Morimoto, 1973). Some other characters supporting this lineage are unambiguous (Kuschel et al., 2000).

The Cossonine lineage in our sense comprises two taxa as follows:

1. Cossoninae of the traditional sense: (1) Fore tibiae with tarsal groove entire open and inner setose fringe on ventral margin, with hooked uncus on each dorsoapical corner in adult (Morimoto, 1973), (2) hind wings with setae or sensilla on the apical margin of stigmal patch (Zherikhin & Gratshev, 1995), (3) head constricted either behind or before eyes, (4) larvae of the usual type of Curculionidae, head hypognathous, tentorium situated in front of the middle in ventral view, cranial suture Y-shaped, frons not subdivided, postmentum much wider at base and rapidly narrowing apically, much wider than stipes, premental sclerite evident (Anderson, 1952; May, 1994).

The tribe Araucariini (sense Kuschel, 1966 and Alonso-Zarazaga & Lyal, 1999) may be defined by the denticulate tibiae on external margin, Scolytid-like general appearance and short rostrum. It includes the genera having either hooked tibiae or not so, and subcontiguous fore coxae or not so. Larval characters are only known by *Xenocnema spinipes* (May, 1994).

2. *Phylloplatypus*: (1) Tibiae prominent from dorsal and ventral corners at apex, inner setose fringe oblique along tarsal groove as in most curculionids even in fore tibiae, not

on ventral margin; fore tibiae with two conical spines in respective socket, one near dorsal prominence and the other near ventral prominence, (2) hind wings without setae nor sensilla on the apical margin of stigmal patch, (3) head not constricted, (4) larvae with head porrect, tentorium situated behind the middle in ventral aspect, frontal sutures reaching the base of coronal suture, frons subdivided into three parts, postmentum parallel-sided, parallel to stipes, the latter a little wider than postmentum, premental sclerite reduced to a pair of small sclerites lying at side margins.

Conclusion

As mentioned above, *Phylloplatypus* is different from the true Cossoninae in the fore tibiae and some important characters in adult, but the larva is definitely different from all the known species of Curculionidae on the head structures. These facts suggest its phylogenetic position as a sister taxon of the subfamily Cossoninae on the adult characters, but is indefinite on the larval characters upon our present knowledge. It is tentatively regarded here as the subfamily Phylloplatypodinae, a taxon of the equivalent rank to the Cossoninae until the larval study would be developed sufficient for the phylogenetic analysis. Placement of *Phylloplatypus* as a sister taxon of *Camarotus* from the molecular (18S rDNA) analysis (Marvaldi et al., 2002, fig.2) must be evaluated again in the future with keeping the characteristic larval structures of *Phylloplatypus* in view.

Biological notes

As the biology was well documented by Kato, 1998, *Phylloplatypus pandani* is a leaf-miner of *Pandanus boninensis* on Chichijima, Hahajima and Iwojima Isls. Though this plant is the only representative of *Pandanus* in the named islands, other foreign species of *Pandanus* are also infested in a plant garden on Chichijima Is. It is also found on Guam (Zimmerman, personal communication), but not found in the Ryukyus in spite of several surveys of the native and foreign species of *Pandanus*.

This weevils mine the parenchyma between veins of the leaves, and the epidermis above the infested galleries is soon discolored to greyish brown in sharp contrast to deep green sound area. The infested leaves may change color partly from shiny deep green to wet green or wet greenish brown owing to the spread of interior rot, since this weevil bears the mycetangia on the fore coxae as seen in fig.2. Adults and larvae are more abundant in the rotten area than in the galleries upon the observations by the

senior author.

When observed the adult on leaves, the senior author soon reminded a sympatric ant of the genus *Monomorium* because of their similarities in size, coloration and walking behavior.

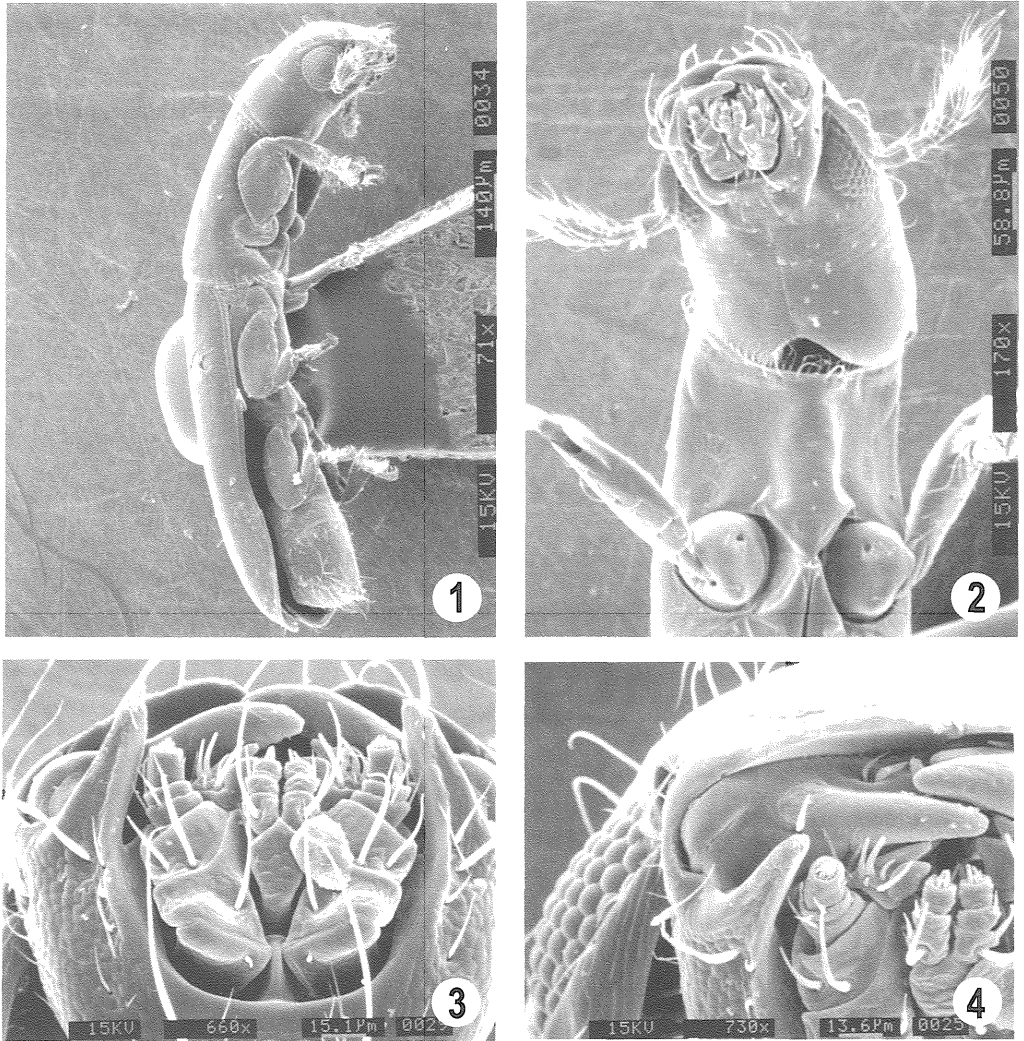
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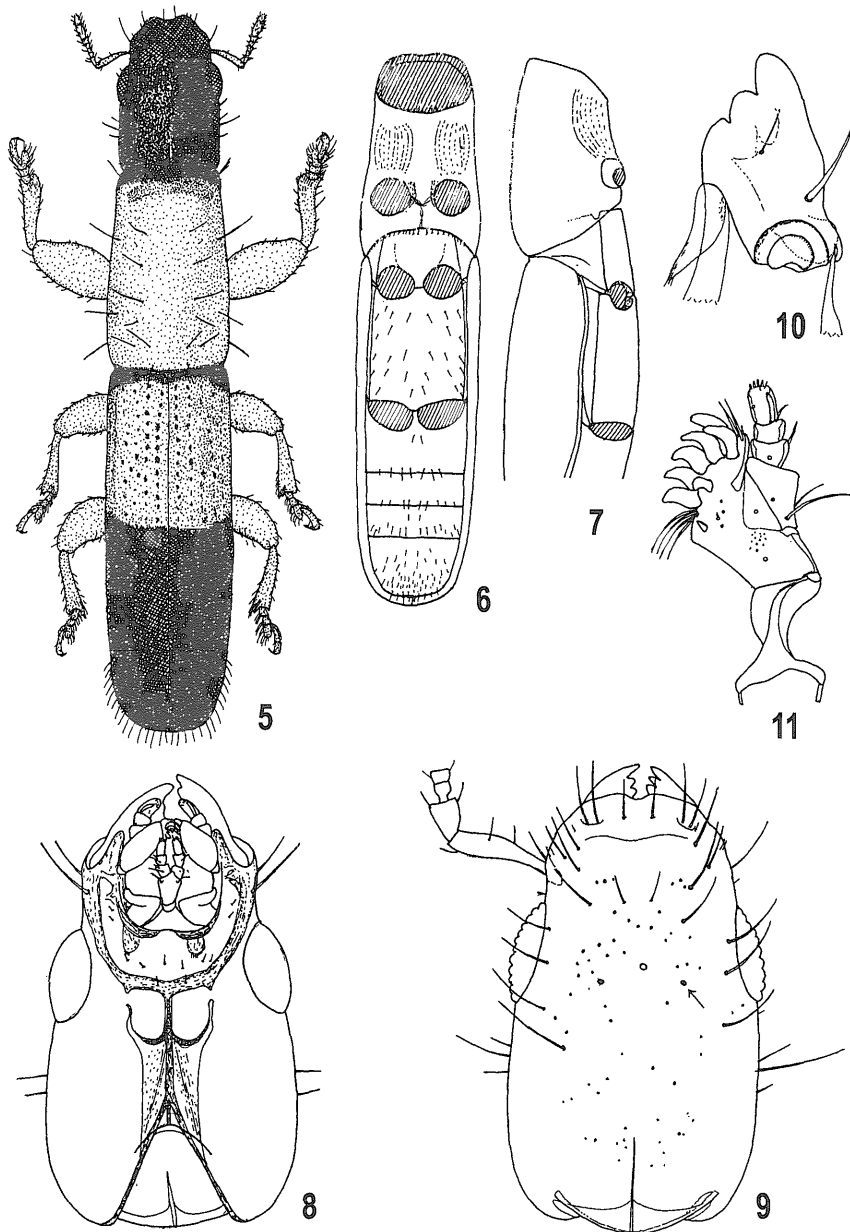
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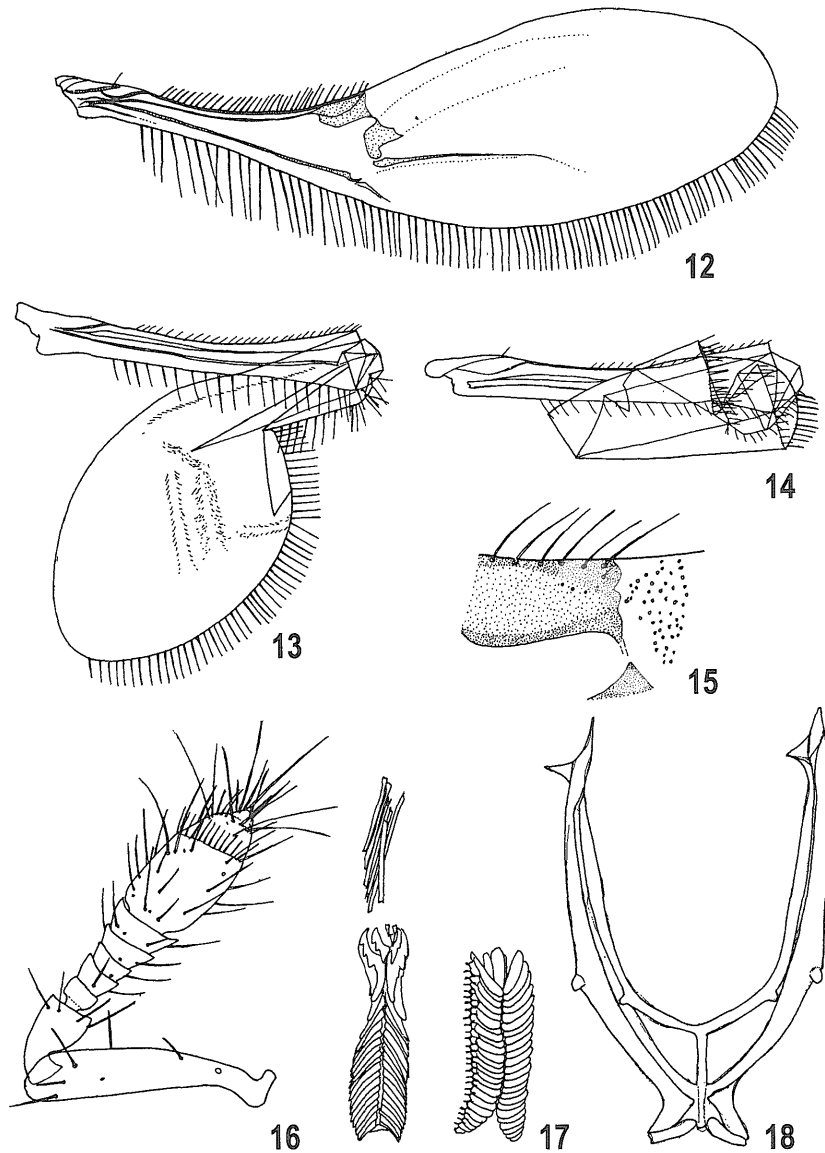
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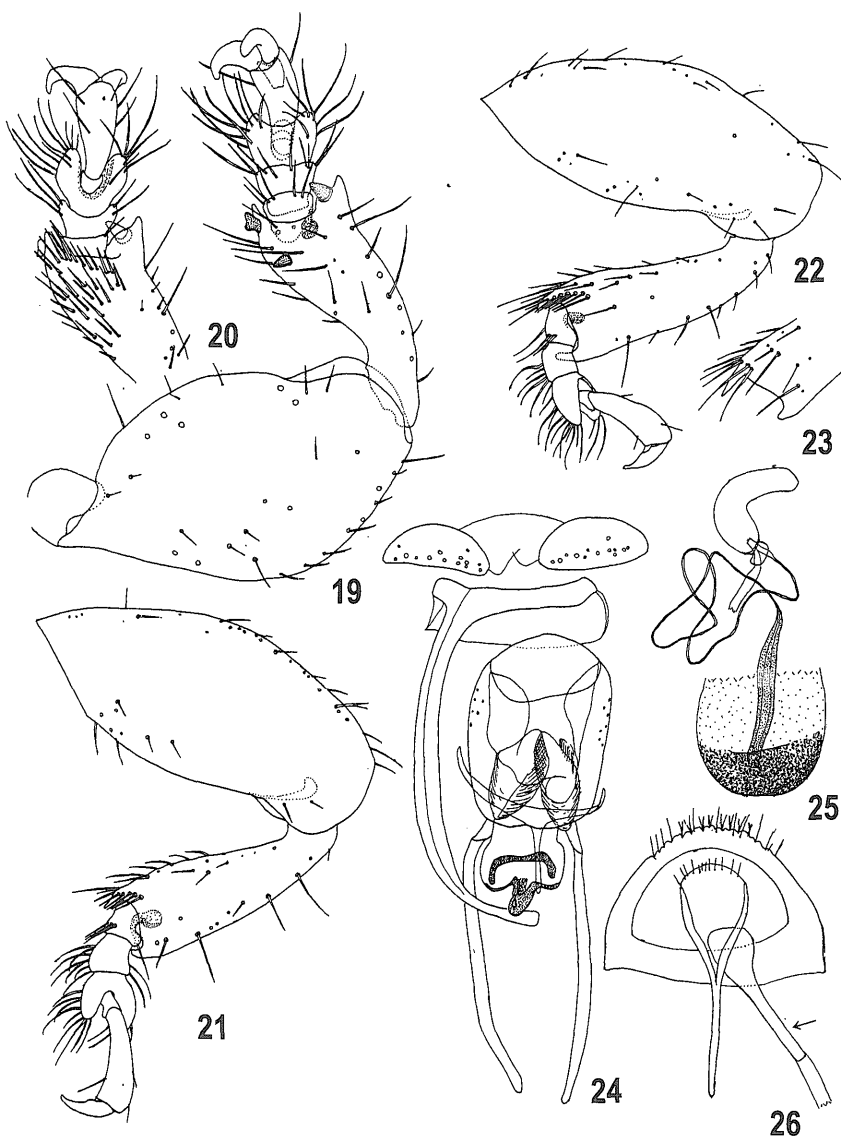
Figs. 1-4. Photographs of *Phylloplatypus pandani* by SEM. 1. Adult, lateral; 2. fore part of body, ventral (notice the cavities on fore coxae); 3, 4. mouth parts.



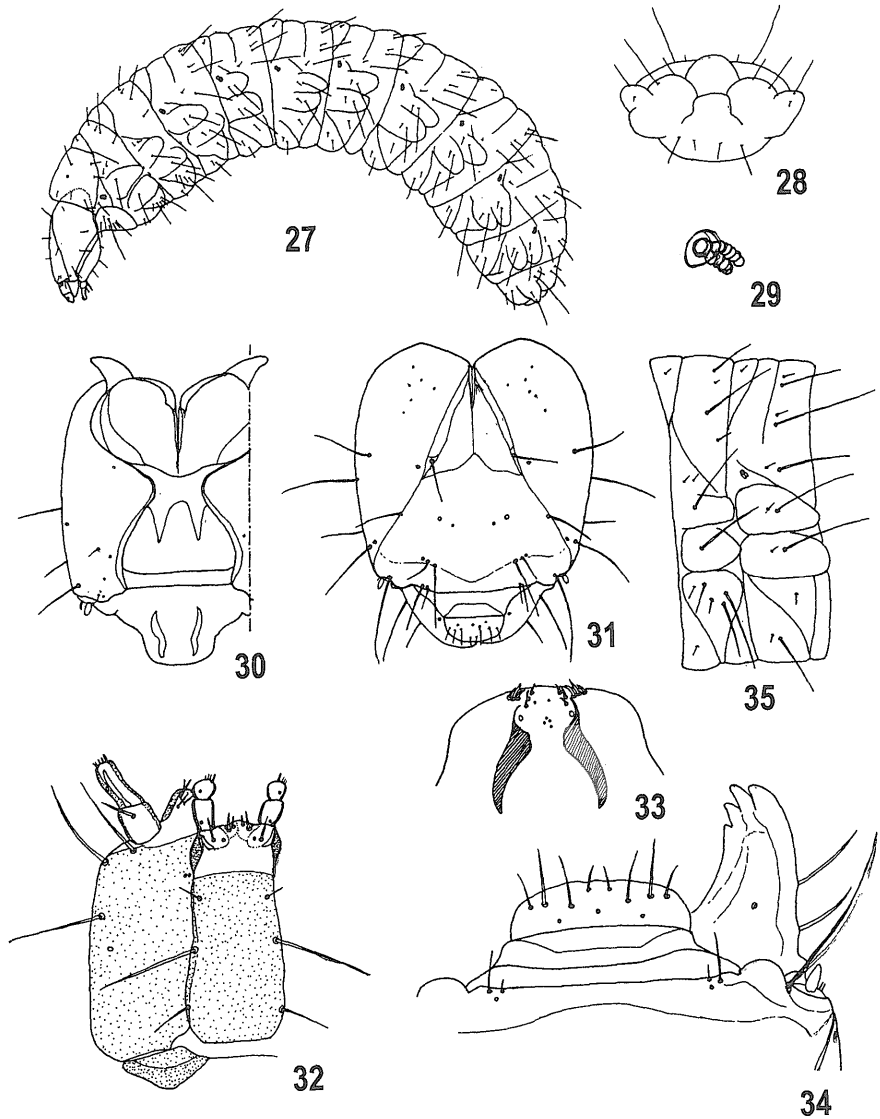
Figs. 5-11. Characters of *Phylloplatypus pandani*. 5. Adult, dorsal; 6. ditto, ventral; 7. thoraces, lateral; 8. head, ventral (tentorium and strengthening structures are added through transparent light); 9. head, dorsal (notice the dorsal tentorial pits, arrow); 10. mandible; 11. maxilla.



Figs. 12-18. Characters of *Phylloplatypus pandani*. 12-14. Hind wing and folding method; 15. stigmal patch, enlarged (showing no seta at apical margin); 16. Antenna; 17. blades of proventriculus in two foci; 18. metendosternite.



Figs. 19-26. Characters of *Phylloplatypus pandani*. 19. Fore leg (notice the spines); 20. Fore tibia and tarsus on the opposite side; 21. Middle leg; 22. Hind leg; 23. Apex of hind tibia on the opposite side; 24. Male terminalia and genitalia; 25. Spermatheca, spermathecal duct and part of vagina; 26. Female terminalia and rectum showing the oblique loop.



Figs. 27-35. Characters of *Phylloplatypus pandani*. 27. Whole larva; 28. anus, caudal aspect; 29. spiracle on second abdomen; 30. head, ventral; 31. head, dorsal; 32. labium and maxilla; 33. epipharynx; 34. clypeus, labrum and right mandible; 35. metathorax and first abdomen.