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EULICHADIDAE: Description of the larva of *Eulichas dudgeoni* JÄCH, with comparative notes on larvae of other *Eulichas* spp., and on *Stenocolus scutellaris* LECONTE (Coleoptera)

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Abstract

The larva of *Eulichas dudgeoni* JÄCH, 1995 (Coleoptera: Eulichadidae) from Hong Kong is described and compared with the larva of *Stenocolus scutellaris* LECONTE, 1853 from California, USA, and *Eulichas* spp. from Malaysia.

Key words: Coleoptera, Elateriformia, Eulichadidae, larvae, systematic position.

Introduction

The Eulichadidae is a very small family comprising two genera: *Eulichas* JACOBSON, 1913, with 20 known species widely distributed in China and the Oriental Region and *Stenocolus* LECONTE, 1853, monotypic, known only from California, North America.

Adults of *Eulichas* were extensively treated by JÄCH (1995). They are characterized by their comparatively large size and elaterid-like general appearance.

Larvae of both genera have never been reared, but were always collected in the same area associated with the adults. Larvae are aquatic while the adults are terrestrial.

BÖVING & CRAIGHEAD (1931) figured for the first time an Asiatic ptilodactylid larva from „Hang Chow" [= Hangzhou, Zhejiang], later identified as *Eulichas* sp.; LEECH & CHANDLER (1956) reproduced BÖVING & CRAIGHEAD's (1931) figures of *Eulichas* sp. to illustrate their larva of *Stenocolus scutellaris* LECONTE, 1853. LAWRENCE (1991) was the first to present formal descriptions of the larvae of both genera.

Considering that the systematic position of Eulichadidae is not well defined yet and is in need of more accurate studies, we find useful to describe here in more detail the larva of *Eulichas*, comparing it with *Stenocolus* and pointing out their main similarities and differences.

Material & Acronyms

The larval description of *Eulichas dudgeoni* is based on the following material identified by M.A. Jäch: 4 specimens from Hong Kong, New Territories, Tai Po Kau, collected by W.D. Shepard on January 2, 1997 (CSUS) and 2 specimens from the same locality collected by D. Dudgeon (ISZE).

In addition, we examined 7 larvae of *Eulichas* sp. (representing two species: *E.* sp. 1 and *E.* sp. 2) from Malaysia (Gombak River, Station III, leg. J.E. Bishop, BMNH), labelled as *E. subocellata*

FAIRMAIRE. The name *E. subocellata* is almost certainly incorrect, because *E. subocellata* was described from Borneo and it is doubtful that this species occurs in Peninsular Malaysia.

The material of *Stenocolus scutellaris* examined is the following: 6 specimens from California, Tulare Co., 10.3 miles NNE Springville, Tule River, 27.VI.1992 and 3 specimens from California, El Dorado Co., 1 mile W Placerville, Webber Creek, all specimens collected by W.D. Shepard (CSUS).

BMNH The Natural History Museum, London (C.M.F. von Hayek)
CSUS California State University, Sacramento (W.D. Shepard)
ISZE Institut für Spezielle Zoologie und Evolutionsbiologie, Universität Jena, Jena (R. Beutel)

DESCRIPTION OF LARVA

Eulichas dudgeoni JÄCH, 1995
(Figs. 1 - 24)

Larva (probably last instar), (Fig. 1). Length: 62 mm, width: 8.0 mm at abdominal segment IV. Dark-brown, dorsal impressions and tergite IX darker; ventral region pale-yellow. Body elongate, parallel-sided, straight, subcylindrical. Integument micrograniulate and dull mainly on dorsal surface; with short and elongate setae and scattered tufts of elongate setae.

Head. (Figs. 10 - 11) Prognathous, strongly retracted into pronotum; almost quadrangular, slightly flattened, deeply emarginate posteriorly forming a broad niche for attachment of retractor muscle, densely punctated and densely covered by longer and shorter setae. Epicranial suture and median endocarina absent. Stemmata consisting of a single large and projected lens, divided in two halves by a dull stripe, one anterior (smaller) and one posterior. Antennae 3-segmented; second segment bearing one small dome-shaped sensorial cone and reduced distal segment, with many apical microsensilla (Fig 6). Frontoclypeal suture present, sinuous; each side of anterior part of frons with one mound-like projection densely clothed with short stout bristles, just in front of the base of antennae; discal region with three more or less aligned mound-like projections, the inner one the smaller and two large mound-like projections near the broad emargination of the posterior margin of the head. Clypeus transverse, divided into anteclypeus and postclypeus; anteclypeus smooth, transparent; postclypeus bearing four transversely aligned mound-like projections, the inner ones bigger and rounded, the outer ones smaller and lens-like. Labrum free, upturned, with four small mound-like projections near apex, the median ones more projected and bordered by a pair of short setae; almost smooth behind tubercles. Epipharynx (Fig. 14) with an anterior curved row of 42 small setae, slightly separated at middle; four patches of microsetae and microsensilla forming two anterior and two posterior groups on median region. Mandibles (Figs. 12 - 13) symmetrical, 4-dentate, one apical tooth, two subapical teeth, one mesal posterior tooth; mesal surface of mandibular base with an articulated, pubecent process. Ventral mouthparts retracted; densely covered by microsetae. Maxilla (Fig. 16) with small articulating area; cardo transverse, with one small seta posteriorly; stipes elongate, with one short and one elongate seta laterally and a small group of microspatulate setae on anterior inner lateral margin, several shallow pits present; palp 4-segmented, distal segment reduced and with several apical microsensilla; galea articulated, oval-elongate, apex acuminate and bearing a dense cluster of short spatulate setae near apex, a brush of large spatulate setae, one on ventral and five on dorsal areas; lacinia articulated, oval-elongate, apex rounded with three dentiform processes, each one intercalate with one lacinial tooth; about 16 lacinial teeth are present forming a posteriorly open ellipsis. Labium (Fig. 16) partially fused to base of mentum; palps 2-segmented, palpiger well developed, distal segment reduced and with several apical microsensilla, proximal segment with 1 sensorial pore, ligula rounded and broad, densely clothed by fine hairs; prementum

membranous with two parallel rows of bristles and a few shallow pits, mentum partially divided in three sclerites, the median one well defined and small, only a pair of short and longer setae present at base, several scattered shallow pits or punctures present. Hypopharynx (Fig. 15) densely clothed by very fine hairs, hypopharyngeal suspensorium consisting of paired rods, hypopharyngeal scleroma absent. Ventral epicranial ridges and posterior tentorial pits present (Fig. 11), a row of long hairs along ventral epicranial ridges. Gula trapezoidal, smooth. Membrane of post-gula with 3 weakly sclerotized areas and 2 lateral clusters of 5-6 spatulate setae.

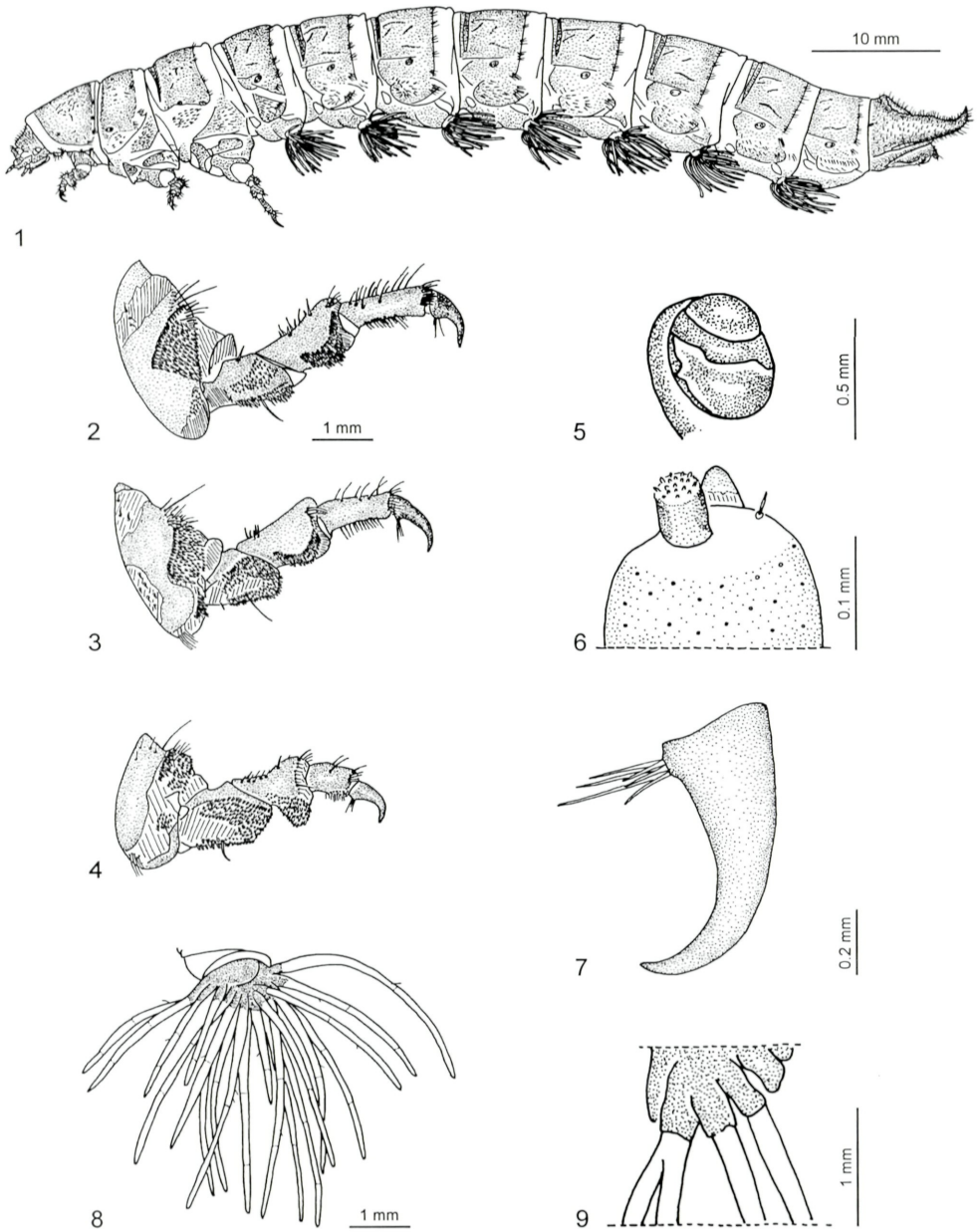
Thorax. Prothorax almost trapezoidal, slightly longer and less wide than mesothorax, with a large patch of small irregular smooth impressions each median side. Mesothorax and metathorax transverse slightly wider and shorter than prothorax, with smaller patches of irregular smooth impressions each median side. Spiracles: 2 pairs, mesothoracic pair large, annular-biforous, metathoracic pair strongly reduced. Legs (Figs. 2 - 4) well-developed, increasing in length from front leg to hind leg. Front leg (Fig. 4): coxa slightly oval, with small patches of bristles associated with a few long hairs, trochanter longer than femur, with a large ventral patch of bristles, and one very elongate hair; femur slightly longer than tibia, with ventral patch of bristles and dorsal and basal small setae associated; tibia, the narrowest segment, with a few bristles and long hairs. Middle leg (Fig. 3): coxa slightly oval-elongate, with large patches of bristles, longer and shorter hairs some of them forming tufts; trochanter almost same length of femur, with a large ventral patch of bristles and one very elongate hair; femur shorter than tibia, with small ventral patch of bristles and a few dorsal short setae associated; tibia very narrow and elongate with a few dorsal and ventral long hairs. Hind leg (Fig. 2) the largest: coxa oval-elongate with large patches of bristles, longer and shorter hairs some of them forming tufts; trochanter as long as femur, with a large ventral patch of bristles and one very elongate hair; femur smaller in length than tibia with small ventral patch of bristles and a few dorsal short setae associated; tibia very narrow and elongate with a few dorsal and ventral long hairs. Tarsungulus (Fig. 7) similar in all legs, with three pairs of basal setae, each pair formed by a long and a short seta.

Abdomen subcylindrical, sides almost parallel and subequal in width to metathorax. Each side of abdominal terga I-VIII (Fig. 21) with one anterior transverse, smooth, dark impression to which converge two pairs of subparallel impressions, one short and one longer; median region with a pair of small transverse impressions on discal region and a patch of irregular ones on lateral sides; posterior margin with 6 tufts of hairs (4 dorsal and 2 lateral behind spiracle) forming a transverse row and 15 - 20 irregular tufts of hairs on the anterior lateral region near spiracles. Abdominal sterna I-VII each with a pair of tracheal-gills, each one having two main groups of 10 imbricate gills (Fig. 8); each main group is ordered in two subgroups of 3 + 6 branches; outer branch bifid (Fig.9). Segment IX (Fig. 23) tapering towards apex, bearing a pair of well developed fixed upturned urogomphi; median region of dorsum slightly concave and wrinkled; anterior region bearing a pair of transverse tubercles depressed at bases. Segment X (Fig. 24) ventral, pygopod-like, with 6 anterior and 2 posterior elongate setae; anal slit y-shaped between two prominent, fleshy lobes. Spiracles (Fig. 22): 2 pairs on each segment I-VIII, lateral, slightly raised above surface of integument, approximately of same size, annular-biforous, elongate oval, ecdysial scar present, closing apparatus absent.

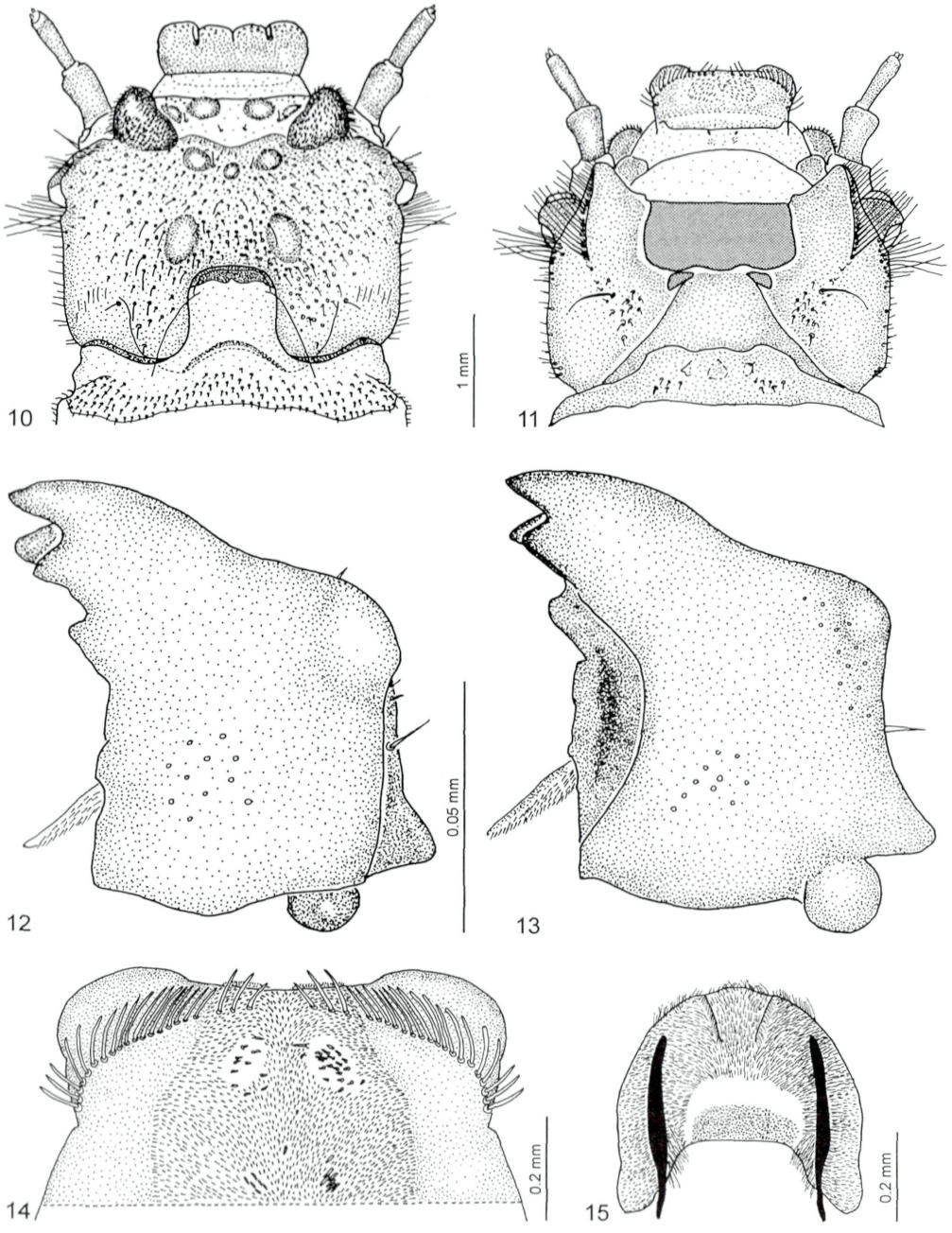
Comments on the systematic position of Eulichadidae

Pic (1914) included *Eulichas* and *Stenocolus* in the Dascillinae, Dascillidae. Forbes (1926) correlated Eulichadidae (as Lichadidae) with Callirhipidae (genera *Zenoa* Say, 1835 and *Callirhipis* Latreille, 1829) based on the similarities of the wing venation and wing folding.

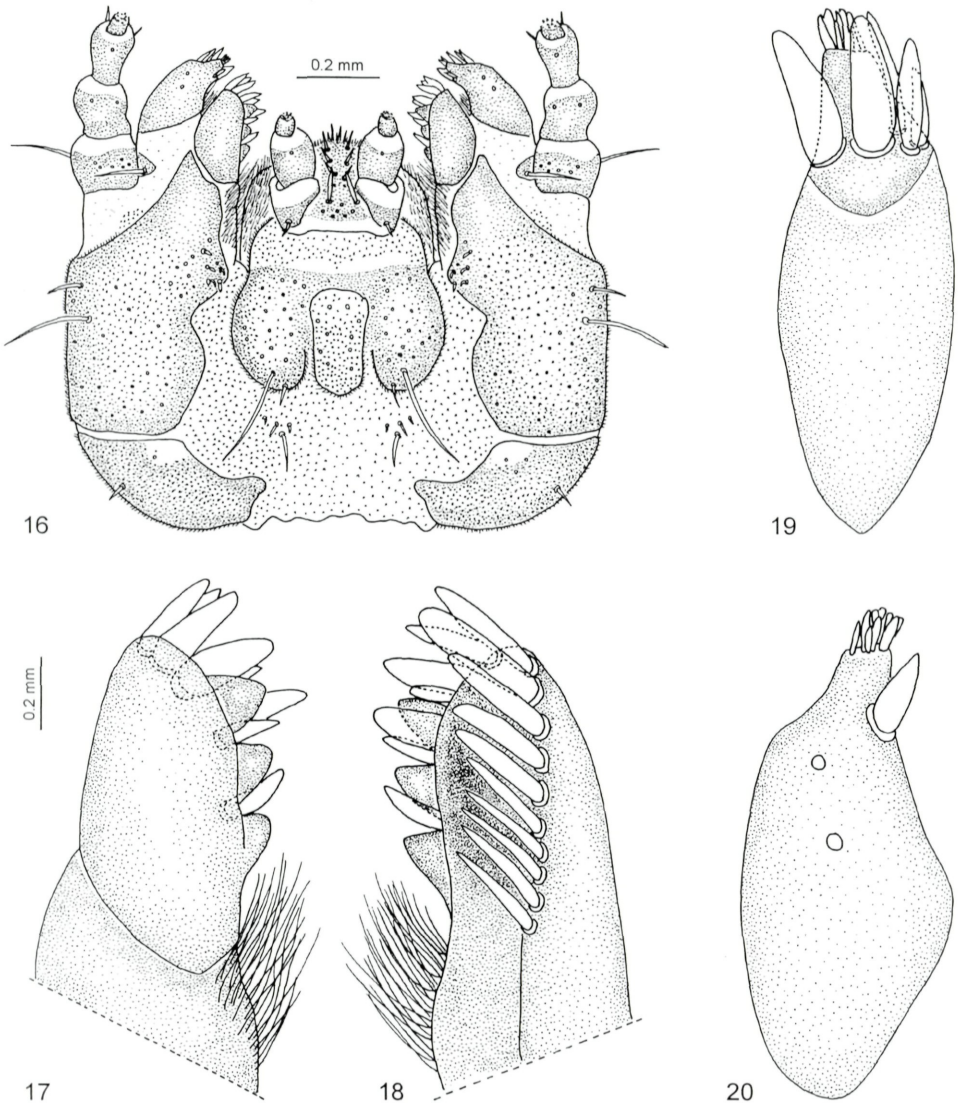
According to Crowson (1967) the empodium, the wing-venation and the metendosternite of *Eulichas* suggest affinities to the Rhipiceroidea.



Figs. 1 - 9: *Eulichas dudgeoni*, larva: 1) habitus; 2) hindleg; 3) middle leg; 4) frontleg; 5) left stemma; 6) apex of antenna; 7) tarsungulus; 8) right tracheal-gills, abdominal segment V; 9) same, detail of outer branches.



Figs. 10 - 15: *Eulichas dudgeoni*, larva: 10) head, dorsal view; 11) head, ventral view; 12) right mandible, dorsal view; 13) left mandible, ventral view; 14) epipharynx; 15) hypopharynx.



Figs. 16 - 20: *Eulichas dudgeoni*, larva: 16) maxillo-labial complex; 17) apex of lacinia, ventral view; 18) apex of lacinia, dorsal view; 19) galea, dorsal view; 20) galea, ventral view.

KASAP & CROWSON (1975) concluded that the systematic position of Eulichadidae is somewhat ambiguous when taking into account the abdominal skeleton and musculature. They considered that there are clear resemblances of Ptilodactylidae, Psephenidae, and Callirhipidae; and, stressed that these structural similarities to Eulichadidae may be correlated with considerable similarities in habits, although this seems not to be the case of Callirhipidae. The authors pointed out that

further information should be obtained on the soft parts of Eulichadidae, Ptilodactylidae, Callirhipidae, etc. to contribute to a solution of these problems.

CROWSON (1978) included Eulichadidae in the Dryopoidea. He considered the wing-venation and folding, and the male paraprocta not fused medially in front of the proctiger, as plesiomorphies. On the other hand, the elongate sclerotized ovipositor (with articulated gonapophyses) of the adult, the plurisetose ungues and the large second pair of thoracic spiracula of the larva were regarded as apomorphies, they together suggest that Eulichadidae might be a sister-group to the rest of the Superfamily.

LAWRENCE & NEWTON (1982) also included Eulichadidae in the Dryopoidea, and stressed the similarity of the mandibular mola, specialized ovipositor and the lacking of functional eighth spiracles. LAWRENCE (1988) redefined Dryopoidea forming an enlarged group, the Psephenoidea. LAWRENCE & BRITTON (1991, 1994), and LAWRENCE & al. (1995), considered Eulichadidae and Callirhipidae in their expanded Byrrhoidea; in this last study the authors stated that both families usually cluster with ptilodactylids and chelonariids at the base of the Elateroidea (including Cantharoidea plus Artematopoidea).

BEUTEL (1997) considered Eulichadidae as sister group of Ptilodactylidae (excl. *Araeopidius* COCKERELL, 1906 and Cladotominae) due to the mandibles and segment X of the larvae.

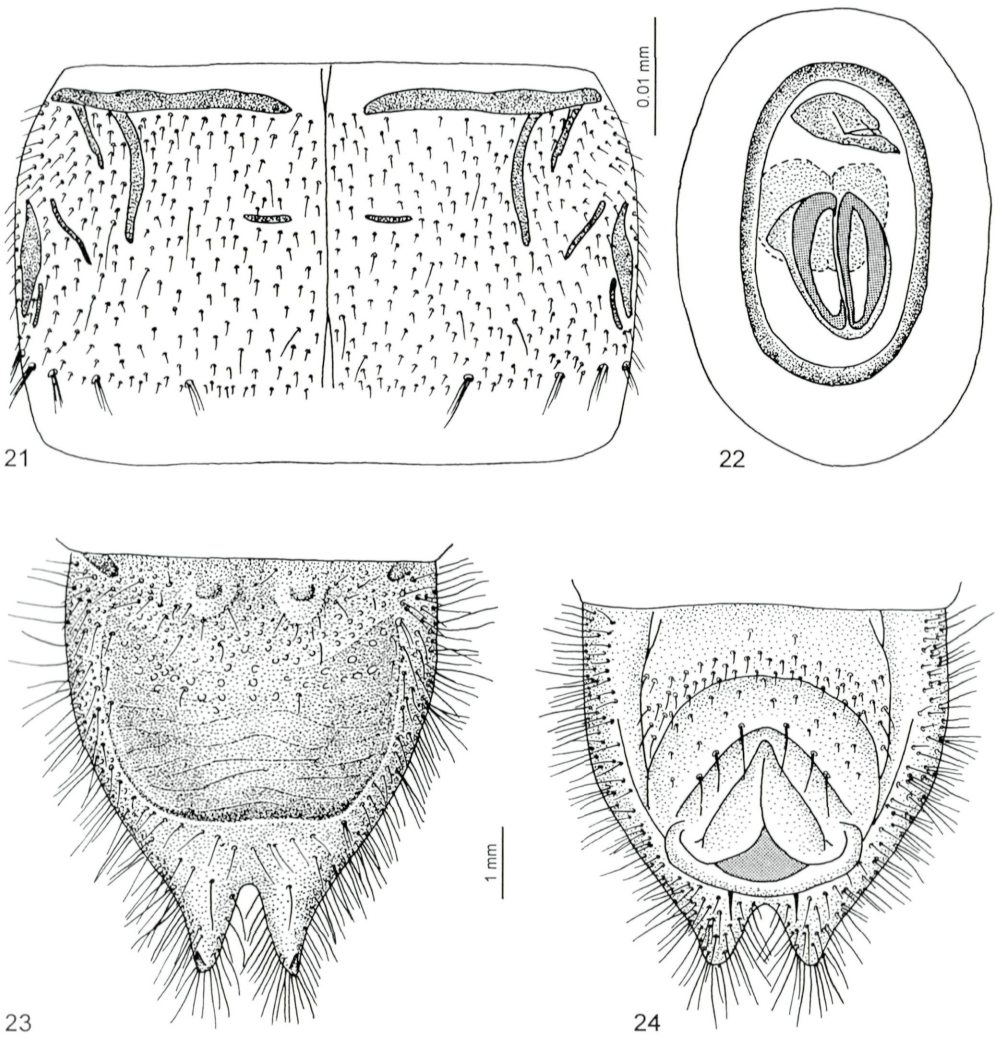
COSTA & al. (in press) point out that the monophyly of Byrrhoidea (sensu LAWRENCE & NEWTON 1995) could not be supported by any synapomorphy. However, after excluding Eulichadidae and Callirhipidae the monophyly of the remainder taxa could be supported by three synapomorphies, the most striking being the wing folding of the dryopoid-type. The conspicuous elateroid pattern of wing folding led the authors to set Callirihipidae and Eulichadidae as „incertae sedis" within the Elateriformia. As a result of the phylogenetic analysis they concluded that aquatic larvae present many highly adaptative and homoplastic structures; and it seems that they probably evolved independently in different lineages, being subjected to convergent adaptation to life in that environment.

Discussion

Larvae of *Eulichas dudgeoni* and *Stenocolus scutellaris* share the following characters: body elongate, parallel-sided, straight, subcylindrical; head prognathous, strongly protracted into pronotum; epicranial suture and median endocarina absent; stemmata consisting of a single large and projected lens; labrum free, upturned; mesal surface of mandibular base with an articulated, setose process; labium partially fused to base of mentum; mentum almost tripartite; abdominal sterna I-VII each with a pair of gills; non-functional metathoracic spiracle present; segment IX tapering towards apex, bearing a pair of well developed fixed upturned urogomphi; anal slit y-shaped between two prominent, fleshy lobes.

CROWSON (1978) called attention to the presence of two pairs of thoracic spiracula in Eulichadidae, a rare condition for larval Coleoptera. He considered the possibility of both pairs being functional. However, the second pair is strongly reduced. When dissected, no connection with trachea was observed, thus evidencing that the metathoracic spiracula are not functional.

Eulichas dudgeoni differs from *S. scutellaris* mainly by the stemmata divided in two halves by a dull stripe, one anterior (smaller) and one posterior; by the labrum with four small mound-like projections near apex (with two less proeminent lateral projections in *S. scutellaris*); by mesal surface of mandibles without a tuft of small setae; by the frontal area tuberculate (depressed in *S. scutellaris*); by a pair of well developed urogomphi and anterior region of segment IX bearing a pair of transverse tubercles depressed at their bases (less developed urogomphi and anterior region of segment IX without tubercles in *S. scutellaris*).



Figs. 21 - 24: *Eulichas dudgeoni*, larva: 21) abdominal segment IV, dorsal view; 22) spiracle of abdominal segment III; 23) abdominal segment IX, dorsal view; 24) abdominal segments IX and X, ventral view.

The larvae of *Eulichas* sp. 1 and *E.* sp. 2 from Malaysia are very similar to *E. dudgeoni* and agree in all characters pointed out above to differentiate *Eulichas* from *Stenocolus*, thus corroborating the generic status given to these two clades.

Larvae of *Eulichas dudgeoni*, *Eulichas* sp. 1 and *Eulichas* sp. 2 differ mainly in regard to the following:

1) Integument of terga of abdominal segments I-VIII. In the three species, the proportion between the smooth and velvity areas varies. The proportion and position of the dark and smooth impressions are very alike, and may present some variation in the same species.

2) Structures on dorsum of abdominal segment IX: a) extension and depth of dorsal depression; more concave and extending to lateral margins in *E.* sp. 2; b) presence of wrinkles; wrinkles are present in *E. dudgeoni* and *E.* sp. 1, but completely absent in *E.* sp. 2; c) size of anterior tubercles; in *E. dudgeoni*, the tubercles are more developed, each one bearing a basal depression; in the two other species they are flatter and without the basal depression.

In addition, we registered some differences concerning the tubercles of head. Larvae of *Eulichas* sp. 1 have a larger number of tubercles and a V-shaped elevation on frons. However, these differences should be considered with care and deserve further studies, based on more representative material, because they seem to be subject to intraspecific variation.

Notes on habitats and bionomics

Bionomic data are very scarce in the literature; Jäch (1995) reported larvae of *E. dudgeoni* living in streams with sandy substrate and large quantities of adults collected with light traps placed near forest streams. Leech & Chandler (1956) mention that adults of *S. scutellaris* are found along streams up to an elevation of 4000 feet and associated larvae have been taken in about the same area in streams varying from small creeks to rivers where they burrow in the substratum of the stream, feeding upon the roots of trees and other vegetation.

We have examined the gut contents of one larva of *E. dudgeoni* and have found a lot of small pieces of wood.

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