New species and records of the *Cylindroiulus madeirae*-group, with notes on phylogenetic reiationships (Diplopoda, Julida: Juiidae)

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Five new species ot *Cylindroiulus* are described, *Cylindroiulus waldeni*, *C. xynon*, *C. ynnox* and *C. zarcoi* from Madeira and *C. disjunctus* from La Palma, the Canary islands. Some new specimens from the Azores and the Desertas islandsare examined. The position of these within the Madeiran *Cylindroiulus* species swarm (the *Cylindroiulus madeirae*-group) is discussed and the relationship of the *madeirae*-group as a whole is re-examined.

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INTRODUCTION

Since the publication of Enghoff (1982) describing 25 endemic species of *Cylindroiulus* frorn Madeira. several further collections have been made. These collections have extended the knowledge of the existing species as well as uncovering several new ones. Thc distribution of the *madeirna*-group has been widened by the collection of specirnens from the Desertas islands and also frorn La Palma, one of the Canary islands. The purpose of the present paper is thus to describe the new species and also to examine the specimens from the nther islands. Enghoff (1982) discussed the various charncters of the *madeirae*-group which could be regarded as plesiomorphic or apomorphic. Using these a cladogram was constructed showing thc possible phylogenetic relationships within the group (Enghoff 1982).

The descriptions of the five new species here has not revealed any further characters of phylogenetic relevance hut by making use of those listed in Enghoff (1982) thc relationships of the new species to those previously clcscribed can bc discussed.

The localities

The geology, fauna and flora of the Madeiran archipelago is surnmarised in Enghoff (1982). The four new species trorn Madeira proper were all found in laurel forest areas. The localities are described more thoroughly under the relevant species descriptions. Several of the new species were collected whilst information was being gathered for Enghoff's 1953-paper. Fig. 1 shows the positions of all the islands referred to in the text. The material was collected by a variety of people. as recorded under the relevant sections. Unless otherwise stated, additional material viewed is from the Zoological Museurn, Copenhagen, Denmark. All freshly described specimens are deposited here unless stated to the contrary.

Methods

The details of each specirnen were recorded as described in Enghoff (1982) with the following differences: antennal length was not measured *in situ*, but in the analysed specirnens antennae were removed and slide-mounted together with the

Fig. 1. Map to show ths positions of the islands mentioned in the text.

legs. Total antennal length of these specimens was recorded as the sum of the outer margin of the antennomeres excluding the basal scgmeiit, given as the mean of both antennae. Only four legs of the analysed specimens were measured, those on the mid-body sepment (or next posterior one if any of ths legs were missing). Measurements given are ths means of the four legs. Where descriptions include measurements of females maximums are given, as juveniles and matures were not distinguished except in analysed specirnens.

The morphology of the Madeiran *Cylindroiulus* is described in Enghoff (1982).

Descriptions

Conventions used in Enghoff (1982) have been maintained here, for example with regard to presentation of sepment numbers and rows of ocelli.

Abbreviations used in the text:

M	Male
F	Female
J	Juvenile
L	Body length
H	Maximum body height
W	Width of mid-body segment
Ø/l	√H x W length of mid-body segment
Tarsus l/h	tarsus length/tarsus width
RO	Rows of ocelli
sgm	body segments

Cylindroiulus from the Canary islands

Cylindroiulus disjunctus *sp. n.*

(Figs. 2–8)

Type material: Holotype M: Canary islands. La Palma. South west of Los Sauces, 1984, Martens leg. – *Para-*

types: 2M 3F same details as above. 1M 1F Los Tilos. 1957, Lundblad leg. 1F Barlovento. 1984, Martens leg. 3F Cumbre **Nueva.** 1984, Martens leg. (All the above specimens are in Natur-Museum und Forschungsinstitut Senckenberg, Frankfurt a.M., W. Germany). 2M 2F 12J Cumbre Nueva. 1972, Brinck & Enckell leg. (In Zoological Museum, University of Lund, Sweden). 1F Cubo de la Galga, laurisilva, undrr litter, 7.iii.1987, Báez & Enghoff leg. 1F Cubo de la Galga, laurisilva, under bark, 7.iii 1987, Báez & Enghott leg. 1J east slope ot Cumbrae Nueva, in *Erica* stump, 8.iii.1987, Báez S-Enghoff leg. 2F, 1JM as above but under stone. 1F Los Tilos, under bark of *Ocotea*, 7 m.1987, Báez & Enghoff leg. 1F Cubo de la Galga, Brezal, in log, 7.iii. 1987. Báez **6** Enghoff leg. 3F 1JM Cumbre Nueva, Brezel, iindcr stone, 8.iii.1987, Báez & Enghoff leg. 7F 3M 1JM east slope Cumbre Nueva, 8.iii.1987, Báez & Enghoff leg. 1M Cumbre Puntellana, Codezo Retana, 14.xi. 1987. **A.** Machado leg. 16F 16M Roque de los Muchachos, under stones, 8.iii 1987, Báez & Enghoff leg. 2F 1M Los Tilos, under bark of *Ocotea*, 7.iii.1987, Báez & Enghoff leg. Total material 27M 43F 16J. 1M 1F analysed.

Diagnosis: A small, many-segmented species with varyiirig pilosity on telson, but mostly marginal. Usually with a variegated colour pattern.

Etymology: This species is named after its distribution with respect to the other species in the group.

Description

M: L 5–14 mm. H 0.6–0.8 mm. L/H 13–17. 6–8RO, 32–44 podous segments. 2–5 apodous segrnents. F: Max. L 19 mm. H 1.3 rnm. L/H 9–15. 1 IRO. 57 podous segments. 1–5 apodous segments. Anterior constriction marked and fairly strong. Xttenuation not present or very slight.

Colouration as shown in Figs. 6–7. Transverse band (T) varying in thickness and intensity, sornetimes almost non-existent. sometimes verv broad. 'Wings' (W) usually entire, may be bilobed. also may be only slightly, or not separated from transverse band. Posterior point (P) usually present. Always dark at ozopore level, forming a longitudinal stripe. Usually, but not always, pale below this stripe. Variation in degree of contrast quite cstensive. most specimens have some contrast, only a few predominantly dark with traces of pattern. Dorsal pattern may vary along the length of the body. Many animals are darker posteriorly.

Eyes slightly reduced, M 11–34 ocelli, F max. 36. Many have very jumbled rows so the RO is difficult to interprete. Antennae M 1.17 x H, F0.89 × H. Midbody segment H/W M 1.04, F 1.05. Ø/l M 1.71, F 2.03. Metazonites slightly vaulted in some males, more usually not. Limbus of the normal type. Lcnyth of legs M 0.58 x H, F 0.40 x H. Tarsus l/h M 2.85, F 2.96. Length of claw M 6.5% of total leg. F 7.2%. Xccessoryclaw surpassing tip of claw by M 41.7%, F 24.1%. Preanai ring with no projection. Setae on preanal ring marginal, ranging from 8–15 setae arranged more or iess regularly. Setae on anal valves mostly marginal 2–12 on each. Where more are present these usually form an additional row ventrally. Subanal scale 2–4 setae (exceptionally more). Ventral margins of male segment seven (Fig. 8) widely separated. Keel usually visible in lateral view. Shelf broadly visible ventrally.

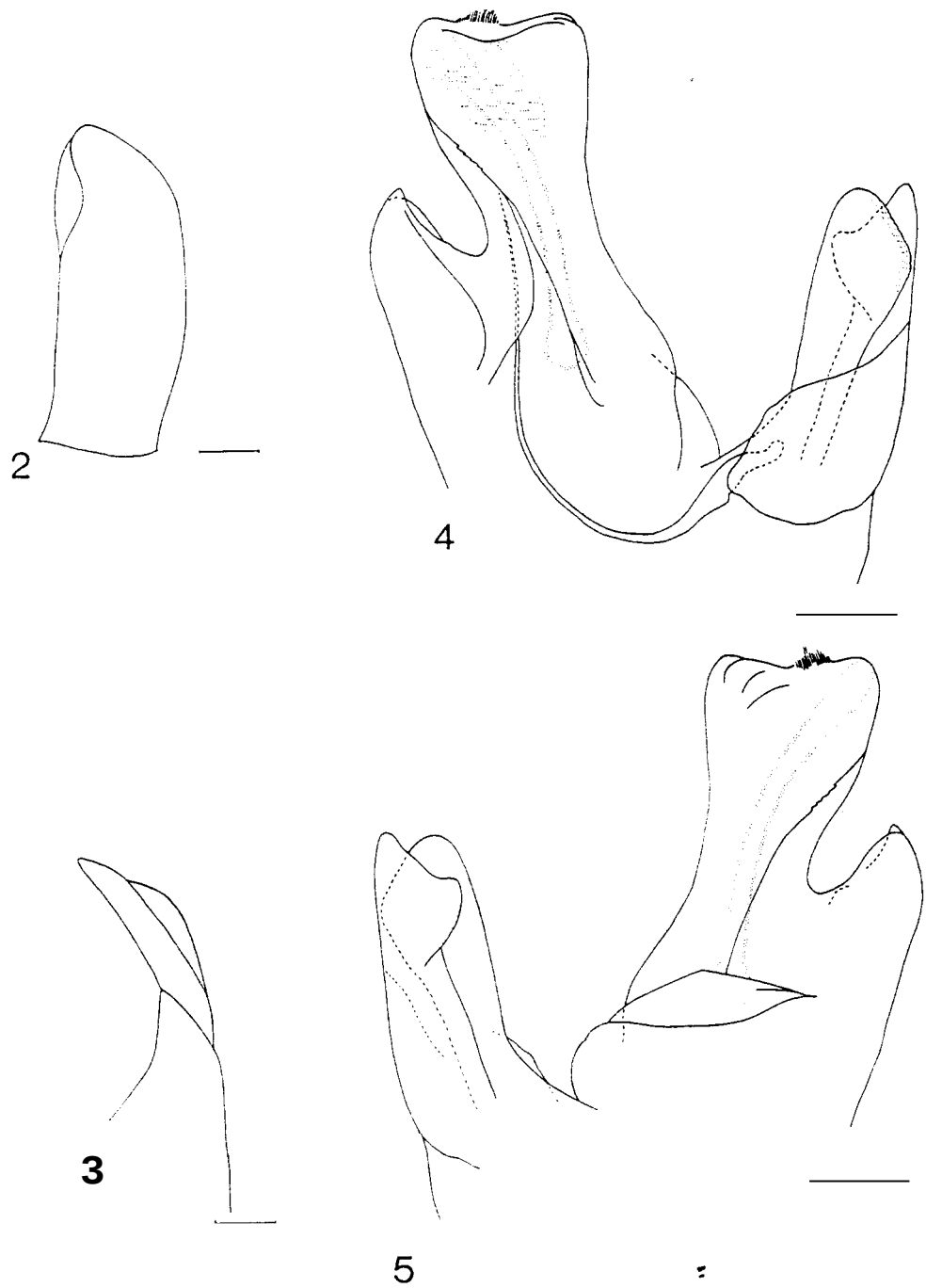
Gonopods (Figs. 2–5). Length of gonopods 0.69 x body height. Promerite in anterior view with concavity in mesal rnargin of apical third. In lateral view with large rugose projection directed posteriorly causing the whole apical region to appear nith a shallow fork. Mesomerite of similar length as promerite. visible mesally in anterior view. Fairly slender in rnesal view. Paracoxal process large and bifid. pointed in posterior view and curved slightly anteriorly. Solenornerite broad apically with median depression in mesal view. Apical fringe in centre of depression. Slight mesal swelling. Apical tliird showing distinct wrinkles in rnesal view.

Comments and phylogenetic relatiotiships

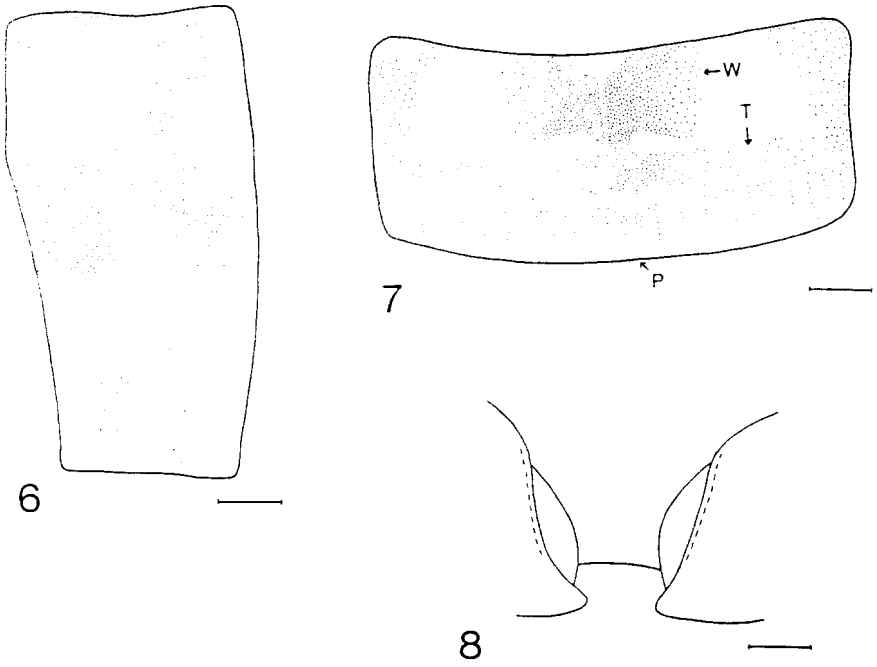
This species is similar to *C. transmarinus* Enghoff. 1982, which is found on the island of Porto Santo. It is however less variable and comparison with specimens of *C. transmarinus* frorn the Natural History Museurn Göteborg showed some distinct differences both in gonopodal characteristics and in others.

The tarsus is stouter, l/h being 2.85–2.96 in *disjunctus* and 3.29–4.56 in *transmarinus*. The setae on the anal valves are sparser and anterior constriction stronger. In addition almost all the *disjunctus* specimens show the sarne design of colour pattern, although it may vary in contrast and in extension of the dark areas. In *transmarinus* many colour patterns are evident none of which correspond to that of *disjunctus*.

The prornerite of the gonopods in the *disjunctus* specimens has a much longer rugose projection than in any *transmarinus* observed so far. It completely distorts the shape of the promerite giving it a shallowly forked apperance. The mesomerite in thc *disjunctus* specimens is also generally more



Figs. 2–5. *Cylindroiulus disjunctus*, right gonopod of holotype: (2) pro- & mesomerite, anterior view. *(3)*opisthomerite, posterior view. (4) mesal view, (5) lateral view. Scale bars represent 0.1 mm.



Figs. 6–8. *Cylindroiulus disjunctus*: (6) colour pattern of male from Rocque de los Muchachos, lateral view. (7) as above hut dorsal **view,** (S) ventral view of male segment 7. W: wing, T: transverse band, P: point (see text for more details). Scale hars represent 0. 1 mm.

slender than in *transmarinus*. The solenomerite in *disjunctus* is 'Y' shaped with the apical fringe situated in the central region. The solenomerite of *transmarinus* is variable with regard to the mesal swelling but is never this characteristic shape. The apical region of the solenomerite in *disjunctus* also bears a field ofwrinkies not seen in *transmarinus*. The paracoxal process in all the *disjunctus* specimens examined was pointed with an apical notch. never flat as seen in some of the *transmarinus*.

Because of these differences. *disjunctus* is considered to be a distinct species. separated from *C. transmarinus*. although the two are probably closely related.

As **La** Palma[1] is one of the most northeriy of the Canary islands, it is perhaps the most likely to be colonised from the north. It seems possible that dispersion took place from Porto Santo or from Madeira proper.

Cylindroiulus from Madeira proper

Cylindroiulus waideni *sp. n.*

(Figs. 9–15)

Type material: Holotype M: hladeira. Faja **da** Nogueira at the innermost bridge across the Ribeira da Ametade. altitude 700 m. laurisilva including giant ***Ucorea.*** in soil between stones. 24.xi. 1980. H. Enghoff & O. hlartin leg. – ***Paratypes***: 1M, 2F Faja da Nogueira. north side. altitude 800 m. laurisilva including giant ***Ocotea***, under leaves at the foot of a giant ***Ocotea***. 18.xi.1980, **H.** Enghoff & O. hlartin leg. 1M locality asabove. under leaves amongst brackens. 1M as above **but** on fallen ***Ocorea*** log. 1JM Rabacal, at the path from 25 fontes to casa do Rabacal. altitude **900–1000 m.** laurisilva. under fallen leaves and moist forna on **a** slope. 16.xi.1977, **A.** & H. Enghoff leg. 1M Achada de Brincão, 17.iii.1983. **los.** 124. H. Waldén leg. (In Natural History Museum, Göteborg, Sweden). Total material 5M, 2F, 1JM (1M 1F analysed).

Note added in proof

Since the completion of the manuscript, a mature male of *Cylindroiulus disjunctus* has been discovered on El **Hierro. another** of **thc Canary** Islands. The sample **collected by A. Fjellberg** from **Mirador de** Jinama contained one male and two females. These are almost identical to the specimens from La Palma both in external features and gonopods. Three other samples from El **Hierro** had immature *Cylindroiulus* in: all these now seem likely to be *C. disjunctus*

Diagnosis: A medium sized, few-segmented species with extensive pilosity on the telson, an attenuate hind end and a variegated colour pattern.

Etymology: This species is named in recognition of Henrik Waldén who has made extensive collections of millipedes on Madeira.

Description

M: L 16.9 mm. H 1.6 mm, L/H 10, 8RO, 35+2 sgm; hl: L 14.9 mm, H 1.4 nim. L/H 11. 7RO. 33+3 sgm; hl: L 16.8 mm, H 1.7 inni. L/H 10, SRO. 34+2 sgm; M: L 13.5 mm, H 1.5 mm. L/H 9, 7RO, 32+2 sgm; M: L 14.5 mm, H 1.6 mm, L/H 9, 7RO, 32+3 sgm; F: L 19.5 mm, H 1.9 mm, L/H 10, SRO. 35+2 sgm; F: L 19.6mm. H 2.0 mm, L/H 10, 8RO, 35+2 sgm; JM: L 17.7mm, H 1.6 mm, L/H 8, 6RO, 29+3 sgm. Anterior constriction slight. Attenuation marked, almost as strong as *C. attenuatus* Enghoff 1982 (Fig. 14).

Dorsal colouration similar to *C. attenuatus* (fig. 55, Enghoff 1982) but triangles with a broader base. Ventrolaterally resembiing *C. caramujensis* Lohmander. 1955 (Enghoff 1982: fig. 73). Overall appearances vnriegated with a reddish brown tinge (especially in Gothenburg specimen). Eyes normal. each with M 25–33 ocelli, F 31–33 ocelli arranged in regular rows.

Antennae M 1.1 x H, F 0.88 × H. Midbody segment H/W M1.01, F1.0, Ø/l M2.01, F2.2, metnzonites weakly vaulted. Limbus of the normal type. Length of legs M 0.65 × H, F0.60 x H, tarsus l/h M 3.91, F 4.19, length of claw M 6.2% of total leg, F 5.6%. Accessoryclaw surpassing tipof claw by M 36%, F32%. Preanal ring without projection. Srtae on preanal ring mostly marginal with additional srtae dorsally. Anal valves with extensive and dense setation. Subanal scale with 2–9 setae (usually 5–9). Ventral margine of segment 7 in males widely separated (Fig. 15). Keel visible in lateral view, shelf just visible in ventral view.

Gonopods (Fips. 9–12). Length of gonopods 0.48–0.50 x body height. Very similar in structure to those of *C. julipes* Enghoff. 1983. Promerite in anterior view parallel sided in the basal 2/3, broadly rounded at apex, almost obscuring the mesomerite in this view. In mesal view, flagelliferous lobe convrx. Flagellum rcduced in length. Mesomerite of similar lcngth as promerite, broad and slightly twisted. Paracoxal process of medium size and pointed. Sub-triangular in lateral and posterior views. Lateral paracoxal rim complicated, with a prominent peak at about mid length. Solenomerite in mesal view parallel sided with mesal swelling of medium size. Apically with fringes. With medium sized posterior and smaller anterior lateral flanges.

Phylogenetic relationships

C. waldeni is apomorphic for the solenomerite fringe and also has a shortened flagellum. Thus it must at present occupy a separate line alongside *transmarinus*, *fimbriatus* Enghoff. 1982 nnd *brachyiuloides* Enghoff. 1982 in Enghoff's (1982: fig. 2-12) cladogram. As discussed in Enghoff (1982) the shortening of the flagellum has probably occurred several times in cylindroiuline evolution. Despite thc resemblance of the gonopods of this species to *C. julipes*, *C. waldeni* does not share the apomorphy of the shortened accessory claw.

Cylindroiulus zarcoi *sp. n.*

(Figs. 16–20)

Type material: Holotype M: **Madeira.** Faja **da Nogueira. north** side, altitude **800 m**, laurisilva including giant ***Ocorea.*** **under** moss and **lichens** on ***Ocorea,*** 20.xi.1980, H. **Enghoff & O. Martin leg.** Total **material 1M (analysed).**

Diagnosis: **A medium sized. many-segmented species. dark in colour. With a characteristic-shaped promerits and short accessory claws.**

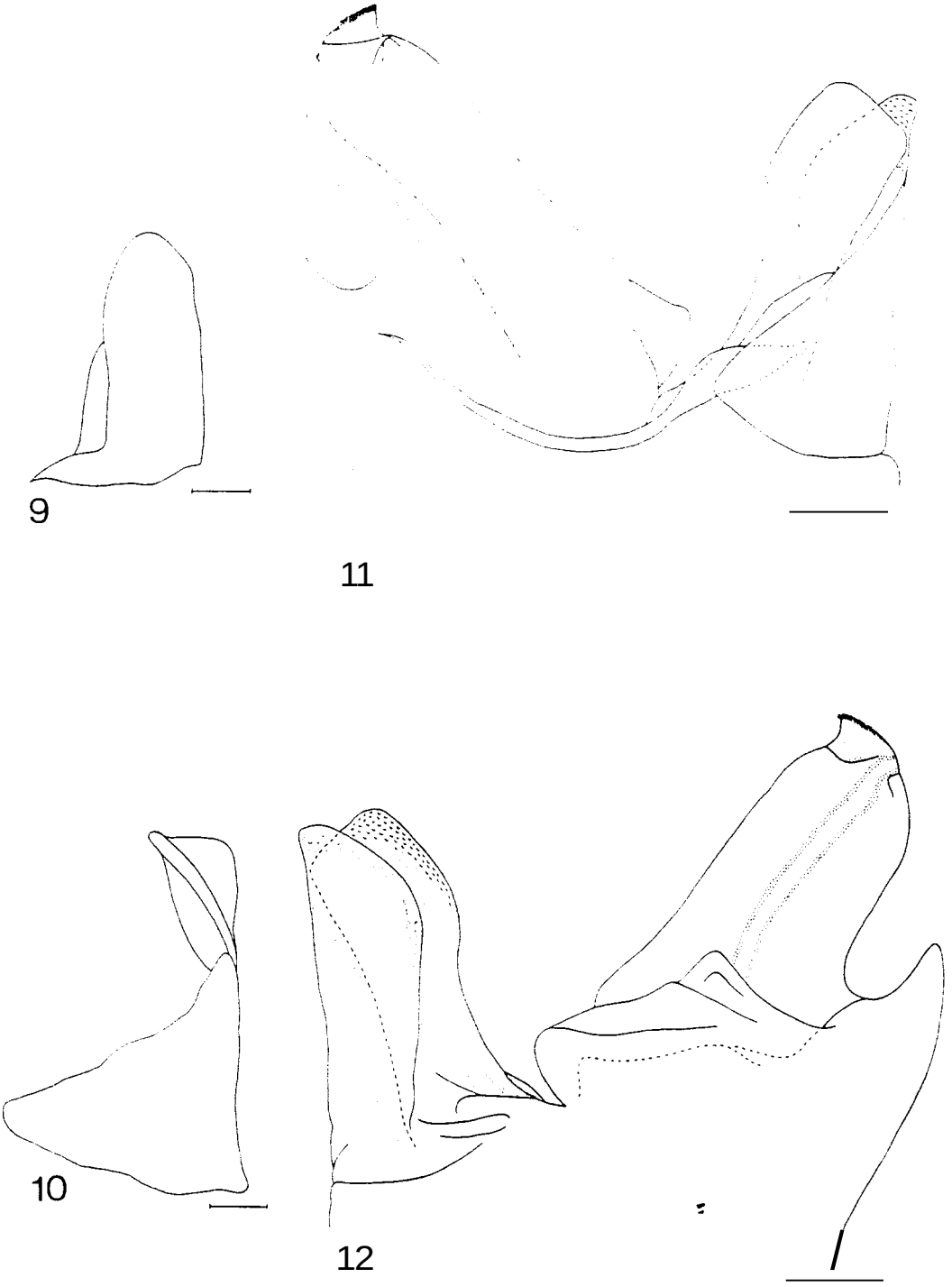
Etymology: This **species is named after the explorer Zarco. who discovered the island of Madeira in 1419.**

Description

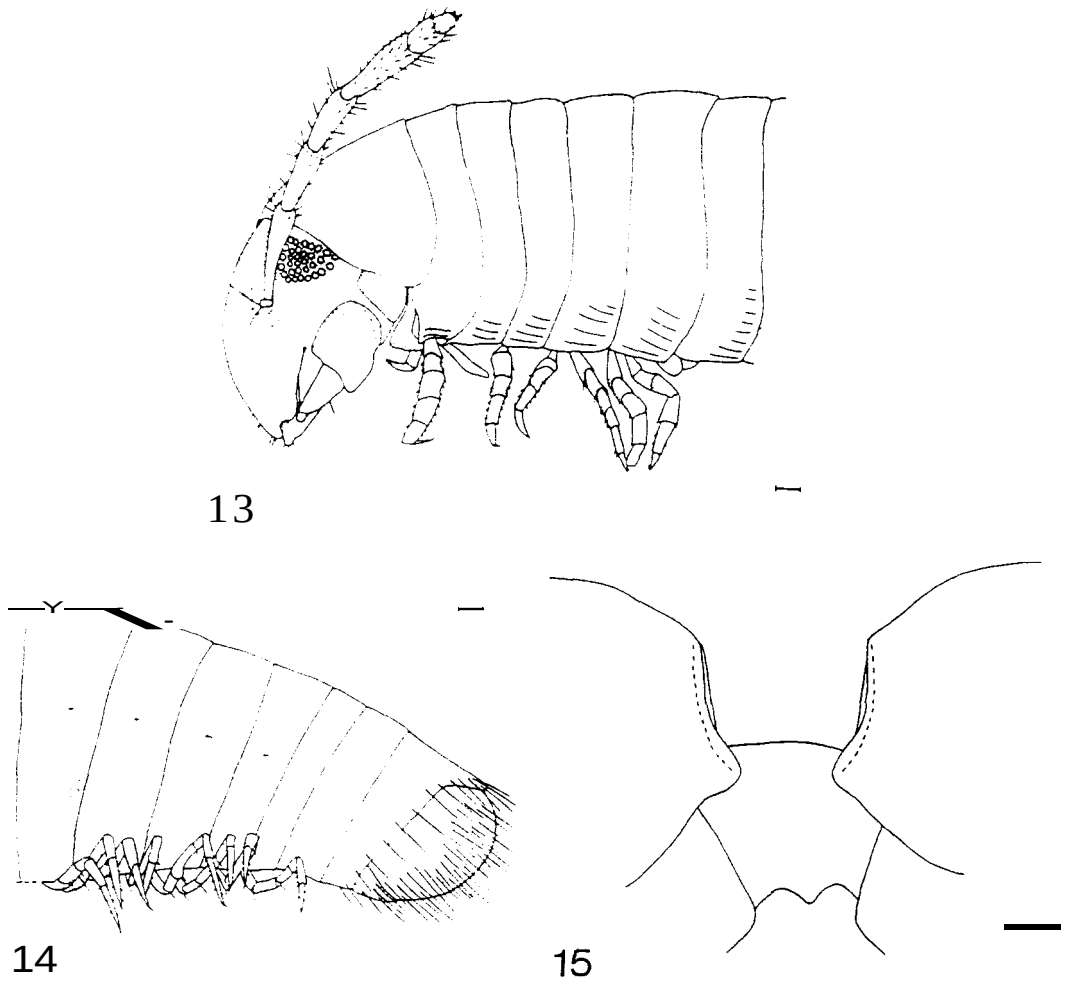
M: L 19 mm, H 1.17 mm, L/H 16, 9RO, 48+3 sgm. Anterior constriction present but small. Slight attenuation.

Colouration predorninantely dark, slightly paler ventrally. Darkest (alrnost black) on dorsal prozonite. Legs dark brown.

Eyes normal with 40–42 ocelli arranged in regular rows. Antennae 0.99 × body H. Midbody segment H/W 0.99, Ø/l 1.9, rnetazonites with slight vaulting, strongest in rnidbody segments. Lirnbus of the normal type. Length of legs 0.81 x H, tarsus l/h 4.49, Iength of claw 6.1% of total leg. Accessory claw 27% shorter than claw. Preanal



Figs. 9–12. *Cylindroiulus waldeni*, right gonopods of holotype: (9) pro- & mesomerite, anterior view, (10) opisthomerite, posterior view, (11) mesal view, (12) lateral view. Scale bars represent 0.1 mm.



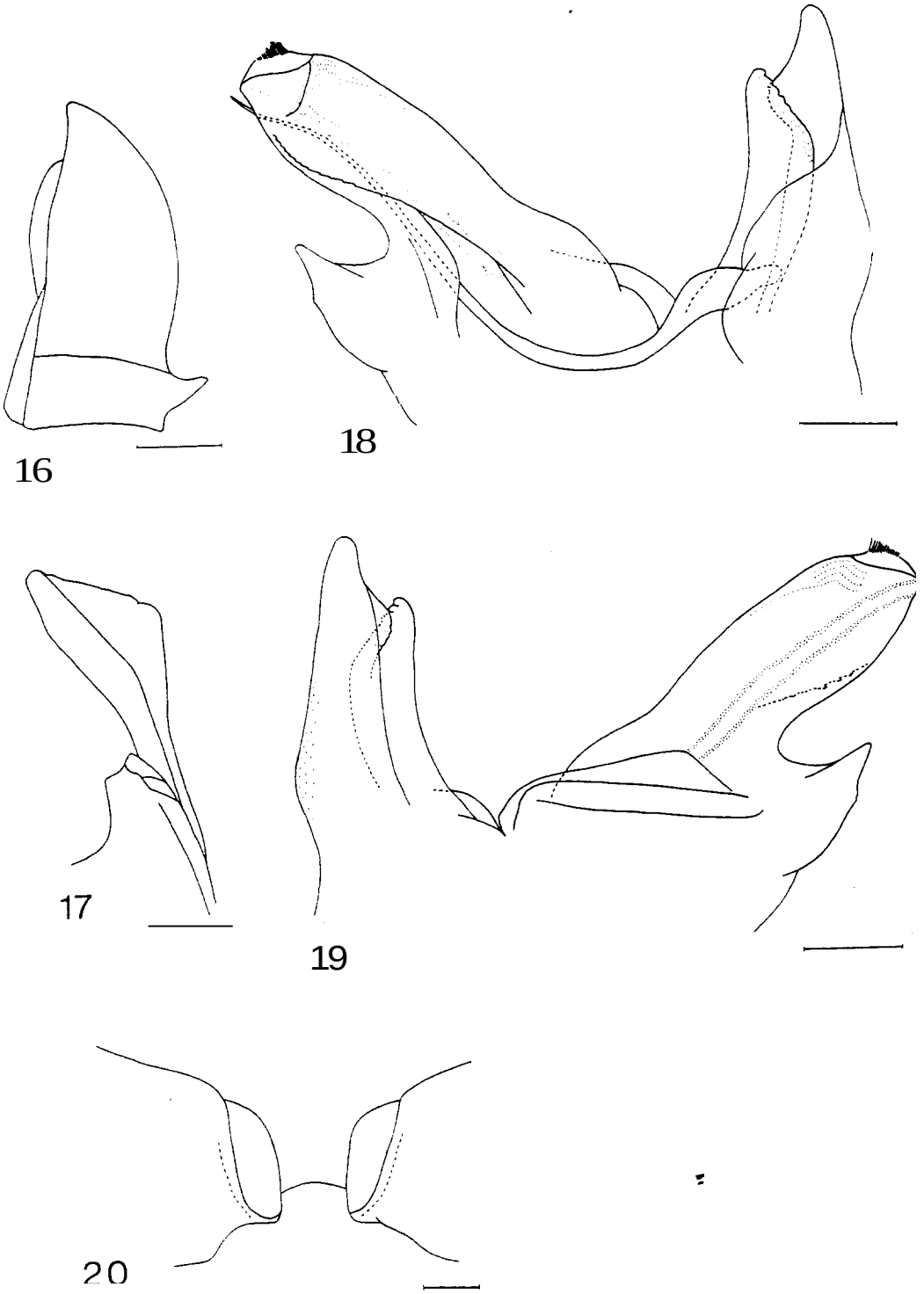
Figs 13–15 *Cylindroiulus waldeni* (13) hrad and anterior trunk region, (14) posterior trunk and telson showing attenuation, (15) ventral view of male segment 7 Scale bars represent 0 1 mm

ring without dorsal projection. with about 30 marginal setae plus additional 20 or so dorsally. Anal valves setose, with 4–5 rows of setae per vaive. Subanal scale with 5 setae. Ventral margins of male segment 7 (Fig. 20) widely separated. Keel clearly seen in lateral view. shelf broadly visible in ventral view.

Gonopods (Figs. 16–19). Length 0.60 x body height. Promerite in anterior view broad. mesal margin almost straight. lateral niargin curving towards ventral margin. tip pointed. in lateral view slender, distally rugose and with a pointed apex. Rugose projection prominent and large in mesal view. Mesomerite considerably shorter than promerite. clender. distally rugose with a pointed apex. Paracoxal process pointed and subtriangular in lateral and mesal view. In posterior view very broad with a less definite apex. Solenomerite with subparallel sides, large mesal swelling and anteriorly with lateral flange seen also in posterior view. Distally with a fine fringe.

Phylogenetic relationships

C. zarcoi has a solenomerite fringe and short accessory claws, suggesting a position close to



Figs. 16–20. *Cylindroiulus zarcoi*, holotype: (16) pro- & mesomerite, anterior view. (17) opisthornerite, posterior view. (18) mesal view. (19) lateral view. (20) ventral view of male segment 7. Scale bars represent 0.1 mm.

obscurior Enghoff, 1982. The strange-shaped promerite bears slight resemblences tu *attenuatus* and *quadratistipes* Enghoff, 1982, however thc limbus does not have the denticles required for this positioning.

Cylindroiulus xynon *sp. n.*

(Figs. 21–27)

Type material: Holotype M: Madeira, Caramujo, altitude 12–1400 m, laurisilva dominated by *Erica*, at path from Estanquinhos, in soil under leaf litter, 23.xi.1980, H. Enghoff & O. Martin leg. – *Paratype:* 1M details as above. (See also note after *C. ynnox*.) Total material 2M, (1M analysed).

Diagnosis: A small species with marginal setae on the telson. Solenomerite hood shaped, strongly concave in lateral view and bearing a large crest in mesal view.

Etymology: This species is named because of its overall similarity to the following species and to *C. exiguus*. Xynon meaning companion or partner.

Description

M: L 13.0 mm. H 0.82 inrn. L/H 16. 6RO, 34+2 sgm; M: L 13.5 mm. H 0.95 mm. L/H 14, 7R0. 36+2 sgm. Anterior constriction fairly strong. No attenuation.

Colouration of holotype generally pale uith darker longitudinal stripe at ozopore level and dark mid dorsally, particularly on prozonite. Paratype mostly paie but with darker rnid-dorsal region.

Eyes reduced with 18–77 ocelli, arranged in reasonably regular rows. Antennae 1.36 + H. Midbody segments H/W 1.0, Ø/l 1.7. metazonites quite strongly vaulted. Lirnbus of the normal type. Length of legs 0.60 × H. tarsus l/h 3.43, length **of** claws 3.1% ot total leg length. Accessory claw surpassing claw by 49%. Preanal ring with no projection. Setae on preanal ring marginal, 11–15 in total. Also marginal on anal valves with 4–6 setae in a single row. Subanal scale with 7 setae. Ventral margins of male segrnent 7 (Fig. 26) fairly well separated. Keel visible in lateral view, shelf broad in ventral view.

Gonopods (Figs. 21–25, 77). Length 0.50 x hody height. Promerite in anterior view basally parallel sided. Distally with mesal margin deeply concave. In rnesal and lateral views with subparallel margins. Mesomerite slightly longer than prornerite. In anterior **view** with a slight tlcxion to the lateral side distally. In rnesal and lateral views expanding to the broadest at approximately **a** third down from the apex. Paracoxal process ot medium size. sub-triangular from lateral view. In posterior view blunt and very broad. Solenomerite of hoiotype (Figs. 23–24) with convex posterior rnargin. Distally 'hood' shaped. Laterally deeply hollowed centrally with anterior and posterior flanges curving round to form the sides of the hood: these two tlanges also obvious in posterior view. **A** large crest along rnesal side from base of solenomerite anteriorly to apex posteriorly. Crest extending beyond posterior margin of solenomerite. Large tooth at apex of solenomerite. more clearly visible in lateral view. Between crest and lateral flange a peg-like projection. visible in lateral view. but hidden by the thickness of thc crest in mesal view. Denticles on the flagellum conducting lamella long and slender.

The solenomerite of the paratype male differs slightly from rhe holotype (Fig. 27). The crest is less well developed posteriorly and does extend beyond the margin of the solenornerite in mesal view. Thus the peg-like projection is also visible. The crest extends further 'downwards' thus concealing the denticles on the flagellum conducting lamella. The apical tooth is larger and has an additional small projection at the base.

Phylogenetic **relntionships**

See after *C. vnnox*.

Cylindroiulus ynnox *sp.* n.

(Figs. 28–32)

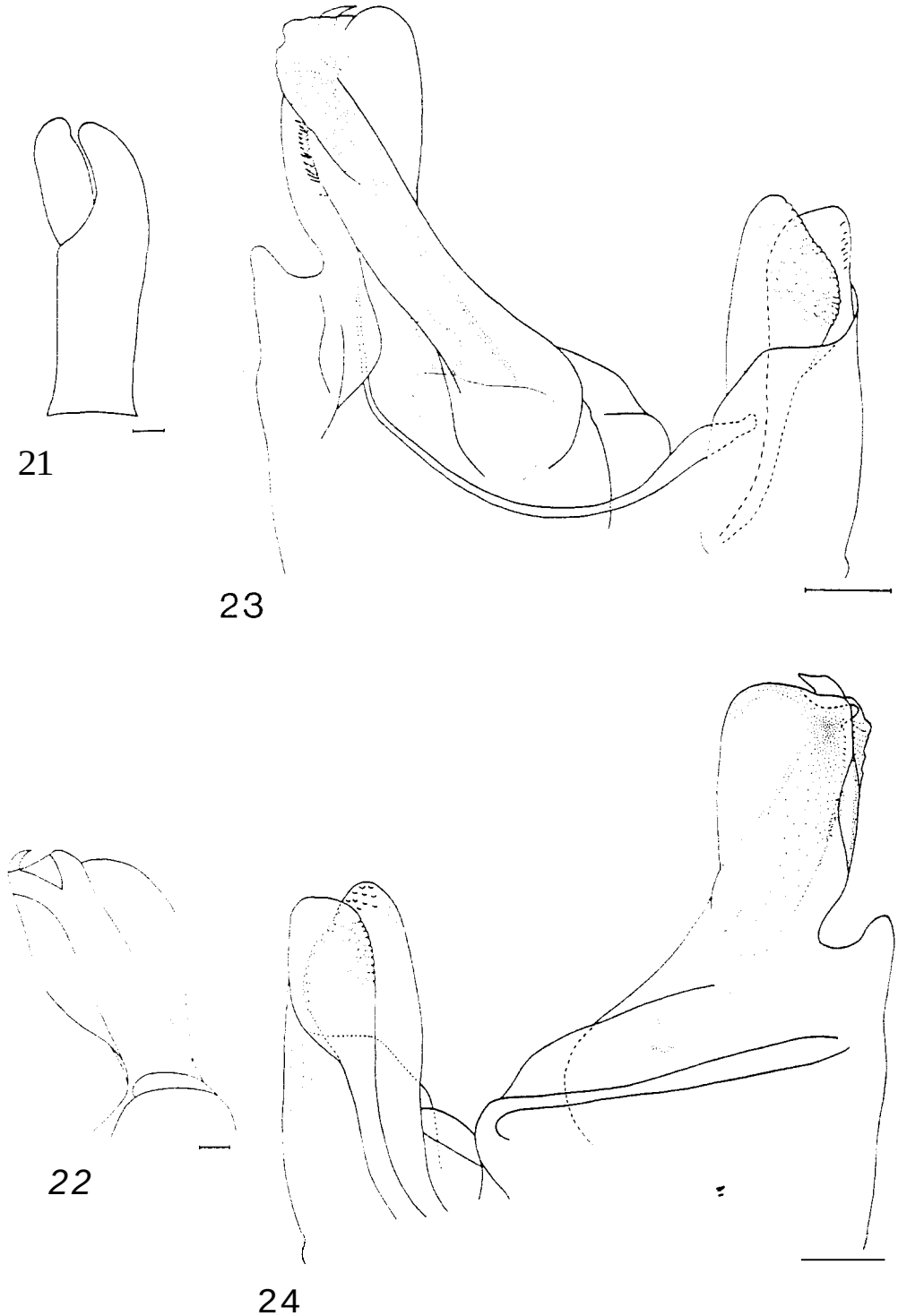
Type material: Holotype M: Madeira: Carарnujo. at path from Estaquinhos. altitude 12–1400 m. laurisilva dominated by *Erica*, in soil under leaf litter. 23.xi.1980. H. Enghoff & O. Martin leg. Total material 1M (analysed). (See also note below.)

Diagnosis: A small to medium sized. many segmented species. with marginal setae on the telson, reduced eyes and colouration **poor** in contrast.

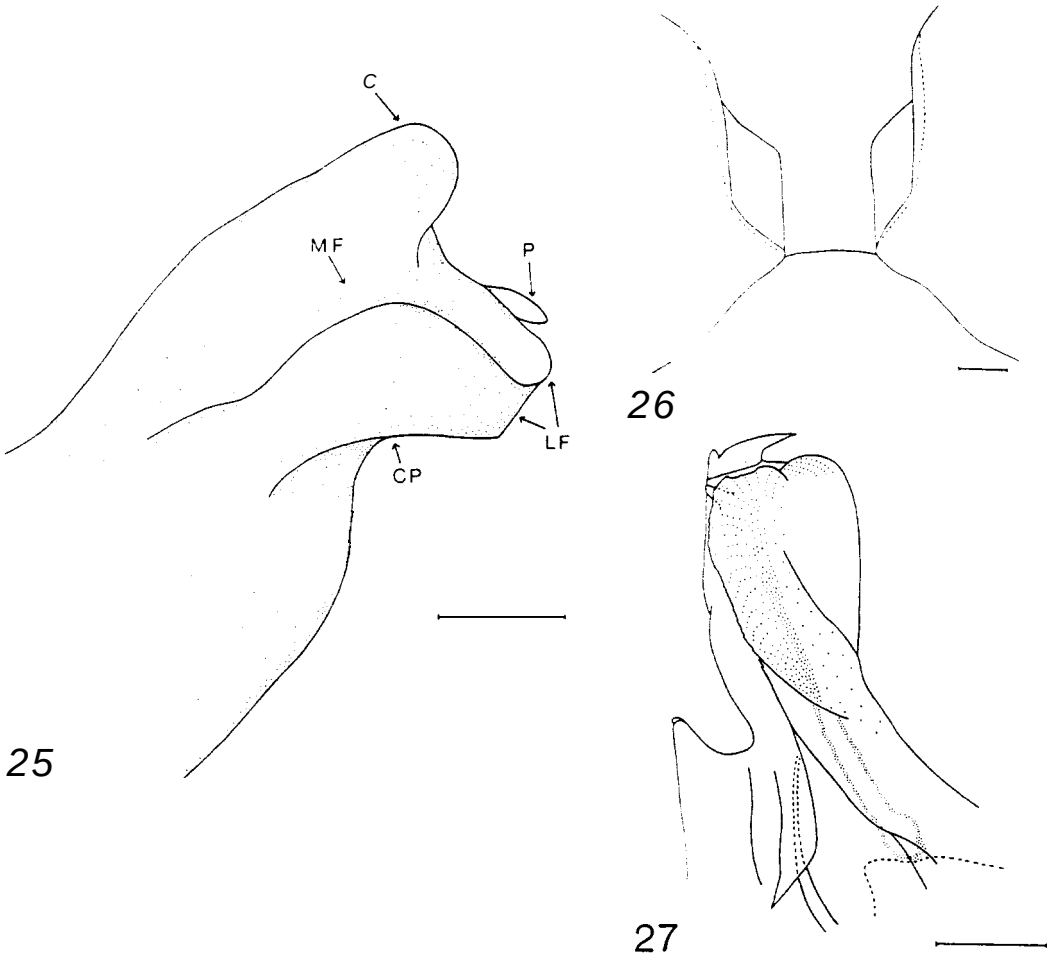
Etymology: The specific name *is* an anagrarn of *xynon*.

Description

M: L 12.1 mm. H 0.97 mm. L/H 12, 7RO, 36+1 sgm. Anterior constriction present but not great. No attenuation.



Figs. 21–24. *Cylindroiulus xynon*, right gonopods of holotype: (21) pro- & mesomerite, anterior view, (22) opistho-nisrits, posterior view, (23) mesal view, (24) lateral view. Scale bars represent 0.1 mm.

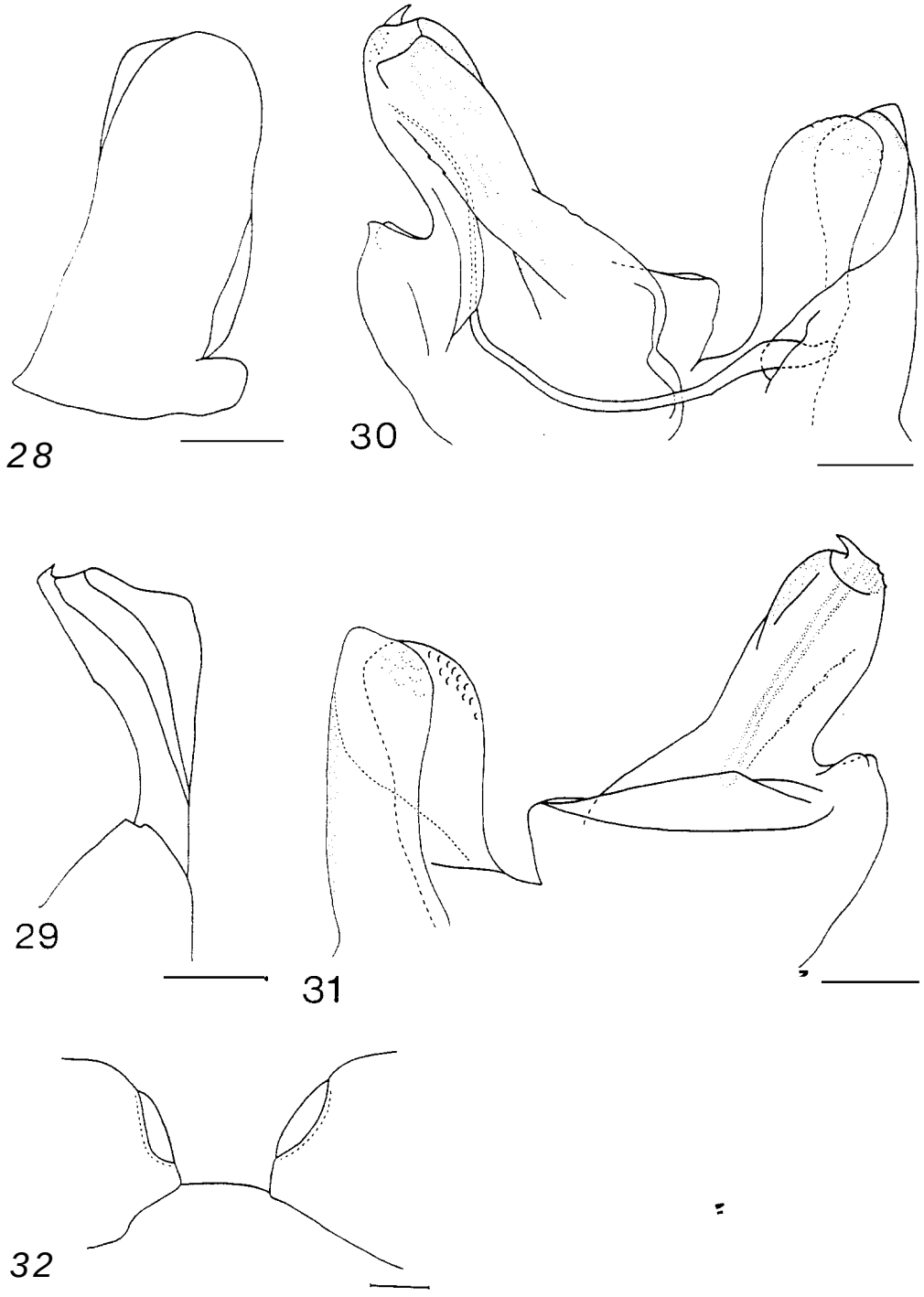


Figs. *15–27. Cylindroiulus xynon*: (25) **solenomerite of holotype from ventro-lateral and slightly anterior.** (26) **ventral view** of male segment 7. (27) **solenomerite** of paratype. C: **crest. CP:** coxal **process (hidden from view),** LP: lateral flanges, MF: mesal flange. **P:** peg. **Scale** bars **represent** 0.1 mm.

Colouration of the basic type with no contrasts in colour. Dorsally darkest on metazonites. Slightly paler ventrally, pale legs.

Eyes reduced, 16–18 ocelli arranged in readable rows. Antennae 91.3 × H. Midbody segment H/W 1.05, Ø/l 7.19, rnetazonite vaulting present posteriorly but weak. Lirnbus of the normal type. Length of legs 0.53 × H, tarsus l/h 3.43, length of claw 2.36% of total leg length. Accessory claw surpassing tip of claw **by** 39%. Preanal ring with no projcction. Setae **on** preanal ring marginal, numbering 13. **Anal** valves with a single row of marginal setae. 5–9 pcr valve. Subanal scale with 1–2 setae. Ventral margins of male segrnent 7 widely separated. Shelf just visible in ventral view. keel small but visible in lateral view.

Gonopods (Figs. 25–31). Length 0.70 x body height. Prornerite in anterior view broad, apically rounded. almost concealing mesomerite. in rnesal view curved over at the top. Mesornerite also broad and rounded, slightly lower than promerite. Paracoxal process broad and **flat** in **all** views. with an apical emargination. Lateral rirn with sharp angle anteriorly. Solenornerite with slightly convex margins. Anterior rnargin forrning lateral tlange seen also in posterior view. Mesal swelling



Figs. 28–32. *Cylindroiulus ynnox*, holotype: (28) pro- & mesomerite in anterior view. (29) opisthomerite in posterior view. (30) mesal view. (31) lateral view. (32) ventral view of male segment 7. Scale bars represent 0.1 mm.

keel-like as in *C. velatus* Enphoff. 1982. Apically with large tooth at the base of which (and siightiy posteriorly) an area of ridges seen clearly in mesal view.

Note. C. xynon and *C. ynnox* were found topether in a sample which also included *C. exiguus* Enghoff, 1982. The general similarity of the thrre species and the variability of *C. exiguus* at this locality caused difficulties in separating the females and juveniles into species. 1 therefore prefer to leave these unidentified, although the gonopods of the males indicate for certain thnt thrre species are involved.

Phylogenetic relationships

These two species (*xynon* and *ynnox*) show no strong apomorphics. although the eyes are slightly reduced in both. The resemblance of these species to *exiguus* has already been noted and this group of small many-segmented species. with a tendency to become pale in colour (*exiguus, pallidior, uroxiphos, velatus, xynon* and *ynnox*) needs further investigation before the relationships between them can be clarified.

Cylindroiulus from the Azores

Cylindroiulus rnadeirae Attema, 1937

A juvenile female of this species was coliected by A.H. Törnvall on the island of Sao Miguel. This confirms the reference rnade in Enghoff (1982) of a male collected by Brinck & Dahl. published by Demange (1970).

Cylindroiulus from the Desertas islands

Cylindroiulus numerosus Enghoff. 1982

Eight *Cylindroiulus* showing contrasting colour patterns were coliected from Chao. the most northerly of the Deserta islands on 13.viii.1981 (*H.* Read leg., University of Manchester expedition). The collection includes four aduit males. The specimens are very similar to *C. numerosus* Enghoff. 1982 which most of them differ from in having fewer setae on the anal valves, a slightly lower number of segments for a given RO and a more slender tarsus. Thc leg length is similar to that of the *C. numerosus* paratypes collected by O. Lomholdt from Prainha. The ponopodes of the specimens from Chão are similar to those of *C. numerosus*, thus it seems appropriate to regard them as the same spccies. The distribution of *C. numerous* which estends onto the Ponta S. Lourenço and the habitat which includes nearly barren ground. makes the possibiiity that the species may occur on Chão more likely.

Cylindroiulus sp.

A female *Cylindroiulus* was coliected from Bugio. the southernmost of the Desertas isiands. on 17.viii.1981 by Gerald le Grande. The specimen appears to be similar to *C. infernalis* Lohrnander. 1955, but this would seem uniikely as the habitat on Bugio is steep rocky ground almost devoid of vegetation, in sharp contrast to the laurel forests of Madeira (and habitat of *C. infernalis*). Unfortunately. as the specimen is a femaie it is not possible to conclusively determine it.

Details: F. L 18 mm, H 1.6mm, L/H 11, 7RO. 39+4 sgm. Slight anterior constriction. Attenuation moderate. Colouration of the basic type although pale below ozopores. Eyes normal with 26 ocelli. Length of legs 0.5 x H, tarsus l/h 3.95. length of claw 5.3% of total leg iength. Accessory claw surpassing tip of ciaw by 15.5%. Setae on preanal ring marginal. Setae on anal valves extensive, forminp several rows. Subanai scale with 4 setae.

Phylogeny of the *madeirae*-group

Enghoff (1982) argued that the *madeirae*-group was monophyletic and proposed two subtie autapomorphic characters, both concerned with the female vulva. These being the near naked operculum and the shape of the receptaculurn and its stalk.

The addition of four new species frorn Madeira and one from the Canary islands, whilst widening the geographical extent of the group. does not contest the monophyiy as defined by Enghoff (1982). Howevcr. new iight can now be shed on some other *Cylindroiulus* species which puts into doubt the suggestion that *C. zinalensis* (Faës. 1902) is the possible sister group of the *madeirae*-proup (see Enghoff 1982).

C. zinalensis possesses denticles on the anterior flagellum-conducting lamella of the maie gonopods and a subcomplete ring of preanal setae like the *madeira*-group. The vulvae of the females differ in bearing two rows of setae on the operculum

A more detailed observation has now been made of *C. perforatus* (Verhoeff, 1905), a species found on the Iberian peninsula which is characterised by a perforation in the promerite. This has revealed the presence of denticles on the flagellum-conducting lamella, as seen in *C. zinalensis* and all the Madeiran species. The vulvae, unlike *C. zinalensis*, have a naked operculum. The receptaculum is also very similar in shape to that of the *madeira*-group, being spherical with an appendix.

The subcomplete ring of preanal setae, which was the final link between *C. zinalensis* and the *madeira*-group, carries less weight as a character than the vulval characteristics and it is difficult to define precisely. The setae on the preanal ring are more sparsely arranged in *C. perforatus* than *C. zinalensis* but may occur in a lateral position.

An undescribed species of *Cylindroiulus* from Portugal has been collected by P. Bailey. This resembles *C. perforatus* and has a perforate promerite, the paracoxal process is however distinct. Denticles are present on the flagellum-conducting lamella and the setae on the preanal ring are similar to *C. perforatus*. Unfortunately no females are as yet available, thus the vulval characteristics cannot be examined.

It would appear that *C. perforatus* and the new Portuguese species are a better sister group to the *madeira*-group than *C. zinalensis*, the geographical location of the species is more convincing too (*C. zinalensis* being found in the Alps). The re-examination of *C. perforatus* casts doubt on two autapomorphic characters suggested by Enghoff (1982) characterising the *madeira*-group, these being the naked (or almost naked) operculum and the shape of the receptaculum. It is possible that the subcomplete ring of setae on the preanal ring are autapomorphic for the *madeirae*-group and are derived independently in *C. zinalensis*. Alternatively the *C. perforatus* group may have originated from within the *madeirae*-group, but this seems unlikely for geographical reasons.

APPENDIX

Adjustments to the key given in Enghoff (1982) to encompass the new species found on Madeira.

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17. Metazonites strongly vaulted, esp. in males, colouration contrastful. ..... 21. *C. rabacalensis*
— Metazonites not or slightly vaulted. **17A**
17A Claws short < 4% of leg length. 17B
— Claws longer > 4% of leg length. 18
17B. Colour pattern of basic type. ..... *C. ynnox*
— Colour pattern otherwise. ..... *C. xynon*

21. Accessory claw much shorter than claw (Fig. 41). 21A
— Accessory claw c. of same length as claw (Fig. 39). 22
21A Long, slender, many-segmented species. M L H 16 L 19 mm 48 ps. ..... *C. zarcot*
— Shorter species with fewer segments. M L/H 9–13 L 10–14 mm 29–33 ps. F L/H 9–10 L 10–13 mm 29–31 ps. ..... *C. obscurior*

24. Posterior end very strongly attenuate (Fig. 2). 24A
— Posterior end less attenuate. 25
24A. Pre-anal ring with short projection. ..... *C. attenuatus*
— Preanal ring with no projection. ..... *C. waldeni*

27. Largerspecies. H 1.2 mm (M) 1.6 mm (F). .. **27A**
— Small species. H 0.8–1.0 mm (M) 0.8–1.2 mm (F). 28
27A. Pre-anal ring with exclusively marginal pilosity. Anal valves with mainly marginal setae, occasionally 1–2 in front of marginal row. ... . 4. *C. cristagalli*
— Pre-anal ring with a few additional setae dorsally. Anal valves with dense and extensive pilosity. ..... *C. waldeni*

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References

Demange, J.-M. 1970. Myriapodes Diplopodes de Madère et des Açores. *Bolm Mus. munic. Funchal* 25: 5–43.
Enghoff, H. 1982. The millipede genus *Cylindroiulus* on Madeira — an insular species swarm (Diplopoda, Julidae). *Ent. scand.*, Suppl. 18. 142 pp.
— 1983. Adaptive radiation of the millipede genus *Cylindroiulus* on Madeira: habitat, body size, and morphology (Diplopoda, Julida: Julidae). *Revue Ecol. Biol. Sol.* 20: 403–415.