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Revision of the millipede genus *Choneiulus* (Diplopoda, Julida, Blaniulidae)

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Choneiulus Brolemann, 1921 is revised. Supplementary descriptive and other notes are given on the included species, viz., *C. lacinifer* Strasser, 1980; *C. palmatus* (Němec, 1895): *C. subterraneus* (Silvestri, 1903); and *C. verhoeffi* (Attems, 1899). *C. palmatus seclusus* Brolemann, 1921 is relegated to synonymy of *C. palmatus*. *C. gallicus* Brolemann, 1921 and *C. minimus* Verhoeff, 1941 are new synonyms of *C. subterraneus*. A unique modification of the second antennomere in some ♀♀ of *C. subterraneus* is described.

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INTRODUCTION

The genus *Choneiulus* includes tiny blaniulid millipedes. They mostly occur in the Mediterranean region although one species, *C. palmatus*, has become widespread due to human activities. Species of *Choneiulus* are found in soil and vegetable debris, under stones, or in caves, and *C. palmatus* is often found in greenhouses.

The genus was erected by Brolemann (1921) and treated in detail in his masterly monograph of the Blaniulidae (Brolemann 1923). *Choneiulus* was, together with *Archichoneiulus* Brolemann, 1921; *Microchoneiulus* Brolemann, 1921, and *Alpiobates* Verhoeff, 1911, included in the tribe Choneiulini Brolemann, 1921. Both genus and tribe have persisted without alterations through recent reclassifications, with the exception that the tribe has been upgraded to subfamily status by some authors (Mauriès 1970a,

Enghoff 1984) and synonymized with Nopoiulini by Hoffman (1979). Hoffman (1979) further synonymized *Archichoneiulus* with *Choneiulus*, but although Hoffman is right in stating that generic splitting has been exaggerated in the Julida, this synonymy is doubtful: *Archichoneiulus* has a possible synapomorphy with *Microchoneiulus* in the vestigial second pair of female legs, so unless *Microchoneiulus* is drawn into the synonymy as well, *Choneiulus* and *Archichoneiulus* should be kept separate. Considering the somewhat deviating gonopods of *Microchoneiulus*, and in the interest of stability, I suggest that Brolemann's original generic concepts be retained.

Whereas nothing can at present be added to Brolemann's treatment of the other choneiuline genera (see, however, Verhoeff (1932) on *Alpiobates*), reexamination of type specimens of most described species in *Choneiulus* has clarified

some obscure points and revealed some new synonyms. In the present paper these discoveries are presented, and a revised key to the species is given, Brolemann's key from 1923 being outdated.

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SYSTEMATIC ACCOUNT

Choneiulus Brolemann, 1921

Choneiulus Brolemann, 1921: 4. Type-species, *Blaniulus palmatus* Němec, 1985, by subsequent designation by Brolemann 1923.

Etymology, according to Brolemann (1923): "χρῶμα = creuset, entonnoir" (= crucible, funnel).

Diagnosis

A genus of Choneiuliinae (sensu Mauries 1970a, Enghoff 1984). Posterior gonopods terminating in a funnel with fringed margins. Second pair of female legs fully developed.

It is impossible to decide whether the fringed margins of the posterior gonopods is a primitive or a derived trait. Fringes are absent in *Microchoneiulus* and *Alpiobates* but present in *Archichoneiulus*, where, however, the second pair of female legs is vestigial. The fully developed second pair of female legs in *Choneiulus* is, of course, a primitive trait. The present diagnosis of *Choneiulus* thus does not include an autapomorphy, which is dissatisfying from a cladistic

point of view. The genus may in spite of this be used as a practical "working unit", the included species being phenetically very similar to each other.

Antennae and legs.

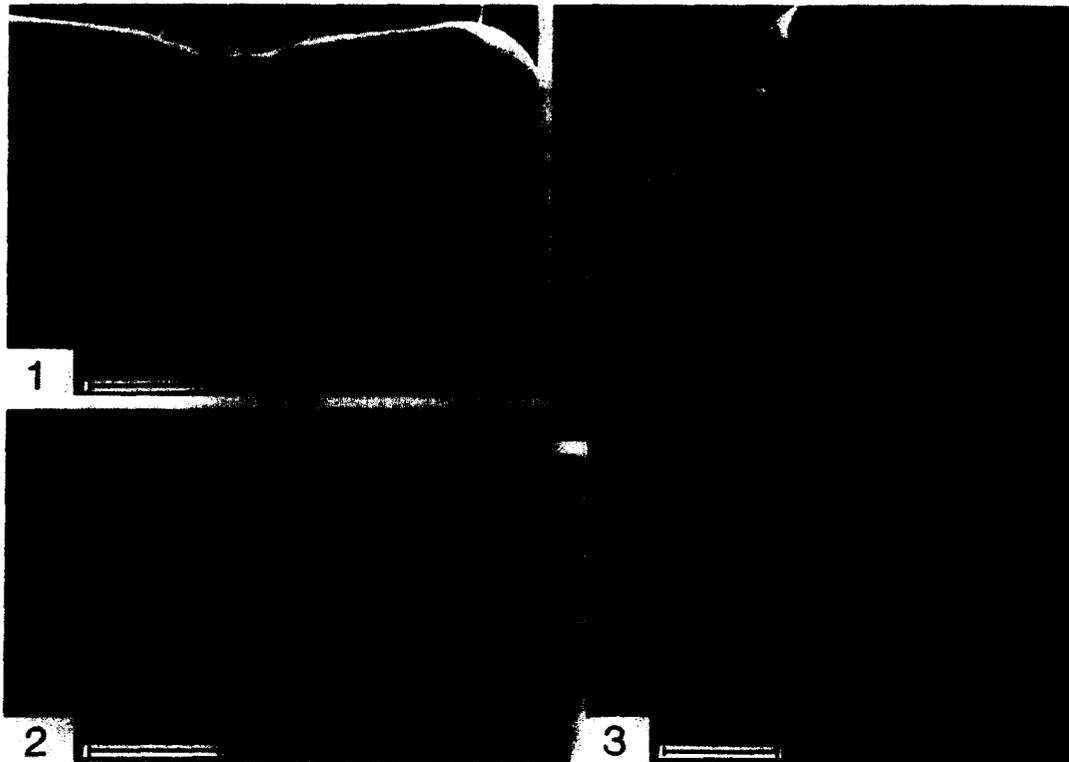
A general description of the genus can be found in Brolemann (1923). **As** with the other blaniuid genera recently revised (Enghoff 1983, 1984) I have measured the dimensions of antennomeres and podomeres and recorded the leg chaetotaxy. This was done on one individual of each sex of each species. One or both antennae and the four legs from one midbody segment were examined. Only moderate differences were found.

Antennae. Length 168-179% of vertical midbody diameter (H) in ♂♂, 136-162% of H in ♀♀. Length of antennomeres 2 - 8 in percent of total length of antenna (excluding antennomere 1): 12-18/18-21/17-19/19-21/15-17/6-8/4-5, i.e., generally as in the Nopoiulinae (Enghoff in press). Length/diameter ratio of apical sensilla 3.8-5.5. See also under *C.subterraneus*.

Legs. Length 81-94% of H in ♂♂, 75-80% of H in ♀♀. Length of podomeres in percent of total leg length (prefemur to claw): prefemur 14-15/ femur 18-20/postfemur 12-14/tibia 13-14/tarsus 27-29/claw 12-14. Length/height ratio of prefemur 1.2 - 1.4, femur 1.7 - 2.2, postfemur 1.3 - 1.5, tibia 1.5 - 1.8, tarsus 4.3 - 5.2, claw 5.0 - 6.7. Chaetotaxy of legs similar to the standard chaetotaxy in the Nopoiulinae (Enghoff in press), i.e., with 1, 5, 5, 5, 6 and 6 setae on coxa, prefemur, femur, postfemur, tibia, and tarsus, respectively. The setae fe5, pof5, ti2, and ti6 (sensu Enghoff in press: fig. 39) absent from many legs; certain other setae absent from a few legs; a few supplementary setae present.

Notes

Brolemann (1921, 1923) included four species in *Choneiulus*, viz., *C.subterraneus* (Silvestri, 1903); *C.gallicus* Brolemann, 1921; *C.verhoeffi* (Attems, 1899); and *C.palmatus* (Němec, 1895) with ssp. *seclusus* Brolemann, 1921. Subsequent authors added *C.minimus* Verhoeff. 1941; *C.la-*

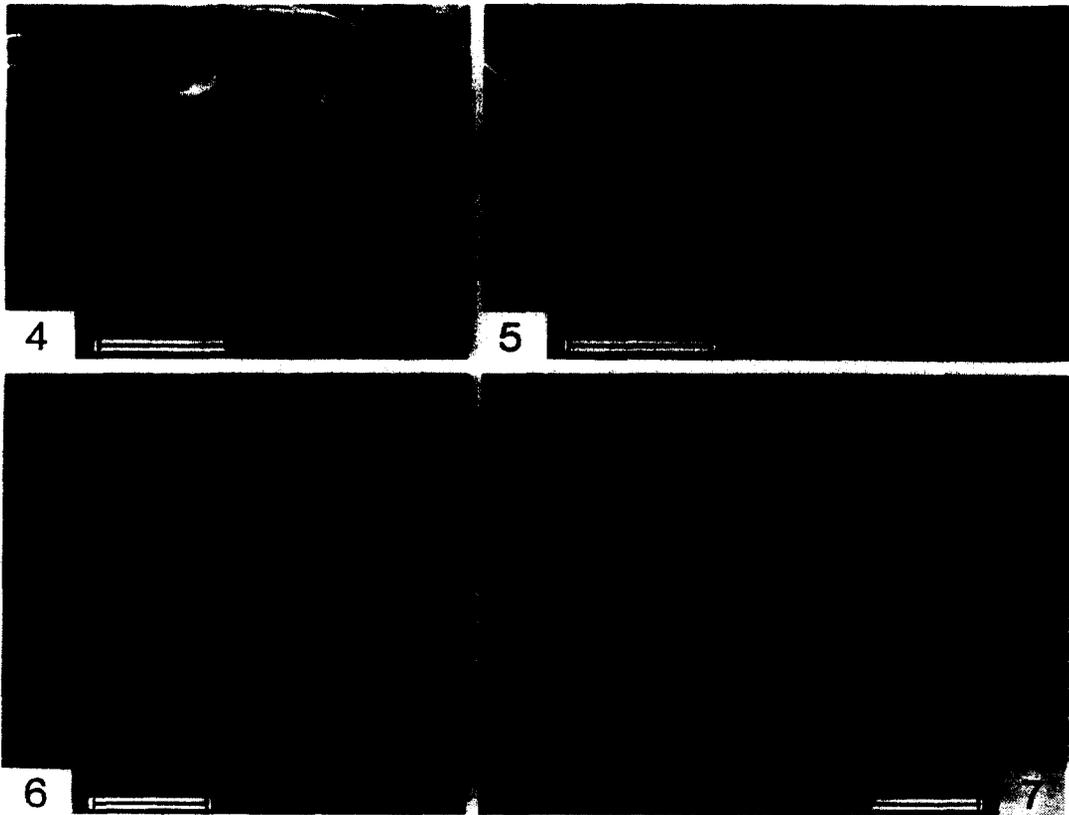


Figs. 1-3. *Choneiulus palmatus*, ♂ from Denmark. 1: first pair of legs, oral view, scale 50 μm . 2: posterior gonopods, ventrolateral view, scale 100 μm . 3: apical fringes of posterior gonopod, scale 10 μm . Scanning electron micrographs.

cinifer Strasser, 1980: and *C. franzi* Loksa, 1967 (the latter was transferred to *Acipes* by Enghoff (1983)). Strasser (1980) compared his *lacinifer* with all previously described species except *franzi*, emphasizing, among other things, differences in the numbers of ocelli recorded for each species. This character should be used with much care, as more ocelli are added at each moult. Comparisons involving numbers of ocelli should therefore include consideration of developmental stadium (preferably) or number of segments (see Enghoff 1983). Numbers of ocelli are not considered in the present study.

In addition to the four species here referred to *Choneiulus*, *Iulus corticalis* Lucas, 1846 may belong in the genus. Lucas' original description

is too general to be of any value, except for the sentence "oculis fuscis, longitudinaliter dispositis", which shows that the species is an ocelliferous blaniulid. Brolemann (1896, 1923) referred *corticalis* to the Blaniulidae but did not make a closer identification because the material of *corticalis* available to him was said to include only females. I have examined Lucas' material of *corticalis* (Mus. natn. Hist. nat. Paris), which bears a label "Brolemann vid.", and found it to consist of two adult males! They are in quite a bad condition and cannot be identified with certainty although they obviously belong to *Choneiulus* or a closely related genus. They bear some resemblance to *C. subterraneus* in the structure of the gonopod and first male legs, but a final identifi-



Figs. 4-7. 4: *Choneiulus subterraneus*, ♂ from Tenerife, tip of right posterior gonopod, ventrolateral view, scale 50 μm. 5-7: *Choneiulus verhoeffi*, ♂ paratype. 5: tip of posterior gonopods, lateral view, scale 50 μm. 6: tip of right posterior gonopod, mesal view, scale 20 μm. 7: dorsal fringes of posterior gonopod, scale 10 μm. Scanning electron micrographs.

cation of corticaiis must await study of fresh topotypes from Skikda (= Philippeville). Algeria.

Key to the species of *Choneiulus*

- 1. Blind *C.verhoeffi*
 - With ocelli 2
- 2. Males. 3
 - Females 5
- 3. Coxal processes of anterior gonopods with smooth mesal margins *C.palmatus*
 - Coxal processes with apically serrate mesal margins (Fig. 8) 4
- 4. Posterior gonopods tapering towards tip, apically with long, simple fringes (Fig. 11) *C.lacinifer*

- Posterior gonopods widening towards tip, apically with branched (featherlike) fringes (Fig.10) *C.subterraneus*
- 5. Operculum of vulva tapering into blunt point (Fig. 15) *C.palmatus*
 - Operculum with subparallel margins 6
- 6. Operculum subrectangular, apical margin slightly emarginate (Fig. 14) *C.lacinifer*
 - Operculum with subcircular profile apically (Fig. 16) *C.subterraneus*

The Species of *Choneiulus*

Full description of species are not given, but references to usable descriptions are included. The descriptive notes include, among other things, the following data for adult specimens: body

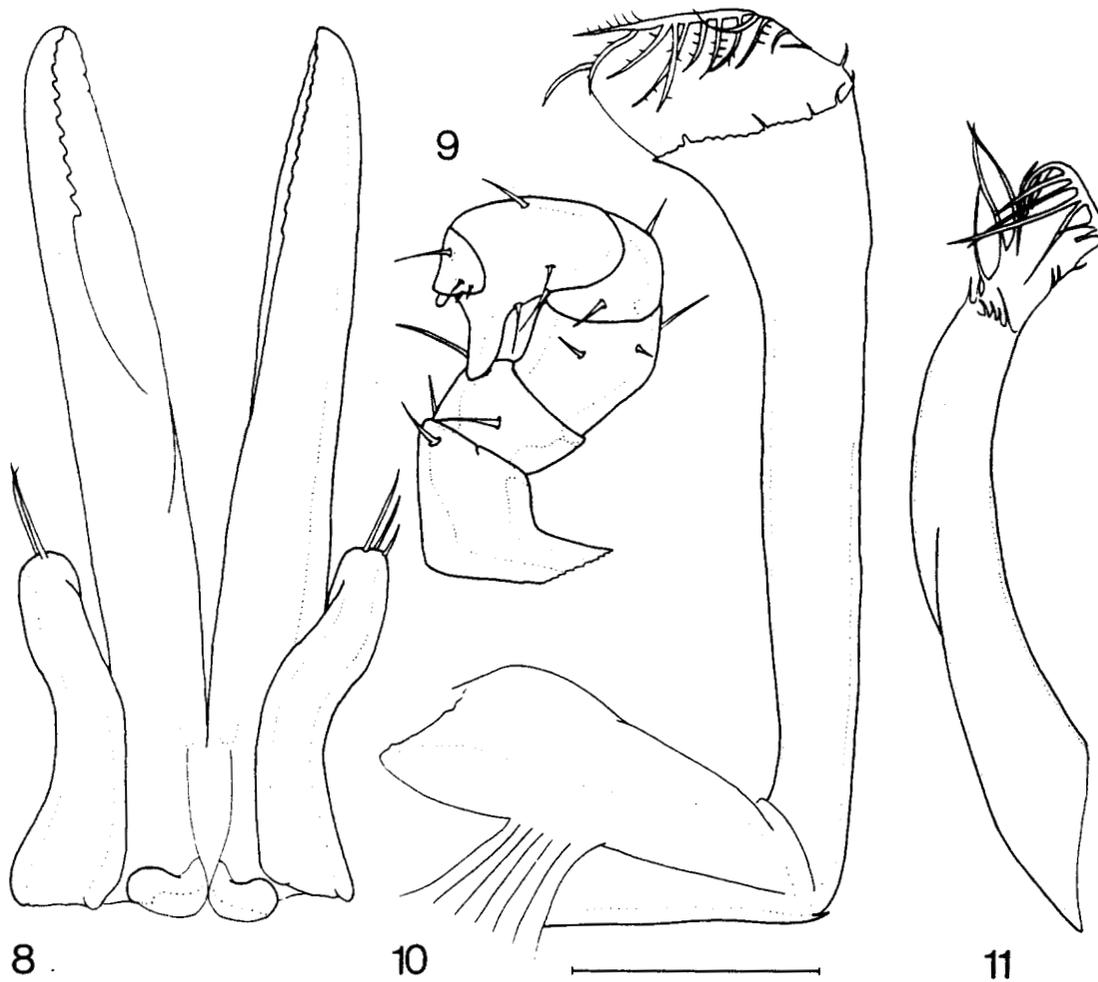


Fig. 8-11. 8-10: *Choneiulus subterraneus*, ♂ cotype. 8: anterior gonopods, dorsal view. 9: right leg of first pair, oral view. 10: left posterior gonopod, lateral view. 11: *Choneiulus lacinifer*, ♂ holotype, right posterior gonopod, lateral view (drawn from Strasser's original slide, basal portion omitted). Scale 100 μ m.

length (L), midbody vertical diameter (H), number of podous segments (p.s.), and number and maximum length of metazonal setae on a midbody segment. For females, only maximum values of L, H, and p.s. are given, because adult and juvenile female stadia cannot be distinguished without dissection.

***Choneiulus lacinifer* Strasser, 1980**

Fig. 11, 14, 17-18.

Choneiulus lacinifer Strasser, 1980: 275.

Material examined: 5♂♂, 5♀♀, 6 juveniles in alcohol, plus 3 slides, ITALY: Sardinia, Grotta del Cane, 4.viii.1977, M. Paoletti leg. (Type series, Mus.civ.Stor. nat.Venezia).

Diagnosis

A thick species of *Choneiulus* (Fig. 18). Anterior gonopods with mesally serrate coxal processes. Posterior gonopods with broad basis, tapering towards tip; apical fringes long and unbranched. Operculum of vulva subrectangular with a slightly emarginate tip.

Descriptive notes

♂: L 7-9 mm, H 0.54-0.60 mm, 26-34 p.s.

♀: L_{max.} 10 1/2 mm, H_{max.} 0.72 mm, max. 36 p.s.

Max. 41 segments (podous + apodous) according to Strasser (1980). See also Figs 17-18.

Midbody segments with ca. 10 setae. Length of setae 14-18% of H.

Strasser's description is accurate except for one point: As shown in Fig. 11, there is a complete ring of apical fringes on the posterior gonopods, as in the other species. The vulvae (Fig. 14) differ from those of other species in having a subrectangular operculum with a slightly emarginate tip.

Distribution and biology

Only known from Sardinia. Cavernicolous.

***Choneiulus palmatus* (Němec, 1895)**

Figs. 1-3, 15, 17-18.

Blaniulus palmatus Němec, 1895: 5.

Nopoiulus fimbriatus Rothenbüchler, 1899: 244 (synonymized by Bigler 1913).

Nopoiulus palmatus: Verhoeff 1907.

*Choneiulus plmatu*s: Brolemann 1921, 1923.

Choneiulus palmatus seclusus Brolemann, 1921: 4, Brolemann, 1923, syn.n.

Material examined: Numerous specimens from Europe and North America.

Diagnosis

A very slender species of *Choneiulus* (Fig. 18). Metazonital setae longer and more numerous than in congeners. Tibia and tarsus of first pair of male legs usually intimately fused into sub-

rectangular structure (Fig. 1). Anterior gonopods with smooth coxal processes. Posterior gonopods with branched apical fringes. Operculum of vulva tapering towards tip.

Notes on synonymy

In spite of some inaccuracies, Němec's original illustrations leave no doubt about the identity of *palmatus*. The synonymy of ssp. *seclusus* with *palmatus* was tentatively suggested by Lohmander (1925) who found a *seclusus*-like male among several normal males in a material from a churchyard in Uppland, Sweden, and who also found some females with vulvae intermediate between typical *palmatus* and *p.seclusus* as illustrated by Brolemann (1923). In my opinion, Lohmander's finding fully justify the synonymization, which is herewith formalized.

Nopoiulus palmatus coelebs Verhoeff, 1907, and *N.p.coelebs* var. *salicis* Verhoeff, 1907 are synonyms of *Proteroiulus fuscus* (Am Stein, 1857) (Lohmander 1925, Schubart 1934).

Descriptive notes

♂: L 5-14 1/2 mm*, H 0.40-0.47 mm, 25-56 p.s.*.

♀: L_{max.} 12 mm, H_{max.} 0.62 mm, max. 58 segments (podous + apodous)**.

* according to Schubart (1934)

** according to Lohmander (1925)

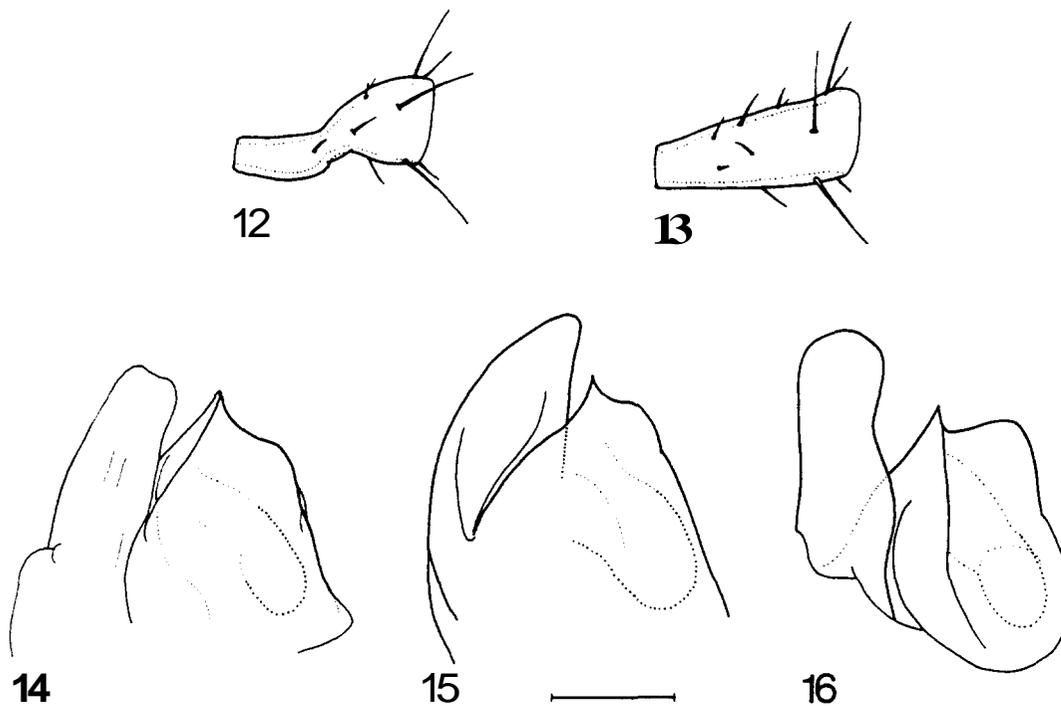
See also Figs. 17-18.

Midbody segments with ca. 20 setae. Length of setae 23-28% of H.

Brolemann (1923) and Schubart (1934) give good descriptions of this species. The posterior gonopods (Figs. 2-3) differ from those of *C.subterraneus* (where the fringes are also branched) in having the fringes projecting more radially.

Distribution and biology

Widely distributed in Europe, Madeira, and the Azores (Schubart 1934, Mauries 1970b, De-



Figs. 12-16. 12-13: *Choneiulus subterraneus*, left antennomere 2. 12: ♀ from Tenerife. 13: ♀ from Corsica. 14: *Choneiulus lacinifer*, ♂ paratype, left vulva. 15: *Choneiulus palmatus*, ♀ from Sweden, left vulva. 16: *Choneiulus subterraneus*, ♀ from Corsica, right vulva. Scale 100 μm.

mange 1970), probably introduced in **most** of its range. Also introduced in Canada: Nova Scotia, Newfoundiand, Ontario and **USA**: New York, Pennsylvania, **Ohio**, Colorado, Nevada, California, Washington (Palmén 1952, Jawłowski 1939, Enghoff unpubiished).

Found in soil and litter, sometimes also under bark of logs. Frequently the species occurs in immediate association with human habitations, e.g., in gardens and greenhouses. A sample of numerous specimens collected on "plumfruit on ground" in Reno, Nevada (Nevada Dept. of Agriculture) indicates that *C. palmatus* may occasionally be a pest, like several other synanthropic blaniulids (Pierrard & Biemaux 1974, Enghoff in Press).

Choneiulus subterraneus (Silvestri, 1903)

Figs. 4, 8-10, 12-13, 16-18.

Nopoiulus subterraneus Silvestri, 1903: Fasc. XCVIII, N.9.

Chonciulus subterraneus: Brölemann 1921. 1923.

Choneiulus gallicus Brölemann, 1921: 4, Brölemann 1923, Mauriès 1969b, syn.n.

Nopoiulus (Choneiulus) [sic] *minimus* Verhoeff, 1941: 165, syn.n.

Choneiulus palmatus minimus: Strasser 1971.

Material examined: 4 dd, 1 juv. **ITALY**: Portici, Parco Gussone, 1903, F. Silvestri leg. (Syntypes of *subterraneus*, **Ist. Ent. agrar. Univ. Napoli-Portici**) - 1 d **FRANCE**: Alpes Maritimes, Tourette-sur-Loups, 26.ü. 1905 (holotype of *gallicus*, **Mus. natn. Hist. nat. Paris**) - 1 d **FRANCE**: Corse, Vizzavona, viii. 1930, P. Grassé leg. (Mauriès 1969b, **Mus. natn. Hist. nat. Paris**) - 3 dd, 5 ♀♀, 4 juv. **FRANCE**: Corse, Castiglione, Grotte de Sa-

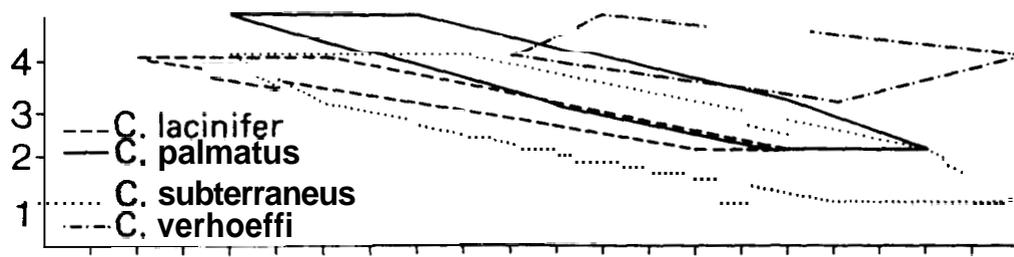


Fig. 17. Numbers of podous (p.s.) and apodous (a.s.) segments in adults of *Choneiulus* spp. The polygons circumscribe all observed points for each species. Based on all examined specimens except for *C. palmatus*, where based on 2 samples from Denmark and Sweden.

bara, 22.xi.1967, P. Beron leg. (Mauriès 1969b, Mus. natn. Hist. nat. Paris) – 1 ♂ ITALY: Ischia (type of *minimus*, Zool. Staatssaml. München) – 2 ♂♂, 2 ♀♀ ITALY: Lazio, Tivoli, Dea Bona, 23.ü.1969, A. Vigna leg. (Strasser 1971, Mus. civ. Stor. nat. Verona) – 5 ♂♂, 7 ♀♀ TENERIFE: Costa del Silencio and Las Galletas, i.1968, P. Johnsen leg. (Naturhist. Mus. Århus & Zool. Mus. København).

Diagnosis

A medium-sized species of *Choneiulus*. Anterior gonopods with mesally serrate coxal processes. Posterior gonopods with branched apical fringes. Operculum of vulvae apically extended, subcircular in profile.

Notes on synonymy

The identity of *subterraneus* has remained obscure owing to Siivestri's (1903: fig. 4) illustration of the first male leg, which he depicted as being almost straight, as opposed to the curved condition in related species. I have not seen the specimen upon which Silvestri based his drawing, but the male syntypes examined have normally curved first legs (Fig. 9) similar to those depicted by Brolemann (1923: fig. 126), Verhoeff (1941: fig. 31), and Strasser (1971: fig. 11). It is therefore probable that Silvestri's drawing is erroneous or based on an abnormal specimen.

Brolemann (1921, 1923) was obviously misled by Silvestri's drawing when he described his

gallicus. Verhoeff (1941) did not compare his *minimus* with either *subterraneus* or *gallicus*. I have examined type specimens of all three nominal species and cannot find any significant differences between them. Therefore, *gallicus* and *minimus* are regarded synonymous with *subterraneus*.

Descriptive notes

♂♂: L 6-11 1/2 mm, H 0.44-0.62 mm, 2741 p.s.
♀♀: L_{max.} 12 mm, H_{max.} 0.70 mm, max. 38 p.s.

See also Figs. 17-18.

Midbody segments with 8-10 setae. Length of setae 18-19% of H.

Brolemann's description of *gallicus* (1923) and Strasser's of *palmatus minimus* (1971) are quite adequate. In addition to the characters given in the key and diagnosis, *C. subterraneus* differs from the other widespread species of *Choneiulus*, *C. palmatus*, in the sparser and shorter metazonital pilosity and in the arrangement of the apical fringes of the posterior gonopods: in *C. palmatus* (Fig. 2) the fringes project somewhat radially from the margin of the funnel, but in *C. subterraneus* (Fig. 10) the long fringes at the distal margin of the funnel tend to be bent laterad, i.e. towards the hollow of the funnel. This character, which is easily observed under the dissecting microscope, is also evident in Brolemann's fig. 130 (1923, *gallicus*),

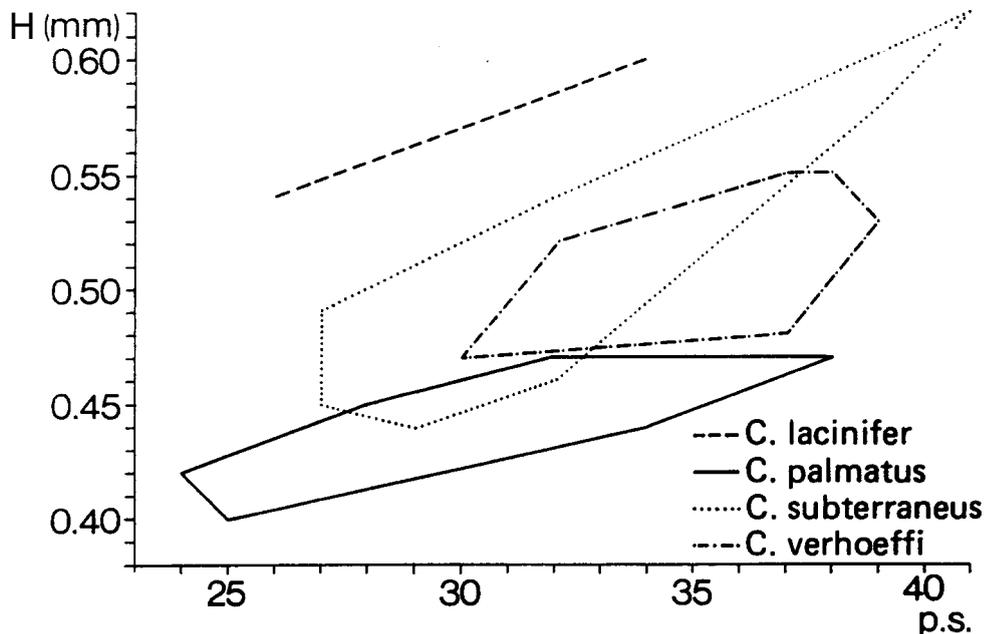


Fig. 18. Midbody vertical diameter (H) as a function of number of podous segments (p.s.) in adult Ud of *Choneiulus* spp. The polygons circumscribe all observed points for each species. Based on the same specimens as Fig. 17.

Verhoeff's fig. 32 (1941), and Strasser's fig. 13 (1971) but not in Silvestri's fig. 9 (1903) and Brolemann's fig. 129 (1923, *gallicus*). I have observed the character in the syntypes of *subterraneus* as well as in the other examined males, so Silvestri's fig. 9 and Brolemann's fig. 129 are either erroneous, or the fringes have been artificially stretched out in their slides, as is the case in the scanning electron microscope mount (Fig. 4).

The first pair of male legs is somewhat variable: Brolemann (1923: Fig. 126) shows an asymmetric pair, and Mauries (1969b: Fig. 23) depicts a first leg with a particularly swollen tibia in a male from Corsica.

The female vulvae are characterized by a apically swollen operculum (Fig. 16).

The females from Tivoli (Italy) and from Tenerife are remarkable for a unique structure of antennomere 2 (Fig. 12): the antennomere con-

sists of a very narrow proximal "stalk" and a wider apical portion which does not form the direct continuation of the stalk but is displaced dorsad. Females from Corsica, like males and juveniles from all localities, have a normal antennomere 2 (fig. 13). Perhaps the modified antennomeres play a role during copulation, where the male grips the female's antenna with his modified "parrot-bill" mandibles (see Mauries 1969a). Evaluation of the taxonomic significance of the modified antennomere 2 must await study of females from further localities.

Distribution and biology

Known from Italy (Portici near Napoli, Ischia, Tivoli in Latium), France (Alpes Maritimes, Corsica), and Canary Islands (Tenerife).

Found under stones, in a cave, in a decaying pole, and in an ants' nest (Silvestri 1903, Verhoeff 1941, Mauries 1969b, Strasser 1971).

***Choneiulus verhoeffi* (Attems, 1899)**

Figs. 5-7, 17-18.

Typholobaniulus verhoeffi Attems, 1899: 330.*Choneiulus verhoeffi*: Brolemann, 1921, 1923.**Material examined:** 8 dd, 2 ♀♀ in alcohol, plus 2 slides, TUNISIA: Zaghuan (type series, Naturhist. Mus. Wien.)**Diagnosis**

A blind species of *Choneiulus*. Metazonitai setae shorter than in other species. Anterior gonopods with mesally serrate coxal processes. Apical fringes of posterior gonopods unbranched except for short dorsal fringes. Apical funnel of posterior gonopods with spines on outside. Operculum of vulva tapering towards tip.

Descriptive notes

♂♂: L 7-9 1/2 mm, H 0.47-0.55 mm, 30-39 p.s.

♀♀: L_{max.} 13 mm*, H_{max.} 0.64 mm, max. 41 p.s. (max. 47 segments (podous + apodous)*).

*according to Attems (1899).

See also Figs. 17-18.

Midbody segments with 12-14 setae. Length of setae 6-9% of H.

Attems' description is quite good; only a few details need to be added. The apical fringes of the posterior gonopods are unbranched except for the dorsal ones which are featherlike (Figs. 5-6). Attems (1899: Fig. 62) depicted some short spines which appear to originate from the inside of the apical funnel; these spines in fact originate from the outside (Figs. 5, 7), the inside being smooth as in the other species. Similar spines have not been found in other species.

The viviparous are indistinguishable from those of *C. palmatus*.

C. verhoeffi has more apodous segments in relation to podous segments than other species of the genus (Fig. 17).

Distribution and biology

Only known from Tunisia: Zaghuan. Biology unknown, but the blindness might indicate troglodytism.

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