

Diplopoda from Malayan caves, collected by M. Pierre Strinati

by

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With 34 text-figures

ABSTRACT

Four species of Diplopoda taken in caves near Kuala Lumpur, Malaya, are described. *Orthomorpha fluminoris* (Paradoxosomatidae) is related to *O. murphyi* Hoffman, from Singapore. Notes on this genus and a key to the three Malayan species are given. *O. bipunctata* (Sinclair) is redescribed from the original types. *Ascetophacus reclinatus* (Doratodesmidae) appears close to *A. macclurei* Hoffman, known from the Batu Caves; the new genus *Cerastelachys* is set up to accomodate *Doratonotus cavernicola* Sinclair, which is redescribed from its type material.

Trachyjulus silvestrii (Cambalopsidae) is a near relative of *T. heteropus* Silvestri, also a Malayan cave species. *Plusioglyphiulus grandicollis* is only tentatively referred to this genus, it differs from the type species in a number of important details. A short essay on nomenclature of tergal crests in cambaloids is presented.

INTRODUCTION

Knowledge of the interesting diplopod fauna of the Malay Peninsula has grown in a sporadic way over the past century and remains today in a very fragmentary and inadequate condition. Many of the existing works on the subject have, actually, contributed little more than confusion and uncertainty. In light of these facts, any opportunity to study Malayan specimens is most welcome, and it was with particular pleasure that I received from Dr. Bernd Hauser a small collection of millipeds made in several caves by the renown speleobiologist Pierre Strinati. Investigation of this material has revealed the existence of new taxa and has also compelled attention to the status of some related forms described from Malaya by F. G. Sinclair in 1901. In all, the state of our knowledge has been materially improved as a result.

Appreciation is here expressed to Dr. Hauser for transmitting the specimens from the Museum d'Histoire naturelle de Genève (to which all types and most of the other

material has been returned), and to Dr. C. B. Goodhart of the University Museum of Zoology, Cambridge, for the generous loan of types of Sinclair's species.

Inasmuch as the localities cited by Sinclair in his 1901 paper are for the most part difficult or impossible to locate on recent maps, it is useful for students of Asiatic Diplopoda to know that details of the "Skeat Expedition" are available in a complete summary of that enterprise written by the expedition leader himself (SKEAT 1953).

Dr. Strinati's material was taken in the celebrated Batu Caves, now located within the northern confines of Kuala Lumpur, and at Gua Anak Takun, in Templer Park, 22 km from that city.

PARADOXOSOMATIDAE

Orthomorpha

Orthomorpha Bollman, 1893, *Bull. U.S. Natl. Mus.*, No. 46, p. 159. Type species, *Polydesmus beaumontii* LeGuillou, 1841, by subsequent designation of Pocock, 1909.—JEEKEL, 1964, *Tijdschr. Ent.*, vol. 107, p. 359.

This genus has been refined through the recent work of C. A. W. JEEKEL into a compact and homogeneous ensemble of species endemic in southeast Asia and Java. The arrangement published by him in 1964 is expected to be still further improved as the result of current research leading to exclusion of some alien elements, and it is possible that only those species included in his original Group A will be retained in *Orthomorpha*.

In general appearance and peripheral structure as well as in gonopod details, the species of this delimitation (about 16 in all) are quite similar, and reliance must be placed on relatively subjective characters to accomplish separation. Several species-groups can be distinguished on the basis of male characters, notably modification of the 5th sternum:

- Group 1. Sternum of 5th segment without processes
 - O. unicolor* Attems, 1930; Java
 - O. hydrobiologica* Attems, 1930; Java
 - O. spinala* Attems, 1932 Karimon; Djawa
 - O. cambodjana* (Attems, 1953); Indochina
- Group 2. Sternum of 5th segment with a single median process
 - O. glandulosa* (Attems, 1937); Indochina
 - O. bipunctata* (Sinclair, 1901); Malay Peninsula
- Group 3. Sternum of 5th segment with paramedian conical processes
 - O. karschii* Pocock, 1895; Burma
 - O. insularis* Pocock, 1895; Burma
 - O. rotundicollis* (Attems, 1937); Indochina
 - O. murphyi* Hoffman, 1973; Singapore
 - O. scabra* Jeekel, 1964; Indochina
 - O. tuberculata* (Attems, 1937); Indochina
 - O. weberi* (Pocock, 1894); Java
 - O. conspicua* (Pocock, 1894); Java
 - O. francisca* Attems, 1930; Lombok
 - O. flaviventer* (Attems, 1898); Java

The status of the various names published by Pocock in 1895 for taxa related to *O. karschii* has been reviewed by Jeekel in 1970, his conclusion being that *clivicola*, *palonensis*, *monticola*, and *gestri* are all synonyms of *O. insularis*.

The remaining species of Group 3 can be further aggregated, in that the last four of the list, from Java and Lombok, have the median tibiotarsal lobe of the gonopod considerably reduced in size. The three Indochinese species require re-examination to verify their generic status.

It is noteworthy that no species of *Orthomorpha* has been found on Sumatra and it is safe to assume that the genus is not represented there. Only two are known so far from the Malay Peninsula: the long-enigmatic "*Strongylosoma bipunctatum*" of SINCLAIR (1901) and *O. murphyi* Hoffman (1973) from Singapore.

A distributional map (Fig. 11) has been prepared to show something of the geographical affinities of the Malayan orthomorphas. Species of the *Karschii-Insularis* group are indicated by circles with a dot in Burma, *O. karschii* itself being known only from southern Tenassarim and offshore islands, *O. insularis* chiefly from the vicinity of Tavoy on north into mainland Burma. *O. murphyi* and *O. fluminoris* (black dots) are south Malayan forms, whilst *O. bipunctata* seems to be closest to *O. glandulosa* of Vietnam. The remarkable absence of records for *Orthomorpha* from Thailand must be due to a lack of collecting in that country.

Dr. Strinati obtained a single male specimen at the Batu Caves, representing a species related to but quite distinct from *O. murphyi*. To preclude the chance that it might be *bipunctatum*, the type material of the latter was obtained on loan from Cambridge and I give here drawings of the gonopods and notes on peripheral structural differences. All three of the Malayan species can now be regarded as adequately clarified; it is interesting that *bipunctatum* turns out to have more in common with the Indochinese species *O. glandulosa*.

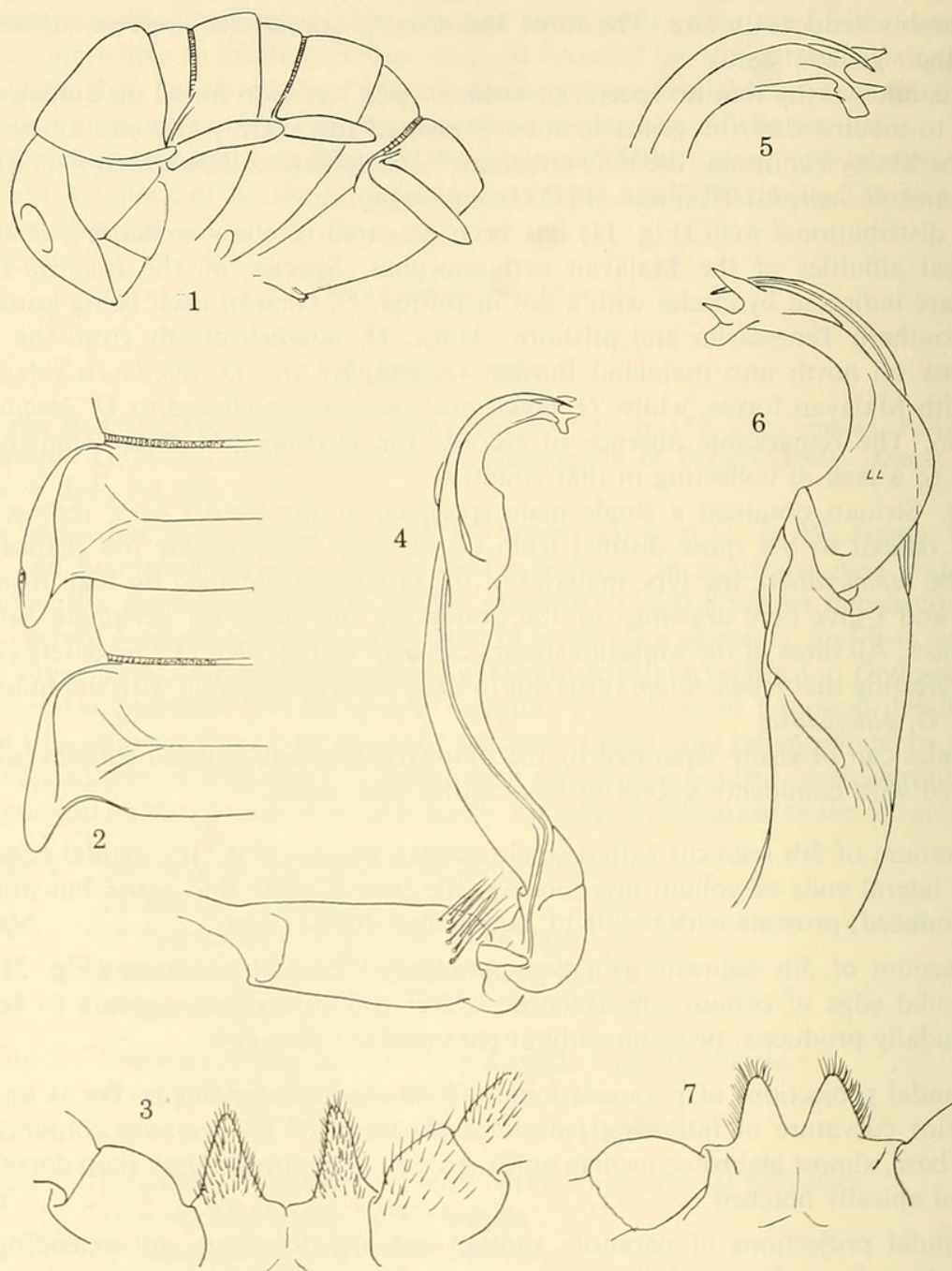
Males can be easily separated by the following key, but as usual females cannot be identified with confidence except by association with males.

1. Sternum of 5th segment with a single median process (Fig. 10), caudal edge of lateral ends of collum not concave, the lateral angle thus acute but not produced; prozona with two light paramedian dorsal spots *bipunctata*
- Sternum of 5th segment with two paramedian conical processes (Fig. 3), caudal edge of collum concave near lateral end which thus appears to be caudally produced; prozona without paramedian light spots 2
2. Caudal projections of paranota long and divergent, extending as far as anterior curvature of following paranota; processes of 5th sternum conjunct at base, almost glabrous; median apical process of gonopod larger than dorsal and apically notched *murphyi*
- Caudal projections of paranota shorter and less divergent, not extending back so far as base of following paranota; processes of 5th sternum widely separated at base and densely setose; median apical process of gonopod smaller than dorsal, and acutely triangular *fluminoris*

***Orthomorpha fluminoris* sp. n. (fig. 1-6)**

Material: Male holotype (Mus. Genève) from the Batu Caves, Kuala Lumpur, Malaya, February 24, 1975, Pierre Strinati leg.

Diagnosis: A species of the *karschii* Group with dark brown dorsum and only slightly incrassate peritremata; apical processes of tibiotarsus rather long and slender, very slightly divergent, subequal in length, separated by a broad diastema.



FIGS. 1 to 7.

Taxonomic characters of *Orthomorpha* species.

FIG. 1. *O. fluminoris* n. sp., head and first five body segments of holotype, legs and antennae omitted, lateral aspect. — FIG. 2. Same specimen, paranota of left side of segments 10 and 11, dorsal aspect. — FIG. 3. Same specimen, sternal processes of 5th segment, posterior view. — FIG. 4. Same specimen, left gonopod, medial aspect. — FIG. 5. Same specimen, distal end of gonopod, medial aspect, enlarged. — FIG. 6. Same specimen, lateral aspect of left gonopod, enlarged, showing demarcation of postfemur by two oblique cingula (LL, lamina lateralis). — FIG. 7. *O. murphyi* Hoffman, sternal processes of 5th segment of paratype male for comparison with Fig. 3.

Holotype: Adult male, broken into several pieces, length about 39 mm, segmental widths as follows:

Segment 1 — 4.3 mm	Segment 10 — 4.4 mm
2 — 4.7 mm	12 — 4.5 mm
4 — 4.5 mm	14 — 4.4 mm
6 — 4.3 mm	16 — 4.3 mm
8 — 4.3 mm	18 — 3.5 mm

Body widest at segment 2, narrowing slightly to segment 5, thence almost parallel-sided back to segment 16 where abruptly attenuated. Approximate W/L ratio at midbody, 12%.

Metaterga and region of stricture generally dark piceous brown, sides of segments somewhat lighter; lateral half of paranota, legs and first five antennomeres yellow; 6th and 7th antennomeres almost black.

Body form in general as described for *O. murphyi* (HOFFMAN 1973) with the following exceptions:

Genae with narrow but sharply-defined lateral margins. Dorsomedian surface of collum with two small paramedian setae in addition to those near anterior margin (perhaps these setae were abraded from the material of *murphyi*). Segments 3 and 4 slightly smaller than 2 and 5, but not "noticeably" smaller and narrower as in *murphyi*. Caudal projections of paranota of most body segments (Fig. 2) shorter than in *murphyi*, not extending so far as anterior edge of following segments. Paramedian tubercles of hypoproct moderate in size, and not extending beyond edge of that sclerite.

Sternum of 5th segment with a pair of acutely conical paramedian processes, these somewhat longer than in *murphyi* and more widely separated at base, the surface also more densely setose than in that species (cf. Figs. 3 and 7).

Gonopods (Figs. 4-6) characteristic for the genus and the *Karschii* Group, the upper two distal processes of tibiotarsus parallel or very slightly divergent, solenomerite extending into the sinus between them.

Remarks: There is little doubt that this species finds its closest relative in *O. murphyi* which is known from Singapore, about 300 km southeast of Kuala Lumpur.

The specific name is a Latinization of the Malay word "*kuala*" which means "mouth of the river".

***Orthomorpha bipunctata* (Sinclair) (figs. 8-10)**

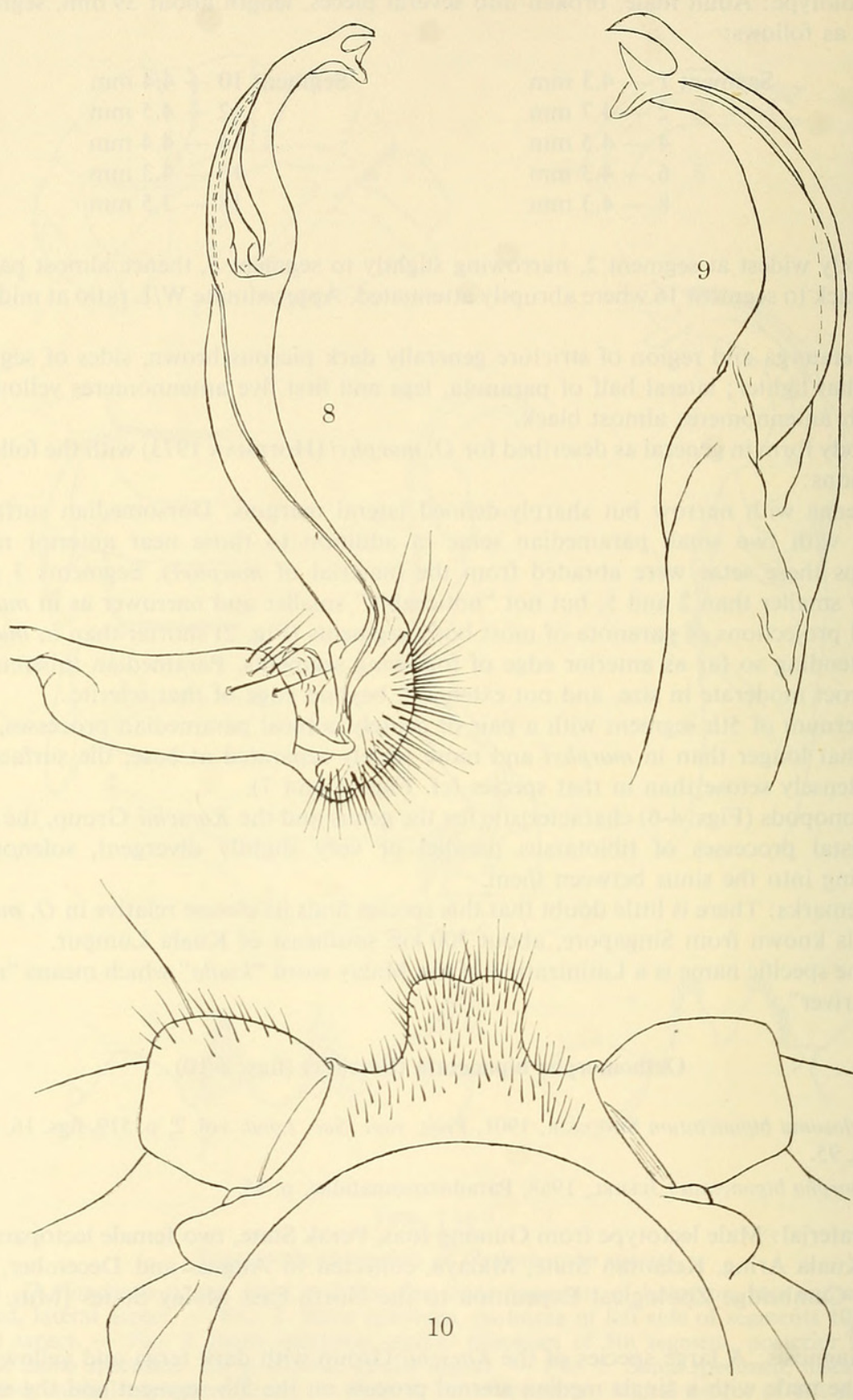
Strongylosoma bipunctatum SINCLAIR, 1901, *Proc. zool. Soc. Lond.* vol. 2, p. 519, figs. 16, 43, 61, 90, 95.

Orthomorpha bipunctata: JEEKEL, 1968, *Paradoxosomatidae*, p. 45.

Material: Male lectotype from Gunong Inas, Perak State, two female lectoparatypes from Kuala Aring, Kelantan State, Malaya, collected in August and December, 1899, by the Cambridge Zoological Expedition to the North-East Malay States (Mus. Cambridge).

Diagnosis: A large species of the *Karschii* Group with dark terga and yellow paranota, the male with a single median sternal process on the 5th segment and the median apical process of the gonopod convergent toward the upper process and almost in contact with it (Figs. 8, 9).

Lectotype: Adult male, length about 42.5 mm, W/L ratio 12%, segmental widths as follows:



FIGS. 8 to 10.

Orthomorpha bipunctatum (Sinclair)

FIG. 8. Left gonopod of male lectotype, mesal aspect. — FIG. 9. The same gonopod, distal half of telopodite, enlarged, lateral aspect. — FIG. 10. Ventral half of 5th segment, posterior aspect.

Segment 1 — 4.4 mm
 2 — 4.9 mm
 4 — 4.7 mm
 6 — 5.0 mm
 8 — 5.0 mm

Segment 10 — 5.1 mm
 12 — 5.1 mm
 14 — 5.1 mm
 16 — 5.1 mm
 18 — 3.9 mm

Original coloration lost through long preservation, at present dark brown with outer half of paranota, legs, and antennae pale. According to Sinclair who saw the material when fresh, the dorsum was dark chocolate brown, with paranota, antennae, labrum, legs, and two paramedian spots on each prozonum yellow.

Structural details agreeing closely with the description of *O. murphyi*, with the following differences noted:

Genae set off from frons by a shallow vertical depression, entire lateral edge provided with a fine, narrow margin.

Lateral ends of collum acutely angular, front edge convex, posterior edge nearly straight, the angle thus less produced caudad and dissimilar to paranota of following segments. Anterior margin of collum with four transverse setae instead of two. Segments 3 and 4 less reduced in size in comparison with 2 and 5, lateral paranotal thickening of these segments narrower than in *murphyi* and more acute apically; posterior edge of metaterga slightly elevated almost to middorsal region.

Paranota similar to those of *murphyi* but peritrematic thickenings very strongly set off and on some segments their median edge forms an overlap onto dorsal surface of paranota. Ozopores located in lateral concavities in posterior 2/3ds of length.

Paraprocts with prominent oblique striation, their median edges very prominently compressed and elevated and set off by a shallow groove.

Stigmata similar in size and shape except posterior somewhat flatter and lacking dorsal knob. Sternum of segment 5 with large, median distally truncate setiferous process (Fig. 10) with two very prominent paramedian pores at base on posterior side.

Gonopods (Figs. 8, 9) characteristic of the *Karschii* Group, the apical processes nearly equal in size but upper somewhat expanded near end, and median curved toward it, nearly closing the normally parallel-sided sinus between the two processes.

Remarks: Although the two female specimens agree closely with the male, the fact that they come from a different locality opens the possibility that they may represent a different species.

This species comes out in JEEKEL's key (1964: 362) to *O. glandulosa* (Attems), and agrees fairly well with the original description of that form except for the absence of metatergal tubercles (ATTEMs 1937: 220). The tibiotarsus of the gonopod in *bipunctata* is less strongly curved, and some differences in the form of the apical processes is evident. Yet it seems likely that these two species might be referred to the same subgeneric group.

DORATODESMIDAE

Ascetophacus

Ascetophacus Hoffman, 1977, *Pacif. Insects*, (in press). Type species, *A. macclurei* Hoffman, by original designation.

This recently published genus was separated from the Java-Sumatra species of *Doratodesmus* primarily on the basis of differences in the male genitalia, although there appear to be corresponding divergences in peripheral structural details as well.

Dr. Strinati obtained females of an apparently undescribed species in Gua Anak Takun, and although the proposal of specific names on female specimens is not always to be recommended, comparison of the material with paratypic specimens of *A. macclurei* leaves no doubt whatever that two distinct species are involved.

The proposal of *Ascetophacus* dealt briefly with the status of the enigmatic *Dorotonotus cavernicola* Sinclair, 1901, which was tentatively included as a possible second

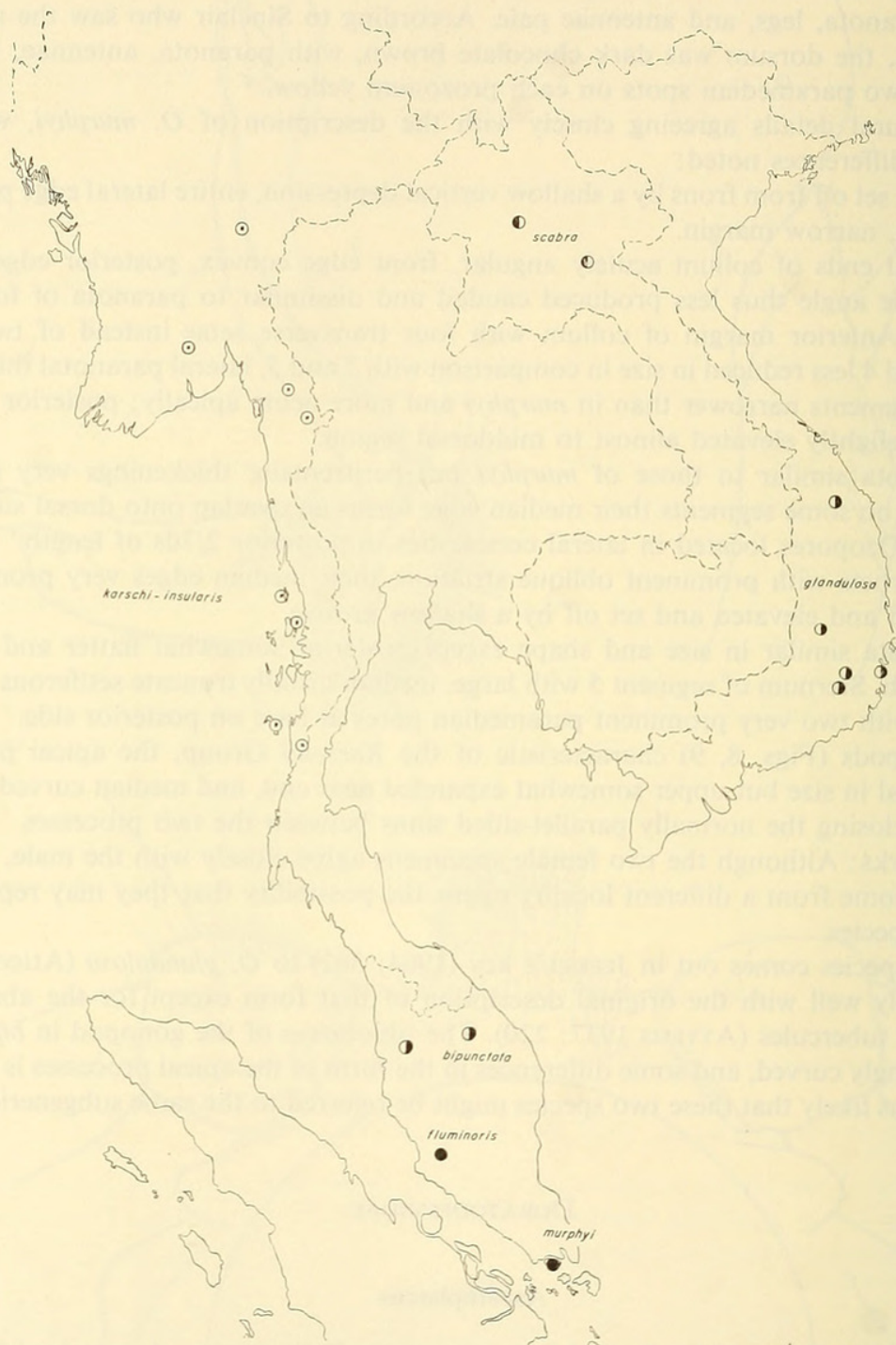
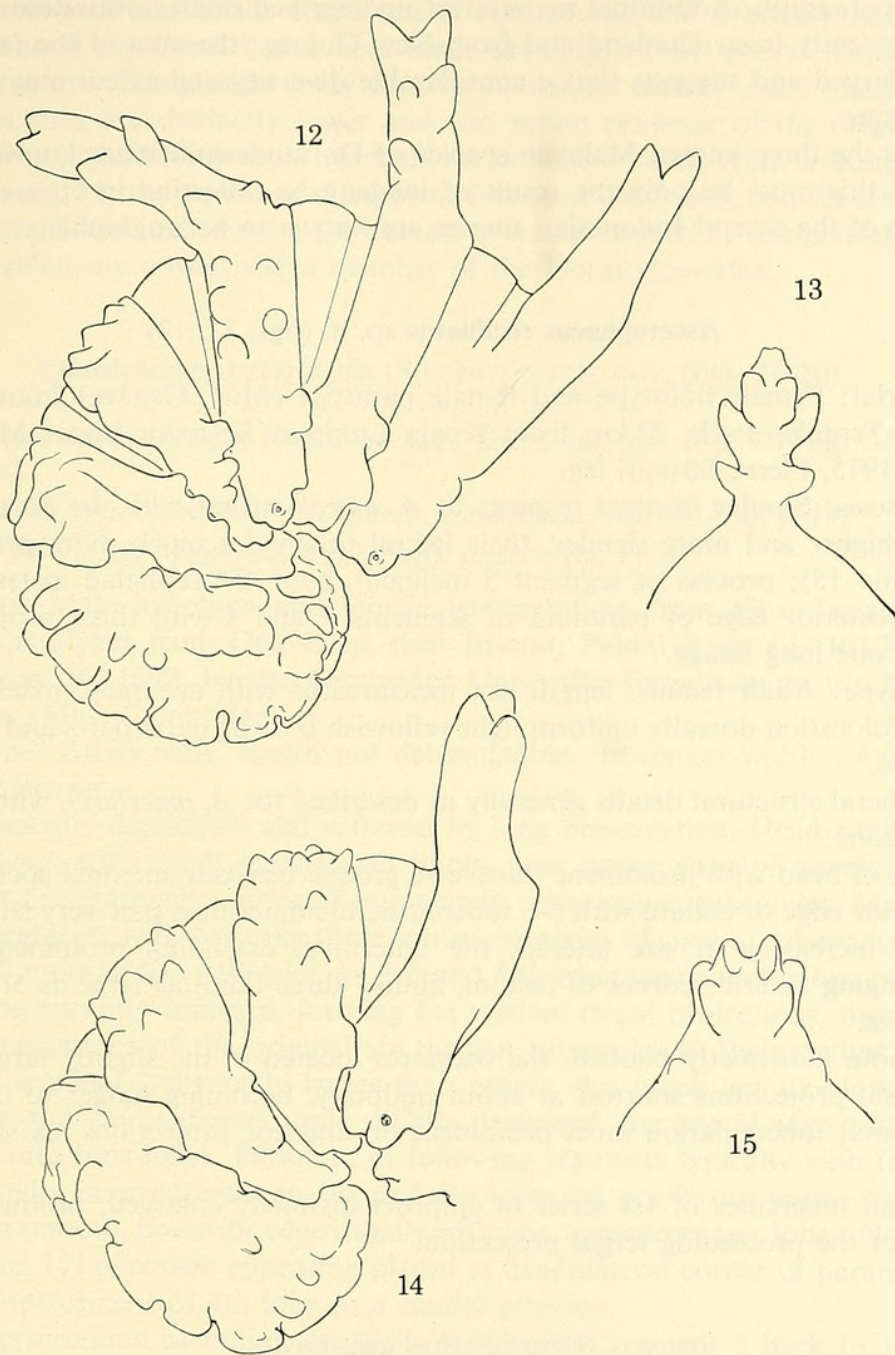


FIG. 11.

Southeastern Asia, showing distribution of seven related species of *Orthomorpha*. Close affinity is suggested by pattern of the symbols: *murphyi* and *fluminoris* (black dots) comprise a species-pair, as do *bipunctata* and *glandulosa* (dots shaded on the right side) and *karschii* and *insularis* (circles with central dot).



FIGS. 12 to 15.

Taxonomic characters of *Ascetophacus* species

FIG. 12. *A. reclinatus*, n. sp., body segments 2-7, lateral aspect, showing inclination of first tergal process and several small lobes on posterior edge of paranota, from holotype. — FIG. 13. Same specimen, tergal process of midbody segment, caudal aspect. — FIG. 14. *A. macclurei* Hoffman, segments 2-5, lateral aspect, showing erect tergal process and a single long lobe on caudal edge of paranota, from paratype. — FIG. 15. Same specimen, tergal process of midbody segment, caudal aspect.

species. The opportunity to examine the original typematerial of *cavernicola* shows it to be clearly not congeneric with *macclurei*, and separate generic status is herein proposed in a later paragraph. Additional material of undescribed small doratodesmids has been obtained recently from Thailand and from New Guinea; the area of the family is thus greatly enlarged and suggests that a considerable diversity and extent may be expected for this group.

So far the three known Malayan species of Doratodesmidae are known only from caves, but this must be only the result of inadequate collecting in epigaeal habitats, since none of the several Indonesian species are known to be troglomorphic.

***Ascetophacus reclinatus* sp. n. (figs. 12, 13)**

Material: Female holotype and female paratype (Mus. Genève) from Gua Anak Takun at Templer Park, 22 km from Kuala Lumpur, Selangor State, Malaya; February 25, 1975, Pierre Strinati leg.

Diagnosis: Similar in most respects to *A. macclurei* but with the dorsal processes distinctly higher and more slender, their lateral tubercles much more prominent (cf. Figs. 13 and 15); process of segment 5 inclined about 45° cephalad instead of nearly vertical; posterior edge of paranota of segments 3 and 4 with three projecting lobes instead of one long flange.

Holotype: Adult female, length not measureable with accuracy, maximum width 1.8 mm. Coloration dorsally uniform light yellowish brown; underparts and legs whitish to colorless.

Peripheral structural details generally as described for *A. macclurei*, with the following exceptions:

Front of head with prominent transverse groove between antennal sockets.

Anterior edge of collum with 6-6 tubercles, the innermost pair very small and flat, tubercles increasing in size laterad, the outermost extending prominently forward and prolonging anterior corner of collum, almost three times as large as 5th tubercles of the series.

Paranota indistinctly bilobed, the ozopores located in the slightly larger posterior lobe. Dorsal projections shortest at about midbody, becoming longer to the 16th and 5th segments; tuberculation most prominent on anterior projections, as shown in figure 12.

Median tubercles of 1st series of epiproct distinctly enlarged, producing a small homolog of the preceeding tergal projection.

***Cerastelachys* gen. nov.**

Type species: *Doratonotus cavernicola* Sinclair, 1901.

Diagnosis: A genus of small doratodesmids in which the median metatergal projections begin on the 3rd segment; the collum is provided with five transverse rows of hemispherical tubercles; the paranota are unusually broad and quadrilobate laterally, with the porosteles placed between the 3rd and 4th lobes; and the gonopods are long and slender, distally broadened and laminate with fimbriated apical edge, the prostatic groove running out the mesal side of the telopodite to base of expanded tibiotarsal region, thence curving 180° around to the lateral surface.

Distribution: Known so far only from caves in Patani district, in the extreme southern part of Thailand.

Remarks: Thanks to the cooperation of Dr. C. B. Goodhart, it has been possible to examine the original type material of *D. cavernicola*. The illustrations published by Sinclair give no real idea of the characters of this species, and although the material is not now in good condition I give here some drawings of peripheral features and of gonopod structure. The general body form is similar to that of *Ascetophacus*, but the dorsal projections are distinctly lower and still retain evidence of the original seriate tubercles from which they were formed. As will be evident from a comparison of Figs. 12, 14, and 16, the paranota of segment 2 are less depressed, and far less flabellate than in *Ascetophacus*, and expose the collum in lateral aspect. It seems likely that this species is a relatively unspecialized member of the Doratodesmidae.

***Cerastelachys cavernicola* (Sinclair) comb. nov. (figs. 16-20)**

Doratonotus cavernicola Sinclair, 1901, *Proc. zool. Soc. Lond.*, vol. 2, p. 521, figs. 54, 69-71, 73, 74, 78, 82.

Doratodesmus cavernicola: ATTEMS, 1914, *Arch. Naturgesch.*, vol. 80 (A 4), p. 182.

Ascetophacus cavernicola: HOFFMAN, 1977, *Pacif. Insects*, vol. 17, p.

Material: Male lectotype and female lectoparatype from Gua Tanan and two female lectoparatypes from Gua Glap, near Biserat, Patani River (± 101.30 E, 6 N), Thailand; May 26, 1899, by the Cambridge University Expedition to the North-East Malay States (Mus. Cambridge).

Lectotype: Adult male, length not determinable, maximum width 1.4 mm. Color overall light brown.

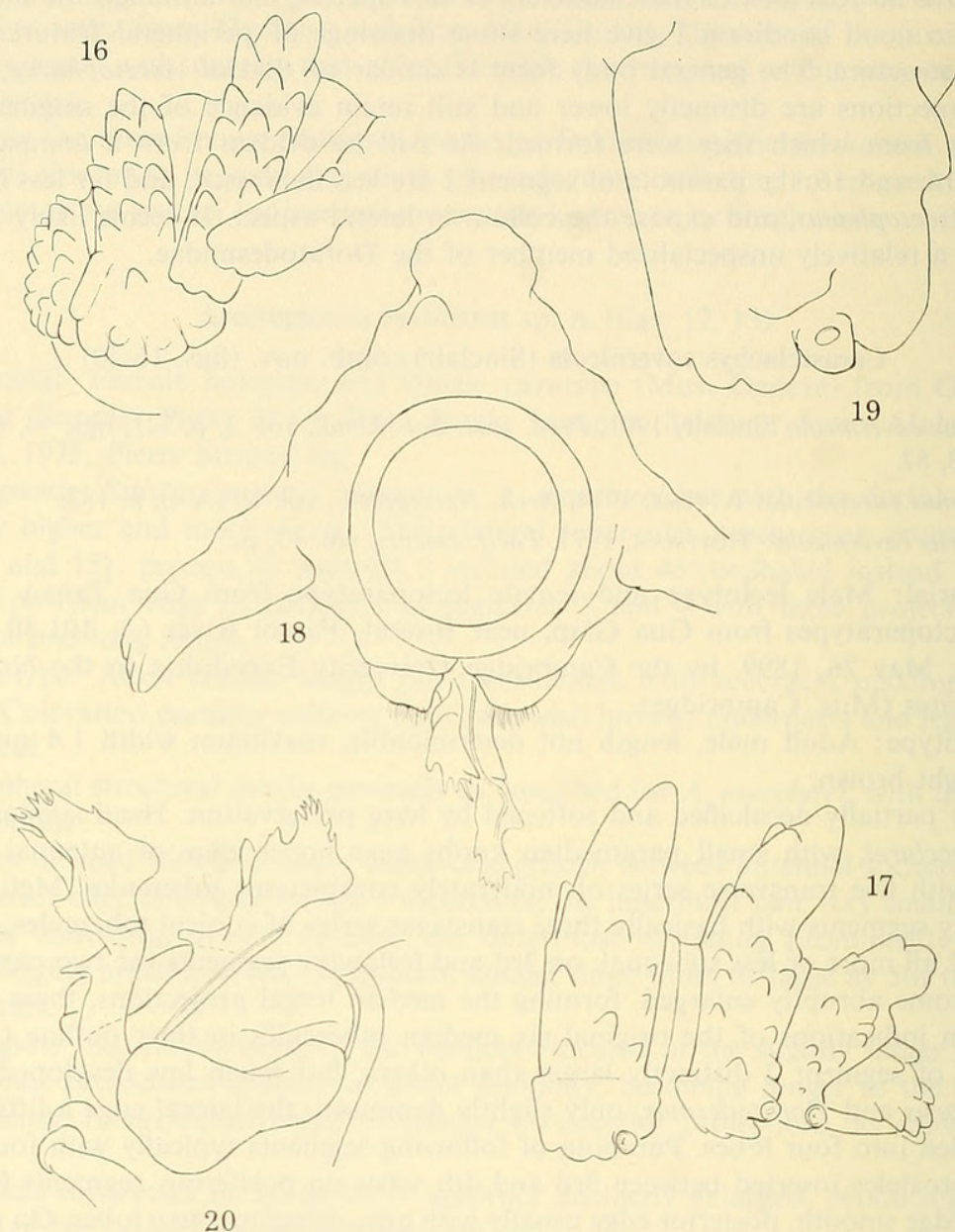
Body partially decalcified and softened by long preservation. Head similar to that of *A. macclurei*, with small paramedian knobs near upper edge of antennal sockets. Collum with five transverse series of moderately conspicuous tubercles. Metaterga of most body segments with basically three transverse series of conical tubercles, those of segment 2 all more or less subequal, on 3rd and following segments the two paramedian series become abruptly enlarged, forming the median tergal projections, these however still retain indications of the original six median tubercles in their outline (Fig. 17). Paranota of segment 2 distinctly larger than others, but much less developed than in *Ascetophacus* and *Doratodesmus*, only slightly depressed, the lateral edge a little curved and divided into four lobes. Paranota of following segments typically with four lateral lobes; porosteles inserted between 3rd and 4th lobes on poriferous segments (Fig. 19), anterior edge smooth, posterior edge usually with one, sometimes two lobes. On posterior segments (Fig. 17) porostele appearing placed at caudolateral corner of paranota owing to inward displacement of 4th lobe to a caudal position.

Tergal projections becoming gradually larger from segment 3 back to 18, that of 19 abruptly smaller; dorsum of segment 20 with several moderate-sized elongate tubercles, laterally with four tubercles each side and two apically.

Legs moderately long and slender, without modifications.

Gonopod aperture of 7th segment large, oval, occupying entire ventral surface of metazonum, coxae large, elongate, firmly attached in aperture, of the form characteristic of most Polydesmoidea, each with a ventral depression into which the telopodite retracts. Telopodites moderately long and slender, nearly straight, prostatic groove running up medial surface to base of the enlarged and broadened tibiotarsal region, where abruptly curved around to lateral surface, disappearing near the deeply lacinated distal edge. Femoral region with a short, slightly retrorse process on posterior side near base of tibiotarsus, latter with a prominent acute process near the base on lateral side

and another near end on mesal side (Fig. 20). No trace of vesicle or hairpad near termination of groove.



FIGS. 16 to 20.

Cerastelachys cavernicola (Sinclair)

FIG. 16. Body segments 1-3, lateral aspect. — FIG. 17. Segments 17-20, lateral aspect. — FIG. 18. Segment 7, anterior aspect, enlarged. — FIG. 19. Paranotum of midbody segment, enlarged, showing location of pore. — FIG. 20. Gonopods, lateral aspect. Drawings from lectoparatype.

CAMBALOPSIDAE

Cambalopsidae Cook, 1895, *Ann. N.Y. Acad. Sci.*, vol. 9, p. 6.

Trachyjulidae Silvestri, 1896, *Annali Mus. civ. Stor. nat. Giacomo Doria*, vol. 36, p. 168.

This family name is retained primarily in deference to tradition, as it seems clear that the entire classification of the cambaloid millipeds must be thoroughly revised

before rational generic groups can be established. The Cambalopsidae has been distinguished from the Cambalidae on the basis of small differences in the gnathochilarium, now regarded as less important phylogenetically in this group than elsewhere amongst Diplopoda.

According to Article 40 of the International Code of Zoological Nomenclature (1961) the older of two synonymous family names is not to be replaced after 1960 if its type genus is found to be a junior synonym of the type genus of a younger family name. There is no doubt that *Cambalopsis* is a junior subjective synonym of *Trachyjulus*.

CARINOTAXY IN CAMBALOID MILLIPEDS

The development among many cambaloid forms of striking and often very complex patterns of carination on the collum and metazona naturally invites the utilization of this variable for taxonomic purposes. One of the first attempts in this direction—aside from verbal accounts in the descriptions of various new species—was made by Verhoeff in 1936. In his treatment of several Oriental cambaloids, Verhoeff assigned numbers to the tubercles of the transverse metasomal series, beginning at the lowest on the side of the body, and was able to produce numerical formulae such as “ $7 + 1 + 5 + 1 + 7 = 21$ ” for *Trachyjulus ceylanicus*. The two numerals “1” apply to the poriferous tubercles, the number 5 indicating the number of dorsal tubercles between the poriferous, and “7” reflecting countable tubercles below them on the side. In the same paper, Verhoeff endeavored to show by diagrammatic drawings the distribution of crests on the collum in three related species, in this case assigning a number to each longitudinal crest series counting from the lateralmost to the middorsal: 1 2 3 4 5 4 3 2 1. These drawings revealed that sometimes the crests occurred in several transverse rows, often incongruent in terms of numbers, but Verhoeff did not attempt to express such variations.

Shortly thereafter, however, VERHOEFF returned to the subject in a short paper (1938) describing some cavernicolous millipeds from eastern Asia. Here he distinguished between the condition found on the metasoma of certain forms in which the two transverse rows of tubercles are congruent longitudinally, and those in which the two series do not coincide exactly, using the new terms “isostich” and “anisostich”.

Extension of this general idea is possible and highly desirable, and on the basis of species known either from the literature or from specimens at hand, I venture to propose the following classification for ornamentation of the collum:

- I. Smooth (no crests or carinae present)
- II. Carinate (if some form of longitudinal ridges are developed)
 - A. Holoseriate (all ridges or crests entire or nearly so)
 - B. Multiseriate (crests interrupted, or present in several rows)
 - 1. Isostichic (crests of the several series forming congruent longitudinal lines)
 - 2. Anisostichic (crests at least partly incongruent or out of order)
 - 3. Mixostichic (some crests entire or isostichic, others anisostichic)

In addition to these categories, it is possible to develop a system for nomenclature of the individual crests, derived from the initiative of Verhoeff. It is proposed that those crests which extend for the full length of the collum be designated by Roman numerals, counting outward from the median line, although a median crest, if present, would be

designated by the letter "M". Arabic numbers can be used for crests originating on the posterior edge and extending forward, again with the letter "m" to indicate a medially placed crest. If a third row is present, italicized or underscored arabic numerals will serve symbolically. Figure 26 shows in a diagrammatic way the generalized distribution of crests on the collum of *Plusioglyphiulus grandicollis* (it is understood that occasional irregularities occur as individual variation, and that species patterns are best derived from a small series).

On the posterior edge there is a median short crest and 1-8 additional short crests on each side, thus: 8-m-8. An additional transverse row occurs near the midlength of the collum, 4-m-4. From the front edge there are six crests each side, the inner two (I, II) being shorter than the outer four and strongly divergent. The complete crest formula for this species would be given thus:

VI-VI

4-m-4

8-m-8

Such a system may facilitate the description of collum ornamentation by providing a brief but precise way of designating each crest. In *Glyphiulus granulatus* (Gervais), the formula is

VI-VI

2-m-2

in which crests II-VI are complete, and I is anisostichic with 1 and m on the posterior series, and 2 is displaced laterad of VI near end of the collum. The same principle may be extended to the crests of the body segments per se, with the enlarged peritrematic crests designated by the Roman numeral I, so that in *P. grandicollis* the crest formula is 3-I-5-I-3, showing that three crests occur laterally below the pore, and five dorsally between the peritrematic crests.

Trachyjulus

Trachyjulus Peters, 1864, *Mber. Akad. Wiss. Berlin* for 1864, p. 547.—JEEKEl, *Stud. fauna Suriname*, vol. 4, p. 150. Type species: *T. ceylanicus* Peters, by monotypy.

Cambalopsis Pocock, 1895, *Ann. Mag. nat. Hist.*, ser. 6, vol. 15, p. 363. Type species: *C. calva* Pocock, by original designation.

Paratrachijulus Verhoeff, 1936, *Zool. Anz.*, vol. 113, p. 51. Type species: *Trachijulus mimus* Silvestri, 1924, by monotypy.

Phanolene Chamberlin, 1950, *Zoologica, N.Y.*, vol. 35, p. 136. Type species: *P. sima* Chamberlin, by original designation.

This genus was a model of confusion until the appearance of JEEKEl's important review in 1963. At that time much of the contradictory and misleading work of the past was explained away, and a total of twenty-two species was accounted. These various taxa were shown to occupy a fairly compact and coherent geographic range: India, Sri Lanka, Malaya, Sumatra, and Java. Jeekel also provided a key to the 15 species then known from the male sex.

Some years later, the gonopod characters of *Cambalopsis calva* Pocock were illustrated from the original type material by MAURIES (1970) and this species shown to be also referable to *Trachyjulus*. At the present, it is possible to work with trachyjulids with some degree of confidence, although there is still plenty to do as regards refinement of

taxonomy within the group. In particular the nominal species *calva* and *nordquisti* appear to be very close if not synonymous; the former remains known only from the type locality (Reef Island near Tavoy, lower Burma) whilst the latter has been found at Singapore, on the islands of Sulawesi, Ambon, and New Britain, and in Brasil and Venezuela, clearly a successful synanthropic species. That a very closely related species (*calva*) would originate on a small coastal island seems improbable.

The trachyjulid taken by Dr. Strinati in Gua Anak Takun comes out readily to couplet 14 in JEEKEL's key, where it has clearly the closest affinity to *T. heteropus* Silvestri, likewise a Malayan cave species.

***Trachyjulus silvestrii* sp. n. (figs. 21-25)**

Material: Male holotype, male paratype, six female paratypes, and three immature females (Mus. Genève) from Gua Anak Takun at Templer Park, 22 km from Kuala Lumpur, Selangor State, Malaya; February 25, 1975, Pierre Strinati, leg.

Diagnosis: Closely related to *T. heteropus* Silvestri, differing in the completely smooth anteriormost segments (with 9+9 small carinae in *heteropus*); apically acuminate coxal processes of the gonopod (shown to be rounded in Silvestri's species); and subglobose form of the first pair of legs of the male (conical in *heteropus*).

Holotype: Adult male, length about 19 mm, maximum width, 1.2 mm, with 44 segments, the last four legless.

Body uniformly light purplish-brown without trace of middorsal stripe; legs pale grayish with tinge of yellow.

Head of form typical for the genus, strongly convex, smooth and polished, two small ocelli on each side. Antennae long and slender, extending back to 6th segment, articles 2-4 cylindrical, similar in size and shape, article 5 slightly longer and abruptly clavate distally where twice the basal width, article 6 about as wide as long, article 7 much smaller, cylindrical, with four long sensory cones. Outer distal edge of 5th and 6th articles with prominent fringe of short, stout, pale sensory setae; 7th with small round sensory pit on outer side at midlength.

Body narrowest at segment 4, segments 6 and 7 conspicuously enlarged, body diameter increasing gradually back to posterior two-thirds of length. Collum and segments 2 and 3 completely smooth, segment 4 indistinctly roughened dorsally. Lateral ends of collum with 4 or 5 fine parallel striations. Carinae of metazona notched at midlength, producing effect of two series of congruent short ridges; a low indistinct middorsal carina present, two larger carinae on each side, with slightly larger peritrematic carinae and four or five smaller lateral carinae, the crest formula thus being 4-I-5-I-4. Sculpture strongly reduced on last three segments, the epiproct smooth and polished; paraprocts convex, with about 20 dispersed setae of moderate length; hypoproct small, flat, smooth, its distal edge a transverse straight line. Sterna narrow, finely granulate like adjacent pleurotergal surface; legs of each segment separated by a distance about equal to length of coxa. Legs long and slender, tarsus, tibia, and end of postfemur visible from above when extended laterad.

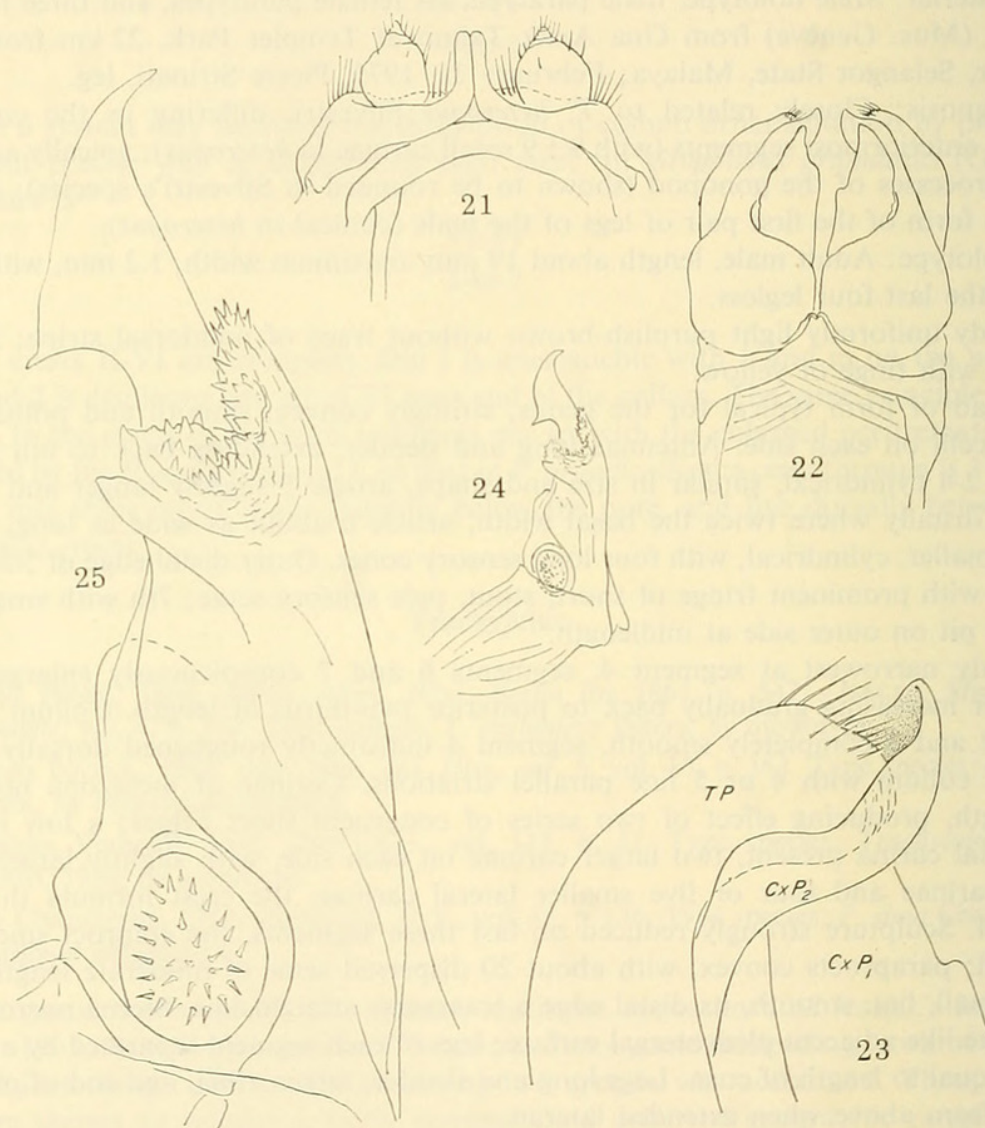
First pair of legs (Fig. 21) with moderately short, closely appressed coxal processes, telopodites almost circular in outline, each with a tiny subtriangular apical remnant.

Anterior gonopods (Fig. 22) with the median coxal process (CxP₁) laminate and apically acuminate, lateral coxal process (CxP₂) longer, apically expanded into a concave surface accomodating apical end of telopodite (Fig. 23), latter with a field of dispersed setae.

Posterior gonopods of the form shown in Figs. 24 and 25, the apical laminate projection larger than in other known members of the genus, lateral spinose area unusually prominent.

Variation: Females of this species are larger than males, the largest paratype approximately 22 mm in length and 1.4 in diameter, with 48 segments and 3-3 ocelli. Tergal sculpture is also more pronounced, carinae present on the last three segments. The male paratype is 18.5 mm long and 1.1 mm in diameter, with 43 segments and 3-3 ocelli, it agrees in external characters precisely with the holotype.

Remarks: This form is manifestly related to *T. heteropus* which occurs on the eastern side of the Malay Peninsula, perhaps the two are subspecies only. It is not clear from Silvestri's small gonopod sketches (1923, Fig. IV, 9-11) if the telopodite is accommodated by the end of the lateral coxal process. However, his description states that the anterior



FIGS. 21 to 25.

Trachyjulus silvestrii, sp. n.

FIG. 21. First pair of legs of male. — FIG. 22. Gonopods, anterior aspect. — FIG. 23. Apical halves of anterior gonopod, greatly enlarged (CxP₁, medial coxal process, CxP₂, lateral coxal process, TP, telopodite). — FIG. 24. Posterior gonopod, lateral aspect. — FIG. 25. Telopodite of posterior gonopod, lateral aspect, enlarged.

body segments are carinate in *heteropus*, and the form of the first male legs seems to be recognizably different in that species.

The name commemorates Filippo Silvestri, author of an important early paper on Asiatic cambaloids.

Plusioglyphiulus

Plusioglyphiulus Silvestri, 1923, *Rec. Indian Mus.*, vol. 25, p. 192 (as subgenus of *Glyphiulus*).

Type species: *G. (P.) cavernicolus* Silvestri, by monotypy.

This taxon was established on the basis of the number of dorsal crests between the peritremata and the form ("etiam singularis") of the first and second pairs of legs of the male sex.

In his 1938 paper on Indochinese millipeds, ATTEMS mentioned *Plusioglyphiulus* but dismissed it as superfluous (unnecessary for a single, aberrant species!) and stated "Am 2. Beinpaar konnte ich nichts besonderes sehen." It is well known that Attems was remarkably conservative in dealing with new names proposed by other workers; actually the second legpair is greatly enlarged and incrassate, and the first legs with their sternum are quite unlike anything else known from southeast Asia.

MAURIES (1970) correctly elevated *Plusioglyphiulus* to generic rank, added the new species *P. boutini* from Cambodia, and transferred in also *Glyphiulus dubius* Attems (1938), likewise a Cambodian species.

An additional member of this genus in its present sense occurs in the Batu Caves and was first taken in 1960 by Dr. H. E. MacClure whose material was forwarded to me through the B. P. Bishop Museum, Honolulu. Dr. Strinati likewise obtained a large series of specimens which have also been used in the description of the following new taxon:

***Plusioglyphiulus grandicollis* sp. n. (figs. 26-34)**

Material: Male holotype and many male and female paratypes (Bishop Museum) from the Batu Caves, Kuala Lumpur, Selangor State, Malaya; February 1960, H. E. McClure, leg., also many male and female topoparatypes (Mus. Genève), 25 April 1975 P. Strinati, leg.

Diagnosis: Distinguished from the other two known members of the genus by the structure of the anterior gonopods, in particular the median projection of the sternum, and complexly branched coxal lobe (Fig. 32, 33).

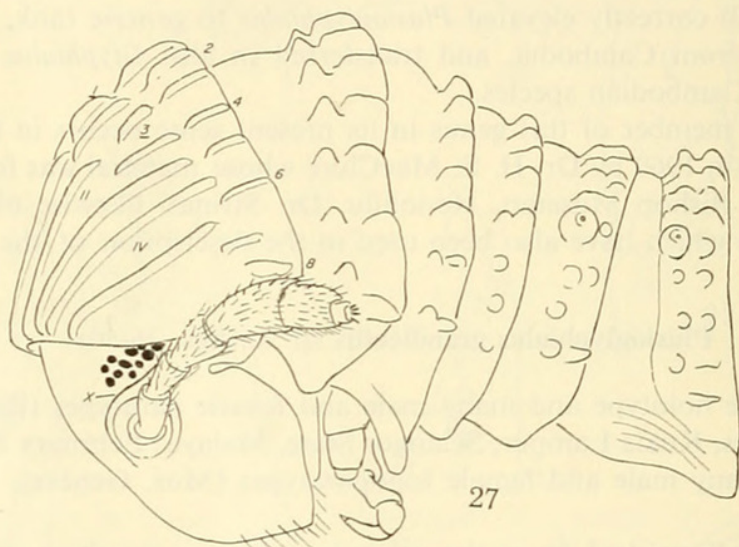
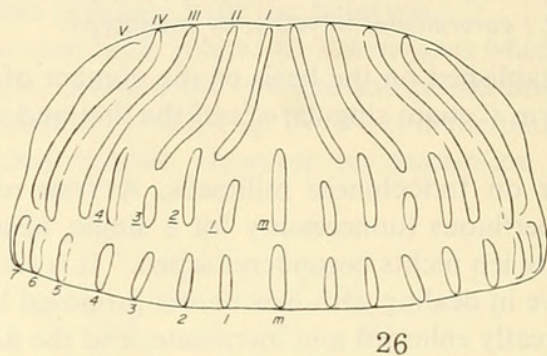
Holotype: Adult male with 71 segments. Body elongate, slender, ca. 40 mm in length (broken), collum and segment 2 approximately 1.7 mm wide, segment 4 abruptly smaller, 1.3 mm, segment 6, 1.4 mm, segment 8, 1.4 mm, body thereafter gradually increasing in diameter, 20th segment 1.7 mm, maximum diameter at posterior third of body, at segment 45, 1.8 mm.

Color appearing uniform brown; with magnification segments dorsally medium brown with the carinae emphasized by subcuticular dark brown pigment; ventral surfaces and legs uniformly yellowish brown.

Head, particularly labroclypeal region, strongly and evenly convex, smooth and polished below inter ocular suture, finely roughened above it; ocelli 12-12 in irregular reniform clusters. Clypeal setae 4-4, labral setae about 8-8. Interantennal and interocular spaces nearly equal in width. Upper edge of antennal socket produced into a conspicuous flattened ridge projecting caudally and subtending ventral end of ocellaria (Fig. 27, x), surface of head shallowly depressed ventrad to this ridge. Antennae moderately long, extending back to 5th segment, basal articles small, increasing in size up to 5th, which

is by far the largest, almost equal to length of 3rd and 4th combined; distal articles laterally compressed, oval in cross-section. Outer distal surface of 5th and 6th articles depigmented and with numerous short fine setae, but no true sensory fields or pits present.

Collum large, crests mixostichic, of the form and distribution shown in Figs. 26 and 27. Extreme lateral end of collum below crest 8 set off as a recessed lobe by an



FIGS. 26 and 27.

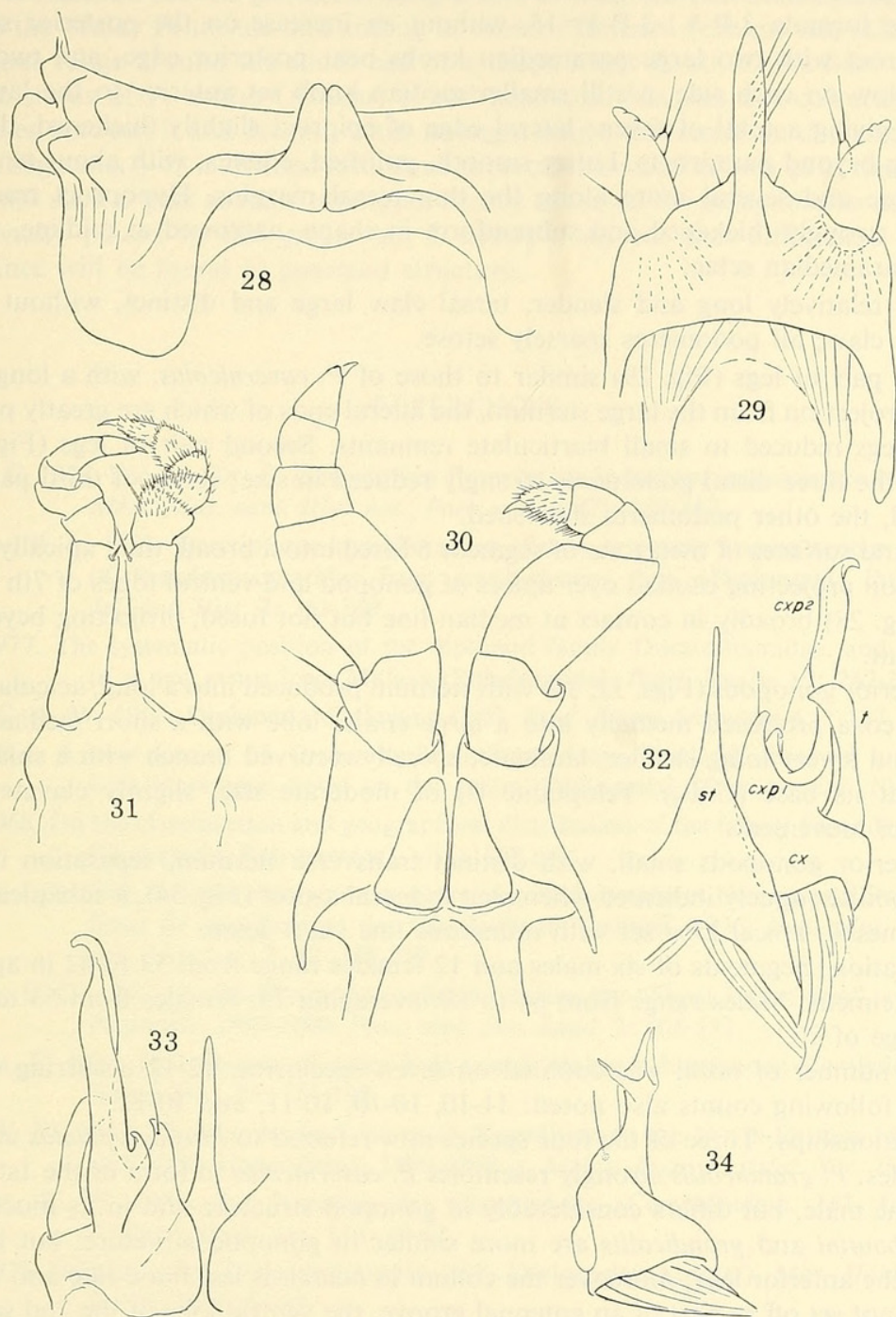
Plusioglyphiulus grandicollis, sp. n.

FIG. 26. Diagrammatic representation of carinotaxy of collum. — FIG. 27. Head and segments 1-6, lateral aspect, from topoparatype.

emargination of anterior edge, the inset surface continuous with that on the head below the ocelli and thus forming a shallow antennal groove.

Body segments divided by a transverse constriction, the posterior half of which contains the costulated stricture; concealed surface of prozona and anterior sterna with fine squamulose-reticulate texture; exposed surface, and lower sides of metazona, with large coarsely reticulate areas which diminish in size ventrally.

Segment 2 with 8-1-8 tubercles in two series, the anterior tubercles conical except for four on each side of the median which are transversely elongated; posterior tubercles elongated, about twice length of anterior. Lower side of metatergum below 8th tubercles produced ventrad as a triangular apically rounded lobe. Segments 3 and 4 each with a single transverse series of 8-1-8 small tubercles. Segments 5-68 with anterior half of



FIGS. 28 to 34.

Plusioglyphiulus grandicollis, sp. n.

FIG. 28. Midventral region of segment 7, ventral aspect. — FIG. 29. First pair of legs of male, anterior aspect. — FIG. 30. Second pair of legs of male, posterior aspect. — FIG. 31. Third pair of legs of male, posterior aspect. — FIG. 32. Anterior gonopods, anterior aspect (*cx*, coxa, *cxp₁*, median coxal lobe, *cxp₂*, lateral coxal lobe, *t*, telopodite, *st*, sternum). — FIG. 33. Right side of anterior gonopods, posterior aspect. — FIG. 34. Posterior gonopod, medial aspect. Drawings from topoparatype.

crest 4 enlarged into a prominent subglobose peritreme, the posterior half strongly reduced; three pairs of conical tubercles ventrad to peritremata, and five divided dorsal crests, the formula 3-P-3-1-3-P-3 = 15, without an increase on the posterior segments.

Epiproct with two large paramedian knobs near posterior edge, and two smaller knobs below on each side, a still smaller median knob set anterior to the large paramedians, giving a total of seven; lateral edge of epiproct slightly thickened, distal and projecting beyond paraprocts. Latter smooth, polished, convex, with about ten pairs of discal setae and several more along the thin mesal margins. Hypoproct transversely elongate, strongly thickened and subreniform in shape, narrowed at midline, with one pair of paramedian setae.

Legs relatively long and slender, tarsal claw large and distinct, without trace of accessory claw; all podomeres sparsely setose.

First pair of legs (Fig. 29) similar to those of *P. cavernicolus*, with a long, slender median projection from the large sternum, the lateral ends of which are greatly prolonged dorsad; legs reduced to small biarticulate remnants. Second pair of legs (Fig. 30) incrassate, the three distal podomeres strongly reduced in size; coxae of third pair of legs elongated, the other podomeres shortened.

Ventral surfaces of metazona of segment 6 fused into a broad, thin, apically truncate sympleuron projecting caudad over apices of gonopod and ventral lobes of 7th segment, latter (Fig. 28) broadly in contact at median line but not fused, projecting beyond edge of segment.

Anterior gonopods (Figs. 32, 33) with sternum produced into a long, acicular median process; coxa produced medially into a large endite lobe with a short median process (CxP₁) and a very long, slender, laminate, apically recurved branch with a small uncate process at its base (CxP₂). Telopodite (t) of moderate size, slightly clavate distally, capable of movement.

Posterior gonopods small, with distinct transverse sternum, separation into coxa and telopodite vaguely indicated when seen in mesal aspect (Fig. 34), a subapical process extends mesad, apical lobe set with numerous fine short setae.

Variation: Segments of six males and 12 females range from 53 to 82 in apparently adult specimens. Males range from 64 to 80, averaging 73; females from 53 to 82 with an average of 70.

The number of ocelli was counted on seven specimens, 12-12 occurring on three, with the following counts also noted: 11-10, 10-10, 10-11, and 10-12.

Relationships: Three of the four species now referred to *Plusioglyphiulus* are known from males. *P. grandicollis* strongly resembles *P. cavernicolus* in form of the 1st and 2nd legs of the male, but differs considerably in gonopod structure and in its much smaller size. *P. boutini* and *grandicollis* are more similar in gonopod structure, but less so in form of the anterior legs; moreover the collum in *boutini* is less hood-like and its lateral ends are not set off as part of an antennal groove, the ventral lobe of the 2nd segment is modified as a posteriorly curved apically acute process, and the 4th segment has the dorsal crests notched to form two distinct transverse series of small tubercles. These species are obviously related, but at what level? So long as only so few are known, it is convenient and practical to regard them as congeneric, but rather disjunct among themselves.

Geographically, *P. grandicollis* (Malaya) is closest to *P. boutini* from Cambodia. Silvestri gave only "Bidi Caves" as type locality for *cavernicolus*, which subsequent authors have assumed to be in India or Ceylon. Drs. Hauser and Strinati have adduced evidence that the cave intended is located near Bidi, in Sarawak, Borneo (cf. R. E. SHELFORD 1907, *Ann. & Mag. nat. Hist.*, ser. 7, vol. 19, p. 28).

If this location be correct, an interesting and apparently rather old distributional pattern is manifest for the genus, forming a sort of long crescent from Indochina down through the Malay Peninsula and ending in western Borneo. Perhaps this reflects a once continuous range around the south end of a much lower South China Sea.

The status of *P. dubius* (Attems) is still unsettled. Mauries has correctly observed similarities between it and *boutini*, while noting a major difference: in *dubius* each dorsal crest on segments 6-45 is divided into three tubercules instead of two as in the other three taxa. Until such a time as male topotypes can be obtained for study, *dubius* may be very provisionally placed in this genus but I strongly suspect that differences of generic importance will be found in gonopod structure.

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