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On the Systematic Position of the Genus *Euphyllobiomorphus*: an Adelognathous Weevil with Cylindrical Rostrum (Coleoptera, Curculionidae)¹⁾

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Abstract. *Euphyllobiomorphus* is unique in its cylindrical rostrum, exposed maxillae and thin mandibles as in the Phanerognatha like an anthonomine weevil, whereas the mandibles have deciduous process and the larval antennae are cushion-shaped as in the Adelognatha. Without regard to the phanerognathous features, this genus conforms to the taxon including Phyllobiini, Polydrusini and Cyphicerini of the Adelognatha principally on the structures of the metendosternite, ovipositor, aedeagus, maxillae and elytra. In this taxon, *Euphyllobiomorphus* belongs to Phyllobiini-Polydrusini group by the connate claws and exposed maxillae in the adult and by the larval spiracles unicameral on thorax and bicameral on abdomen. In consideration of these characteristics and character polarities, stepwise change in *Euphyllobiomorphus*-Phyllobiini-Polydrusini-Cyphicerini lineage from the phanerognathous ancestor is inferred, and *Euphyllobiomorphus* is considered to be the first branch of this lineage before the loss of drilling function in the head and rostrum.

Euphyllobiomorphus was established by the senior author in the subfamily Anthonominae near *Brachyonyx*. But it was transferred to the Adelognatha and downgraded as a subgenus of the genus *Phyllobius* by Sawada (1.987). As these facts indicate, this weevil has paradoxical features like the deciduous process of the mandibles in the adult and cushion-shaped antennae in the larva as in the

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Adelognatha, whereas in the mouth-parts and rostrum are of typical Phanerognatha. Moreover, only one species in this genus, *kurosawai*, is wonderfully similar to a certain species of *Phyllobius* at first sight except for the cylindrical rostrum. The present paper is aimed to revise the systematic position of *Euphyllobiomorphus* based on the detailed morphology of the adult and larva, with review of the time-honored divisions of the Curculionidae into the Adelognatha and Phanerognatha.

Euphyllobiomorphus Morimoto

Euphyllobiomorphus Morimoto, 1962, J. Fac. Agr., Kyushu Univ., 11:386 (Type-species: *Euphyllobiomorphus kurosawai* Morimoto, 1962, by original designation; near *Brachyonyx*). – Morimoto, 1962, J. Fac. Agr., Kyushu Univ., 12:56 (in Anthonominae: Brachyonychini).

Phyllobius (*Euphyllobiomorphus*): Sawada, 1987, Gekkan-Mushi, (199):4.

Euphyllobiomorphus kurosawai Morimoto

Euphyllobiomorphus kurosawai Morimoto, 1962, J. Fac. Agr., Kyushu Univ., 11:386 (Male; Yakushima I.). – Nakane, 1963, Icon. Ins. Jpn. col. nat. ed., II:374, pl.187, fig.30. – Morimoto, 1984, Coleopt. Jpn. Col, IV:300, pl.59, fig.11.

Phyllobius (*Euphyllobiomorphus*) *kurosawai*: Sawada, 1987, Gekkan-Mushi, (199):8 (morphology, larval head, biology).

Adult:

Brownish to blackish; antennae, legs and apical half of rostrum reddish brown, apical *ventrites* or entire venter and ventral side of rostrum often reddish brown to yellowish brown; whole derm excepting rostrum, legs and antennae covered with metallic green hairy scales and sparsely with recumbent pubescence.

Head subspherical, evenly and roundly narrowed anteriorly, not constricted behind eyes, forehead between eyes as broad as the base of rostrum, with an oblong median fovea; eyes well convex from head, oval, latero-anterior in position; rostrum porrect, slender, cylindrical, weakly curved, shiny, sparsely with minute punctures, sparsely pubescent, without any trace of epistome; antennal scrobes shallow, becoming indefinite posteriorly, the lower edge directed towards the ventral margin of eye in lateral aspect; antennae slender, inserted at one-fourth from the base of rostrum, scape slender, reaching posteriorly a little beyond the anterior margin of pronotum across the median part of eye in lateral aspect when rested, clavate at apex, almost as long as funicle, funicle 7-segmented, sparsely with fine setae, not scaled, all segments slender, with relative length from base as 25: 19: 18: 14: 12: 12: 12 (70=1mm), club slender, three times as long as broad, basal segment 0.4 times as long as total length, second segment longer than broad. Tentorium of the curculionid type. Mandibles' flat extero-internally in morphological sense, with three sharp teeth, inner surface shallowly concave, its ventral cutting edge constitutes the exterior margin in ventral aspect; deciduous mandibular process present on each mandible, of the same shape to each other,

conspicuous, sickle-shaped, sharply pointed at apex, with a large tooth behind the middle, not keeled along outer margin on dorsal surface, scars not raised. Maxillae exposed, maxillary palpi exposed below mandibles. Postmentum pedunculate, narrow; prementum as long as broad, trapezoidal, with a pair of setae, apex of labial palpi on the level between the apex of postgenal arms.

Prothorax broader than long (7:6), broadest at the middle, anterior margin a little narrower than the posterior one, disc reticulately punctured, punctures smaller at anterior margin, with a shiny median carina, anterior and posterior margins truncate, anterior lateral margin weakly oblique, without ocular lobe; prosternum evenly and shallowly emarginate, fore coxae broadly contiguous, submarginal transverse sulcus apparent before coxae, but indefinite in the middle; anterior foramen just circular for fitting head.

Scutellum evident, tongue-shaped, shiny, with a few hairs at anterior part, sparsely with fine **punctures**.

Elytra parallel-sided from humeri to one-fourth from apex, about 2.2 times as long as broad, humeri rectangularly rounded, weakly depressed a little behind the base, conjointly rounded at apices; punctured striae narrow, gradually shallowed posteriorly, first and tenth striae continuous along margin of elytra, intervals flat.

Mesosternal process narrow, parallel-sided, much narrower than the base of middle femur, mesocoxal cavities connate internally; metasternum much longer than first ventrite behind coxa, with a transverse sulcus along, posterior margin, with a median short fovea at base. Metepisternal suture complete, metepistema narrow, parallel-sided on basal 3/4 and dilated at anterior end. Abdomen with intercoxal process much narrower than coxa, first ventrite behind coxa slightly shorter than the second, which being almost as long as third and fourth combined at the middle. Venter depressed medianly and notched at apex in male. Pygidium concealed.

Femora clavate, dentate. Tibiae flattened, dorsal (external) margin costate, straight, inner margin weakly bisinuate, weakly expanded internally at basal one-third, mucronate; fore tibiae weakly curved and dilated internally at apex; middle tibiae strongly and hind ones weakly dilated internally at apex. Tarsi of hind pair a little slenderer than those on fore and middle pairs, third segment bilobed, fourth segment slender, about as long as two basal segments combined. Claws connate at base, without seta.

Metendosternite Y-shaped, with slender stalk, without lateral arms, anterior margin inflected, anterior tendons narrowly distant at base.

Male terminalia with eighth sternite paired, spiculum gastrale of ninth sternite much longer than main body of penis, weakly curved at apex. Penis weakly sclerotized on dorsum, apodemes normally conjoined with penis at its latero-ventral parts, tegmen completely ringed, parameres about half as long as main body of penis, paired, connate to each other at base.

Ovipositor divided into a pair of hemistemites, hemistemite subdivided into apical and basal parts, apical part pale yellowish brown with setae at apex, basal part twice as long as apical part, not pigmented, styli absent, vagina folded, bursa copulatrix not developed, spermatheca bent at the middle, spermathecal gland less than half as long as spermatheca.

Body length: 4.3-6.2 mm (excluding rostrum).

First instar larva:

Head free, longer than broad, pale brownish, with brownish anterior margin, without marking on cranium. Pigmented anterior ocellus present. Posterior ocellus absent. Antennae of adelognathous type, papilla conspicuously projecting outwards. Hypopharyngeal bracon readily discernible, without sclerites. Frontal sutures distinguishable in entire length. Epicranial suture about half as long as head. Endocarina absent. Frons with five pairs of setae, setae 1-3 minute or often absent, setae 4 and 5 long and subequal. Dorsal epicranial setae 1, 2, 3 and 5 long and subequal, seta 4 minute. Lateral epicranial setae 1 and 2 long, and subequal. Ventral epicranial seta 1 moderately long, seta 2 short. Four minute posterior epicranial setae present. Clypeal setae minute. Labrum evenly and continuously rounded from lateral to anterior margins, labral seta 1 long, seta 2 moderately long, seta 3 short, median sensillum present, lateral sensilla present in front of seta 1. Labral rods sclerotized until posterior epipharyngeal spines. Epipharynx with three anterolateral setae, of which the outermost seta narrower and shorter, and with six small anteromedian setae, anterior median spines widely distant than the posterior pair. Epipharynx without asperities. Mandible with two apical teeth, dorsal cutting edge serrulate, with about 9 denticles, inner cutting edge of dorsal tooth simply curved, without denticles, mandibular seta 1 long, seta 2 short and placed close in front of seta 1. Premental sclerite complete, with anterior and posterior median extensions. Postmentum with three pairs of setae, the posterior pair separated by a distance approximately $2/3$ as broad that between setae of middle pair. Labial palpus two-segmented, basal segment short and transverse, apical segment longer than broad, with a sensillum. Lateral margin of stipes convex at basal seta. Maxillary palpus with two segments, basal segment with one short seta and two sensilla, apical segment with a finger-shaped appendage and with a sensillum. Mala with four ventral and six dorsal setae, the posteriormost dorsal seta **slender**.

Pronotum with six setae on disc and two short setae on latero-anterior area before spiracle. Thoracic spiracle bicameral, air tubes much longer than diameter of peritreme. Spiracular area of meso- and metathorax with two setae. Alar area of meso- and metathorax with one long seta. Prodorsum of meso- and metathorax with four setae, seta 1 moderately long, seta 2 short, seta 3 long, seta 4 of the intermediate length of the 1 and 3. Epipleuron of meso- and metathorax with two setae. Pleuron of prothorax with two setae and that of meso- and metathorax with one long seta. Pedal area with six setae, two long and four short. Sternum with one long seta.

Abdomen with eight pairs of spiracles. Spiracles all lateral, unicameral, first to seventh spiracles subequal in size or the first slightly larger than the posteriors, eighth spiracle with air tube long, 1.5-1.8 times as long as that of seventh. Typical abdominal segment with three dorsal folds. Prodorsum of the first to sixth segments with one long seta and one lateral minute seta, which being born in a socket and subequal in size to a process of asperities. Postdorsum of the first to seventh segments with five setae, setae 1 and 2 short and subequal, setae 3 and 5 long, subequal, seta 4 a little longer than 1. Spiracular area with two setae seta 1 short and seta 2 long. Epipleuron with two setae. Pleuron with two setae. Pedal area with one long seta. Eusternum with two long setae. Eighth segment of abdomen with prodorsal seta minute and latero-dorsal in position, postdorsum with three setae, spiracular area with two setae. Ninth segment with one postdorsal and two spiracular setae. Anus terminal, with a minute seta on lateral lobe. Asperities sparse on dorsal area from metathorax to sixth segment of abdomen.

Materials examined. Adults: 19 exs. from March 25 to July 21, Yakushima I. First instar larvae: 5 exs., same materials as Sawada (1987) examined, which were obtained by rearing the adults taken in May 13–15, 1987.

Distribution. Yakushima Island, lying about 60 km south of Kyushu, Japan.

Biology. According to Sawada (1987), this weevil feeds on *Cryptomeria japonica*, a conifer of the family Taxodiaceae, by inserting the cylindrical rostrum into the crowded cluster of young leaves at the tip of twigs. Several eggs are deposited in a hole made in the tip of twig as in the same manner as feeding. Egg is 0.55 x 0.4 mm in size, and its duration until hatching is about 10 days at 20°C. Adults are attracted to light at night.

DISCUSSION

The time-honored divisions of the Curculionidae into the Adelognatha and Phanerognatha must be reviewed at the outset of discussion, because *Euphyllobiomorphus kurosawai* is unique in having both characteristics of the Phanerognatha and Adelognatha as described above. These two divisions are characterized as in the followings:

Curculionidae Adelognathi

Adults

1. Mentum comparatively large and covering or nearly covering the buccal cavity, so as to conceal more or less completely the maxillae and their palpi (Lacordaire, Marshall).
2. Postmentum not or at most shortly pedunculate (Lacordaire, Marshall).
3. Rostrum more or less robust and short, with flattened dorsum or latero-dorsal carinae, never cylindrical (Lacordaire, Reitter).
4. Mandibles each with a deciduous process, with a few exceptions (Reitter, Emden, Thompson).
5. Antennae inserted near the apex of rostrum (Lacordaire, Reitter).
6. Rostrum often with triangular or semicircular emargination at apex (Reitter).
7. Mandibles robust, deeply concave internally, so as to receive maxillary palpi and mala (galeatlacinia) between them, their ventral cutting edge lying far interior to the outer contour in ventral aspect excepting Sitoninae (this paper).
8. Dorsal cutting edge of mandibles almost straight until apical tooth in dorsal aspect (this paper).
9. Postgenal arms triangular in ventral aspect, not or hardly exceeding apically beyond anterior margin of prementum (this paper).

Larvae

10. Antennae markedly wider than long, dorso-ventrally compressed, lying on anterior declivity of head, provided with a collar-like interior reinforcement at base (Emden).
11. Larvae feed on roots externally in the soil (Emden).

Pupae

12. Mandibles with setae (May).

Curculionidae Phanerognathi

Adults

1. Mentum comparatively small or narrow in relation to the buccal cavity, and leaving maxillae

- entirely or largely exposed (Lacordaire, Marshall).
2. Postmentum pedunculate (Lacordaire, Marshall).
 3. Rostrum various (Lacordaire), or rarely short, usually long and cylindrical (Reitter).
 4. Mandibles without deciduous process (Reitter, Emden).
 5. Antennae inserted about or behind the middle of rostrum with exceptions (Reitter).
 6. Rostrum truncate or feebly trisinate, or triangularly emarginate in some large weevils at apical margin (Reitter).
 7. Mandibles often thinner, weakly concave internally, and ventral cutting edge lying on the exterior margin in ventral aspect (this paper).
 8. Dorsal cutting edge of mandibles often dentate (this paper).
 9. Postgenal arms usually slender, bent internally toward apex and much exceeding apically beyond anterior margin of prementum in ventral aspect (this paper).

Larvae

10. Antennae much longer than wide, ogival or subconical (Emden).
11. Larvae feed on plant tissue internally (Emden).

Pupae

12. Mandibles without setae (May).

The Adelognatha were subdivided into six or seven subfamilies by Lacordaire and Marshall, and Coleopterorum Catalogus was compiled as such. Recently, this division was separated into Brachyceridae (including Microcerinae) and Entiminae by Thompson. His Entiminae include the tribes Sitonini, Ectemnorhinini and Pachyrhynchini. The Entiminae excluding these tribes are almost equivalent to the Otiorynchidae of LeConte or Otiorynchinae of Morimoto.

Sitonini or Sitoninae can be separated first from the rest of Entiminae by the exposed maxillae with free galea and lacinia, whereas in the other weevils of the Adelognatha examined these are fused together into mala and maxillae are at most partly exposed. The mandibles are very different from the others by the characters as in the followings: Mandibles shallowly concave internally as in the Phanerognatha; left mandible with straight dorsal cutting edge from base to apical tooth, with a cusp-like process protruding internally just behind apex; both mandibles with dense setae and scales externally. Taken into consideration of these characteristics together with reduced ovipositor, this taxon will be better to treat as an independent subfamily and placed more ancestral position as a sister taxon of Entiminae.

Pachyrhynchini or Pachyrhynchinae are another taxon without any trace of deciduous mandibular process in the adult. But, May (1978) inferred its systematic position in advance of the bulk of the Adelognatha by the presence of the setae on the mandible in the pupae, which are associated with the theca of the deciduous cusp of the teneral adult in the Adelognatha and indicated the secondary loss of the cusps in this taxon. For the loss of the cusps, she also mentioned that the mandibular cups are presumed to be tools for tearing open the hardened chamber made by weevils which pupate in the soil, and such appendages are unnecessary and could be a hindrance for *Pantorhytes*, which pupates subcortically in a fibrous cocoon in branches. Same setae are also present in the pupa of *Pachyrhynchus infernalis* by our examination. This taxon is unique in the structures of the metendosternite,

of which the ventral longitudinal flange is strongly lamellate and projects anteriorly as a vertical lamella, and the anterior tendons are widely distant. The separated fore coxae are another uncommon character to the Adelognatha.

Without regard for the phanerognathous mouth parts and rostrum, *Euphyllobiomorphus* conforms to Phyllobiini, Polydrusini and Cyphicerini (=Ptochini sensu Reitter and Morimoto) in the following characters:

1. Metendosternite Y-shaped, without lateral arms, with slender stem, and with inflected anterior margin.
2. Ovipositor developed, divided into two parts, basal part very often membranous, vagina long and folded.
3. Basal segment of maxillary palpi oblique at apex so as to bend the palpi upwards (internally in situ), and with two setae and one sensillum at anteroventral corner (anterolateral corner in situ). (These character states are also observed in some of the other taxa.)
4. General resemblance with rather soft integument, vestiture, flattened tibiae, open corbel of hind tibiae, rectangular humeri of elytra, etc.

These tribes can be divided into the following groups and subgroups as:

1. *Euphyllobiomorphus*–Phyllobiini–Polydrusini group. Adults: prementum narrower, leaving–maxillae more or less exposed, claws connate at base. Larvae: apex of abdomen not sclerotized; spiracles bicameral on thorax and unicameral on abdomen.
 - a. Polydrusini. Ovipositor with styli, antennal scrobes curving downwards before eyes, deciduous process of mandibles not dentate but weakly dilated internally in the middle.
 - b. Phyllobiini. Ovipositor without styli, antennal scrobes dorsal on rostrum, deciduous process of mandibles dentate internally a little behind the middle.
2. Cyphicerini group. Adults: prementum almost completely concealing maxillae, claws free. Larvae: apex of abdomen sclerotized, spiracles annular, with or without vestigial air tubes.

By the character states mentioned above, *Euphyllobiomorphus* can be attached to Phyllobiini when the phanerognathous mouth organs and cylindrical rostrum are ignored. The phanerognathous characteristics of *Euphyllobiomorphus* are as follows:

1. Rostrum cylindrical, as broad as forehead between eyes, without any punctured striae nor carinae.
2. Head subspherical, with convex eyes on anterolateral face.
3. Mandibles thinner, with rather sharp teeth, shallowly concave internally and the ventral cutting edge constitutes the exterior margin in ventral aspect.
4. Postmentum pedunculate.
5. Postgenal arms slender and much protruding anteriorly beyond anterior margin of prementum.
6. Epistome and its setal fringe absent at the apex of rostrum.

Furthermore, porrect rostrum, straight sutures of ventrites and not uncinata tibiae bring this genus close to Anthonominae and Eugnominae in appearance.

Taken into consideration of all characteristics mentioned above, the following inference could be drawn for their stepwise change in *Euphyllobiomorphus*–Phyllobiini–Polydrusini lineage in the

Adelognatha as follows:

- Step 1. Ancestor of Curculionidae is possibly phanerognathous and larvae feed on plant tissue internally.
- Step 2. Deciduous process of mandible occurs parallel in several taxa for breaking its way out of the cocoon or through the soil from the pupal cell under the ground, and is different in shape according to the taxa.
- Step 3. Antennae (sensory appendage of penultimate segment in morphological sense) in the larvae become cushion-shaped in several taxa including Adelognatha, Ceutorhynchinae and *Lissorhoptrus*.
- Step 4. Rostrum loses its function for drilling hole for feeding or oviposition.
- Step 5. Rostrum becomes shortened in accompanying with changing function of head.
- Step 6. Mandibles become thick and deeply concave internally with the simultaneous development of the ventral cutting edge for the adaptation to bite the soft part of plants.
- Step 7. Enlargement of prementum coincides with the concealing of the maxillae, shortening of postgenal arms, and shortening of postmentum.

Euphyllobiomorphus can be assigned to step 3, whereas Phyllobiini and Polydrusini to step 6 and Cyphicerini and the bulk of Adelognatha to step 7 in this hypothesis.

Another amphibious taxa having the characters of the Adelognatha and Phanerognatha are *Metacinops* and *Auchmeresthes*, which were established by Kraatz near *Metallites*, a subgenus of *Polydrusus*. The former has often been classified in the Phyllobiini and the latter in Polydrusini by some European authors, or in the independent subfamilies Metacinopinae and Auchmeresthinae respectively since Reitter (1912 & 16). But, Faust (1885) assigned both to Eugnominae. One more example of this kind was reported by Oberprieler (1991) on a species without giving name, whose weevil is an Adelognatha with elongate rostrum. He concluded on this paradox weevil that the long rostrum of some Adelognatha is a secondary modification, allowing them to force open the tight, stiff sheaths of flowers and seed heads to feed on the inner floral parts and seeds, instead of a reversal to the ancestral state, where it is primarily used to make oviposition holes into plant tissues. Ectemnorhinini are the another interesting tribe in the Adelognatha, but remain unknown to us.

Euphyllobiomorphus kurosawai does not lost the drilling function by its subspherical head and cylindrical rostrum on the contrary to the Oberprieler's weevil.

Contribution to this genus by Sawada (1987) is remarkable, but whose treatment of *Euphyllobiomorphus* as a subgenus of *Phyllobius* is apparently unjust because he emphasized the similarity but did not paid any interest on the difference. *Euphyllobiomorphus* is considered to deserve an important position for the phylogenetic study of the Curculionidae as mentioned above as a full genus.

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Explanations of Figures 1-38

1–5. *Euphyllobiomorphus kurosawai*.

1: Male. 2: Male rostrum. 3: Ventral side, female. 4: Mesocoxal cavity, lateral view showing internal connection. 5: Hind wing.

6-11. Deciduous mandibular process of:

6,7: *Euphyllobiomorphus kurosawai*. 8: *Phyllobius longicornis*, dorsal. 9: *Scythropus ornatus*, dorsal. 10: *Macrocorynus naso*, dorsal. 11: *Macrocorynus variabilis*, dorsal.

12-14. Mandible, showing ventral cutting edge of:

12: *Euphyllobiomorphus kurosawai*. 13: *Phyllobius rotundicollis*. 14: *Sitona japonicus*.

15-19. *Euphyllobiomorphus kurosawai*.

1.5: Eighth and 9th sternites, male. 16: Male aedeagus, dorsal and lateral. 17: Meso- and metendosternites of thorax, internal. 18: Ovipositor, lateral. 19: Ovipositor of *Scythropus scutellaris*.

20-32. First instar larva of *Euphyllobiomorphus kurosawai*.

20: Head, dorsal. 21: Head, ventral. 22: Antenna, dorsal and lateral. 23: Apex of right mandible, showing serrulate dorsal cutting edge. 24: Mentum and maxilla. 25: Anterior part of body from prothorax to 2nd segment of abdomen, left lateral. 26: Caudal part of body from 7th to 10th segments of abdomen, left lateral. 27: Epipharynx. 28: Clypeus and labrum. 29: Thoracic spiracle. 30: First spiracle of abdomen. 31: Seventh spiracle of abdomen. 32: Eighth spiracle of abdomen.

33-38. Mouth-parts by SEM, ventral and apical aspects of:

33,34: *Euphyllobiomorphus kurosawai*. 35: *Phyllobius intrusus*. 36: *Scythropus isshikii*. 37,38: *Anthonomus terreus*. (**pga**: postgenal arm, vce: ventral cutting edge)











