A Review of the Millipedes (Diplopoda) of Namibia, with Identification Keys and Descriptions of Two New Genera and Five New Species

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A review of the millipedes (Diplopoda) of Namibia, with identification keys and descriptions of two new genera and five new species

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ABSTRACT

The entire millipede fauna of Namibia is reviewed. Brief diagnoses of and identification keys to three orders, six families and nearly all 25 species of diplopods known from the country are provided. Two new genera, *Praeterpediculus* and *Umbridesmus*, and five new species, namely *Bandeirenica andara*, *Brevitibius oongongololo*, *B. ondundu*, *Podochresimus latus*, and *Syndesmogenus fragilis*, are described. "*Habrodesmus*" *niger* (Attems, 1928) and "*Habrodesmus*" *semiflavus* (Attems, 1944) are synonymised and placed in the new combination *Praeterpediculus niger* (Attems, 1928). *Umbridesmus millequingentesimus* (Attems, 1944) is also a new combination. In addition, the following species have been recorded from Namibia: *Afraustraloxenodes namibiensis* Nguyen Duy-Jacquemin, 2003, *A. coineaui* Nguyen Duy-Jacquemin, 2003, *Chaleponcus hereronius* (Attems, 1922), *C. limbatus* Attems, 1914, *C. niger* Attems, 1914, *Cnemodesmus riparius* Shelley & Crawford, 1996, *Condexenus biramipalpus* Nguyen Duy-Jacquemin, 2006, *Doratogonus rugifrons* (Attems, 1928), *Harpagophora arida* Redman, 2003, *H. diplocrada* Attems, 1909, *Kartinikus australis* Attems, 1914, *Namibostreptus kymatorhabdus* (Attems, 1914), *Oxidus gracilis* (C.L. Koch, 1847), *Podochresimus unistolonis* Attems, 1944, *Spinotarsus xanthonotus* Attems, 1909, *Spirostreptus heros* Porat, 1872, *Synophryostreptus rugosostriatus* (Schubart, 1966), and *Zinophora sabulosa* (Attems, 1928).

KEY WORDS: Harpagophoridae, Odontopygidae, Paradoxosomatidae, Polyxenidae, Spirostreptidae, Synxenidae, southern Africa, identification keys, distribution, new taxa, taxonomy, revision.

INTRODUCTION

At the onset of the long-term biodiversity monitoring project in Africa, BIOTA (Biodiversity Transect Analysis in Africa), it became apparent that there was need for a detailed review of the millipede (Diplopoda) fauna of Namibia. This work facilitates identification and makes relevant information available in a single comprehensive publication as a basis for more detailed studies on millipede biogeography and ecology, and on the role of millipedes in litter management.

The first species of millipede recorded from Namibia was *Harpagophora diplocrada* Attems, 1909, which was collected during an expedition by Dr Leonhard Schultze of Jena that explored south-western Africa from 1901–1903 (Attems 1909*a*). The identity of *Spirostreptus damarensis* Porat, 1893, also an early record from Namibia, remains unclear, as no illustrations exist. The only subsequent reference to this species is that of Attems (1914*a*), who listed it under *incertae sedis* from 'Deutsch-Südwestafrika'. A number of other species were described from Namibia during the past almost 100 years, and these descriptions are scattered across many different publications.

The Namibian millipede fauna is typically Afrotropical in nature, with the largest number of species in the characteristic family Odontopygidae. Harpagophoridae are represented by the southern African genera *Harpagophora* and *Zinophora*, and the Spirostreptidae chiefly by *Doratogonus rugifrons* (Attems, 1928), which also occurs

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in Botswana and South Africa (Hamer 2000), and the widespread, large-bodied *Spirostreptus heros* Porat, 1872 (Hoffman *et al*. 2001; Mwabvu *et al*. 2009).

In northern Namibia's humid savanna woodlands, species occur that belong to genera more typical of the humid woodland biome, and which are distributed from Angola and the Democratic Republic of Congo to more eastern parts of the continent. These genera include the spirostreptids *Brevitibius* and *Synophryostreptus* (Fig. 37), together with the odontopygid *Bandeirenica* (Fig. 75). The larger polydesmid millipedes of the families Gomphodesmidae and Oxydesmidae are completely absent from Namibia, probably due to a lack of suitable forest habitats (Hoffman 1990). The family Dalodesmidae has also not been recorded, although representatives of this diverse family do inhabit fairly arid savanna woodland in South Africa (Hamer *et al*. 2006). The pill millipedes of the order Sphaerotheriida, which are mostly associated with forest and woodland in southern Africa, are likewise not known to occur in Namibia.

Millipedes have a restricted dispersal capacity and therefore express a high degree of endemism in southern Africa (Hamer & Slotow 2002). Many species in Namibia are only known from their type locality. What needs to be clarified is whether their spatial distribution really is very restricted, or whether sampling is biased because of the high degree of unpredictability of rain, which probably strongly influences population dynamics of millipedes. Based on existing knowledge, it seems that the millipede fauna of Namibia is not rich due to the extremely dry environment, as millipedes in general prefer humid environments and microhabitats. One of the few millipede species found in the Namib Desert, *Cnemodesmus riparius* Shelley & Crawford, 1996 (Paradoxosomatidae), is restricted to ephemeral riverbeds and exhibits behavioural adaptations in respect of its life history (Shelley & Crawford 1996).

Millipedes still belong to the under-sampled category of taxa as a result of their mainly cryptic way of living as well as their lack of spectacular colouration and relatively uniform habitus. Most conservation approaches target mammals or plants, which are more conspicuous, and neglect invertebrates, despite the fact that the latter account for the vast majority of species in ecosystems and play a critical role in ecosystem processes (Horwitz *et al.* 1999; Myers *et al.* 2000). Millipedes are part of the invertebrate decomposer community. In southern Africa, they consume up to 39 % of the litter standing crop and accelerate nutrient availability for plants (Dangerfield & Milner 1996). A reduction in accessible litter due to, for example, monocultures and urbanisation, has already led to a reduction in millipede abundance and diversity (Hamer 1997; Mwabvu 1997; Hamer & Slotow 2002). The inclusion of millipedes in ecological and soil ecosystem research is therefore important, but this requires access to accurate taxonomic information. The objectives of this study were, accordingly, to review the known millipede species from Namibia and include new localities, and to describe newly discovered taxa from the country. In order to facilitate future work on millipedes, illustrations of key characters of chilognath millipedes and identification keys are provided.

MATERIAL AND METHODS

This research is chiefly based on material housed in the National Museum of Namibia, Windhoek (NMNW; SMN on original labels), supplemented by the first author's own collections made as part of the BIOTA programme, together with additional material housed in the Museum für Naturkunde, Berlin, Germany (ZMHB), Forschungsinstitut und Naturmuseum Senckenberg, Frankfurt-am-Main, Germany (SMFD), Naturhistorisches Museum Wien, Austria (NHMW), and the KwaZulu-Natal Museum, Pietermaritzburg, South Africa (NMSA). The material is stored in 70% alcohol. If co-ordinates for localities were not provided on the specimen labels, these were identified using Google Earth. In cases where the exact locality was not given, only degrees and minutes have been stated. Where co-ordinates have been added in the text to the specimen data, this is indicated in square brackets.

Figures were drawn using a Leica MS5 binocular microscope with a maximum magnification of 40× and a drawing tube. Distribution maps were prepared using ArcView 9 (ESRI), indicating the few localities where millipedes have been recorded. As many species are represented only by a single specimen, 'record map' rather than 'distribution map' would be a more suitable title for most species.

In polydesmids, 20 segments including the anal segment are counted, whereas for juliforms, the segment number refers to body segments excluding the anal segment and including the collum. In some cases, the relative size of the antennomeres is described using a '>' or '=' sign.

Bilaterally symmetrical (paired) structures are described in the singular. Terminology in this paper mainly follows Attems (1926), Kraus (1966), Hoffman (1968) and Hamer (1999).

TAXONOMY

Key to the six families of Namibian Diplopoda

1 Body covered in tufts of trichomes, soft animals of very small size (max. length 4 mm) (Order Polyxenida) ... 2

– Body surface smooth, cuticle hardened, with a wide range of body sizes (min. length ~5 mm / max. length >30 cm) ... 3

2 13 pairs of legs and 6–8 ocelli in each eye ... **Polyxenidae**

– 17 pairs of legs and 8–11 ocelli in each eye ... **Synxenidae**

3 Body plates merged into a complete ring, with lateral projections (paraterga); on the 2nd segment, these set lower than on other segments, adult animals with 20 segments, lacking eyes; ozopores on segments 5, 7, 9, 10, 12, 13, 15–19; gonopods exposed (Order Polydesmida) ... **Paradoxosomatidae**

– Body with free sternites, lacking lateral projections, adult animals with more than 40 segments, eye patches ovoid or subtriangular; ozopores on each body segment from segment 5 or 6 onwards; gonopods retracted inside body cavity (Order Spirostreptida) ... 4

4 Medium to minute species (min. length ~15 mm / max. length ~50 mm), paraprocts with small dorsal spines (Fig. 80), except in the case of very small species; gonopod telopodite very complicated, twisted, with tarsus strongly broadened into leaf-like appendages (Figs 79, 83, 85, 88) ... **Odontopygidae**

– Medium to extremely large species (min. length ~9 cm / max. length >30 cm), paraprocts lacking spines; gonopod telopodite long, sometimes divided into several endings or with lateral branches (Figs 47, 50, 52, 64) ... 5

5 Anal segment extended to form obvious spine (Fig. 74); gonopod telopodite directed caudally; gonopod solenomere ending in broad setose plate (Figs 63, 65, 71)........ ....**Harpagophoridae**
– Anal segment not extended (lacking spine), gonopod telopodite directed laterally; gonopod solenomere long and slender, tapering distally (Figs 39, 46, 48, 52, 57) ....**Spirostreptidae**

Subclass Penicillata Latreille, 1831
Order Polyxenida Lucas, 1840

Diagnosis: Minute (up to 7 mm long), soft-bodied millipedes with body covered by fine hairs (trichomes).

Remarks: In southern Africa, only a few species of these millipedes are known. Three species have been described from Namibia, two in the family Polyxenidae and one in Synxenidae.

Polyxenid or penicillate millipedes are mainly encountered in decaying wood, under stones (Lawrence 1984) and on the bark of trees (Hamer pers. observ.), where they feed on soft tissues such as algae and perhaps fungal hyphae.

Family Polyxenidae Lucas, 1840

Diagnosis: 10 tergites plus telson, 13 pairs of legs and 6–8 ocelli in each eye. Lateral extension of palps of gnathochilarium shorter than in Synxenidae (Condé & Nguyen Duy-Jacquemin 2008).

Genus *Afraustraloxenodes* Nguyen Duy-Jacquemin, 2003

Afraustraloxenodes: Nguyen Duy-Jacquemin 2003: 72–73, fig. 1.

Type species: *Afraustraloxenodes namibiensis* Nguyen Duy-Jacquemin, 2003.

Diagnosis (after Nguyen Duy-Jacquemin 2009): Short, thick trichomes. Pseudoarticulated gnathochilarial sensilla present, setiform sensilla as opposed to a spine on metatarsus (tarsus II), antennal, prefemoral, femoral and tibial setiform sensilla ending in a single spine.

Remark: The genus is known only from southern Africa, and currently includes four species; two from Namibia, one from the Eastern Cape in South Africa and one from South Africa and Botswana.

Afraustraloxenodes namibiensis Nguyen Duy-Jacquemin, 2003

Afraustraloxenodes namibiensis: Nguyen Duy-Jacquemin 2003: 73–78, figs 1–20.

Diagnosis: Antennal article VI with four sensilla basiconica. Labrum with short, cuspidate papillae. Pseudoarticulated sensilla on the outer palps of the gnathochilarium are more numerous (15 or 16) than in the other species in the genus (Nguyen Duy-Jacquemin 2003).

Remarks: This species has been found near Rehoboth [23°18'59"S 17°04'59"E, 1396 m] and 150 km West of Windhoek (Nguyen Duy-Jacquemin 2003), and was recorded in the BIOTA programme at the biodiversity observatory Gellap near Keetmannshoop, 26°24'12.8"S 18°00'22.8"E.

Afraustraloxenodes coineaui Nguyen Duy-Jacquemin, 2003

Afraustraloxenodes coineaui: Nguyen Duy-Jacquemin 2003: 78–81, figs 41–54.

Diagnosis: Antennal article VI with three sensilla basiconica, and diameter of the sensilla constant up to the attenuated apex, while the anterior sensillum is slightly shorter than the others. The setiform sensillum is located between the anterior and median sensilla. Labrum ornamented with flat papillae enclosing small granules (Nguyen Duy-Jacquemin 2003).

Remarks: The type locality for the species is Hamilton Range (co-ordinates uncertain) and it has also been recorded from Swartbank, 40 km NW of Gobabeb [23°30'53"S 15°02'35"E, 418 m], and Mirabib Rock (co-ordinates uncertain). This species was recorded in the BIOTA programme at the biodiversity observatory Gellap near Keetmannshoop, 26°24'12.8"S 18°00'22.8"E.

The type locality habitat was described by Nguyen Duy-Jacquemin (2003) as being "on top of marble mountain, in cracks of rocks and under stones".

Family Synxenidae Silvestri, 1923

Diagnosis: Long, thin and dark trichomes, 17 pairs of legs, with last two pairs adapted for jumping, and 8–11 ocelli in each eye. Palps of gnathochilarium with well-developed lateral extensions (Condé & Nguyen Duy-Jacquemin 2008).

Remarks: Only two genera have been described in the family, *Condexenus* Nguyen Duy-Jacquemin, 2006 and *Phryssonotus* Scudder, 1885. The latter genus includes several fossil species from amber.

Genus *Condexenus* Nguyen Duy-Jacquemin, 2006

Condexenus: Nguyen Duy-Jacquemin 2006: 238–247, figs 1–25.

Type species: *Condexenus biramipalpus* Nguyen Duy-Jacquemin, 2006.

Diagnosis: Gnathochilarium with short median expansion, three trichobothria of equal size on head just median to ocelli, labral surface covered by numerous flat papillae with four to six posterior rows of smaller papillae, telotarsus without posterior lamellate process (Nguyen Duy-Jacquemin 2006).

Remarks: In the description of *Condexenus*, Nguyen Duy-Jacquemin (2006) suggested that this genus has 11 tergites and 15 pairs of legs, as opposed to the 12 tergites and 17 pairs of legs in *Phryssonotus*. However, a recently described *Phryssonotus* species from Table Mountain in Cape Town, South Africa, was found to have 11 tergites and 15 pairs of legs (Nguyen Duy-Jacquemin *et al*. 2011).

The genus is currently only known from the type species.

Condexenus biramipalpus Nguyen Duy-Jacquemin, 2006

Condexenus biramipalpus: Nguyen Duy-Jacquemin 2006: 239–243, figs 1–25.

Remarks: This species was collected in pitfall traps from the Gellap district, 3.23 km from Keetmanshoop, at localities with co-ordinates 26°24'11.8"S 18°00'22.8"E, 26°24'13.3"S 18°00'22.9"E, 26°24'30.2"S 19°00'28.5"E, and from the Nabaos district (Nuwe Fontein), 24 km NW of Keetmanshoop, 26°23'36.1"S 17°59'43.9"E (Nguyen Duy-Jacquemin 2006).

Subclass Chilognatha Latreille, 1802–1803
Order Polydesmida Leach, 1815

Diagnosis: Adult polydesmids with the number of segments restricted to 20 (sometimes 19), the sclerites form a ring, with lateral processes termed 'paraterga', the animals lack eyes, and males have one pair of external gonopods.

Family Paradoxosomatidae Daday, 1889

Diagnosis: Features of the family Paradoxosomatidae include position of the paraterga of the 2nd segment which lie below the collum (Fig. 32), the medially constricted gonopod aperture, the unconnected gonopod coxae, a distinct postfemoral cingulum (constriction or girdle) in the gonopods (Fig. 8, *ci*) and paired setae on the paraprocts lying parallel to the midline (Fig. 10).

Remarks: The paradoxosomatid tribe Cnemodesmini Jeekel, 1968 includes the only polydesmidans occurring natively in Namibia. Two genera (*Cnemodesmus* Cook, 1896, and *Podochresimus* Attems, 1926) were previously known, and an additional two (*Praeterpediculus* Vohland, gen. n. and *Umbridesmus* Vohland, gen. n.) are described here. In addition, the pandemic *Oxidus gracilis* (C.L. Koch, 1847) of the tribe Sulicferini occurs in the coastal region. The tribe Cnemodesmini is defined by the gonopod having one or more femoral processes near the base of the solenomere (Jeekel 1968). All Namibian paradoxosomatid millipedes have very similar somatic features; they are small in size, with narrowly rounded paraterga, and microsensilla on antennomere 5 and 6, and only differ in male secondary sexual characters, namely the gonopods, the conus on sternite 5 and peculiarities of the pregonopodial legs. Therefore, the key is based almost entirely on these features.

The distribution pattern of the genera is mainly extrapolated from single records, except for *Cnemodesmus riparius* Shelley & Crawford, 1996, which is apparently found along an ephemeral river (Fig. 1).

Key to species of Paradoxosomatidae occurring in Namibia

1 Sternite 5 of male lacking cones, but with four brushes (Fig. 11); pregonopodial legs lacking femoral processes; tibiotarsus of gonopod divided into one short basal and two longer, slender appendages (Fig. 8).....**Oxidus gracilis** (C.L. Koch, 1847)
– Sternite 5 of male with cones (Figs 6, 16); pregonopodial legs with femoral processes (Fig. 26); tibiotarsus not as above 2

2 Gonopod acropodite coiled in a broad loop; solenomere with folded, laminate process (Fig. 2)..................................**Cnemodesmus riparius** Shelley & Crawford, 1996
– Gonopod acropodite not coiled in a broad loop; solenomere lacking process (Figs 12, 17, 23, 31) 3

3 Gonopods with large femoral process; tibiotarsus divided (Figs 12, 17) (*Podochresimus*) 4
– Gonopods with reduced femoral processes (Fig. 23); tibiotarsus undivided (Fig. 24) or shield-like (Fig. 31)..5

4 Very small species (width ~0.7 mm), femoral process divided into an acute and a laminate process (Fig. 13), tibiotarsus with enlarged lobe (Fig. 12)...**P. latus** sp. n.

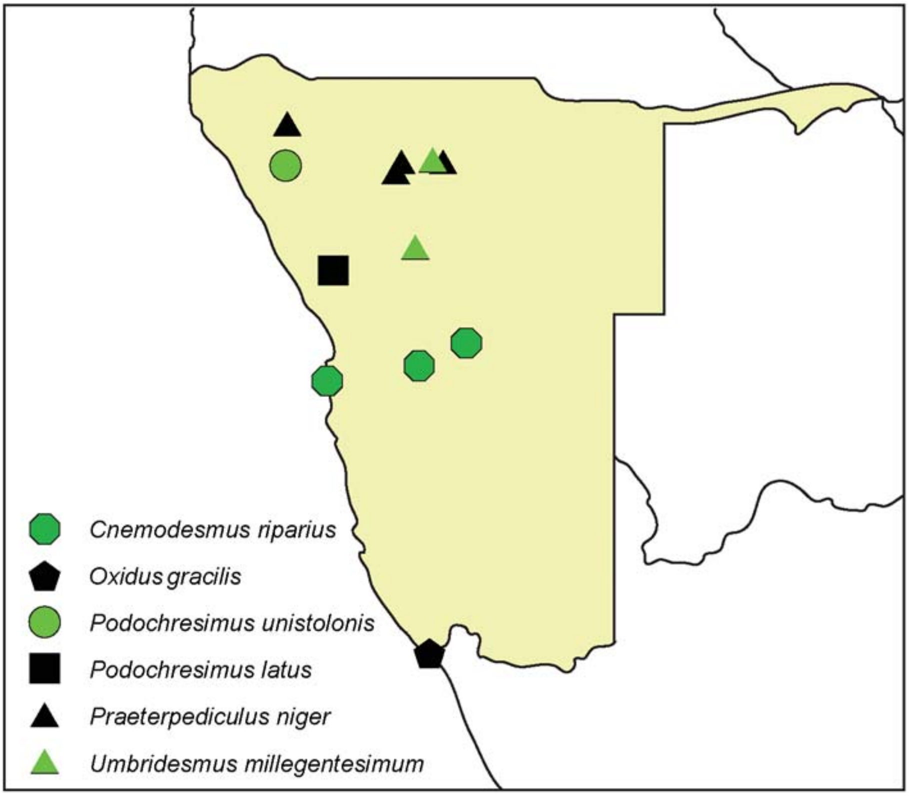


Fig. 1. Distribution of the family Paradoxosomatidae (Diplopoda) in Namibia.

– Small species (width ~2.0 mm), femoral process not divided, tibiotarsus divided into two slender processes (Fig. 17)............................**P. unistolonis** Attems, 1944

5 Small species (width ~1.2 mm); pleurotergal ridge structured (Fig. 28). Gonopod tibiotarsus and solenomere parallel, with small process at base (Fig. 23) ....**Praeterpediculus niger** (Attems, 1928)

– Very small species (width ~0.9 mm); pleurotergal ridge smooth. Gonopod tibiotarsus enlarged, forming undulated lamina (Fig. 31)... .... **Umbridesmus millequingentesimus** (Attems, 1944)

Genus *Cnemodesmus* Cook, 1896

Cnemodesmus: Cook 1896: 97; 1898: 705; Hoffman 1953: 80; 1968: 212; Kraus 1958: 49; Jeekel 1968: 105; 1971: 219; Hamer 1998: 25; Shelley *et al*. 2000: 93.
Dysthymus Attems, 1929: 276 (*partim*). Synonymised by Hoffman (1968: 212).
Lundacus Chamberlin, 1951: 69. Synonymised under *Dysthymus* by Hoffman (1953: 82).

Type species: *Paradesmus thysanopus* Cook & Collins, 1893, by monotypy.

Diagnosis: Cones on sternite 5 fused together. Legs 4–6 of male with third joint enlarged below into a distinct tuberculiform process (Fig. 5). Gonopod tibiotarsus and solenomere coiled and bent ventrally (Fig. 2).

Remarks: The non-Namibian species referred to this genus, namely *C. calundensis* Kraus, 1958, *C. brunneus* (Attems, 1929) and *C. thysanopus* (Cook & Collins, 1893), were described from Angola and the Democratic Republic of Congo.

Cnemodesmus riparius Shelley & Crawford, 1996

Figs 2–7

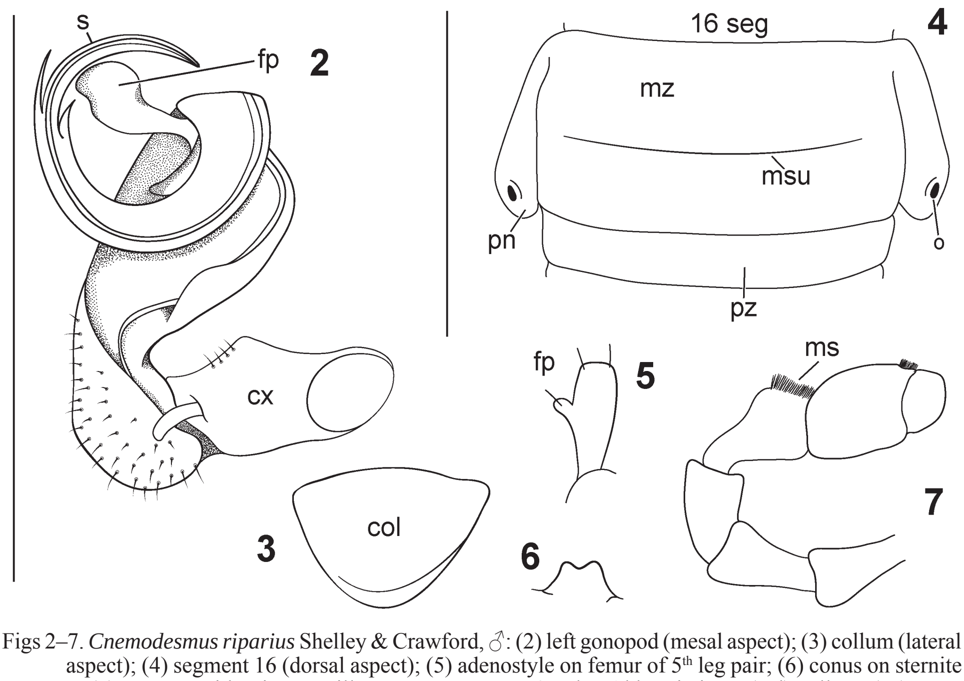
Cnemodesmus riparius: Shelley & Crawford 1996: 2–4, figs 1, 2; Hamer 1998: 25.

Diagnosis: Gonopod solenomere slender, long, coiled with laminate, folded process along inner margin near midlength, femoral process club-like. Tibiotarsus with broad, short basal process and acute, more distal process (Fig. 2).

The closest relatives of this species are *C. thysanopus* (Cook & Collins, 1893) and *C. calundensis* Kraus, 1958, from Angola. In *C. thysanopus*, the tibiotarsus is much longer and bifurcate, and the basal process more acute, while *C. calundensis* can be distinguished mainly by the less curved solenomere.

Description:

Size: Width 1.1–1.4 mm.
Colour: Dark brown, suture dirty white posterior to metatergites, dark spot medially giving animal appearance of having dorsal longitudinal band.
Head: Frons setose. Antenna becoming thicker distally, microsensilla on distal part of antennomeres 5+6 (Fig. 7, *ms*).



Figs 2–7. *Cnemodesmus riparius* Shelley & Crawford, ♂: (2) left gonopod (mesal aspect); (3) collum (lateral aspect); (4) segment 16 (dorsal aspect); (5) adenostyle on femur of 5th leg pair; (6) conus on sternite 5; (7) antenna with microsensilla on antennomeres 6 and 7. Abbreviations: (col) collum, (cx) coxa, (fp) femoral process, (ms) microsensilla on antennae, (msu) metatergal sulcus, (mz) metazonite, (o) ozopore, (pn) paratergite, (pz) prozonite, (s) solenomere. Scale bars = 1 mm.

Collum: Broadly rounded (Fig. 3).
Tergites and sternites: Metatergal sulcus smooth and long (Fig. 4). Paraterga narrow, projecting slightly backwards up to segment 19, distally rounded. Pleurotergal ridges thin, reaching to the mid-body. Surface smooth. Progonopodial sternite setose, postgonopodial sternite smooth. Sternite 5 with cones fused together, forming a subrectangular process (Fig. 6).
Legs: Femur of legs on segments 4–6 with digitiform process (Fig. 5, *fp*). Tibia of legs without brushes.
Gonopods: As in diagnosis.

Material examined: NAMIBIA: 1♂ Khomas district, Windhoek [22°34'12"S 17°05'01"E], 19.iv.1972, P.G. Olivier, under stone [anterior part crushed] (SMN 21695) (NMNW).

Distribution: Namibia, Kuiseb [23°12'S 15°37'E] and Gaub [23°25'S 16°01'E] rivers, as well as Windhoek.

Habitat: In Namibia, the species is distributed along the ephemeral beds of the Kuiseb and Gaub Rivers. Specimens were located in wet silt along river banks and a distribution throughout the river system therefore seems probable. Windhoek, where the examined specimen was collected, is part of the Swakop River catchment area [22°16'S 15°45'E], but only a few kilometres southwest of Windhoek, the Kuiseb River catchment area begins (Jacobson *et al*. 1995). The animals can only survive in this dry environment by selecting more humid places like deep silt deposits close to the river banks, from where they are presumed to emerge and aggregate on patches of green cyanobacteria under favourable conditions (Shelley & Crawford 1996). Experiments concerning desiccation resistance showed great variability between individuals.

Remarks: The specimen examined is smaller than the measurements given for the holotype, which is in the National Museum of Natural History, Smithsonian Institution, Washington, DC, USA (Shelley & Crawford 1996). Moreover, the solenomere is shorter, with the tips of the tibiotarsus more acute in the specimen examined. These differences are small enough to be regarded as falling within the range of variation of a species.

Genus *Oxidus* Cook, 1911

Oxidus: Cook 1911: 628–631; Jeekel 1971: 229; Kraus 1956: 405; Mikhaljova 1998: 59; Hoffman 1999: 436; Chen *et al*. 2006: 253.
Kalorthomorpha Attems, 1914*b*: 191.

Remark: *Oxidus* is an East/Southeast Asian genus, with *O. gracilis* being ubiquitous.

Oxidus gracilis (C.L. Koch, 1847)

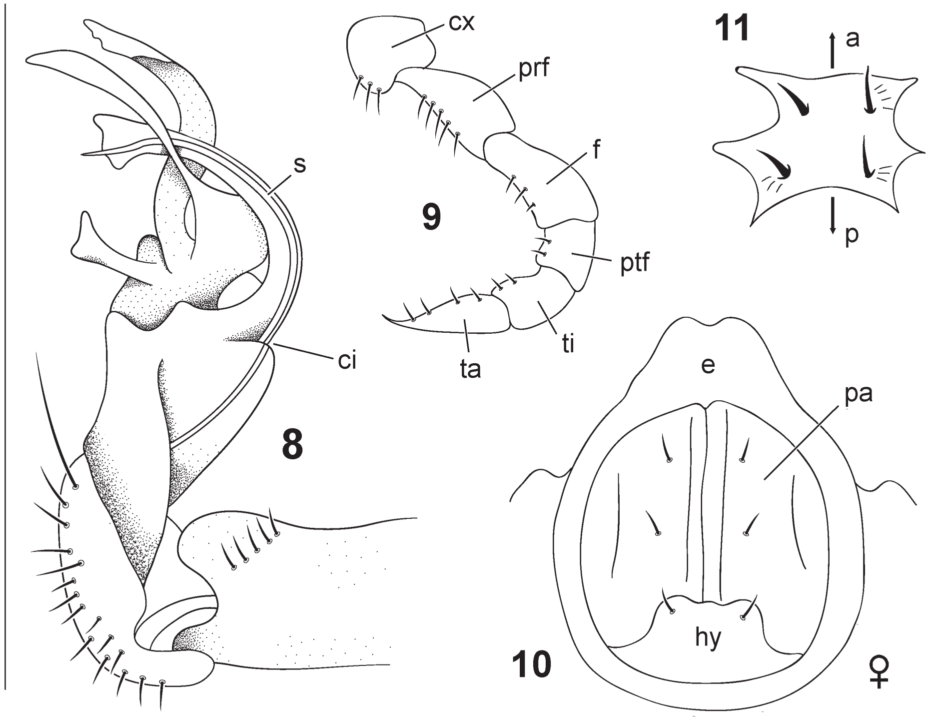
Figs 8–11

Fontaria gracilis: C.L. Koch 1847: 142; 1863: 51.
Polydesmus gracilis: Porat 1872: 9; Karsch 1880: 78.
Paradesmus dasys Bollman, 1887: 619.
Paradesmus gracilis: Latzel 1895*a*: 116; 1985*b*: 104; Verhoeff 1891: 126; Schubart 1926: 64.
Kepolydesmus sontus Chamberlin, 1910: 247.
Orthomorpha gracilis: Pocock 1895: 354.
Oxidus gracilis: Cook 1911: 628; Mikhaljova 1993: 30; 1998: 59; Mikhaljova & Nefediev 2003: 83; Hoffman 1999: 436; Tajovský 2001: 18; Enghoff *et al*. 2004: 39; Geoffroy & Golovatch 2004: 20; Korsós 2004: 24; Chen *et al*. 2006: 265.
Orthomorpha (Kalorthomorpha) gracilis: Attems 1914*b*: 191; 1937*a*: 82; Lawrence 1953: 344; Schubart 1966: 16.

Diagnosis: Four tufts of setae on sternite 5. Solenomere with broadened tip, intertwined with median tibiotarsal process (Fig. 8). Apical tibiotarsal process tapered and acute, basal tibiotarsal process sheath-like.

Description:

Size: Width of male 1.3 mm.
Colour: Brown, antennomeres darker distad except for a whitish tip. Anterior and lateral border of collum as well as peritremata (calluses) dirty yellow. Prozonites distally dirty white, anterior with dark border. Legs and venter light brown.
Head: Epicranial suture distinct, antenna long, reaching back to 4th segment, antennomere 2>6=3>4=5>1>7; antennomeres 5+6 with microsensilla.
Collum: Broadly rounded.
Tergites and sternites: Metatergal sulcus deep and finely rifled. Surface porous, prozonite and metazonite separated by a constriction bearing small ridges. Sternites broad, sternite 5 and 6 with four setose fields (Fig. 11). Paraterga slightly protruding from 5th segment onwards, more expressed posterior to mid-body, on segments 15 (in some cases 17) to 19 acute. Pleurotergal ridges weak, only in segments 2–4 distinct, distad only small swellings. Epiproct slightly bilobed (Fig. 10).
Legs: Tibia of legs with small setose projections.
Gonopods: As in diagnosis.



Figs 8–11. *Oxidus gracilis* (C.L. Koch), ♂: (8) right gonopod (mesal aspect); (9) leg 2; (10) last segment (ventral aspect); (11) sternite 6. Abbreviations: (a) anterior direction, (ci) cingulum, (cx) coxa, (e) epiproct, (f) femur, (hy) hypoproct, (p) posterior direction, (pa) paraproct, (prf) prefemur, (ptf) postfemur, (s) solenomere, (ta) tarsus, (ti) tibia. Scale bar = 1 mm.

Material examined: NAMIBIA: 3♂ 3♀ Oranjemund [28°33'06"S 16°25'35"E, 24 m], 25–27.ii.1972, LGC, M. Sa & M.-L. Penrith (SMN 21679) (NMNW).

Distribution: This species, which probably originated in East or Southeast Asia, is distributed worldwide, and is known to occur in hothouses. It was first recorded from South Africa in 1914 (Attems 1914), and is now recorded for the first time from Namibia.

Genus *Podochresimus* Attems, 1926

Podochresimus: Attems 1926: 141, 143; 1928: 243; 1929: 274; 1931: 113; 1937*a*: 215; Schubart 1956: 18; Hoffman 1968: 219; Jeekel 1968: 107; 1971: 232.

Type species: *Podochresimus fruticinus* Attems, 1926, by monotypy.

Diagnosis (modified from Hoffman (1968)): Cones present on sternite 5. Gonopod femur with one or two spiniform processes. Postfemur of acropodite separated from femur by basal constriction. Postfemur with process, and a fairly long solenophorous tibiotarsus branch which curves ventromedially, this branch having a basal process. The acropodite little or not rotated, so that the seminal groove runs almost directly up the medial face to reach the base of the solenomerite.

Distribution: The genus occurs in Namibia and western South Africa.

Remarks: The genus previously included four species, with a range from the Western Cape in South Africa (three species) to Namibia (one species). A second Namibian species is described below.

Podochresimus latus Vohland, sp. n.

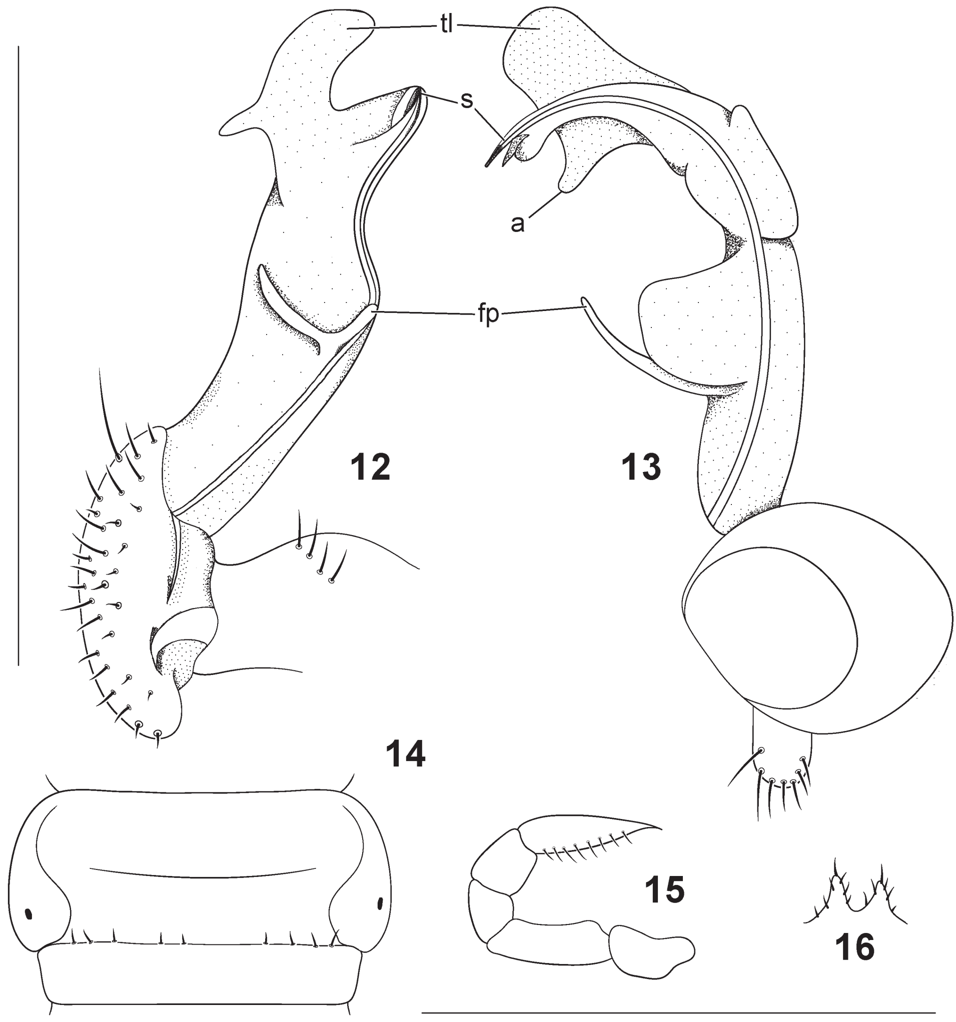
Figs 12–16

Etymology: From Latin *latus* (broad), with reference to diagnostic tibiotarsal projection on gonopod.

Diagnosis: Small. Gonopod with solenophorous tibiotarsus branch apically dentate (Fig. 13, *s*) and with two additional postfemoral branches laminate (Fig. 12, *a*, *tl*).

Description:

Size: Width of male 0.7 mm.
Colour: Overall colour brown (in alcohol).
Head: Epicranial suture deep, ending above antennal sockets. Antenna long, antennomere 2=3>6>5=4>1>7; antennomeres 5+6 distally with microsensilla.
Tergites and sternites: Paraterga only slightly protruding backwards, very small and rounded (Fig. 14). Constriction between prozonite and metazonite indistinct; metatergal sulcus smooth, slightly wrinkled distally (Fig. 14). On juvenile specimen, two rows of setae on metatergum. Pleurotergal ridges distinct to about 8th segment, vanishing posteriad. Pregonopodial sternite setose, sternite 5 with two small setose cones (Fig. 16); postgonopodial sternites smooth.
Legs: Pregonopodial legs with tarsal brush (Fig. 15); femur of anterior legs with small swelling only on segment 6. Postgonopodial legs unmodified.
Gonopods: Femur with bilobed process, divided into a broad shield and a more acute process (Figs 12, 13, *fp*). Gonopod with solenophorous tibiotarsus branch curving slightly and apically dentate (Fig. 13, *s*), with basal process broad and laminate (Fig. 12, *tl*). A third postfemoral process smaller, short and roughly triangular (Fig. 13, *a*).



Figs 12–16. *Podochresimus latus* sp. n., ♂: (12) left gonopod (mesal aspect); (13) left gonopod (lateral aspect); (14) segment 16 (dorsal aspect); (15) mid-body leg; (16) conus on sternite 5. Abbreviations: (a) postfemoral process, (fp) femoral process, (s) solenomere, (tl) tarsal lobe. Scale bars = 1 mm.

Holotype: ♂ NAMIBIA: Erongo region, north end of Tsisab [21°06'01"S 14°33'52"E, 614 m], 21.i–27.ii.1995, E. Marais (SMN 22104) (NMNW).

Paratypes: 1♂ 2 juv., same data as holotype (SMN 22104) (NMNW).

Remarks: In *Podochresimus capensis* (Porat, 1893) one gonopod tibiotarsal branch is also shield-like and apically bilobed (Attems 1928, fig. 86).

Contrary to the concept of *Podochresimus* (Attems 1929), the pregonopodial femora of the legs do not have setose projections but only slight protuberances, which might be related to the small size of the animals.

Kraus (1958) described another small species from Angola as *P. erratus*, which shows similarities in the position of the femoral process, the course of the solenomere and a distinct division between the femur and postfemur of the acropodite. Jeekel (1968) removed it from *Podochresimus* to one of his "unnamed genera" because of the reduced femoral process.

Distribution: *Podochresimus latus* is only known from one locality in the Tsisab area of northern Namibia (Fig. 1).

Podochresimus unistolonus Attems, 1944
Figs 17–22

Podochresimus unistolonus: Attems 1944: 245–246, figs 34–36; Jeekel 1968: 107; Hoffman 1968: 221.

Diagnosis (based on illustration in Attems (1944)): Gonopod with one long, curved and apically tapered femoral process (Fig. 17, *fp*). Process at base of solenophorous tibiotarsus branch (Fig. 17, *b*) long and spiniform, and third process of postfemoral region slightly ventrally directed, and apically widened (Fig. 17, *a*).

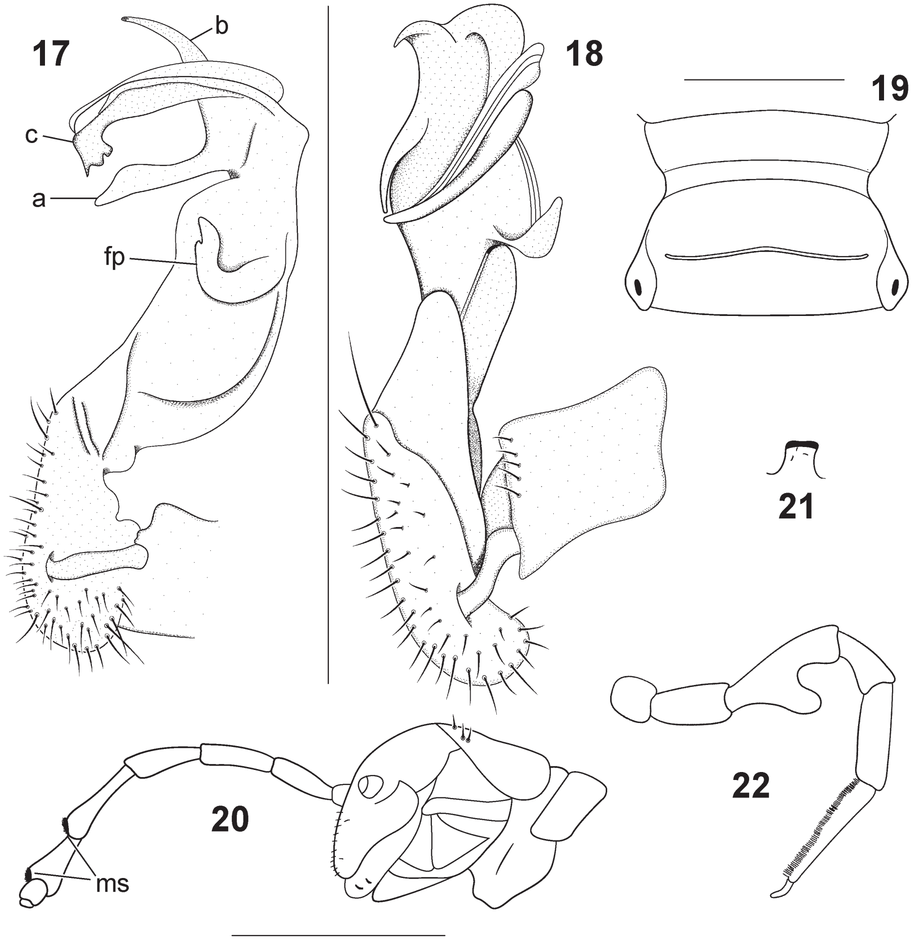
Description (after Attems (1944)):

Size: Width: metazonites 1.25 mm, prozonites 1 mm.
Colour: Body and antennae dark castaneous brown, legs light yellow.
Tergites and sternites: Pleural keels weakly expressed, dorsally limited by a depression, posteriorly rounded, only on last segments forming small tooth. Metazonites dorsally smooth, with two transverse rows of minute, fragile bristles on first five segments. Metatergal sulcus well developed. Anterior segments with fine, ridged pleural keels. Sternites with deep, cross-like depression and four fields of fine bristles. Sternite 5 with large conus between anterior legs, either subdivided into two knobs or even and enlarged distally. Hypoproct broadly rounded, paraprocts with small lateral bulges.
Legs: Long. Femur of legs on segments 3–8 with large bulge terminally. Tibia and tarsus of anterior legs with dense brush.
Gonopods: Prefemur elongated. Femur medially broader than distally, and on medial side, having a distal, curved lateral branch (Fig. 17, *fp*). Tibiotarsus with three branches, two of which are basally connected, and third which is solenophorous (Fig. 17, *c*).

Remarks: No types were designated by Attems (1944), but Hoffman (1968) stated that the syntypes are in the NHMW. He did not provide any details concerning them. The gonopods of the type material (Fig. 18) do not match those illustrated by Attems (1944) in his original description of the species (Fig. 17). We can only assume that the incorrect gonopods were placed in the container for *P. unistolonis*, and the origin of these gonopods and the identity of the species to which they belong are unknown. It is therefore not possible to be certain about the source of the other body parts examined (Figs 19–22), although these do seem to match the description by Attems (1944).

Syntype (examined): NAMIBIA: 1♂ "Kapland, Camacis" [19°07'30"S 13°36'54"E, 827 m] (Inv. NR. 3475; Attems B 6429; NHMW).

Distribution: Known only from the type locality in Namibia. The original label is partly illegible and this has led to some confusion as to the correct type locality. Attems (1944) cited 'Kapland: Besfontein, Camacis' in South Africa as the type locality in the original species description. Lawrence (1962), however, suggested 'Sesfontein' and 'Camaeis' in the former Kaokoveld, Namibia, as the correct type locality, because these two localities were sampled during the South African Museum's Expedition in 1925 and 1926.



Figs 17–22. *Podochresimus unistolonis* Attems, ♂: (17) gonopod, redrawn from Attems (1944); (18–22) specimen in NHMW labelled as type material of *P. unistolonis*: (18) right gonopod (mesal aspect), (19) segment 10 (dorsal aspect), (20) head with antennae, (21) conus on sternite 5, (22) leg 7. Abbreviations: (a, b) postfemoral processes, (fp) femoral process, (ms) microsensilla on antennae, (c) solenophorous branch. Scale bars = 1 mm.

Considering that Lawrence's (1962) assumption appears to be the most plausible, the type locality is here regarded as being within Namibia (Fig. 1).

Genus **Praeterpediculus** Vohland, gen. n.

Etymology: From Latin *praeter* (alongside) and *pediculus* (small foot), in reference to its small size, with legs appearing comparatively long.

Type species: *Phaeodesmus niger* Attems, 1928.

Diagnosis: Medium-sized paradoxosomatids with expressed pleural keels on first segments, frons setose, microsensilla on antennomere 6+7 (Fig. 25), femoral processes (adenostyles) on leg pairs 3–5 (Fig. 26) and indented sternital process on segment 5. Gonopod with short, stout, anteriad-directed femoral process at the base of solenophore (Figs 23, 24, *fp*). Solenophorous tibiotarsus elongated (Fig. 23, *tt*, 24, *s*).

Remarks: While we initially hesitated to erect a monotypic genus, work by Jeekel (1968) and Hoffman (1981) supports this decision. *Praeterpediculus niger* was originally described as a species of the genus *Phaeodesmus* by Attems (1928), but as *Phaeodesmus* is defined as having the gonopod tibia and bi- or tri-ramous tarsus clearly separated, this concept does not fit the species, and as a result, *P. niger* was assigned to the genus *Habrodesmus* Cook, 1896 by Attems (1944).

The concept of *Habrodesmus*, tribe Xanthodesmini Jeekel, 1968, has a colourful history. In a key to the species, Cook (1896: 97) defined the genus *Habrodesmus*, but only later did he formally describe the type species, *H. laetus* Cook, 1898. Attems (1944) chose *Habrodesmus andreinii* Brölemann, 1904, as the type, which was not valid (Kraus 1956). This species is currently placed in *Oranmorpha* Verhoeff, 1941 (Jeekel 1968). Jeekel (1968) listed mainly west African species as belonging to *Habrodesmus*. He and subsequent taxonomists (Hoffman 1981) excluded *P. niger* from *Habrodesmus* because of the elongated tibiotarsus and solenomere of the gonopods.

Hoffman (1981) suggested *Anaclastopus* as a new genus for *Phaeodesmus neglectus* Attems, 1934, and also discussed assigning *P. niger* to the new genus, as Jeekel (1968) had already indicated uncertainty about its placement by including quotation marks for ‘*Habrodesmus*’ *niger* and ‘*H.*’ *neglectus*. In fact, there are similarities concerning the gonopods: in both genera, *Anaclastopus* and *Praeterpediculus*, the solenomere and tibiotarsus are elongated and parallel. However, there are some differences that force a generic distinction: the gonopods in *A. neglectus* are bent in comparison to *P. niger*, resulting in the small (post)femoral process being directed mesally in *A. neglectus* and anteriorly in *P. niger*. The solenomere and tibiotarus are longer and more strongly curved in *A. neglectus*, while in *P. niger* they are straight to slightly curved.

In terms of somatic characters, *A. neglectus* has only one femoral process (adenostyle) on leg pair 3; the constriction between metazonite and prozonite is smooth compared to the structure in *P. niger*; the metatergal sulcus is only faintly visible compared to the structured one in *P. niger*; the process on sternite 5 is flat compared to the indented one in *P. niger*; and, lastly, there are small projections on sternite 6 and two subcoxal cones on the rear margin of sternite 8, none of these are features being seen in *P. niger*.

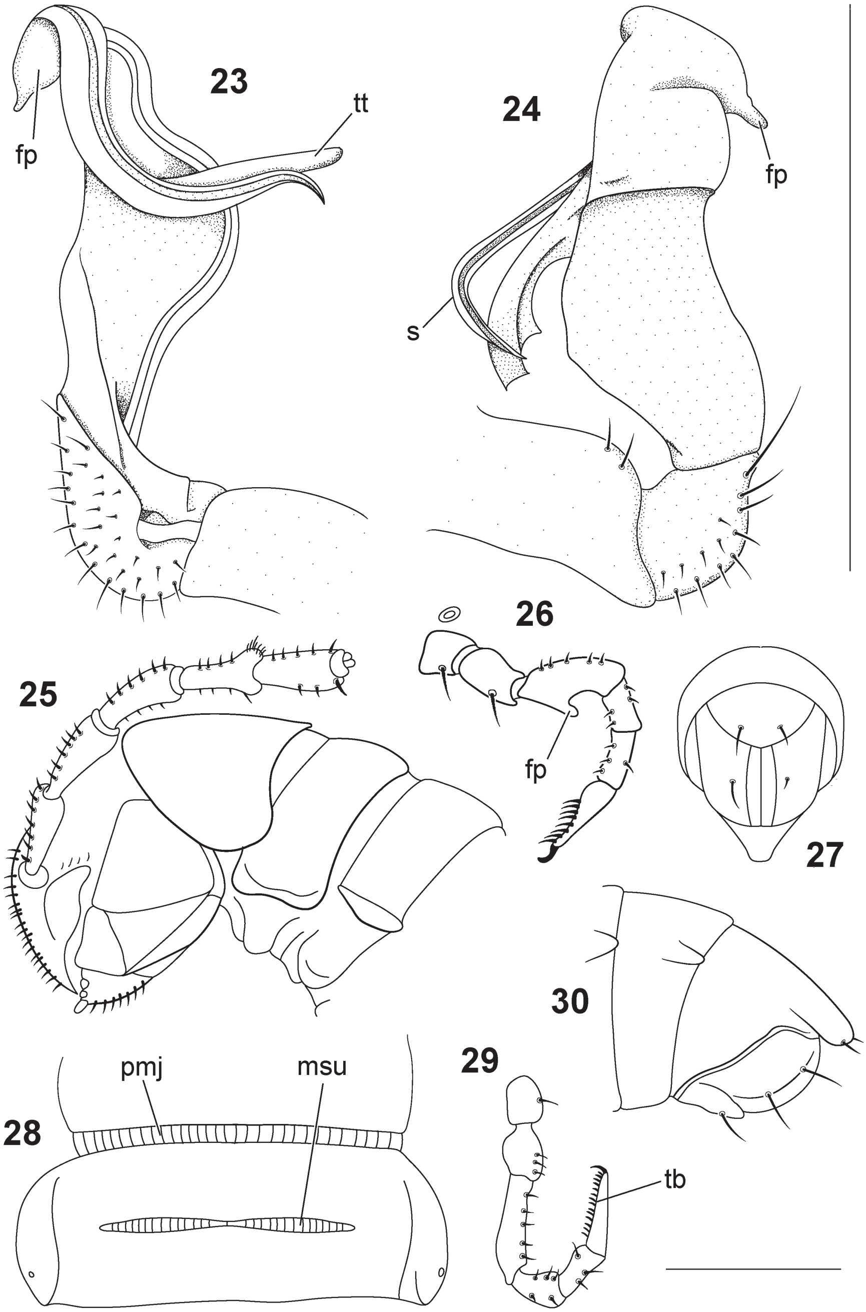
According to Hoffman’s (1981) discussion of the tribal position of *Anaclastopus*, *Praeterpediculus* is placed in the tribe Cnemodesmini instead of Xanthodesmini because of the (post)femoral process.

Praeterpediculus niger (Attems, 1928), **comb. n.**

Figs 23–30

Phaeodesmus niger: Attems 1928: 249, figs 503–506, 567.
Habrodesmus niger semiflavus: Attems 1944: 243.
‘*Habrodesmus*’ *niger*: Jeekel 1968: 111; Hamer 1998: 27.
‘*Habrodesmus*’ *semiflavus* Jeekel, 1968: 111; Hamer 1998: 26. **Syn. n.**

Diagnosis: Tibiotarsus and solenomere elongate, fused together from shortly after base, apically tibiotarsus forms a sheath that covers the longer, acute solenomere. Distinct, apically acute femoral process (Figs 23, 34).



Figs 23–30. *Praeterpediculus niger* (Attems), ♂: (23) left gonopod (B 5939) (mesal aspect); (24) left gonopod (B 6467) (lateral aspect); (25) head & segments 1–3 (lateral aspect); (26) leg 4; (27) last segment (ventral aspect); ♀: (28) segment 10 (dorsal aspect); ♂: (29) leg 9; (30) segments 19 & 20 (lateral aspect). Abbreviations: (fp) femoral process, (msu) metatergal sulcus, (pmj) junction between prozonite and metazonite, (s) solenomere, (tb) tarsal brush, (tt) solenophorous tibiotarsus. Scale bar = 1 mm.

Description:

Size: Width 1.2 mm, length about 16 mm.
Colour: Dark brown; border of collum, tip of antenna and distal parts of antennomere 6+7, posterior to metatergal fold dirty white, lighter posterior to metatergal suture.
Head: Epicranial suture distinct, ending above antenna. Antennomeres 6+7 with microsensilla, in antennomere 7 less expressed than in antennomere 6 (Fig. 25).
Collum: Widely rounded, anterior and lateral margin slightly raised.
Tergites and sternites: Metatergite in segment 2 set lower than collum (Fig. 25), broadly bordered. Pleurotergal ridges slightly dentate in segments 2–4. In segment 3, metatergite with small border, protruding slightly backwards, pleurotergal ridges slightly broader than in 2nd segment, in segment 4 smaller. From segment 5 onwards, paraterga protruding backwards, relatively narrow, only slightly acute. Anterior legs up to segment 8 with tarsal brush (Fig. 29, *tb*); on 8th segment in first leg pair more expressed than in second one; femur of 3rd to 5th pair of legs with a ventral digitiform projection (adenostyle) (Fig. 26, *fp*). Suture between meta- and prozonite as well as metatergal sulcus costulate (Fig. 28, *msu, pmj*). Sternital process on 5th segment indented. Epiproct truncate to slightly indented, bent down in lateral view (Figs 27, 30).
Gonopods: Femur medially broadened. Lateral femoral process small and acute, slightly variable in size and orientation. Tibiotarsus and solenomere separated at the base, then fused together, acute solenomere only free at tip (Figs 23, 24).

Syntype of *Habrodesmus niger* (examined): 1♂ NAMIBIA: Namutoni [18°48'27"S 16°56'25"E, 1099 m] (B5939) (NHMW).

Syntype of *H. (P.) niger semiflavus* (examined): 1♂ NAMIBIA: Kaoko Otavi [18°18'04"S 13°39'10"E, 1422 m] (B6464) (NHMW).

Other material examined: NAMIBIA: 1♂ Kunene district, Wolfsnes, 19°03'S 15°52'E, 24.iii–10.v.1988, E. Griffin (SMN 21909) (NMNW); 1♂ same data but 12.ii–16.iii.1987 (SMN 21848) (NMNW); 1♂ Kunene district, road to Ondundu Mountains [19°32'S 15°27'E, 1271 m], 12.ii–17.iii.1987, E. Griffin (SMN 21852) (NMNW); 1♂ Kunene district [?], N of Kamaseb [co-ordinates uncertain], 13.ii–20.iii.1987, E. Griffin (SMN 21854) (NMNW).

Distribution: Namibia. Widely distributed in northern part of the country (Fig. 1).

Habitat: Most of the samples consist of many specimens. The animals may have been aggregating in favourable (humid) habitats in the same manner as described by Shelley and Crawford (1996) for *C. riparius*. It would be a challenging investigation to see how this aggregation behaviour might be related to the success of the species; one of the few millipedes living in this semi-desert country.

Remarks: The closest relative is probably *Anaclastopus neglectus* (Attems, 1934) from Katanga, Democratic Republic of Congo, which also has the solenomere and tibiotarsus parallel. Attems (1934*a*) as well as Jeekel (1968) and Hoffman (1981) stressed the close relationship of these species.

Attems (1944) distinguished *niger* and *niger semiflavus* only because of differences in colouration. Consecutive taxonomic publications listed them as distinct species (Jeekel 1968; Hamer 1998) without explaining their status as two valid species. Reinvestigation of the types could not solve the colour problem as the colour was leached out. There is some variation in the degree of curvature of the solenomere and tibiotarsus between the populations, but no consistent form in the type material examined which would allow any distinction indicative of different species. Other features such as the form of the conus in segment 5, the form of the pleural keels and the occurrence of the femoral process in the pregonopodial legs were stable.

The co-ordinates for Kamaseb in the Kunene district could not be identified since Kamaseb is, in fact, located much further south than the Kunene district.

The syntype material in the NHMW is labelled as being from the South African Museum in Cape Town.

Genus **Umbridesmus** Vohland, gen. n.

Etymology: From Greek *umbra* (shade) and *desmus* (millipede), in reference to the umbrella-shaped distal projection of the tibiotarsus.

Type species: *Pagioprium millequingentesimum* Attems, 1944.

Diagnosis: Small paradoxosomatid species with distinct pleurotergal ridges (Fig. 32, *pt*) and sternal cones (Fig. 34). Gonopod tibiotarsus widely enlarged, with lamellate sheath, solenomere acute (Fig. 31).

Remarks: Jeekel (1968) suggested a generic relationship between '*Cnemodesmus*' *cavicolus* Kraus, 1958, from Angola and *Pagioprium* Attems, 1937, due to similarities in the position and relative length of the tibiotarsus and the femoral processes. '*Cnemodesmus*' *cavicolus* is much larger, however, and thus a revision of the type material is required. At this stage, the genus *Umridesmus* is monotypic. Jeekel (1951) synomised *Pagioprium* under *Tectoporus* Carl, 1902, which is restricted to species from Java, Sumatra and Sulawesi (as Celebes) (Jeekel 1968; Hoffman 1979; Hamer 1998).

Umbridesmus millequingentesimus (Attems, 1944), **comb. n.**

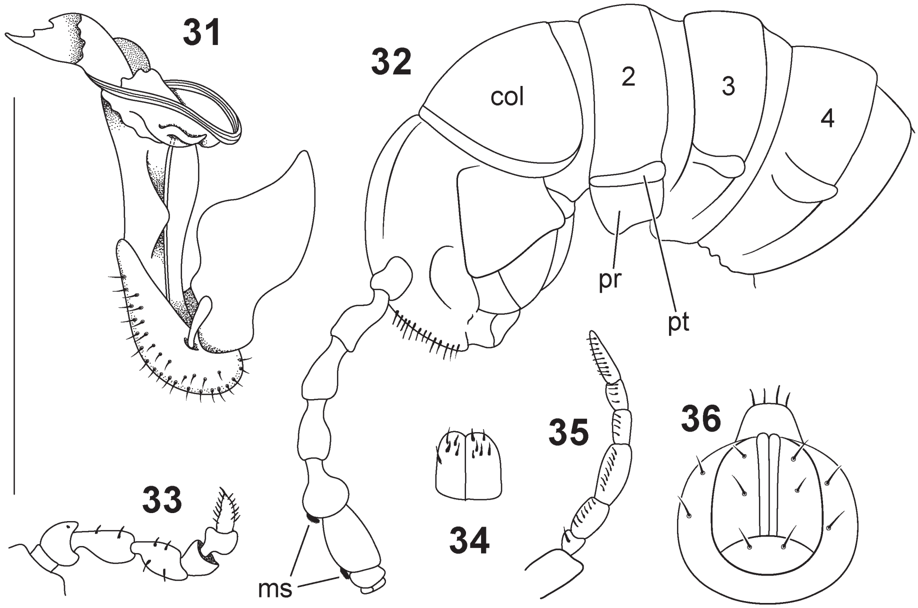
Figs 31–36

Pagioprium millequingentesimum: Attems 1944: 239–241, figs 26, 27.
'*Pagioprium*' *millequingentesimum*: Jeekel 1968: 104; Hamer 1998: 27.

Diagnosis: Very small polydesmids. Gonopod tibiotarsus extremely enlarged, ending in incised or undulate lamella (Fig. 31).

Description:

Size: Width of male 0.9 mm, female 1.1 mm, length about 13 mm.
Head: Epicranial suture deep. Antenna long, antennomere 6>5>4=3=2>1>7; antennomeres 5+6 distally with microsensilla (Fig. 32, *ms*).
Tergites and sternites: Metaterga slightly porous and wrinkled posterior to metatergal sulcus, which is smooth and often slightly curved. Paraterga narrow, broadly separated from metaterga. Prozonite with porous surface; suture between metazonite and prozonite smooth. Pleurotergal ridges (Fig. 32, *pt*) distinct, in anterior body region dentate, best expressed in segments 6 and 7. Leg 2 with partly thickened podomeres (Fig. 33). The distal 1–5 podomeres of the pregonopodal legs with brush (Fig. 35). Sternite 5 with slightly indented subrectangular conus (Fig. 34). Sternite distal to gonopods relatively broad, smooth. Hypoproct broadly rounded (Fig. 36). Gonopodial aperture slightly protruding anteriorly.
Gonopods: Gonopod femur relatively broad, with large, sheath-like dentate process where the acropodite is bent at a right angle. Solenomere long, slender, acute and slightly



Figs 31–36. *Umbridesmus millequingentesimus* (Attems), ♂: (31) left gonopod (mesal aspect); (32) head and segments 1–4 (lateral aspect); (33) leg 2; (34) conus on sternite 5; (35) leg 5; (36) last segment (ventral aspect). Abbreviations: (col) collum, (ms) microsensilla on antennae, (pr) paraterga, (pt) pleurotergal ridges. Scale bar = 1 mm.

curved around tibiotarsus, which consists of a subcircular plate and a short, tapering upward-directed process (Fig. 31).

Holotype (examined): ♂ NAMIBIA: Outjo [20°06'32"S 16°09'17"E, 1267 m] (B 6437) (NHMW).

Other material examined: NAMIBIA: 1♂ Helio, 19°03'S 16°29'E, 14.ii–23.iii.1987, E. Griffin, preservative pitfall traps (SMN 21856) (NMNW).

Distribution: Namibia; Kaokoveld (Fig. 1).

Remarks: The gonopod acropodite of the specimen from Helio is less bent and the slender tibiotarsus process is differently directed compared to the drawing of the holotype given by Attems (1944, figs 26, 27). As Attems tended to press the gonopods between slides and this is the only difference, we judge it as merely being a variation and not a different species.

Jeekel (1968) suggested an intrageneric relationship between '*Cnemodesmus*' *cavicolus* Kraus, 1958, from Angola and '*Pagioprium*' *millequingentesimum* from Namibia. Both species share the attribute of a sheath-like femoral process.

Order Spirostreptida Brandt, 1833
Family Spirostreptidae Brandt, 1833

Spirostreptid millipedes belong to the best-studied group of millipedes in southern Africa. Hamer (1999) provided detailed information about genera, and Dangerfield (1998) gave insights into their ecological role within semiarid ecosystems.

Records are restricted to the more northern parts of Namibia (Fig. 37).

Key to the species of Spirostreptidae occurring in Namibia

1 Large species, 100–300 mm in length; collum with anterior corner strongly projecting; gonopod telocoxite without lateral conus (Fig. 47) 2
– Medium-sized species, <100 mm in length; anterior corner of collum not or only slightly projecting; gonopod telocoxite with lateral conus on median lamella (Figs 45, 50, *lc*)... 4

2 Very large species, up to 300 mm in length, antennae reaching beyond 4th segment; gonopod telocoxite lacking sclerotised spines, telopodite slender and trifid at apex (Figs 52, 56) 3
– Large species, about 175 mm in length, antennae reaching distal edge of collum; gonopod telocoxite with sclerotised spines on each distal corner; telopodite apically forked (Fig. 48) .... **Doratogonus rugifrons** (Attems, 1928)

3 Lateral lamella of gonopod telocoxite broadly rounded apically, without any distinct projections (Fig. 53, *ll*), femoral process of telopodite (Figs 52, 53, *fp*) straight to slightly curved .... **Spirostreptus heros** Porat, 1872
– Lateral lamella of gonopod telocoxite apically projected and with triangular median lobe (Fig. 56, *ll*), femoral process of telopodite strongly curved (Fig. 56, *fp*).......... .... **Namibostreptus kymathorhabdus** (Attems, 1914)

4 Metazonite broader than prozonite, posterior border of metazonites strongly striated (Fig. 60).............................. **Synophryostreptus rugosostriatus** (Schubart, 1966)
– Metazonite and prozonite subequal, posterior border of metazonotites smooth or slightly undulated (Fig. 43), animal only striated to a maximum height of ozopores 5

5 Pads on legs present and distinct; lateral conus of telocoxite short (Fig. 50, *lc*), solenomere with femoral process (Fig. 50, *fp*) .... **Kartinikus australis** Attems, 1914
– Pads on legs very small or absent; lateral conus of telocoxite long, solenomere with tarsal process (Fig. 46, *tp*) (*Brevitibius*) 6

6 55–57 segments, collum with 3 folds (Fig. 43); median lamella of telocoxite longer than lateral lamella (Figs 38, 39)... **B. oongongololo** sp. n.
– 60 segments, collum with 1 fold; median lamella of telocoxite shorter than lateral lamella (Fig. 45) .... **B. ondundu** sp. n.

Genus *Brevitibius* Attems, 1950

Brevitibius: Attems 1950: 249, fig. 93; Demange 1970: 394; Krabbe 1982: 131; Hamer 1999: 10.

Type species: *Spirostreptus angolanus* Attems, 1934, by original designation.

Diagnosis: Ozopores from the 6th segment onwards. Prozonites with punctures, metazonites with distinct striae below ozopores. Limbus smooth. Sternites striated. Legs with much reduced pads (Fig. 40), hypoproct surface porous; with fold(s) and rows of punctures on collum. Gonopod aperture open distally, segments not fused ventrally (Fig. 41).

Gonopod telopodite with tibial process originating distad of femoral knee (Figs 38, 39, 46, *tp*), its tip covered in fold of tibiotarsus, which is wrinkled at the outer side; tip of solenomere acute, with two small folds before end of seminal duct; lateral lamella with lateral conus (Figs 44, 45, *lc*).

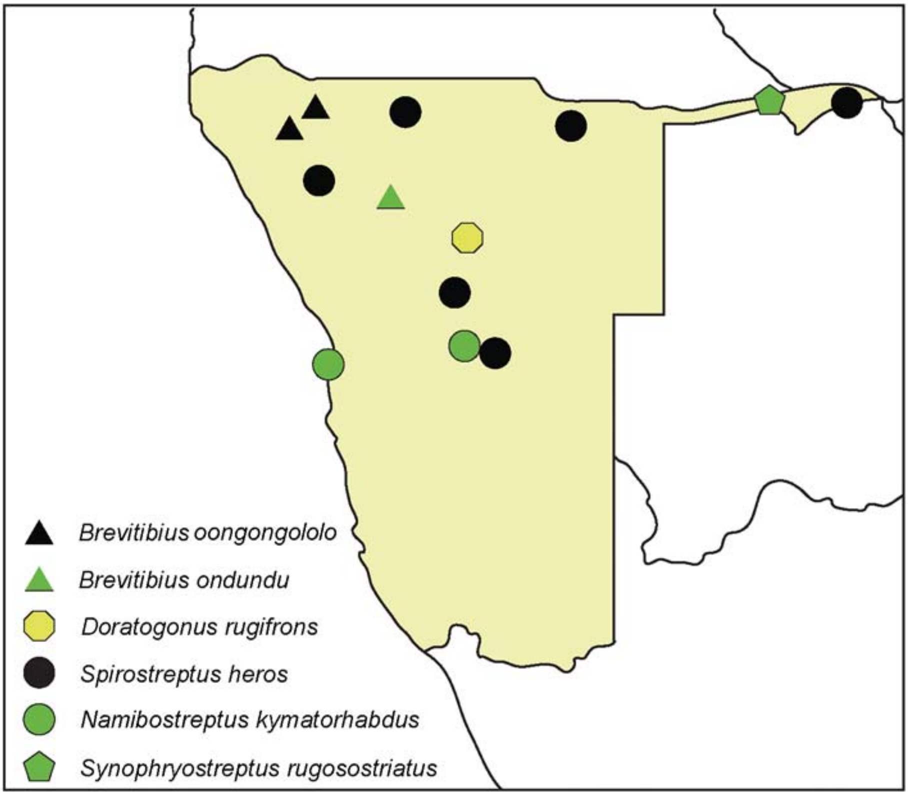


Fig. 37. Distribution of the family Spirostreptidae (Diplopoda) in Namibia.

Remarks: *Brevitibius* is a small genus, containing only two species: *B. angolanus* (Attems, 1934) and *B. obtusus* Kraus, 1958, both known from Angola. Krabbe (1982) described a species from Tanzania, which she tentatively placed in this genus as *Brevitibius* (?) *bulbiferans*.

Attems (1950) erected the genus based on the abruptly shortened tibial part of the telopodite, the anteriorly directed gonocoel and the large lateral conus (which is missing in *B. obtusus*).

Brevitibius oongongololo Vohland, sp. n.

Figs 38–43

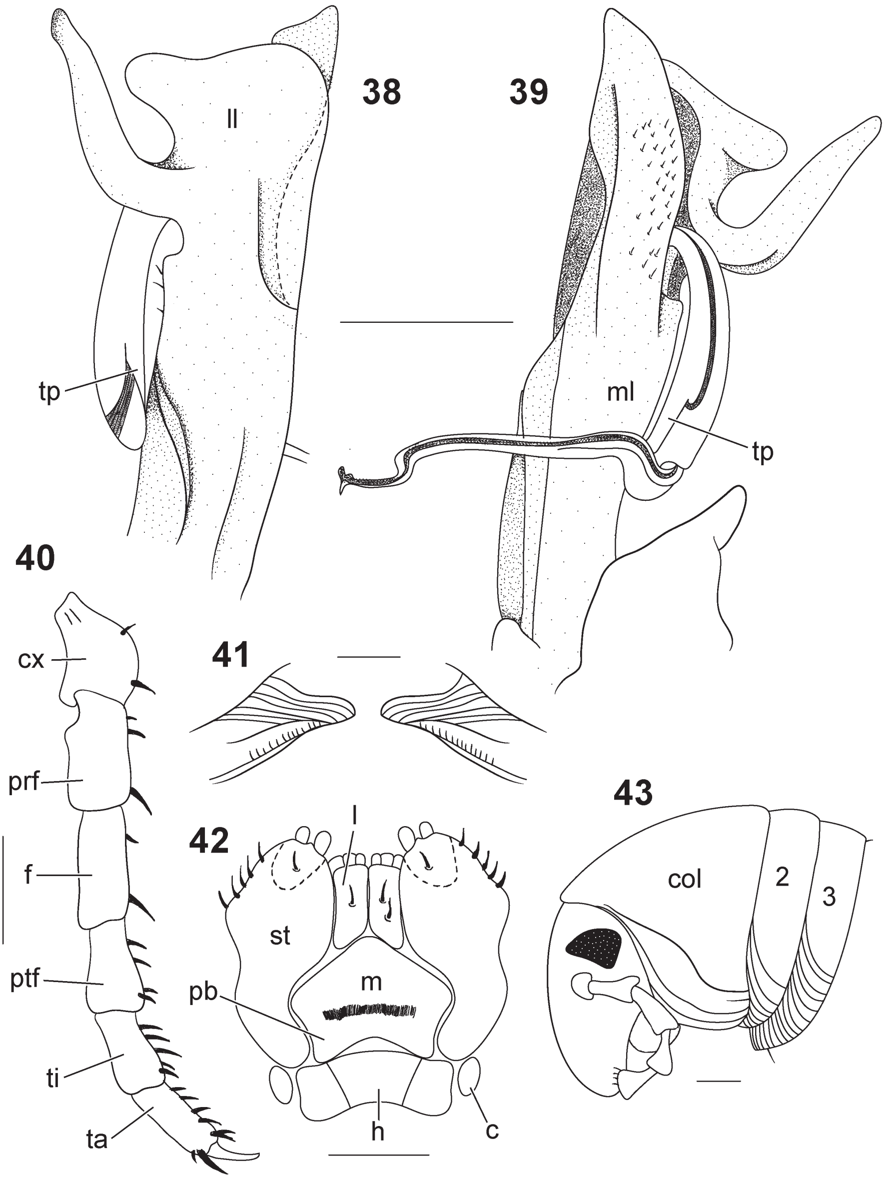
Etymology: From OshiWambo *oongongololo* (a millipede).

Diagnosis: Tibial process of telopodite originating proximally to knee of solenomere (Fig. 39). Median lamella of telocoxite longer than lateral lamella and apically acute, lateral conus long, slender and strongly distally directed (Figs 38, 39).

Description:

Size: Holotype with 55 segments, mid-body width 8.7 mm, length about 90 mm; male paratype with 57 segments.

Colour: Badly preserved, giving striped appearance. Animal dark brown, prozonites yellowish, metazonites green-brown up until black ozopores, distally dark brown, reddish brown bordered, limbus orange. Head, antenna, legs and anal segment dark brown.



Figs 38–43. *Brevitibius oongongololo* sp. n., ♂: (38) aboral aspect of gonopod; (39) oral aspect of gonopod; (40) mid-body leg; (41) gonopod aperture; (42) gnathochilarium; (43) head and first segments (ventral aspect). Abbreviations: (c) cardo, (col) collum, (cx) coxa, (f) femur, (h) hypostomum, (l) lamella lingualis, (ll) lateral lamella of telocoxite, (m) mentum, (ml) median lamella of telocoxite, (pb) prebasilare, (prf) prefemur, (ptf) postfemur, (st) stipes, (ta) tarsus, (ti) tibia, (tp) tibial process. Scale bars = 1 mm.

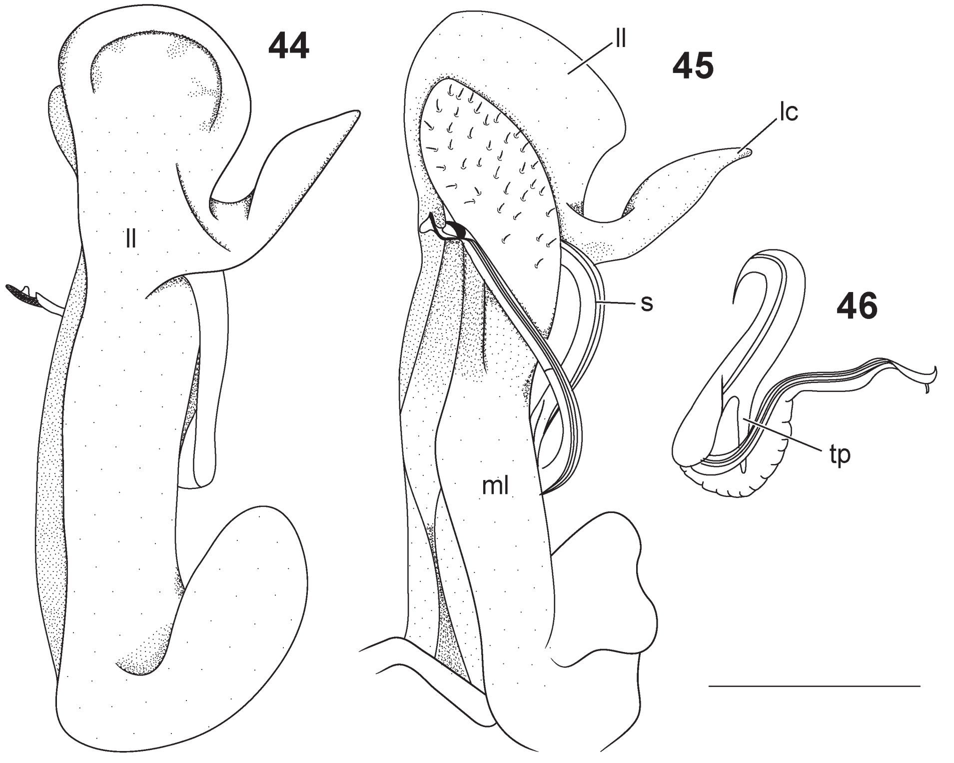
Head: Epicranial suture and interocular suture distinct. Frons slightly wrinkled. Mentum and prebasilare merged (Fig. 42). Antenna short, reaching back to 2nd segment only.
Collum: Broadly surrounded with about 3 strong folds, subquadratic, anteriorly broadly rounded (Fig. 43).
Tergites and sternites: Rows of punctures on prozonites visible. Prozonites with oblique striae, metazonites with longitudinal striae below ozopores. Sternites with oblique striae. Paraprocts with distinct median bulge.
Legs: Pads on legs absent, but spines present on all podomeres (Fig. 40).
Gonopods: Gonopod telocoxite with median lamella extending beyond distal margin of lateral lamella. Telopodite with tibial process (Figs 38, 39, *tp*) on solenomere, its tip hidden in a fold of the solenomere.

Holotype: ♂ NAMIBIA: Kaoko Otavi [18°18'00"S 13°42'00"E, 700 m], 27.xi.1970, P.G. Olivier (SMN 21639) (NMNW).

Paratypes: 1♀ 1 juv. same data as holotype (SMN 21639) (NMNW).

Other material examined: NAMIBIA: 1♂ 2 juv. Ovamboland, 17°53'S 14°13'E, 9.x.1993, M. Griffin & M.A. de Kock (SMN 22043) (NMNW).

Distribution: At present, recorded from northern Namibia in the Kunene district and Ovamboland (Fig. 37).



Figs 44–46. *Brevitibius ondundu* sp. n., ♂: (44) aboral aspect of gonopod; (45) oral aspect of gonopod; (46) tip of solenomere in detail. Abbreviations: (lc) lateral conus on median lamella, (ll) lateral lamella of gonocoxite, (ml) median lamella of gonocoxite, (s) solenomere, (tp) tibial process. Scale bar = 1 mm.

Brevitibius ondundu Vohland, sp. n.

Figs 44–46

Etymology: From Ondundu Mts, where the type series was collected.

Diagnosis: Tibial process originating distally to solenomere knee (Fig. 46); median lamella of telocoxite distally ovoid and shorter than lateral lamella. Lateral conus with doral surface slightly bulbous (Figs 44, 45).

Description:

Size: Mid-body width of male 7.4 mm, 60 segments, female 7.8 mm and 58 segments.
Colour: Badly preserved. Faint black longitudinal dorsal line. Distal border of metazonite reddish brown.
Head: Epicranial suture distinct, interocular suture visible. Frons slightly rifled.
Collum: Broadly surrounded with 1 lateral fold.
Tergites and sternites: Rows of punctures on prozonites, metazonites striated below ozopores. Sternites striated. Paraprocts with median bulge.
Legs: Without pads.
Gonopods: Median lamella of telocoxite ovoid, setose, not reaching tip of lateral lamella (Figs 44, 45). Lateral conus distally directed, with bulbous upper surface, and tapered apically (Fig. 45). Telopodite long and slender, in anterior part broadened to cover tip of tibial process (Fig. 46, *tp*).

Holotype: ♂ NAMIBIA: Ondundu Mountains, 19°51'S 15°43'E, 26.iii–6.v.1988, E. Griffin (SMN 21912) (NMNW).

Paratypes: 2♀ same data as holotype (SMN 21912) (NMNW).

Genus *Doratogonus* Attems, 1914

Alloporus Porat, 1872: 43; 1876: 45; Saussure & Zehnter 1902: 175; Attems 1928: 346; 1950: 204; Schubart 1966: 90; Krabbe 1982: 113. Synonymised by Hoffman (1987).
Doratogonus: Attems 1914*a*: 109; 1928: 339; 1934*b*: 483; Schubart 1966: 90; Demange 1970: 401; Hoffman 1987: 13; Hamer 1998: 47; 1999: 10; 2000: 2; Hamer & Slotow 2000: 295.

Type species: *Spirostreptus setosus* Voges, 1878.

Diagnosis: Mandible with 10–12 pectinate lamellae. Collum projects anteriorly (Fig. 49). Lateral lamella of telocoxite with a small spine-like projection on lateral edge, median lamella typically setose and extended distally as a slender, spinous projection (Fig. 47). Telopodite with long, slender shaft, curved proximally, with long, strongly curved femoral process, and with torsion of main branch of telopodite at position of origin of femoral process, distal to which main branch is looped (Figs 47, 48). Solenomere distally forked or apically bifid (Fig. 47).

Remarks: Attems (1914) erected *Doratogonus* as a new genus, but its differentiation from *Alloporus* Porat, 1876, remained unclear. The two genera were separated only by the position of the first ozopore. Krabbe (1982) combined the generic concepts under *Alloporus*, but Hoffman (1987) revived the name *Doratogonus* for medium- to large-sized spirostreptids which differ from *Alloporus* in having more pectinate lamellae on their mandibles and more numerous small setae on the distal half of the stipes. The genus *Alloporus* was placed on the list of genera *incertae sedis*. Hoffman (1987) considered *Doratogonus* to be heterogeneous and provided a diagnosis, which he believed was too inclusive (Hamer 2000).

Doratogonus rugifrons (Attems, 1928)

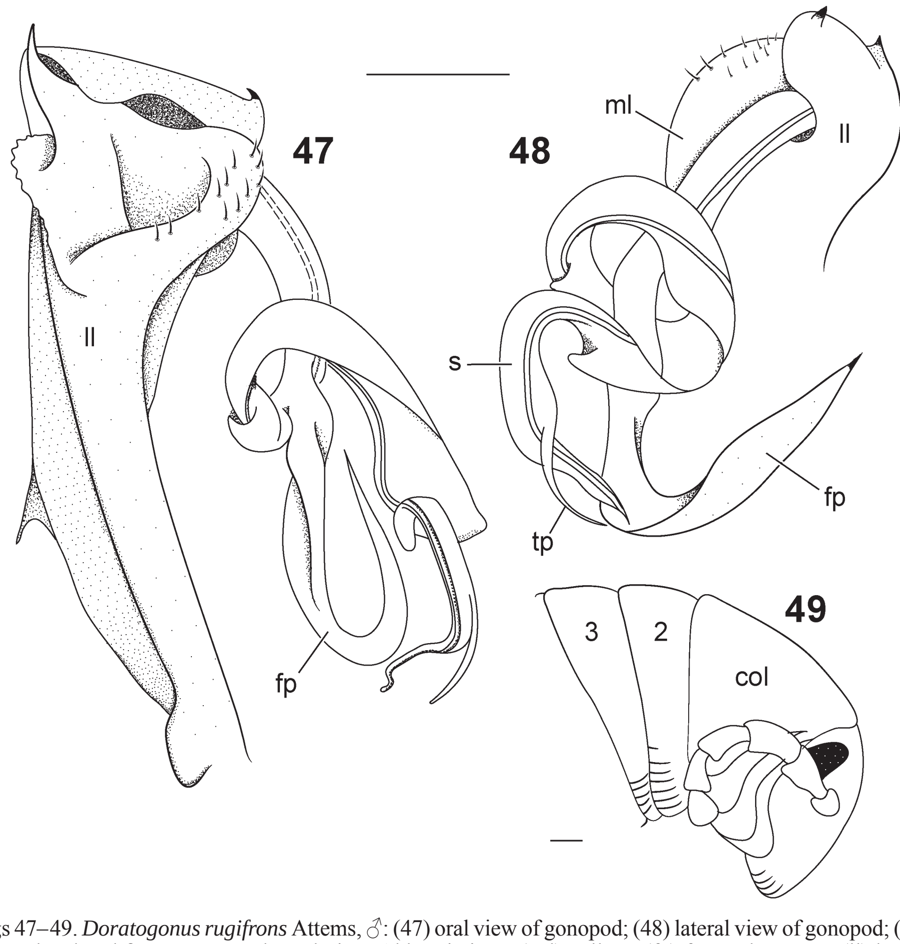
Figs 47–49

Alloporus rugifrons: Attems 1922: 98 (*nomen nudum*); 1928: 349, figs 305, 306; 1950: 205; Lawrence 1965: 49; Schubart 1966: 76; Krabbe 1982: 123.
Doratogonus rugifrons: Hamer 1998: 49; 2000: 56; Hamer & Slotow 2000: 301.

Diagnosis: Distal half of median lamella of telocoxite cup-shaped, median edge of cup serrated, and setae confined to rim area of cup. Median lamella with a distinct, triangular, spine-like projection medially on distal margin (Fig. 47). Telopodite long, with lamellate femoral process curved through about 300° (Fig. 48, *fp*); postfemoral process lamellate, narrowing abruptly at second bend (Fig. 47).

Description:

Size: Male about 175 mm long, 63 segments in male and female.
Colour: Dark brown, legs chestnut brown, anal segment dark brown.



Figs 47–49. *Doratogonus rugifrons* Attems, ♂: (47) oral view of gonopod; (48) lateral view of gonopod; (49) head and first segments, lateral view. Abbreviations: (col) collum, (fp) femoral process, (ll) lateral lamella, (ml) median lamella, (s) solenomere, (tp) tibial process. Scale bar = 1 mm.

Head: Antenna reaching to just behind collum.
Collum: Subquadratic, projected anteriorly and with folds (Fig. 49).
Tergites and sternites: First ozopore on 5th segment. Prozonites finely striated longitudinally, horizontal ridge of metazonites ending below ozopores, metazonites medially with fine suture.
Legs: Pads on legs up until last body segment.
Gonopod: Median lamella of telocoxite with strong, tapered distal spine; telopodite with tibial and femoral processes (Figs 47, 48).

Material examined: NAMIBIA: 1♂ Otjozondjupa region, Waterberg [20°31'S 17°14'E], xi.1972, H.C. Strauss (SMN 21738) (NMNW); 1♂ 1♀ Otjozondjupa region, Biodiversity Observatory Otjiamongombe, 100 km N of Windhoek (Erichsfelde), 21°35'S 16°56'E, 14.iv.2001, S. Lüdecke (BIOTA-638) (ZMHB/MYR 13728); 1♂ 1♀ same locality and date, K. Vohland (BIOTA-614/5) (NMNW).

Distribution: This is one of the most widely distributed species of the genus *Doratogonus* (Hamer 2000). It is to be found from the Okavango region in northern Namibia to the northern parts of South Africa and has also been recorded from Botswana.

Habitat: *Doratogonus rugifrons* occurs predominantly in the savanna biome and its presence seems to be related to the distribution of *Brachystegia* woodland in the northern parts of its range (Hamer & Slotow 2000).

Remarks: According to a cladistic analysis by Hamer and Slotow (2000), *D. rugifrons* is most closely related to *D. rhodesianus* (Chamberlin, 1927), the distribution range of which is adjacent to that of *D. rugifrons*. The gonopods of the two species are almost identical, but in *D. rhodesianus* the projection on the median lamella of the telocoxite is smaller, the lower rim of the cup on the surface of the median lamella is shallower and the femoral process is less curved (Hamer 2000).

Genus *Kartinikus* Attems, 1914

Kartinikus: Attems 1914*a*: 127; 1928: 342; 1950: 188; Kraus 1958: 67; Schubart 1966: 98; Krabbe 1982: 153; Hamer 1998: 40; 1999: 13.

Type species: *Kartinikus australis* Attems, 1914, designated by Kraus (1958).

Diagnosis: Gonopod telocoxite with distinct lateral cone (Fig. 50, *lc*), small femoral process originating at the telopodite knee behind the median lamella (Fig. 50, *fp*). Telopodite of consistent width.

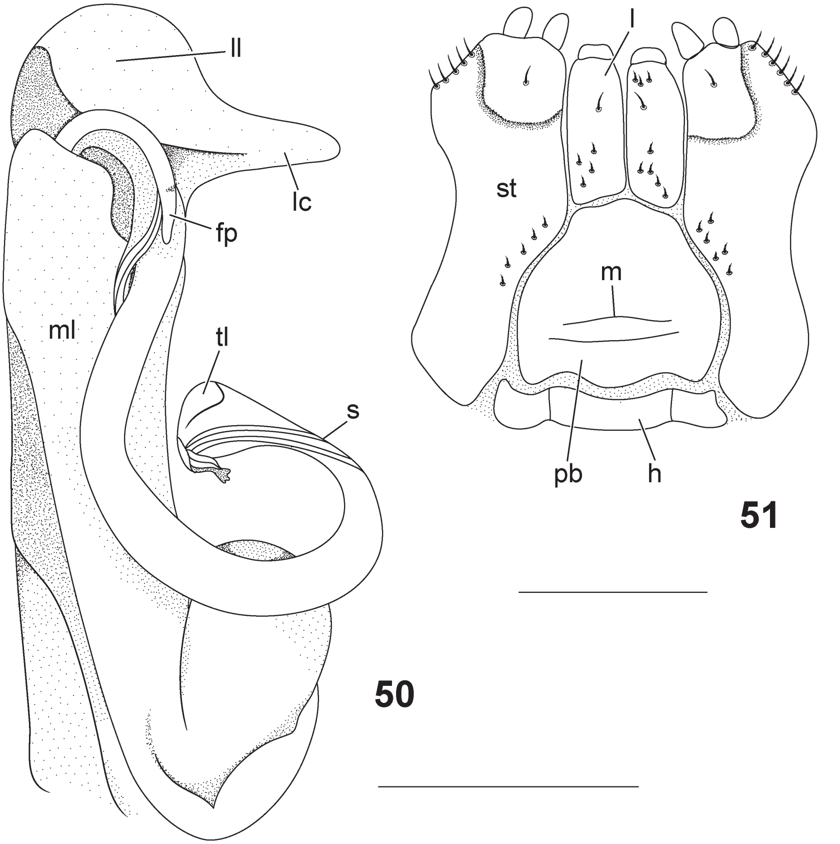
Remarks: Attems (1950) proposed synonymising *Kartinkus* with *Epistreptus* Silvestri, 1897, a South American genus. This was not accepted by other taxonomists (Lawrence 1965; Schubart 1966; Hoffman 1979; Krabbe 1982).

Kartinikus australis Attems, 1914

Figs 50, 51

Kartinikus australis: Attems 1914*a*: 127–128, figs 135, 136; 1928: 342; 1934*a*: 193; 1950: 216; Kraus 1958: 67; Schubart 1966: 98; Krabbe 1982: 154; Hamer 1998: 50.
Charactopygus frequens: Attems 1938: 256–258, figs 26, 27; 1950: 216.
Epistreptus (Epistreptus) australis: Attems 1950: 216.
Scaphiostreptus freqens: Attems 1950: 229.
Epistreptus australis: Attems 1953: 117.

Diagnosis: Paraprocts with a broad bulge. Tip of slender solenomere broadened, with a wide process (Fig. 50).



Figs 50, 51. *Kartinikus australis* Attems, ♂: (50) oral view of gonopod; (51) gnathochilarium. Abbreviations: (fp) femoral process, (h) hypostomum, (l) lamella lingualis, (lc) lateral conus on lateral lamella, (ll) lateral lamella of gonocoxite, (m) mentum, (ml) median lamella of gonocoxite, (pb) prebasilare, (s) solenomere, (st) stipes, (tl) tarsal lobe. Scale bar = 1 mm.

Description:

Head: Presbasilare of gnathochilarium incised (Fig. 51, *pb*), without cardines. Antenna relatively stout.

Legs: Pads of legs seem to be surrounded by faint bulge.

Gonopods: Median lamella of telocoxite shorter than lateral lamella; the latter with horizontal and apically narrowed lateral conus (Fig. 50, *lc*). Femoral process originating proximal to knee in the gonocoel (Fig. 50, *fp*). Tip of slender solenomere broadened, with a broad process (Fig. 50, *s*).

Holotype (examined): ♂ NAMIBIA: 'South West Africa' (ZMHB 1460).

Distribution: The type locality is simply labelled as "South West Africa". The species has been recorded from the Democratic Republic of Congo (Attems 1935) and Ruanda (Krabbe 1982). Schubart (1966) doubted whether *K. australis* really occurs in Namibia and it has not been recorded in the country since the type material was collected.

Remark: The only congener is *Kartinikus colonus* Attems, 1914, from Cameroon.

Genus *Spirostreptus* Brandt, 1833

Spirostreptus: Brandt 1833: 203; Pocock 1894: 388; Hoffman *et al.* 2001: 37; Hoffman 2008: 172; Mwabvu *et al.* 2009: 38.

Triaenostreptus Attems, 1914*a*: 149; 1928: 363; Schubart 1966: 116; Hoffmann 1971: 210; Krabbe 1982: 279; Hamer 1998: 52; 1999: 7. Synonymised by Hoffman *et al*. (2001).

Type species: *Spirostreptus sebae* Brandt, 1833, by subsequent designation of Pocock (1894).

Diagnosis: A large lateral lobe present on lateral lamella of gonocoxite (Fig. 52, *lal*), and apical region of lateral lamella broadly rounded (Figs 52, 53). Origin of femoral process of telopodite concealed under apex of median lamella. Femoral process unmodified, with smooth edges (Fig 52, *fp*). Post-knee region of telopodite coiled or spiralled proximally, becoming lamellate before narrowing distally into a long thin extension with a trifurcate ending.

Distribution: Known from southern Africa (Angola, Botswana, Democratic Republic of Congo, Mozambique, Namibia, South Africa, Zambia and Zimbabwe) (Mwabvu *et al.* 2009).

Remarks: The true identity of *Spirostreptus* remained unclear from 1833 until 2001. The type species (*S. sebae*) was described from a single female specimen that was not examined by taxonomists, who subsequently assigned hundreds of species to the genus. Hoffman *et al*. (2001) used somatic characters to match the female type to *Triaenostreptus petersi* (Karsch, 1881) from Mozambique and Zimbabwe, and this species was synonymised with *S. sebae*. In addition to the type species, the genus currently includes *S. heros* Porat, 1872, *S. kruegeri* (Attems, 1928), *S. tripartitus* (Cook & Collins, 1893), *S. unciger* (Attems, 1928) and *S. batokensis* Mwabvu, 2009. The generic position of the other species previously assigned to *Spirostreptus* remains largely unresolved.

Some of the largest millipede species found in southern Africa are in this genus.

Spirostreptus heros Porat, 1872

Figs 52–55

Spirostreptus (Nodopyge) heros: Porat 1872: 29.

Spirostreptus triodus Attems, 1909*a*: 46.

Triaenostreptus triodus: Attems 1914*a*: 150; 1928: 366; Schubart 1966: 117; Hoffman 1971: 218; Krabbe 1982: 283; Hamer 1998: 52.

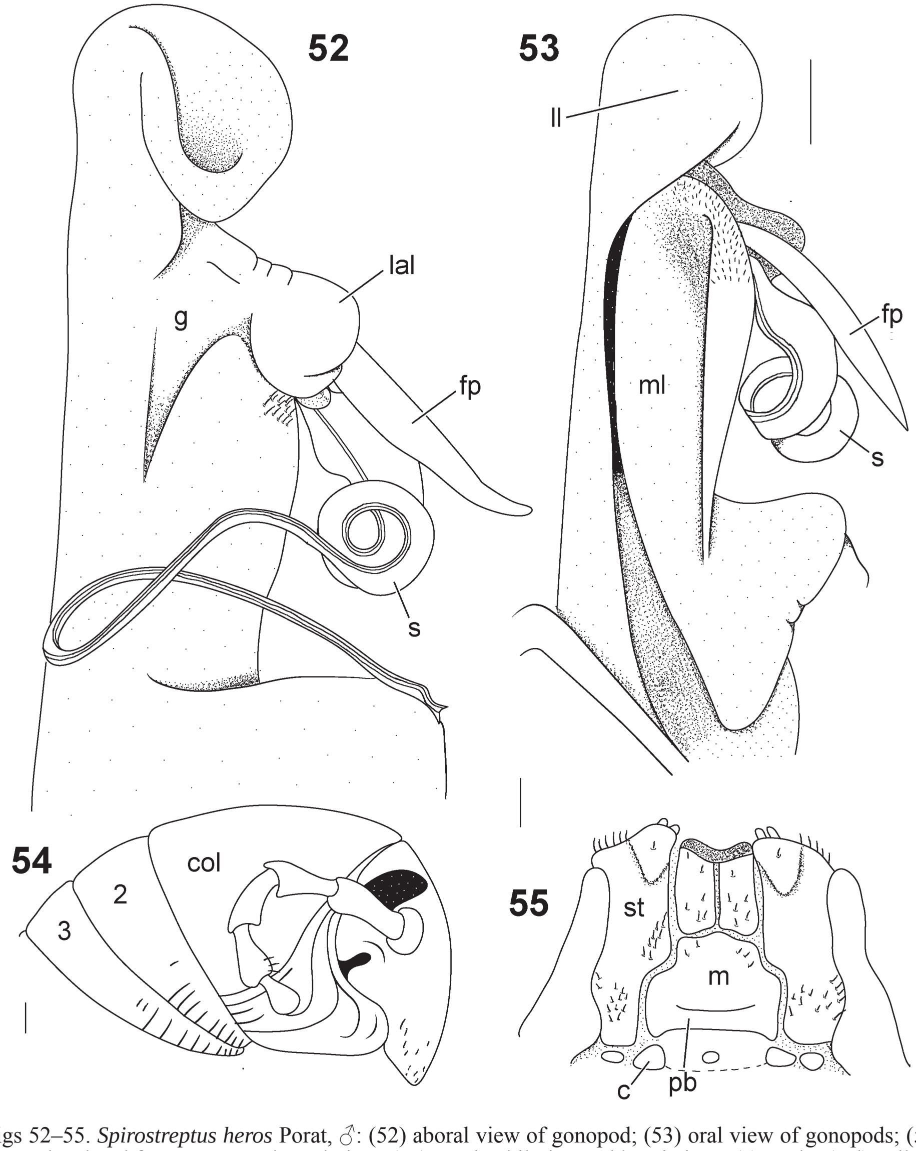
Spirostreptus heros: Hoffman *et al.* 2001: 41 (synonymised with *T. triodus*); Mwabvu *et al.* 2009: 39.

Diagnosis: Very large species. Digitiform process of telocoxite apically broad and without prominent knobs (Fig. 52, *lal*). Femoral process of telopodite straight to slightly down-curved (Fig. 53, *fp*), and main part of telopodite having a coiled section, with distal region long and slender (Figs 52, 53).

Gonopods of *S. heros* and *S. kruegeri* similar, but in *heros* the angle between the lateral lobe and distal lobe of the telocoxite is equal to or less than a right angle, whereas in *S. kruegeri*, the angle is wider. Additionally, *heros* has the lateral edge of the lateral lamella straight, without abrupt widening subapically; in *kruegeri*, the lateral lamella is subapically wide (Mwabvu *et al*. 2009).

Description:

Size: Length of male about 300 mm, mid-body width 16 mm. Male 64–70 segments, female 66–70 segments.



Figs 52–55. *Spirostreptus heros* Porat, ♂: (52) aboral view of gonopod; (53) oral view of gonopods; (54) head and first segments, lateral view; (55) gnathochilarium. Abbreviations: (c) cardo, (col) collum, (g) gonocoel, (fp) femoral process, (lal) lateral lobe of gonocoxite, (ll) lateral lamella of gonocoxite, (m) mentum, (ml) median lamella of gonocoxite, (pb) prebasilare, (s) solenomere, (st) stipes. Scale bar = 1 mm.

Colour: Prozonite and venter light brown, metazonite dark brown to black. Antenna brown, darkening distally. Legs dark brown.
Head: Epicranial suture present, interocular suture not visible. Antenna reaches 4th segment.
Collum: Anterior corner projects to form lobe. Laterally, edges slightly prominent, with 2–4 folds (Fig. 54).

Tergites: Prozonites striated, metazonites with furrows below ozopores.
Gonopods: Lateral lamella of telocoxite distally bulbous. Lateral process broadly digitiform (Fig. 52, *lal*). Median lamella about two thirds the height of lateral lamella, apically bluntly rounded and distally narrower than in mid-region. Telopodite with femoral process emerging within gonocoel, curved slightly downwards and apically acute (Fig. 53, *fp*). Main part of telopodite with coiled region, and distally long and slender (Figs 52, 53).

Syntype (examined): 1♂ NAMIBIA: Kalahari, between Kang and Kgokong [co-ordinates uncertain], 1904, Schultze (ZMHB 4968).

Other material examined: NAMIBIA: 1♂ Ovamboland, Opoivondo [co-ordinates uncertain], vi.1970, H. Strauss (SMN 21640) (NMNW); 1♂ Windhoek district, Cochegans [22°33'33"S 17°04'57"E, 1659 m], 20.ii–20.iii.1982, E. Makgoabane (SMN 21937) (NMNW); 1♂ Windhoek district, Richthofen 126 [22°33'S 17°04'E], x.1979, S. Louw & M.-L. Penrith (SMN 21797) (NMNW); 1♂ Hobatere [19°18'55"S 14°28'14"E, 1253 m], 23–24.iv.1996, E. & M. Griffin (SMN 22131) (NMNW); 1♂ Otjozondjupa region, Biodiversity Observatory Otjiamongombe, 100 km N of Windhoek, 21°35'S 16°56'E, 16.iv.2001, K. Vohland (BIOTA-614) (NMNW); 1♀ same locality, 18.iv.2001, S. Lüdecke (BIOTA-633) (NMNW); 1♂ Okavango region, Biodiversity Observatory Mutompo (Sovo), 18°18'S 19°15'E, 20.iv.2001, E. Marais (BIOTA-632) (ZMHB/MYR 13729); 1♀ same locality, 18.iv.2001, K. Vohland (BIOTA-634) (ZMHB/MYR 13729); 2♂ 1♀ 1 juv., Katima Mulilo district, Salambala camp site, 17°50'01"S 24°36'09"E, 23–30.xii.2002, A.H. & M.K. Kirk-Spriggs, hand collected (SMN 22142–22145) (NMNW).

Distribution: Known from southern Botswana, north-western South Africa, northern Namibia and southern Zimbabwe. This large species is very common and widely distributed. Hoffman *et al*. (2001) assumed that the label of early material (not examined in this study) which gave the locality as "Caffraria, Wahlberg" refers to a region in the Orange River valley, which may be the southern limits of the distribution, while the BIOTA programme sampled it as far north as the Rundu district.

Habitat: The species was observed actively moving around during the day, feeding on fresh herbaceous plant material (Vohland pers. observ.), such as *Aptosimum* sp. (Scrophularicaceae) and *Tribulus terrestris* (Zygophyllaceae) (R. Austermühle pers. comm.). It was also observed feeding on small mammal faeces (J. Zeller & A. Simang pers. comm.).

The flesh fly *Sarcophaga inzi* Curran (Diptera: Sarcophagidae) has been reared from dead *S. heros* from a dune farm in the Kalahari sandveldt of southern Namibia (Kirk-Spriggs 1999).

Genus *Namibostreptus* Mwabvu, 2009

Namibostreptus: Mwabvu *et al*. 2009: 49.

Type species: *Triaenostreptus kymatorhabdus* Attems, 1914, by original designation.

Diagnosis: Very large millipedes. Median lamella of gonopod approximately half the length of lateral lamella, and apical region wide with an acute median peak (Fig. 56). Distal half of lateral lamella with large convex lateral lobe, short lateral process and apical, folded process. Telopodite long, looped, with abrupt narrowing distal to the telopodite coil and with a trifurcate ending (Fig. 57). Femoral process strongly curved (Figs 56, 57).

Distribution: Only found in the central part of Namibia.

Remark: *Namibostreptus* is currently represented by a single species. Hoffman (1971, 2008) noted that *T. kymatorhabdus* is distinct because of the form of the coxal folds, and

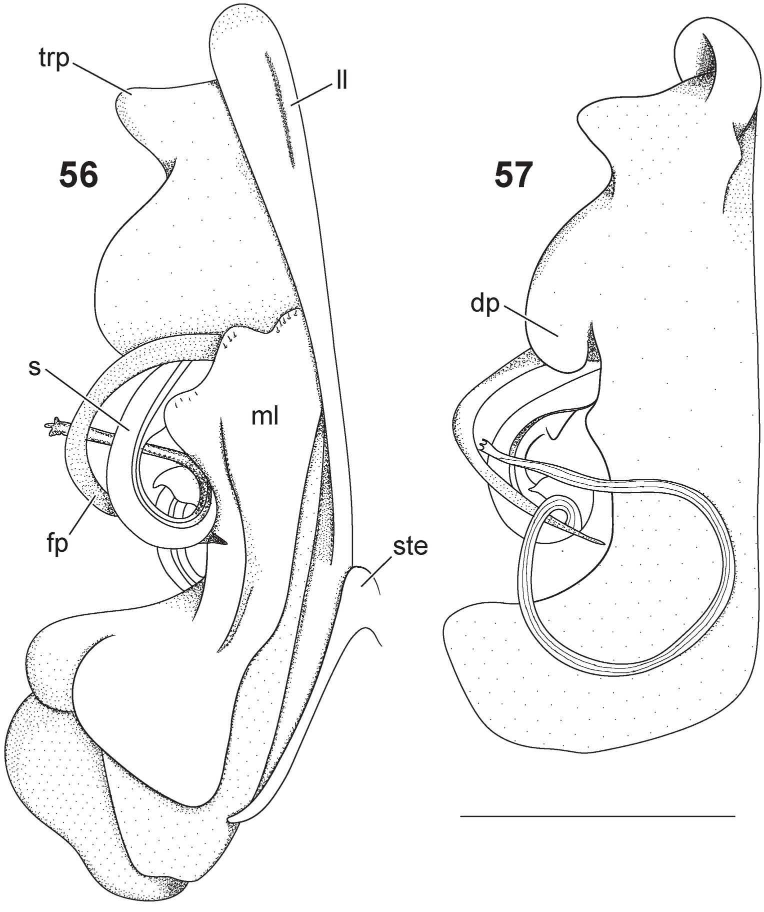
Mwabvu *et al.* (2009) confirmed the distinction with additional telopodite characteristics. Based on Hoffman's (2008) diagnosis of the Spirostreptini, *Namibostreptus* is a member of the tribe; the prebasilar plate, telopodite structure and the trifurcate apex resemble those of other member genera.

Namibostreptus kymatorhabdus (Attems, 1914)

Figs 56, 57

Triaenostreptus kymatorhabdus: Attems 1914*a*: 151–152, figs 147–149; 1922: 98; 1928: 366; Schubart 1966: 116; Hoffman 1971: 218; Krabbe 1982: 281; Hamer 1998: 52.
Spirostreptus kymatorhabdus: Hoffman 2008: 173.
Namibostreptus kymatorhabdus: Mwabvu *et al.* 2009: 50, fig. 8.

Diagnosis: Lateral lamella produces a broad, convex-shaped lateral lobe (wider than it is long and distal to median lamella apex), which extends beyond lateral edge of median



Figs 56, 57. *Namibostreptus kymatorhabdus* (Attems), ♂: (56) oral view of gonopod; (57) aboral view of gonopod. Abbreviations: (dp) digitiform process, (fp) femoral process, (ll) lateral lamella of gonocoxite, (ml) median lamella of gonocoxite, (s) solenomere, (ste) sternite, (trp) triangular process of lateral lamella. Scale bar = 1 mm.

lamella (Fig. 57, *dp*); a smaller more distal lateral, bluntly triangular process is present (Fig. 57, *trp*), and a folded apical process (Fig. 57). Median lamella apically undulate with median acute peak (Fig. 56). Gonopod femoral process strongly curved (Fig. 57). Main part of telopodite with single loop, distal to which it abruptly narrows; apically trifurcate (Figs 56, 57).

Description:

Size: Width of males 9–12 mm, 62–74 segments; length 210 mm.
Colour: Prozonite yellow, metazonite chestnut brown. Legs and antennae dark chestnut brown.
Collum: Anterior corner extended into a short, rounded lateral lobe, with 3–4 complete and 2 or more incomplete folds.
Gonopods: As for diagnosis.

Material examined: NAMIBIA: 1♂ Walvis Bay [22°56'S 14°30'E], Lübbert (ZMHB 2043); 1♂ Windhoek [22°34'12"S 17°05'01"E], Lübbert (ZMHB 5197).

Distribution: Only known from the Walvis Bay and Windhoek regions (Mwabvu *et al.* 2009) (Fig. 37).

Genus *Synophryostreptus* Attems, 1926

Synophryostreptus: Attems 1926: 199; 1928: 343; Demange 1970: 394; Krabbe 1982: 215; Hamer 1998: 51; 1999: 10.
Krugerostreptus Schubart, 1966: 111; Demange & Mauriès 1975: 76.

Type species: *Synophryostreptus punctatus* Attems, 1928, by monotypy.

Diagnosis: Metazonites wider than the prozonites. Surface with numerous strongly raised, short, longitudinal keels. Femoral process (Fig. 58, *fp*) of telopodite originating at femoral knee together with short, broad lobe (Fig. 58, *fl*), and telopodite with a second short, acute, femoral process slightly more distad (Figs 58, 59, *fp2*).

Remarks: The tribe Trachystreptini to which *Synphryostreptus* belongs is mainly restricted to East Africa. Members of the tribe live cryptically and occur mostly in humid tropical and subtropical forests (Lawrence 1973). Three species are known, *S. carli* (Attems, 1928) from Mozambique, *S. punctatus* from the northern provinces of South Africa, and *S. rugosostriatus* (Schubart, 1966) from the northern parts of South Africa, including the Kruger National Park, and the more forested Caprivi region of Namibia.

It is unclear exactly who synonymised *Krugerostreptus* under *Synophryostreptus*, since Krabbe (1982) cited Hoffman (1976), but she did not include this paper in her reference list and it does not appear to exist.

Synophryostreptus rugosostriatus (Schubart, 1966)

Figs 58–61

Krugerostreptus rugosostriatus: Schubart 1966: 111–113, figs 98, 99; Demange & Mauriès 1975: 77.
Lophostreptus rugosostriatus: Lawrence 1966: 257; 1973: 5.
Synophryostreptus rugosostriatus: Krabbe 1982: 216; Hamer 1998: 52.

Diagnosis: Gonopod lateral lamella with prominent, long, tapered lateral cone (Fig. 59, *lc*). Apex of median lamella reaching or extending beyond distal margin of lateral lamella (Fig. 58).

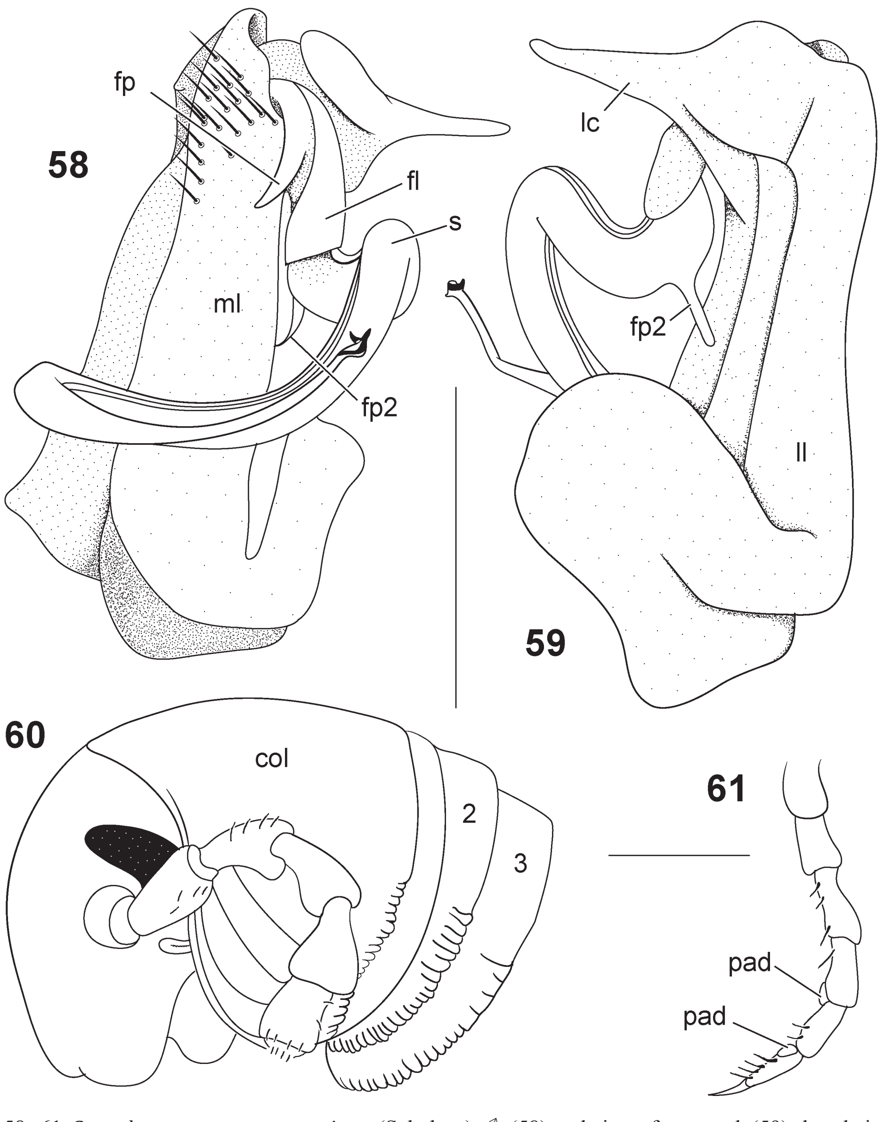
Description:

Size: Mid-body width 3.3 mm, 44 segments.

Colour: Leached, but animal relatively dark reddish brown.

Head: Shallow epicranial suture, interocular suture not visible, eye slightly more medial than antennal socket.

Collum: Anterior corner broadly rounded, with 3 folds, dorsal border smooth, laterally slightly undulated (Fig. 60).



Figs 58–61. *Synophryostreptus rugosostriatus* (Schubart), ♂: (58) oral view of gonopod; (59) aboral view of gonopod; (60) head and first segments, lateral view; (61) mid-body leg. Abbreviations: (col) collum, (fl) femoral lobe, (fp) femoral process 1, (fp2) femoral process 2, (lc) lateral conus on lateral lamella, (ll) lateral lamella, (ml) median lamella, (pad) pad, (s) solenophore. Scale bar = 1 mm.

Tergites and sternites: Ozopores present from the 5th segment onwards. Sigilla present. Prozonites with regular, fine riffles, metazonites with low keels, weak dorsally. Sternites subtriangular, with longitudinal striae, 7th segment with fold ventral to gonopod aperture. Anal valves with deep furrow just inside outer edge.
Legs: Pads small (Fig. 61), absent from legs of last diplosegments.
Gonopods: As in diagnosis.

Remarks: The gonopods are congruent with drawings of *S. rugosostriatus* (Lawrence 1966; Schubart 1966) but the specimens from the 'Transvaal' region are much larger in size and have more segments (50) than this specimen, which is attributed to intraspecific variation.

The closest known relative is *S. carli* Attems, 1928, but in this species the lateral cone is shorter and more bulbous, and the median lamella of the telocoxite is shorter, not reaching the distal margin of the lateral lamella.

Material examined: NAMIBIA: 1♂ West Caprivi, Manywa River, 17°48'S 23°05'E, 4–10.iv.1990, E. Marais, preservative pitfall traps (SMN 21962) (NMNW).

Distribution: Namibia and South Africa. In Namibia, occurs in the more humid and forested Caprivi region.

Remark: Krabbe (1982) stressed that *Synophryostreptus* is defined by smooth metazonites. This is not the case in the investigated material, however, and also not in the original description of *S. rugosostriatus*.

Family Harpagophoridae Attems, 1909

Harpagophorid millipedes occur in areas as arid as Gobabeb in the Namib Desert (Crawford & McClain 1983). During the BIOTA project, representatives of the family were located in soil at a depth of 5–10 cm adjacent to east-facing bases of granitic boulders. As no adult males were found, the species identity is uncertain. In more northern parts of Namibia, harpagophorid millipedes have not been recorded (Fig. 62).

Diagnosis: A diagnostic somatic character of this family is the epiproct, which is prolonged into a spine (Fig. 74). In the gonopods, the seminal duct ends in a typical plate which is beset with spines (Fig. 63, *pe*).

Key to species of Harpagophoridae occurring in Namibia

1 Stout appearance, 46 segments; gonopod telopodite with 1 femoral process (Fig. 71) ....**Zinophora sabulosa** (Attems, 1928)

– More slender, 48 or more segments; gonopod telopodite with 2 femoral processes, one larger, distally directed and terminating in 2 or more points (Figs 64, 65) (*Harpagophora*) 2

2 Gonopod telocoxite distally rounded, without protruding projection (Fig. 66); telopodite with larger femoral projection only slightly bifurcate; bifurcated projection (spine branch) closer to femoral processes than to pectinophore (Fig. 65).. **H. arida** Redman, 2003

– Gonopod telocoxite with protruding, finger-like projection (Fig. 64); telopodite with larger femoral projection deeply bifurcate (Fig. 64), simple spine branch present, just proximal to pectinophore (Fig. 63).......................**H. diplocrada** Attems, 1909

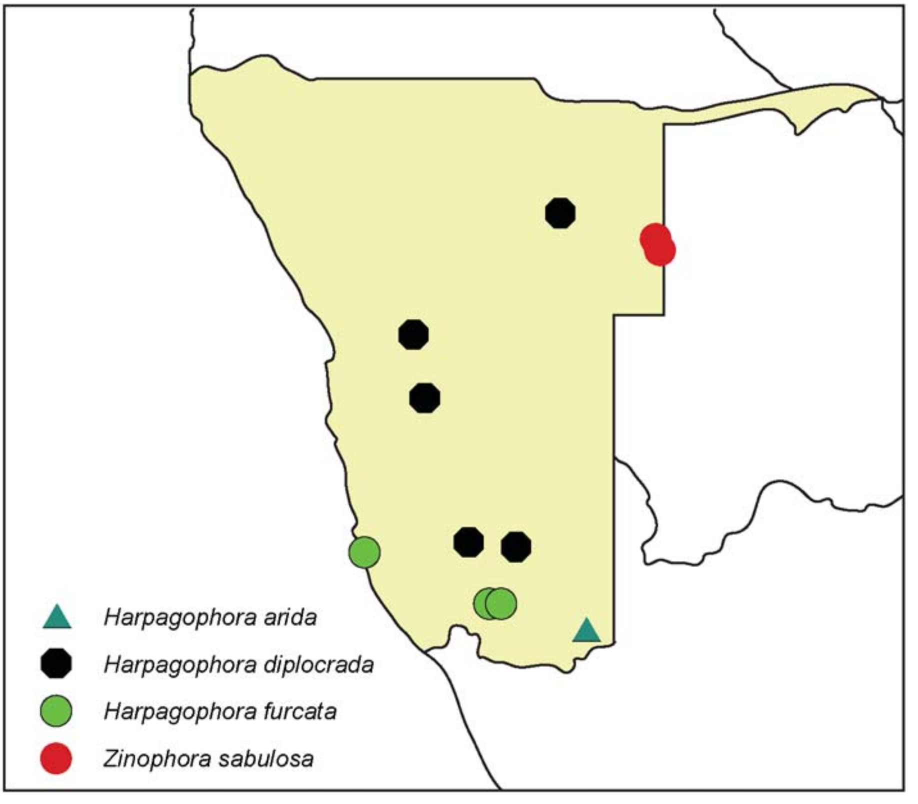


Fig. 62. Distribution of the family Harpagophoridae (Diplopoda) in Namibia.

Genus *Harpagophora* Attems, 1909

Harpagophora: Attems 1909*a*: 41; 1914*a*: 162; 1928: 372; Lawrence 1965: 50; Schubart 1966: 166; Demange 1983: 579; Hamer 1998: 54; 1999: 13; Redman *et al.* 2003: 210.

Type species: *Harpagophora diplocrada* Attems, 1909, designated by Jeekel (1970).

Diagnosis: Two femoral processes on the telopodite, these unequal in length and width (Figs 64, 65, *fp1, fp2*); posterior limb of telopodite comprising two branches, the spine branch (Fig. 64, *sb*) and the pectinophore (Fig. 64, *pe*). Syncoxosternite of first pair of legs with suture or divided.

Distribution: Four species occur in South Africa (Western Cape and Northern Cape) and two in Namibia.

Remarks: *Spirostreptus (Nodopyge) spirobolinus* Karsch, 1881, was the first *Harpagophora* species to be named but the description was based on a female, and only later was a male described from Hantam in the Northern Cape by Attems (1914*a*). While *spirobolinus* was placed in *Harpagophora* by Attems (1914*a*, 1928), Demange (1983) followed Jeekel (1970) in allocating *H. diplocrada* as the type species of the genus. Redman *et al*. (2003) subsequently created a new monotypic genus, *Metaphora* Redman, 2003, for *spirobolina*.

Demange (1983) divided *Harpagophora* into two subgenera on the basis of the structure of the margin of the spine branch. Redman *et al*. (2003), however, suggested that this character does not show any relationship in its occurrence to the other major taxonomic characters in the genus, including the form of the femoral process and telocoxites, and so the two subgenera were synonymised.

Harpagophora diplocrada Attems, 1909

Figs 63, 64

Harpagophora diplocrada: Attems 1909*a*: 42, figs 90, 91; 1922: 42; 1928: 374; Schubart 1966: 168; Demange 1983: 579; Hamer 1998: 54; Redman *et al.* 2003: 221.

Diagnosis: Lateral lamella of telocoxite with large median digitiform process directed distally, and with one to three small teeth below this (Fig. 64). First femoral process (Fig. 63, *fp1*) small, partially curved around the base of the larger spine and concealed in gonocoel. Second femoral process (Fig. 63, *fp2*) originating at knee, distally divided into 2 spines. Pectinophore ribbon-like (Fig. 64, *pe*), and incurved towards spine branch, Spine branch narrow and apically acute (Fig. 64, *sb*).

Description:

Size: Mid-body width in males 9 mm, in females 11 mm. Male with 48 segments, female with 49.

Colour: Frons chestnut brown, head darker. Antenna chestnut brown, 6th antennomere darker. Collum dark brown; prozonites yellowish, dark yellow longitudinal stripes present at height of ozopores; metazonites dark brown to black, anteriorly lightly bordered; ozopores darker. Limbus yellowish. Last segment dark, only median ridge on paraprocts lighter. Sternites yellow, legs dark brown.

Head: Frons finely wrinkled, with 5 supralabral pits. Epicranial suture distinct, interocular suture only faint. Suture from hind corner of eye visible, eye relatively close to antenna. Antennomere 2>3>4>5>1>6>7, and antenna hardly reaching posterior border of collum.

Collum: Lateral margin wide, thickened, 1 or 2 folds at anterior and lateral borders.

Tergites and sternites: Ozopores from 6th segment onwards. Prozonites longitudinally striated, ventrally turning into horizontal ridges of metazonites; metazonites with longitudinal striation, ending below ozopores. Prozonites and metazonites divided by a distinct suture. Limbus finely dentate. Sigilla ovoid.

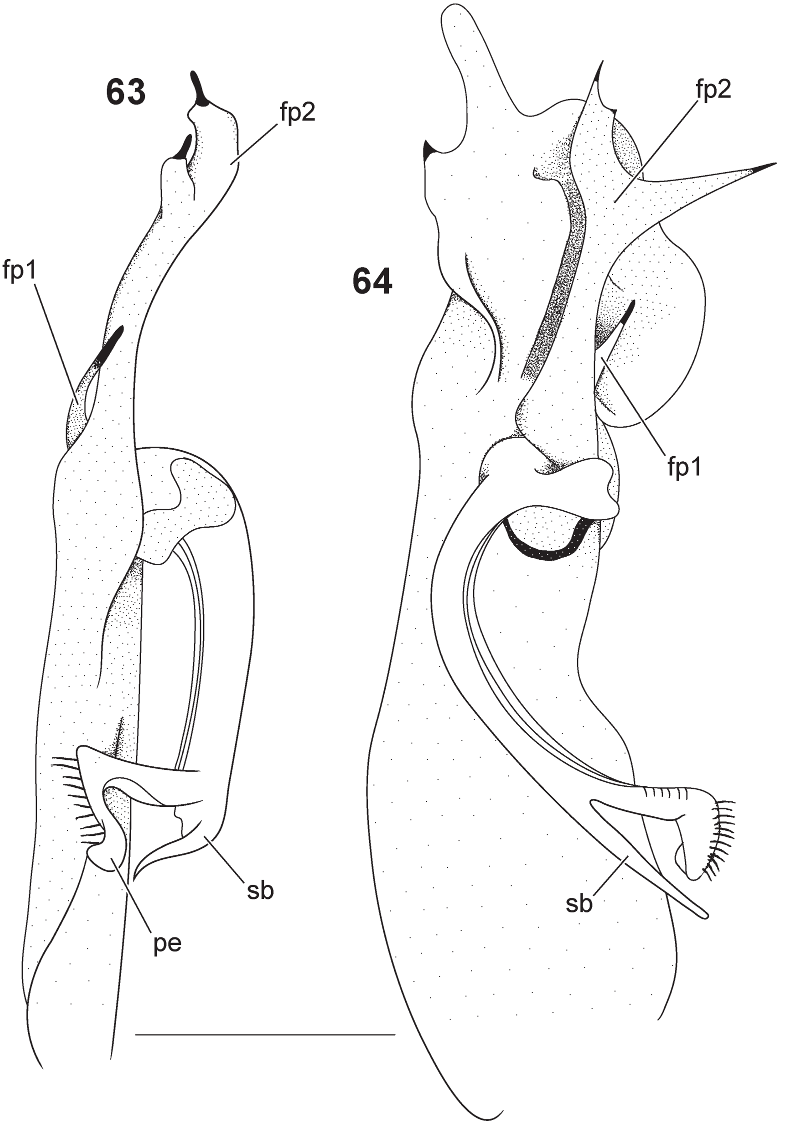
Legs: Pads becoming smaller posteriorly, on last segments only distal pad present, this always being larger than interior pad.

Gonopods: As in diagnosis.

Material examined: NAMIBIA: 1♂ 1♀ Keetmanshoop district, Noachabeb 91 [27°26'00"S 18°31'15"E, 1477 m], 7–12.i.1972 (SMN 21671) (NMNW); 1♂ Windhoek, Nauchas 14 [23°39'02"S 16°17'42"E, 1764 m], 27–30.iii.1995, E. Marais (SMN 22130) (NMNW).

Distribution: Namibia, widely distributed north of Windhoek. Redman *et al*. (2003) provided the following additional localities: Otjimbingwe [22°21'01"S 16°07'59"E, 898 m], Keetmanshoop [26°34'28"S 18°07'58"E, 1004 m], Narldas Sil [co-ordinates uncertain], Naukluft Mountains [24°07'S 16°10'E, 1585 m], Grootberg area [more than one site by this name], Halsos Mountains [co-ordinates uncertain] and Daan Viljoen Nature Reserve [22°32'18"S 16°56'38"E, 1669 m].

Remarks: The whereabouts of the type material is unknown.



Figs 63, 64. *Harpagophora diplocrada* Attems, ♂: (63) telopodite of gonopod, lateral view; (64) gonopod, oral view. Abbreviations: (fp1) femoral process 1, (fp2) femoral process 2, (pe) pectinophore, (sb) spine branch. Scale bar = 1 mm.

Harpagophora arida Redman, 2003

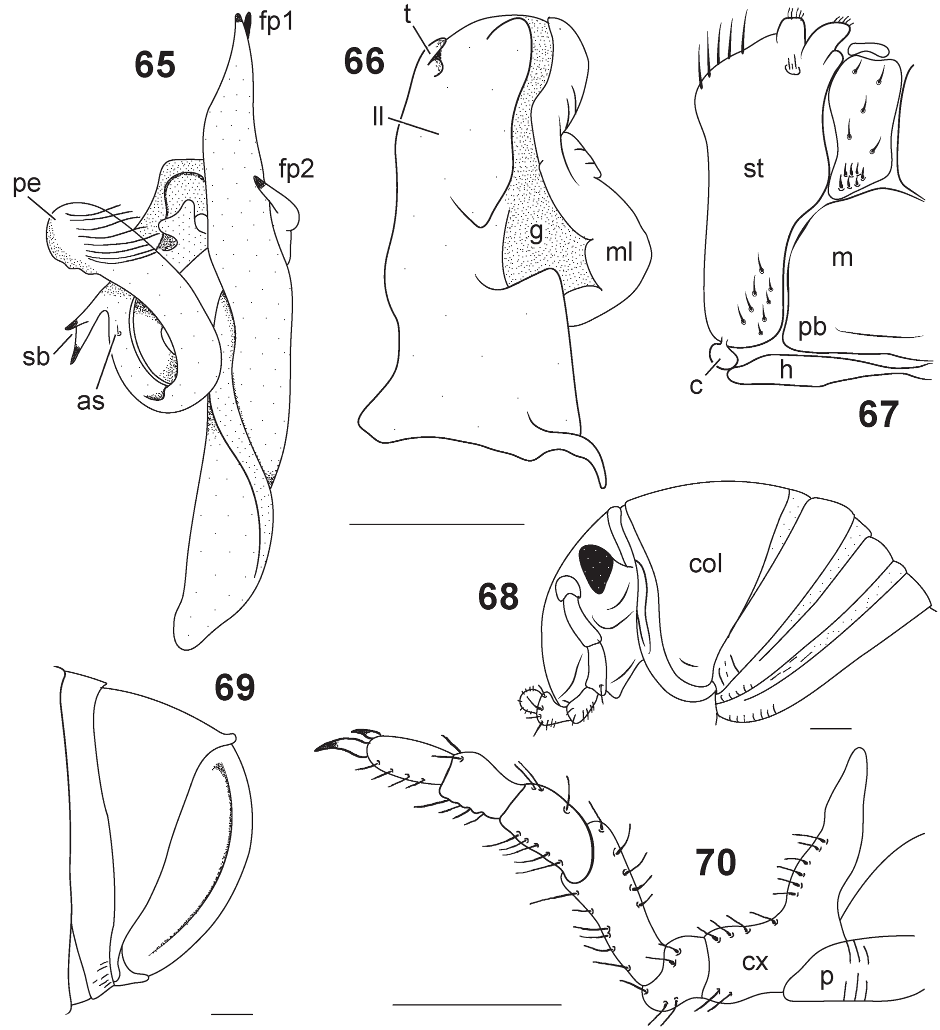
Figs 65–70

Harpagophora arida: Redman *et al*. 2003: 215–217, figs 20–26.

Diagnosis: Gonopod teloxocite apically broadly rounded, in oral view with small sclerotised, basally directed projection (Fig. 66, *t*). Gonopod telopodite with a larger straight femoral spine having a slightly furcated tip (Fig. 65, *fp1*), and a shorter strong spine at the telopodite knee (Fig. 65, *fp2*), as well as a smaller third spine at flexure of telopodite (Fig. 65, *as*). Pectinophore elongate, ribbon-like, curling distally, with proximal margin serrated (Fig. 65, *pe*). Spine branch short, narrow, and apically bifid (Fig. 65, *sb*).

Description:

Size: Relatively stout. In males, body width anteriorly 8.4 mm, posteriorly 8.5 mm, length about 90 mm; in females 8–9 mm, 9–10 mm and 93–101 mm, respectively. There are 56–58 body segments.



Figs 65–70. *Harpagophora arida* Redman, ♂: (65) telopodite, oral view; (66) telocoxite, oral view; (67) gnathochilarium; (68) head and first segments, lateral view; (69) epiproct, lateral view; (70) leg 2 of male. Abbreviations: (as) additional small spine on telopodite, (c) cardo, (col) collum, (cx) coxa, (fp1) femoral process 1, (fp2) femoral process 2, (g) gonocoel, (h) hypostomum, (l) lamella lingualis, (ll) lateral lamella of gonocoxite, (m) mentum, (ml) median lamella of gonocoxite, (p) penis, (pb) prebasilare, (pe) pectinophore, (sb) spine branch, (st) stipes, (t) telocoxite projection. Scale bar = 1 mm.

Colour: In life, dark red-brown to black, appearing slightly striated due to lighter prozonites and venter. Frons and first antennomeres chestnut brown. Head, collum and segment 2 dark brown, further segments nearly black, anal segment dark brown. Legs and distal antennomeres dark brown. Sternites and anterior part of prozonites yellowish, ventrally and dorsally reaching suture between meta- and prozonite.
Head: Frons hairless, slightly wrinkled. Epicranial groove shallow, ending at distinct interocular groove. There are 6 supralabral pits. Eyes with suture from hind edge. Antenna reaching 2nd segment; antennomere 2>3>4>5=6>2>7. Gnathochilarium having mentum (Fig. 67, *m*) and prebasilare (Fig. 67, *pb*) merged; stipes (Fig. 67, *st*) connected with cardo (Fig. 67, *c*); hypostoma with median suture (Fig. 67, *h*).
Collum: Subquadratic, slightly protruded backwards, with a strong lateral ridge, channeled anteriorly (Fig. 68).
Tergites and sternites: Ozopores from 6th segment onwards. Prozonites and sternites with transverse striation, metazonites below ozopores with marked longitudinal stripes. Limbus finely dentate. Epiproct (Fig. 69) with very small, slightly upwards-directed projection, hypoproct broadly rounded.
Legs: Syncoxosternite of 1st pair of legs with distinct suture. Pads present on tibia and postfemur, distal pad always larger than interior one, smaller on posterior legs, absent on legs of last 3 or 4 diplosegments.
Gonopods: As in diagnosis.

Paratypes (examined): 1♂ 3♀ NAMIBIA: Karasburg district, Karios 8, Fish River Canyon, 27°40'58"S 17°48'47"E, 1.iv.2001, M. Uhlig, BIOTA 522, plot 19 (ZMHB/MYR 13730).

Other material examined: NAMIBIA: 1♂ 'Plateau', Aar, Lüderitz [26°42'S 15°16'E], 15–18.i.1972 (NMSA 19707); 1♂ 1♀ Fish River Canyon [26°50'S 17°17'E], 14–15.i.1972 (SMN 22138) (NMNW).

Distribution: Distributed in southern Namibia, in the Fish River Canyon area (Karas). The holotype (Albany Museum, Grahamstown, South Africa, uncatalogued) was collected from Ais-Ais [27°55'20"S 17°29'23"E, 242 m] (Redman *et al.* 2003), which is part of the Fish River Canyon.

Ecology: The animals were seen in large numbers after a rain event by M. Uhlig (pers. comm.).

Genus *Zinophora* Chamberlin, 1927

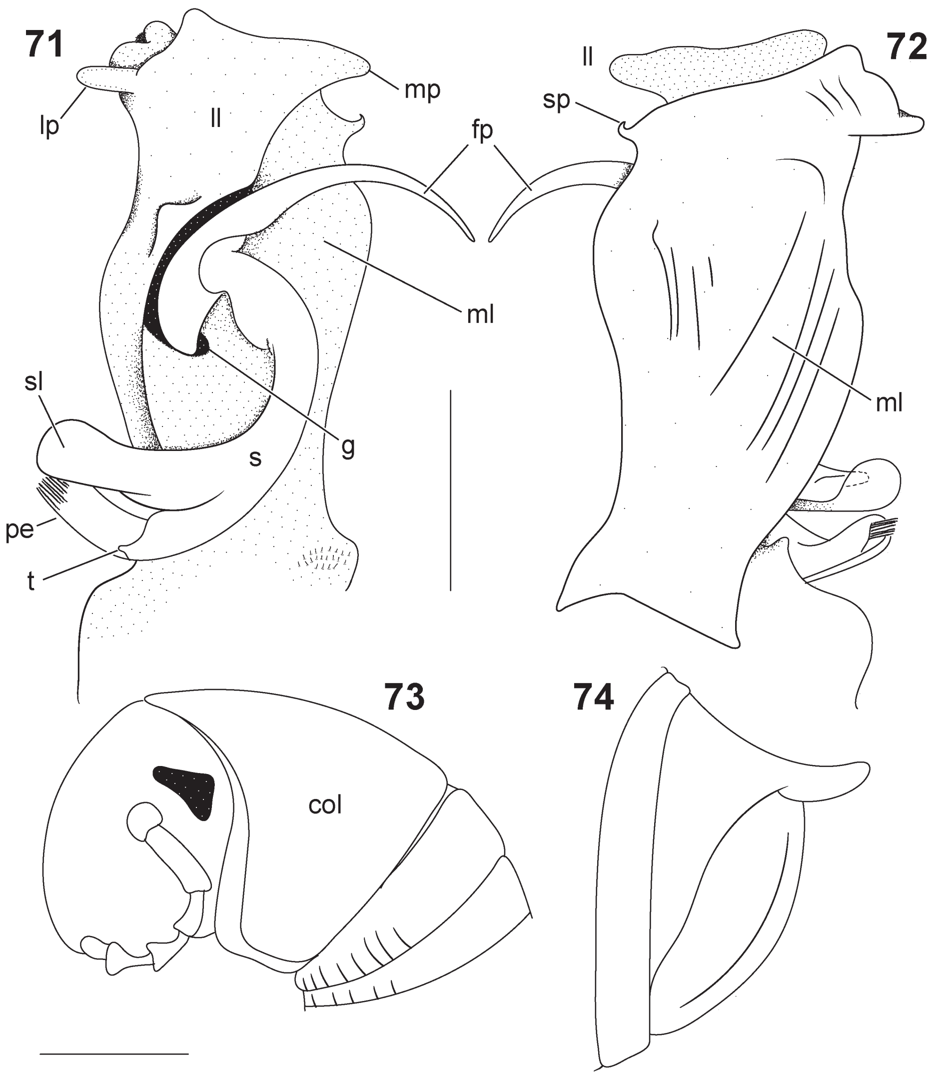
Zinophora: Chamberlin 1927: 211; Schubart 1966: 164; Demange 1983: 579; Hamer 1998: 55; Redman *et al.* 2003: 230.
Poratophilus: Attems 1928: 376.
Philoporatia: Attems 1928: 376; Lawrence 1965: 50. Synonymised by Demange (1983: 579).
Poratophilus (Philoporatia): Schubart 1966: 156.

Type species: *Zinophora munda* Chamberlin, 1927, by original designation.

Diagnosis: Telopodite with one or two simple femoral processes, where two spines present these of similar size. Apical elements comprising three components: the pectinophore, thumb and second lamella (Fig. 71, *p*, *t*, *sl*). Thumb narrow and falcate, or a saucer-shaped, laminate plate broadening apically, curving away from other apical elements. Distal ends of telocoxites complexly lobed (Fig. 71). Prefemora of first legs not touching medially and syncoxosternum without suture (Redman *et al.* 2003).

Distribution: Most diverse in South Africa, where the genus is widely distributed; also occurs in Mozambique, Zimbabwe, Zambia and Namibia (Redman *et al.* 2003).

Remarks: Attems (1928) assigned five new species to the genus *Poratophilus* Silvestri, 1897, but stated that the illustrations of the type species, *P. australis* Silvestri, 1897, were so poor that it was not possible to be certain about this designation, or of the three species described by Carl (1917) in *Poratophilus*. Attems (1928) suggested that if the five species described were found not to be congeneric with *australis,* then the name *Philoporatia* should be used. He did not provide any diagnosis for this genus. Schubart (1966) used the name *Philoporatia* as a subgenus of *Poratophilus*, and Demange (1983)



Figs 71–74. *Zinophora sabulosa* Attems, ♂: (71) gonopod, oral view; (72) gonopod, aboral view; (73) head and first segments, lateral view; (74) epiproct, lateral view. Abbreviations: (col) collum, (fp) femoral process, (g) gonocoel, (ll) lateral lamella of gonocoxite, (lp) lateral process of telocoxite, (ml) median lamella of gonocoxite, (mp) median process of telocoxite, (pe) pectinophore, (s) solenomere, (sl) second lamella, (sp) spinous process, (t) thumb. Scale bar = 1 mm.

later synonymised *Philoporatia* with *Zinophora*, and placed Attems's (1928) and Carl's (1917) three species into the latter genus. Hoffman (1994) later verified *Poratophilus* as a valid genus and described the South African *P. gorteri* Hoffman, 1994, as a second species in the genus.

Zinophora sabulosa (Attems, 1928)

Figs 71–74

Poratophilus sabulosus: Attems 1922: 98 (*nomen nudum*); 1928: 380, figs 343–346.
Poratophilus (Philoporatia) sabulosus: Schubart 1966: 159.
Zinophora sabulosa: Hamer 1998: 56; Redman *et al*. 2003: 259.

Diagnosis: Lateral lamella of telocoxite with prominent lobe medially (Fig. 71, *mp*), and digitiform process laterally (Fig. 71, *lp*). Median lamella with median spinous process (Fig. 72, *sp*). One long femoral spine on telopodite, this being curved inwards, passing just below telocoxal spine and lobe and reaching opposite gonopod telocoxite (Figs 71, 72, *fp*). Thumb reduced, branching off base of pectinophore and curved away from other apical elements (Fig. 71, *t*).

Description:

Size: Width 11 mm, length about 110 mm; 46 segments.
Colour: Antennae dark brown, legs red-brown. Prozonites light brown, metazonites darker, posterior margin orange-brown. Anal segment dorsally light brown, paraprocts darker brown.
Head: Eye parallel to antenna, antenna almost reaching posterior margin of collum, antennomere 2>3>4>5>6>7=1>8 (Fig. 73).
Collum: Subquadratic, with thick raised margin anteriorly (Fig. 73).
Tergites and sternites: Prozonites with irregular longitudinal striation, metazonites with striation reaching above the ozopores. Ozopores set below mid-body from lateral view, starting from 6th segment. Sternites smooth. Terminal segment with distinct spiniform process (Fig. 74).
Legs: Pads on legs up until the terminal diplosegments.
Gonopods: As in diagnosis.

Material examined: NAMIBIA: 1♂ 5 ♀ Omaheke region, Eiseb River, Hereroland, 20°40'S 20°59'E, 18.xi–15.xii.1988, E. Marais & M. Paxton (SMN 21981) (NMNW); 1♂ Omaheke region, Hereroland, 20°33'S 20°54'E, 20.xi–16.xii.1988, E. Marais & M. Paxton (SMN 21984) (NMNW).

Distribution: Namibia and South Africa. Occurs widely in northern parts of South Africa, from Pretoria in Gauteng to North West and Northern Cape provinces. In Namibia, found in the Otjozondjupa (Farm Neitsas, Grootfontein, Otjiwarongo) and Omaheke regions.

Remarks: The whereabouts of the type material is unknown.

Family Odontopygidae Attems, 1909

Odontopygidae probably have their origin in central Africa and in southern Africa, where highly derived genera occur (Kraus 1960, 1966). Diagnostic features are the maintenance of the sternite on the gonopod segment and a large, lamella-like gonopod tarsus and spines on each of the paraprocts of the anal segment (wanting in some small species). The males can be recognised by their enlarged 6th segment (Fig. 82) and the pads on the legs (Fig. 84). In contrast to other millipedes, which defend themselves by rolling into a spiral, the agile odontopygids show active defensive behaviour.

More odontopygids are recorded in the northern parts of Namibia than in the southern parts (Fig. 75).

Key to species of Odontopygidae occurring in Namibia

1 Minute species, width <1 mm, paraprocts without spines (Figs 78, 89); gonopod solenomere with distal spinous processes (Figs 78, 88) 2
– Medium-sized species, width >2 mm, paraprocts with dorsal spines (Fig. 80); gonopod solenomere without distal processes (Figs 79, 83, 85).............................3

2 Less than 60 segments; telocoxite without basally directed acute process (Fig. 77) .... **Bandeirenica andara** sp. n.
– More than 70 segments; telocoxite distal-orally with basally directed acute process (Fig. 88, *tc*)..**Syndesmogenus fragilis** sp. n.

3 With red longitudinal line dorsally; solenomere spiralled distally, main part of tarsus comprising a single leaf and much enlarged (Fig. 86) ....**Spinotarsus xanthonotus** Attems, 1909

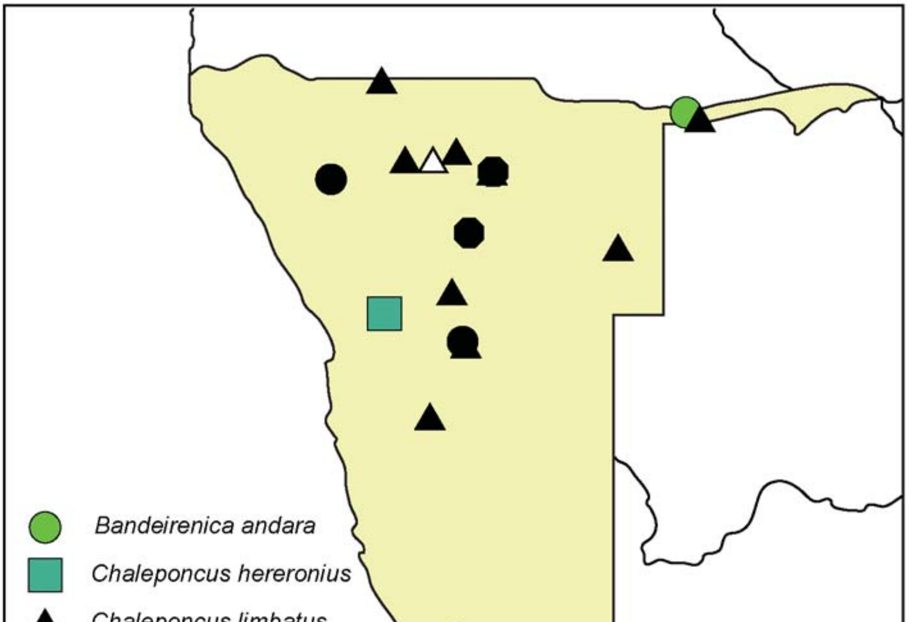


Fig. 75. Distribution of the family Odontopygidae (Diplopoda) in Namibia.

– Animal with transversely striped appearance; solenomere not distally spiralled, main part of tarsus divided into three leaves, the medium one beset with hairs (Figs 79, 83) (*Chaleponcus*) 4
4 Gonopod telocoxite apically sclerotised, with lateral spines (Fig. 83) ....**C. niger** Attems, 1914
– Gonopod telocoxite not sclerotised apically, but broadly widened (Fig. 79)..........5
5 Median lamella of telopodite tarsus prolonged............. **C. limbatus** Attems, 1914
– Median lamella of telopodite tarsus not prolonged..... **C. hereronius** Attems, 1922

Genus *Bandeirenica* Kraus, 1960

Bandeirenica: Kraus 1960: 19–20; Hoffman 2000.

Type species: *Spinotarsus bandeirensis* Kraus, 1958, by original designation.

Diagnosis: Paraprocts without spines, but wrinkled in dorsal part (Fig. 78, *pa*). Gonopod tarsus tube-like, solenomere with long slender spinous process at base of distal quarter (Fig. 77, *tp2)* and with triangular process near apex (Fig. 77, *tp1*).

Distribution: Two species, *B. bandeirenica* (Kraus, 1958) and *B. donguensis* (Kraus 1958), are known from southeast Angola. One species, *B. caboverda* (Pierrad, 1987), was accidently introduced to the Cape Verde islands, probably from Angola, and acts as a crop pest for potatoes (Hoffman 2000).

Remarks: Kraus (1960) described this genus and distinguished it from the extremely species-rich *Spinotarsus* on the basis of the latter genus having a typical basal lamella on the gonopod tarsus that is lacking in *Bandeirenica*. Hoffman (2000) discussed the presence or absence of this process as being of specific value only and suggested that *Bandeirenica* be synonymised under *Syndesmogenus*.

Bandeirenica andara Vohland, sp. n.

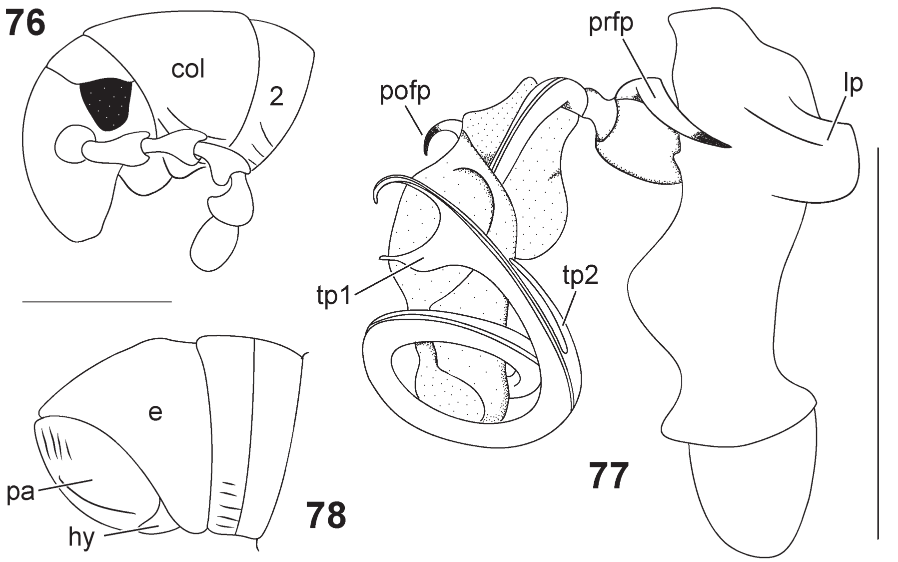
Figs 76–78

Etymology: The species name *andara* refers to the place of collection; a noun in apposition.

Diagnosis: Gonopod solenomere with broadly triangular process at distal end (Fig. 77, *tp1*).

Description:

Size: Animal slender, width of male 1.5 mm, length about 30 mm, 56 segments; female, 57 segments.
Colour: Leached out, brown, with darker lateral stripes; antennomeres distally reddish and darker, with a broad dirty white border.
Head: Epicranial suture deeper than interocular suture. 6 supralabral pits. Eye basally flattened, subtrapezoid (Fig. 76). Antenna reaching back to 4th segment, antennomere 2>3=6>4=5>1>7, distal antennomeres thickened.
Collum: 2 distinct folds, slightly excavated for antenna.
Tergites and sternites: Ozopores from the 6th segment onwards. Metazonites and prozonites divided by faint suture. Surface finely porous and with faint horizontal striae, becoming stronger below ozopores. Limbus slightly fringed. Sternites subquadratic.



Figs 76–78. *Bandeirenica andara* sp. n., ♂: (76) head and first segments, lateral view; (77) gonopod, aboral view; (78) last segments, lateral view. Abbreviations: (col) collum, (e) epiproct, (hy) hypoproct, (lp) lateral process, (pa) paraproct, (pofp) postfemoral process, (prfp) prefemoral process, (tp1) tarsal process 1, (tp2) tarsal process 2. Scale bar = 1 mm.

Anal segment without spines, but paraprocts with ridges dorsally (Fig. 78, *pa*). Epiproct bent downwards, with slight hump (Fig. 78, *e*).

Legs: Small pads present on postgonopodal legs, absent in terminal pair.

Gonopod: Telocoxite with broad lateral process (Fig. 77, *lp*). Telopodite with prefemoral (Fig. 77, *prfp*) and postfemoral process (Fig. 77, *pofp*), each darkened distally. Tarsus encircling the long and slender solenomere. Solenomere subdistally with slender process (Fig. 77, *tp2*), distally with broad and flat triangular tarsal process (Fig. 77, *tp1*).

Holotype: ♂ NAMIBIA: Okawango, Andara [18°03'44"S 21°26'35"E, 1029 m], 19–24.viii.1971 [no collector's name] (SMN 21714) (NMNW).

Paratype: 1♀ same data as holotype (SMN 21714) (NMNW).

Remarks: Hoffman (pers. comm.) stressed the similarity to *Kompsoprium* Attems, 1935 species because of the large subapical triangular projection being typical for this genus. On the other hand, a generic characteristic for *Kompsoprium* are the fringes or at least dentated border of the tarsal lamella (Kraus 1966), which is smooth in *B. andara*.

Genus *Chaleponcus* Attems, 1914

Chaleponcus: Attems 1914*a*: 202; 1928: 409; 1934*b*: 494; 1938: 279; Kraus 1960: 20; 1966: 92; Schubart 1966: 122; Hamer 1998: 57; 1999: 18.

Type species: *Chaleponcus limbatus* Attems, 1914, designated by Kraus (1960).

Diagnosis: Telocoxite of gonopods distally helmet-like; in oral view without basal process. No femoral process, tibial process weak or absent. Solenomere very long and slender (Fig. 79, *s*). Tarsus distally divided into three lamellae (Fig. 79, *tl1, tl2, tl3*), with the inner one beset with small spines or hairs.

Distribution: The genus *Chaleponcus* currently includes 18 species distributed in Mozambique, Namibia, South Africa and Zimbabwe.

Biology: In the laboratory, females of *C. limbatus* were observed to lay single eggs in the soil (Dangerfield 1998).

Chaleponcus hereronius (Attems, 1922)

Odontopyge hereronia: Attems 1922: 101–103, figs 2a–d; 1928: 391.
Chaleponcus hereronius: Kraus 1960: 25; Schubart 1966: 123; Hamer 1998: 58.

Diagnosis: Gonopod telocoxite broadly widened, with apical region folded as a "lappet" (Attems 1928), which forms a median triangular process apically. A low triangular process on lateral margin of telocoxite.

Description:

Size: Width 4.2–4.5 mm; 60 segments.
Colour: In life black, antenna yellow-brown, darkening distally, legs yellow-brown.
Head: 5 or 6 supralabral pits, epicranial and interocular suture distinct.
Collum: Only very slightly anteriorly projected and with 1–2 complete folds.
Paraprocts: With distinct dorsal spines.
Legs: All legs with pads.
Gonopods: As in diagnosis.

Material examined: NAMIBIA: 1♂ 1♀ Usakos [22°00'11"S 15°34'59"E, 866 m], 1911, Michaelsen (NHMW 2622).

Distribution: The species is only known from the type locality, Usakos, which is close to Swakopmund in the Erongo region (Fig. 75).

Remark: Unfortunately, the gonopods were prepared in a manner that makes it impossible to redraw them to show the diagnostic characters.

Chaleponcus limbatus Attems, 1914

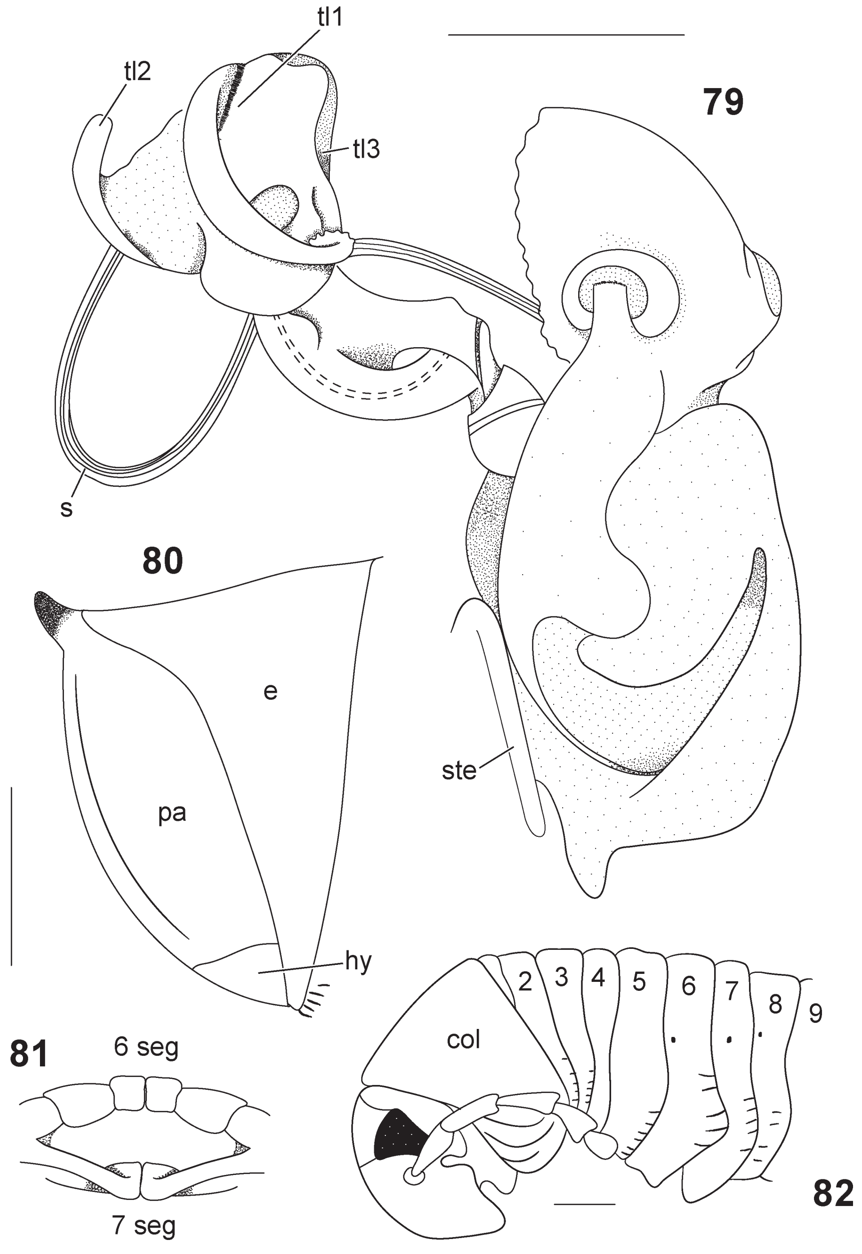
Figs 79–82

Chaleponcus limbatus: Attems 1914*a*: 203–205, figs 257–260; 1922: 204; 1928: 412; Kraus 1960: 27; Schubart 1966: 125; Hamer 1998: 58.
Chaleponcus dolabratinus Kraus, 1960: 21, 27, figs 30–34; Schubart 1966: 123; Hamer 1998: 58. **Syn. n.**

Diagnosis: Telocoxite rounded but with median apex angular, and median distal margin serrated. Basal lamella of gonopod tarsus with angular extension (Fig. 79, *tl2*).

Description:

Size: Width of male 4.0–4.5 mm; 61–64 segments.
Colour: Dark brown, metazonites posteriorly bordered with reddish brown.
Head: 6 supralabral pits.
Collum: 2–3 folds (Fig. 82).
Tergites and sternites: Prozonites with longitudinal striation, partly with faint horizontal striae. Metazonites and sternites smooth.
Gonopods: Telocoxite aborally with a rounded lamella, and medially with a distally directed lamella having a faintly serrated border. Telopodite with tibial process very small, having 0–2 minute basal processes. Three tarsal lamellae as usual, the basal inner one (Fig. 79, *tl1*) beset with fringes, the outer one (Fig. 79, *tl2*) with angular extension of variable length.



Figs 79–82. *Chaleponcus limbatus* Attems, ♂: (79) gonopod, aboral view; (80) epiproct, lateral view; (81) gonopodial aperture; (82) head and segments 1–8, lateral view. Abbreviations: (col) collum, (e) epiproct, (hy) hypoproct, (pa) paraproct, (s) solenomere, (ste) sternite, (tl1, tl2, tl3) tarsal lobes 1–3. Scale bar = 1 mm.

Holotype of *C. dolabratinus* (examined): ♂ NAMIBA: Waterberg [several localities by this name, so co-ordinates uncertain], 26–28.x.1952, Mertens (SMFD 2725/1).

Paratype (examined): 1♀ same data as holotype (SMFD 2726/2).

Other material examined: NAMIBIA: 1♂ Rehoboth district, Garies Oos 489 [23°19'S 17°07E], 9.ii–23.iii.1996, E. Marais (SMN 22134); 1♂ Windhoek district, Hoffnung 66 [22°32'22"S 17°11'47"E, 1922 m], 3.ii.1971, M.-L. Penrith, 'B.H. & E.M.' (SMN 21713) (NMNW); 1♂ Kamanjab district, Etosha Game Park [18°41'S 15°46'E], 5.iii.1969, P.G. Olivier (SMN 21649) (NMNW); 1♂ West Caprivi, Buffalo Base [17°50'S 23°57'E], iii–x.1990, E. Marais (SMN 21964) (NMNW); 1♂ Kamanjab district, Bloubokdraai [19°37'S 14°50'E], 10.viii.1987, E. Griffin (SMN 21920) (NMNW); 1♂ Omaheke region, east Hereroland, Eiseb River [21°29'S 18°31'E], 18.xi–15.xii.1988, E. Marais & M. Paxton (SMN 21982) (NMNW). 1♂ Otjozondjupa region, 100 km N of Windhoek, Biodiversity Observatory Otjiamongombe, 21°35'S 16°56'E, 3.ii.2003, J. Frisch & K. Vohland (BIOTA-1529) (ZMHB); 8♂ 7♀ 5 juv. Katima Mulilo district, Salambala camp site, 17°50'01"S 24°36'09"E, 23–30.xii.2002, A.H. & M.K. Kirk-Spriggs, hand collected (SMN 22146–22164) (NMNH); 1♂ 1♀ 7 juv. Owambo, Onkeleiwa, 17°25'S 15°29'E, in mopane leaf litter, 20.i.1993, E. Marais (SMN 22132) (NMNW).

Distribution: Widely distributed in northern Namibia (Khomas and north up to Kunene River).

Remarks: The only distinction between *C. limbatus* and *C. dolabratinus* is the size of the outer tarsal lamella. Examintion of numerous specimens showed that this is a variable feature. O. Kraus (pers. comm.) indicated that characteristics of the gonopods might have been overstressed in relation to somatic features.

Chaleponcus niger Attems, 1914

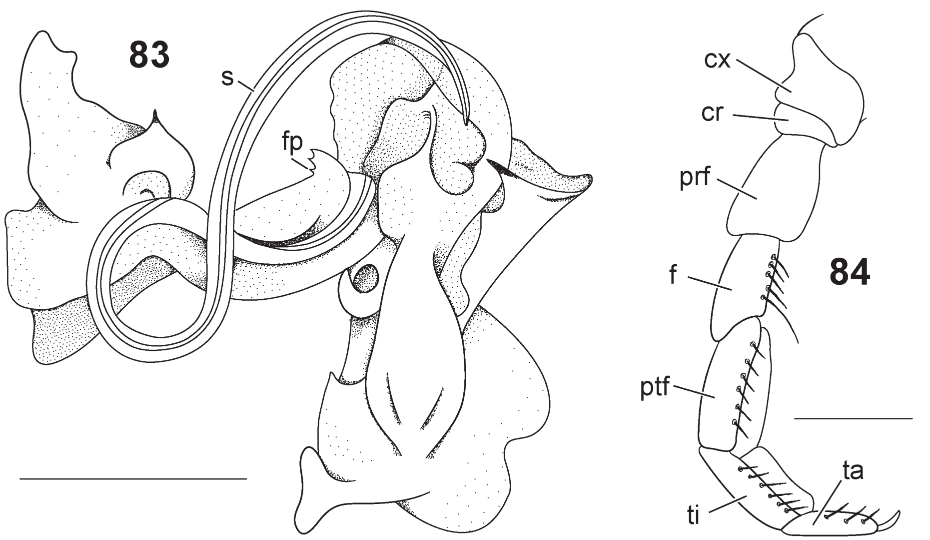
Figs 83, 84

Chaleponcus niger: Attems 1914*a*: 203–204, figs 266–271; 1928: 410; Kraus 1960: 27; Schubart 1966: 126; Hamer 1998: 58.

Diagnosis: Lateral lamella more strongly sclerotised than other parts of the telocoxite, ending in spiniform processes (Fig. 83).

Description:

Size: Width of male 4.8–5.2 mm; 62–64 body segments.



Figs 83, 84. *Chaleponcus niger* Attems, ♂: (83) gonopod, aboral view; (84) mid-body leg. Abbreviations: (cx) coxa, (f) femur, (fp) femoral process, (prf) prefemur, (ptf) postfemur, (s) solenomere, (ta) tarsus, (ti) tibia. Scale bar = 1 mm.

Colour: Black, legs and antennae yellow-brown.
Head: Epicranial suture and interocular suture fine. 6 supralabral pits. Antenna slender, reaching hind border of 4th segment.
Gonopod: Telocoxite with distal lamella, medial lamella and aborally directed lateral lamella with small teeth and a larger, arched hook (Fig. 83, *ll*).

Material examined: NAMIBIA: 1♂ Oshikoto region, Tsumeb [19°14'53"S 17°42'38"E, 1323 m] (ZMHB 5233); 1♂ Otjozondjupa region, Waterberg [20°20'55"S 17°19'42"E, 1670 m], xi.1972, H.C. Strauss (SMN 21738) (NMNW).

Distribution: Namibia. From Windhoek north to Omaheke and the Oshikoto region.

Genus *Spinotarsus* Attems, 1909

Spinotarsus: Attems 1909*a*: 51; 1909*b*: 46; 1914*a*: 200; 1928: 396; Kraus 1960: 118; Schubart 1966: 115; Hamer 1998: 61; 1999: 18.
Ardiophyllum Attems, 1928: 402. Synonymised by Kraus (1960: 118).
Storthophorus Attems, 1928: 405; 1935: 381. Synonymised by Kraus (1960: 118).

Type species: *Spinotarsus xanthonotus* Attems, 1909, by original designation.

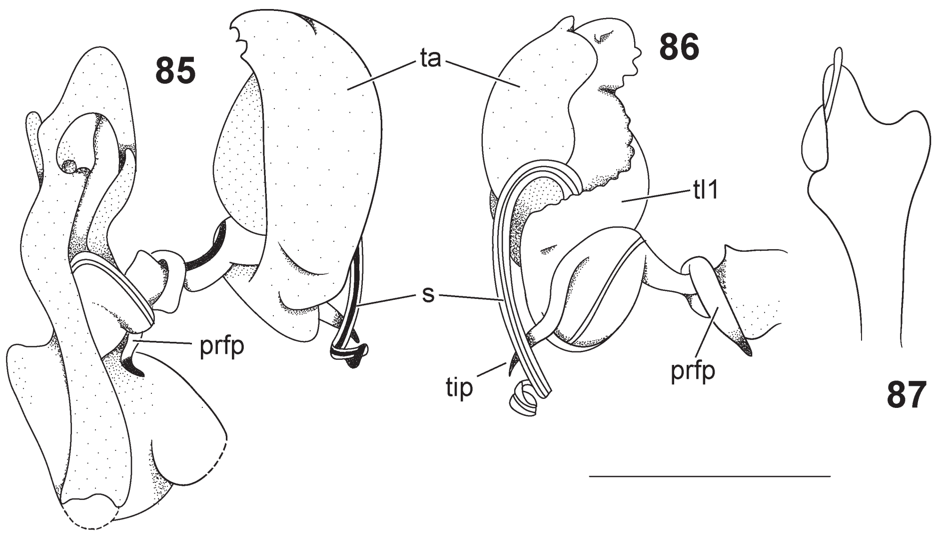
Diagnosis: Gonopod telopodite with tarsus comprising main lobe and smaller basal lobe, mostly with fine hairs or spines (Fig. 86, *ta*, *tl1*). Tip of slender solenomere with faint furrows, often helix-like (Fig. 85, *s*).

Spinotarsus xanthonotus Attems, 1909

Figs 85–87

Spinotarsus xanthonotus: Attems 1909*a*: 47–49, figs 9–11, 74, 80–82; 1909*b*: 51 (*nomen nudum*); 1914*a*: 201; 1928: 400; Schubart 1966: 171; Hamer 1998: 68.

Diagnosis: Gonopod solenomere with apical spiral (Fig. 85, *s*), tarsus much enlarged (Fig. 86, *ta*), and both prefemoral (Fig. 86, *prfp*) and tibial processes (Fig. 86, *tip*)



Figs 85–87. *Spinotarsus xanthonotus* Attems, ♂: (85) gonopod, aboral view; (86) telopodite, oral view; (87) telocoxite, oral view. Abbreviations: (s) solenomere, (prfp) prefemoral process, (ta) tarsal lobe, (tip) tibial process, (tl1) basal lobe of tarsus. Scale bar = 1 mm.

distinct. Telocoxite narrowly rounded apically, with lateral bulge about midway along length, and narrow lobe distal to this (Figs 85, 87).

Description:

Size: There are 60 body segments.
Colour: Head black-brown. Antenna brown, 6th segment black. Collum black-brown, posteriorly black, with dark reddish border. Prozonites black-brown. Metazonites dark brown, yellow-red midline dorsally up to tip of epiproct, middle region of bulge of paraprocts lighter.
Head: Epicranial suture weak, interocular suture absent.
Collum: 1–3 folds.
Tergites and sternites: Ozopores present from 6th segment onwards, striation on metazonites ending distinctly below ozopores.
Legs: Pads present up to last leg pair.
Gonopods: As in diagnosis.

Material examined: NAMIBIA: 1♂ Kamanjab district, Kaross [19°37'S 14°50'E], 10.ii.1987, E. Griffin (SMN 21925) (NMNW); 1♂ Windhoek district, Colorado [22°33'S 17°04'E], xii.1976, M.-L. Penrith & 'S.L.' (SMN 21779) (NMNW); 1♂ Windhoek district, Regenstein 32 [22°42'55"S 17°01'50"E, 1948 m], 7.ii.1973, M.-L. Penrith, J. Tebje & B.A. Harding (SMN 21743) (NMNW); 1♂ Windhoek district, Portsmut 33 [25°05'S 16°21'E], 7.ii.1969, P.G. Olivier (SMN 21648) (NMNW).

Distribution: Nambia (Windhoek district) and Botswana.

Genus *Syndesmogenus* Attems, 1909

Syndesmogenus: Attems 1909*b*: 159; 1909*c*: 59; 1914*a*: 211; 1937*b*: 22; Brölemann 1926: 78; Kraus 1958: 80; 1960: 175.
Dundonus Chamberlin, 1951: 86. Synonymised by Kraus (1958).

Type species: *Syndesmogenus gracilis* Attems, 1909, by monotypy.

Diagnosis: Small millipedes. Gonopod telocoxite with small, basally directed process (Fig. 88, *tc*). Solenomere with small process about three quarters along length (Fig. 88, *sp2*) and with long, slender spinous projection at apex (Fig. 88, *ap*).

Distribution: To date, this genus has 13 described species, which are mainly distributed in central Africa.

Remark: Chamberlin (1951) wrote that encircling striae on the prozonite are absent, but the animals are very finely striated.

Syndesmogenus fragilis Vohland, sp. n.

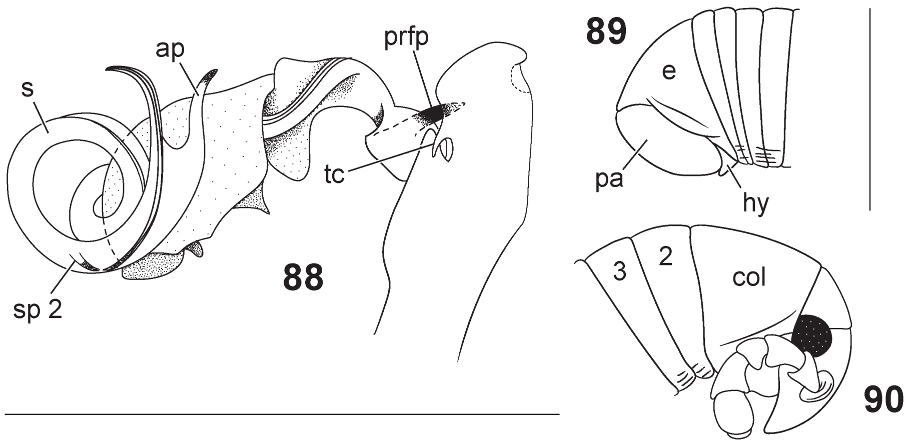
Figs 88–90

Etymology: From Latin *fragilis* (brittle, weak), in reference to the extremely small size of the species.

Diagnosis: Anal segment without spines, epiproct strongly curved downwards, sides with small folds (Fig. 89). Gonopod solenomere (Fig. 88, *s*) subdistally with short, darkened process (Fig. 88, *sp2*), distally with larger spine-like process (Fig. 88, *ap*).

Description:

Size: Very small millipede, width 0.8 mm; 74 segments.
Colour: Brown, dorsally lighter, ventrally light with dark stripes. Head brown, slightly reddish. Antenna brown, antennomeres distally with white border.



Figs 88–90. *Syndesmogenus fragilis* sp. n., ♂: (88) gonopod, aboral view; (89) last segments, lateral view; (90) head and first segments, lateral view. Abbreviations: (ap) apical process, (col) collum, (e) epiproct, (hy) hypoproct, (pa) paraproct, (prfp) prefemoral process, (s) solenomere, (sp2) small process of solenomere, (tc) telocoxite process. Scale bar = 1 mm.

Head: Epicranial and interocular suture present, 6 supralabral pits, eyes subquadratic. Antenna stout, reaching 3^{rd} segment, antennomere 6>5>2>4=3>1>7, with antenomeres 5 and 6 thicker than the others (Fig. 90).

Collum: 3 folds, leaving space for antenna (Fig. 90).

Tergites and sternites: Prozonites with faint longitudinal striation, metazonites with some more marked striations ventrally. Sternites finely striated. Limbus faintly undulated. Paraprocts striated. Epiprocts bent downwards (Fig. 89), paraprocts without spines. Gonopod aperture anteriorly with sternite and legs of 6^{th} segment clearly visible.

Legs: Pads become smaller on more posterior legs.

Gonopods: Telocoxite with darkened process (Fig. 88, *tc*). Telopodite with prefemoral process (Fig. 88, *prfp*), tarsus with smooth border, encircling long slender solenomere. Further distally, there is a small process (Fig. 88, *sp2*), distal to which solenomere becomes broader, the apical region having a spinous lateral branch (Fig. 88, *ap*).

Holotype: ♂ NAMIBIA: Helio, 19°03'S 16°29'E, 27.iii–4.v.1988, E. Griffin, preservative pitfall trap (SMN 21898) (NMNW).

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