An illustrated key to the spirostreptidan (Diplopoda: Spirostreptida) genera of Southern Africa

by

M. L. Hamer

(Natal Museum, P. Bag 9070, Pietermaritzburg 3200, South Africa; e-mail: mhamer@nmsa.org.za)*

ABSTRACT

Twenty three genera and 228 species of the millipede order Spirostreptida are currently known from Southern Africa. Non-specialists face considerable problems in identifying spirostreptidan millipedes even to generic level. This publication provides an illustrated and annotated key to the genera of the four families of spirostreptidans (Julomorphidae, Spirostreptidae, Harpagophoridae and Odontopygidae) represented in Africa south of the Zambezi and Kunene Rivers. Data on diversity within each genus and its distribution in and outside of Southern Africa are provided, as are references for keys to species where these exist.

INTRODUCTION

Southern Africa has a rich diplopod fauna with approximately 552 species and 71 genera recorded to date (Hamer 1998). The order Spirostreptida is represented by four families, 23 genera and 228 species in Africa south of the Zambezi and Kunene Rivers. The spirostreptidans are probably the most familiar, conspicuous and commonly encountered group of diplopods in the tropics.

Many publications have dealt with the Southern African spirostreptidan fauna or at least covered some species from here, and several publications do include keys to genera (Attems 1928; Kraus 1960; Schubart 1966; Hoffman 1973 1994; Lawrence 1965 1973; Krabbe 1982). Non-diplopod specialists, however, still encounter problems in identifying spirostreptidans even to generic level. There are two main reasons for this: the keys seldom explain the rather complicated terminology used and the keys of Kraus (1960), Schubart (1966), and Krabbe (1982), although in combination cover most of the genera in Southern Africa, are in German and are not in readily accessible publications. The keys of Kraus (1960) and Krabbe (1982) are further complicated by the inclusion of non-Southern African genera. Most of the genera that occur in the subregion are endemic, or nearly so.

Diplopods are important and abundant soil arthropods and are informative in ecological and biodiversity studies. For most researchers, however, identification even to genus either requires the assistance of experts, or a lengthy and frustrating learning period using foreign, fragmented literature, thus severely hampering both

* Current address: School of Botany and Zoology, University of Natal, P. Bag X01, Scottsville 3209, South Africa; e-mail: HamerM@zoology.unp.ac.za
taxonomic and ecological research on millipedes. The aim of this key is, therefore, to allow non-specialists to identify spirostreptidans to genus, to provide references to keys to species for each genus where these are available, and to give some brief information about the geographic distribution and diversity within genera.

It should be noted that this key reflects the current taxonomic state of knowledge. Hoffman (1985) considered the classification of three of the families dealt with here to be in order, but he also suggested that many of the genera within these families require revision. For the present work genera were not revised and there are problems with large genera that require splitting, others that require redefinition, genera that occur in, but have not previously been recorded from the subregion, and quite possibly even genera that have not yet been described.

Six spirostreptidan species were, at some stage, placed ‘temporarily’ or erroneously in genera that certainly do not occur in Southern Africa, and these genera (Spirostreptus Brandt, 1833; Urotropis Silvestri, 1896; Phyllogonostreptus Carl, 1918; Thyropygus Pocock, 1894; Haplothysanus Attems, 1909 and Solenozophyllum Attems, 1914) have been excluded. Two genera (Kartinikus Attems, 1914 and Plagiotaphrus Attems, 1914) are currently known from the type material only. In the case of the latter genus, the one species from Southern Africa is known from a single female, but Plagiotaphrus occurs in Angola so there is a possibility that this is a valid record for the subregion. Of course, much work remains to be done on Southern African spirostreptidans and ideally the current key should be published only after several thorough revisions have been completed – but this would cause a lengthy delay. In addition, it is hoped that the key will act as a catalyst in stimulating future research.

MATERIAL AND METHODS

Nomenclature and classification used follows Hamer (1998), and this work should be referred to for synonyms and references. Existing keys, together with generic

Figs 1–2. Spirostreptidan gonopod terminology used in key; oral view of generalised morphology of gonopods. 1. Spirostreptidae. 2. Odontopygidae. c = telocoxite; f = femoral process; l = lateral lamella of telocoxite; m = median lamella of telocoxite; s = solenomerite with sperm duct; t = telopodite; ta = tarsus.
diagnoses from the literature, were used to compile the key presented here. Diagrams were done using material in the South African and Natal Museums, utilising a Wild M5A stereo microscope and drawing tube. All scale bars for figures represent 0.1 mm unless otherwise stated. For four genera material was not available and illustrations were redrawn from other publications. Terminology used (illustrated in Figs 1 & 2) is from Kraus (1960), Krabbe (1982) and Hoffman (1987 1994).

Figs 3–4. Distal region of legs of male, showing position of pads. 3. Spirobolida. 4. Spirostreptida.

THE SPIROSTREPTIDA OF AFRICA SOUTH OF THE ZAMBEZI AND KUNENE RIVERS

Characteristics of the Spirostreptida

The spirostreptidan order contains worm-like millipedes which have elongate, cylindrical bodies comprising 40–70 body rings. They have a compact group of ocelli arranged in the form of a triangle at the base of the antenna. They can be distinguished externally from the other worm-like order, the Spirobolida, by the absence of a fleshy pad on the last segment of the legs of the male (Fig. 3). Instead, most spirostreptidans possess a similar pad on the fourth and fifth segments of the leg (Fig. 4). In addition, the spirobolids are characterised by a distinct mid-ventral frontal suture on the head, while this is absent in the spirostreptidans. The gonopods of the two orders are also distinct.

Characters used in the key

Females or juveniles currently have little value when identifying millipedes, even to the generic level. The gonopods, found on the seventh body ring of mature males, are modified legs which serve to transfer sperm to the reproductive opening of the female. These gonopods are extremely elaborate and are the most useful character in millipede identification. In the Spirostreptidae, Harpagophoridae and Odontopygidae there are two main parts to each gonopod. These are the telocoxite and telopodite (Figs 1 & 2), and both structures are used extensively in this key. The shape of the telocoxite, however, often varies in shape interspecifically and is thus more useful.
as a specific, rather than a generic character in the spirostreptidans. The form of the telopodite, particularly the number and shape of processes arising from it, is essential for generic identification. In the fourth family, the Julomorphidae, the gonopods are quite different from those of the other families, and comprise an elaborate anterior gonopod, followed by a smaller and much simpler posterior gonopod (Figs 9, 10, 12, 13, 14, 15). The anterior gonopods consist of a telocoxite and telopodite (Figs 10 & 13), both of which are useful in generic and species identifications.

The gonopods are usually withdrawn into the body, but either a pair of dark structures ventrally on the seventh body ring or a distinct gap in this same position indicates that a specimen is a male. In the odontopygids the seventh body ring is often swollen and broader than the others are. The presence of white pads on the ventral surface of legs of males is another way of distinguishing the sexes (see Lawrence 1984).

Gonopods generally need to be dissected out of a specimen for identification purposes. To achieve this, the seventh body ring and the position of the gonopods must be identified. Bending the body backwards in this region, or using a pair of strong forceps inserted between the body rings often separates these and exposes the gonopods. Once they can be clearly seen the gonopods can be removed by carefully cutting through the basal muscle tissue that attaches them to the body. An effort should be made to avoid separating the two gonopods as this usually results in damage to the basal/sternal region which provides useful taxonomic characters. The telopodite should be separated from the telocoxite. Part of the telopodite lies behind the median fold of the telocoxite (Figs 1 & 2). By inserting fine forceps behind the median fold of the telocoxite and grasping the telopodite, the basal region can be located and cut with fine scissors, and the telopodite can then be carefully worked free of the telocoxite. Orientation of the gonopods is an important consideration when using the key and illustrations.
Key to the Spirostreptida of Southern Africa

1. Anal valves each with a small tooth, or preanal ring with a large tooth or spine (Figs 5 & 6) .............................................................. 2
   - Penultimate body ring and anal valves smooth, without teeth or spines (Fig. 7) .... 3

$t = $ telopodite.
2 Each anal valve tipped with a small tooth on the upper surface (Fig. 5); body slender, ratio of body length to body width 14–17: 1 ..........Odontopygidae...18
– Preanal ring with a large spike or tooth (Fig. 6); ratio of body length to body width about 12: 1 .................................................................Harpagophoridae...16

3 Small (generally less than 30 mm long and 3 mm wide); first pair of legs of male much reduced relative to size of second pair of legs (Fig. 8).Julomorphidae....4
– Medium to very large body size, first pair of legs of male not reduced, resembling the remaining legs ..................................................Spirostreptidae....5

Julomorphidae (modified from Schubart 1966)

4 Telocoxite of anterior gonopods with broad, simple or more complex lamella that covers the telopodite when viewed from the front (Figs 9, 10, 11) .........Julomorpha
– Telocoxite of anterior gonopods with median lamella strongly narrowed distally, so that only the basal part of the telopodite is covered (Figs 12, 13) .................Stenjulomorpha

Spirostreptidae (modified from Hoffman 1971; Lawrence 1965 1973)

5 Posterior half of each body ring distinctly wider than anterior half, and most of each body ring broken up by numerous strongly raised, short, longitudinal ridges (Figs 16 & 21) .................................................................6
– Body rings without such patterning ..................................................7

6 Preanal ring dorsally with a distinct granular keel in the middle (Fig. 17); gonopod telopodite with complex inflated area about two-thirds along length (Figs 18, 19, 20); 47–48 body rings ..................................................Calostreptus
– Preanal ring dorsally without a median granular keel (Fig. 22); gonopod telopodite lacking inflated area, more-or-less evenly tapered along length (Figs 23 & 24); 44–54 body rings ..................................................Lophostreptus

7 Animal large to gigantic (length 100–270 mm; width 10–18 mm); seminal duct of gonopod distally with 3 branches, and with each division running out on a separate solenomerite (Fig. 25) .................................................................8
– Animal small to large (length 30–150 mm; width 3–12 mm); seminal duct of gonopod unbranched distally .....................................................10

8 Prebasilar plate of gnathochilarium divided into 3 widely separated sclerites (Fig. 28); lateral edge of telocoxite produced into a prominent digitiform lobe behind point of exit of telopodite (Figs 26 & 27) ............................Triaenostreptus
– Prebasilar plate undivided or with only 2 distinct sclerites; lateral edge of telocoxite not projecting laterally as described above ..........................9

9 Gonopod telopodite with short, tongue-like process (visible from aboral side) in addition to femoral process; median lamella of telocoxite about four-fifths height of lateral lamella (Figs 29 & 30).................................Plagiotaphrus
– Gonopod telopodite only with femoral process and without additional shorter process; median lamella of telocoxite less than three-quarters height of lateral lamella (Figs 31 & 32); femoral process sometimes spinous or tasseled distally (Fig. 33) ...............................Archispirostreptus
Figs 34–37. Characters of *Orthoporoides* sp. 34. Oral view of left telopodite. 35. Aboral view of left telopodite. 36. Oral view of gonopods, left telopodite removed. 37. Detail of left telocoxite of gonopod.

10 Telopodite of gonopods without femoral, or other processes (Figs 34 & 35)........

- Telopodite of gonopods with femoral or other processes ..................................11

11 Gonopod telopodite short and thick, with apex wide and complex (Figs 39 & 40), and not reaching base of telocoxite ..............................................Camaricoproctus

- Gonopod telopodite slender with apex simple and usually tapered, reaching base of telocoxite.................................................................................................12

12 Gonopod telopodite apically deeply forked (Fig. 42); femoral process long and often curved into a complete or almost complete circle (Figs 42 & 43).........

- Doratogonus

- Gonopod telopodite apically not deeply forked; femoral process never curved into a circle..............................................................................................................13

13 Femur of gonopod telopodite with 2 short processes/spines (Figs 46 & 48)......14

- Femur of gonopod telopodite with 1 process/spine (Figs 53 & 54).........................15

14 Femoral, plus one other process present just distal to exit-point of telopodite from telocoxite; femoral lobe present (Figs 46 & 47), median lamella of telocoxite without median projection (Fig. 46)....................Synophryostreptus

- Two short spines about halfway down length of telopodite (Fig. 48); femoral lobe absent, median lamella of telocoxite apically with broad, angular median projection (Fig. 49)..................................................................................Bicoxidens

15 Origin of femoral process distal to exit-point of telopodite from telocoxite; proximal half of telopodite much broader than distal half, with an abrupt change in width between the 2 regions, and with distal region with folded appearance (Figs 52, 53)..................................................................................Brevitibius
Figs 46–47. *Synophryostreptus punctatus* Attens, 1928. 46. Oral view of gonopods. 47. Aboral view of gonopod. *f* = femoral process; *l* = femoral lobe; *m* = median lamella of telocoxite; *p* = second process of telopodite.

Harpagophoridae (Hoffman 1994)

16 Gonopod telopodite with 2 spiniform processes (Figs 57, 65, 68); syncoxosternum of first pair of male legs medially suturate between coxal elements (Fig. 56) ......................................................... Harpagophora

- Gonopod telopodite with 1 spiniform process (Figs 61, 63); syncoxosternum of first male legs without trace of median suture (Figs 59, 62) ................................................................. Zinophora

17 Prefemora of first pair of legs of males of normal size and not in contact medially (Fig. 59). Telopodite of gonopod with a thin, laminate distal process closely associated with other apical elements (Fig. 61); distal ends of telocoxal folds (lamellae) completely lobed and folded against each other (Figs 69, 70, 71, 72) ........................................................................................................ Zinophora

- Prefemora of first legs of males notably reduced in size and broadly in contact medially (Fig. 62). Telopodite of gonopod with slender elongate process located substantially proximal to and widely separated from the other apical elements (Figs 63, 73); distal ends of telocoxal folds (lamellae) simple, without lobes or processes (Figs 73 & 74) ................................................................................ Poratophilus
Odontopygidae (modified from Kraus 1960)

18 Fringes of metazonae composed of broad, almost square plates with rounded corners, and with several small, longitudinal grooves (Fig. 75); gonopod telopodite without femoral spine (Figs 76 & 77)..................................................Patinatius

- Fringes of metazonae with smooth, even margin, or with margin uneven with tooth-like projections with one or several points (Fig. 95), or if broadly rounded plates present, these lacking longitudinal grooves; femoral spine sometimes present on gonopod telopodite ..................................................19

19 Distal part of solenomerite twisted into a tight spiral (Figs 89 & 90); solenomerite with long, slender, basal accessory process (Figs 90 & 91).............. Helicochetus

- Distal part of solenomerite not twisted into a tight spiral; if spiralled only loosely (Fig. 92 & 93), long slender process near base of solenomerite absent.............20

20 Tarsus distally divided into 3 lobes, median one with a large pad of spines or hairs (Fig. 87)..............................................................Chaleponcus

- Distal region of tarsus not with 3 distal lobes ...........................................21

21 Tarsus with a large main lobe and a smaller basal lobe usually with fine spines, although these may be confined to the edge of the lobe (Figs 92 & 93).............. Spinotarsus

- Tarsus of gonopod without a smaller spinous basal lobe ................................22

22 Solenomerite irregularly broadened distally, often with a distal spinous process (Figs 81, 82, 83, 84)..................................................Ctenoiulus

- Solenomerite simple, whip-shaped (Figs 96 & 97)..............................Prionopetalum

Distribution, diversity and references for keys to species

Suborder Cambalidea

Julomorphidae

Julomorpha Porat, 1872

14 species, all Southern Africa (Eastern and Western Cape, Lesotho). Key to species (German) provided by Schubart (1966).

Stenjulomorpha Schubart, 1966

4 species, all South Africa (Eastern Cape). Key to species (German) provided by Schubart (1966).

Suborder Spirostreptidea

Spirostreptidae

Archispirostreptus Silvestri, 1895

14 species, 2 recorded from Southern Africa (Northern Province, Zimbabwe); mainly in East and Central Africa.

Bicoxidens Attems, 1928

5 species, Northern Province, Zimbabwe. Key provided by Schubart (1966) (German).
**Brevitibius** Attems, 1950

1 valid species recorded from northern Namibia and Angola.

**Camaricoproctus** Attems, 1926

8 species, all from South Africa: KwaZulu-Natal, North-West Province, Northern Province, Eastern and Western Cape. (Note: the gonopod telopodite of this genus is very unlike that of the other members of the family. It has been suggested that *Camaricoproctus* might be better placed in the Harpagophoridae).

**Calostreptus** Cook, 1896

3 species, 1 from Mozambique and Zimbabwe, 1 from Tanzania and 1 from Angola.

**Doratogonus** Attems, 1914

About 25 species, at least 20 in Southern Africa, mainly in eastern part of South Africa, with only 1 species known from Namibia. Other species are from subequatorial Africa. Key in two parts (*Alloporus* Porat, 1872 and *Doratogonus*) provided by Schubart (1966) in German.

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**Kartinikus** Attems, 1914
2 species, mainly in East and Central Africa, 1 species recorded once from Namibia.

**Lophostreptus** Cook, 1895
9 species, 2 from Southern Africa (North-West Province, Northern Province and Mpumalanga in South Africa, Zimbabwe, Mozambique), other species from Central and East Africa, also Somalia and Ethiopia (Krabbe 1982).
(Note: some confusion between this genus and *Synophryostreptus*, see below).

**Orthoporoides** Krabbe, 1982
7 species, 6 in South Africa (Western and Eastern Cape, KwaZulu-Natal), 1 supposedly in Lesotho and East Africa (doubtful) and 1 in Central and East Africa. Key to species provided by Schubart (1966) under the genus *Orthoporus* (German).

**Plagiotaphrus** Attems, 1914
3 species, 1 from Zimbabwe, others from Malawi and Angola. Zimbabwean species known only from one female.

**Synophryostreptus** Attems, 1926
3 species, 1 from North-West Province, 1 from Northern and North-West Province and Mpumalanga, and 1 from Mozambique. (Note: The latter two species, *S. carli* (Attems, 1928) and *S. rugosostriatus* (Schubart, 1966), will key out as *Lophostreptus* species. Both were formerly included in that genus but were transferred to *Synophryostreptus* by Krabbe (1982). There is very little difference in the gonopod telopodite of *Synophryostreptus* and *Lophostreptus*; the main difference between the two genera being the shallower, less obvious ridges on the body rings of the type species of *Synophryostreptus*, *S. punctatus* Attems, 1928, and a difference in the apical region of the telocoxites.

**Triaenostreptus** Attems, 1914
8 species, all Southern Africa (KwaZulu-Natal, Eastern, Northern and Western Cape, and Namibia). Key to species provided by Hoffman (1971).

**Harpagophoridae**

**Harpagophoragora** Attems, 1909
8 species, all Southern Africa (KwaZulu-Natal, Eastern, Northern and Western Cape, Namibia).

**Poratophilus** Silvestri, 1897
3 species; 1 known only from types and locality for these unknown, 1 species from Lesotho described from a female and 1 species from Northern Province.

**Zinophora** Chamberlin, 1927
About 16 species (Hoffman 1979/80), 12 in Southern Africa (Free State, Gauteng, KwaZulu-Natal, Mpumalanga, Eastern, Northern and Western Cape, Northern Province, Mozambique, Namibia, Zimbabwe) and others in Angola, Tanzania and Democratic Republic of Congo. Key to species provided by DeMange (1970) in French.
Odontopygidae

*Chaleponcus* Attems, 1914

About 19 species, all in Southern Africa (Gauteng, KwaZulu-Natal, Mpumalanga, Northern Cape, Northern Province, Mozambique, Namibia, Zimbabwe). Key to species provided by Kraus (1966) in German.

*Ctenoiulus* Cook, 1893

6 species, 2 in Southern Africa (Mozambique, Zimbabwe Highlands), others in Angola. Key to species in Kraus (1960) under the genus *Solenozophyllaria* (German).

*Helicochetus* Attems, 1909

13 species, 2 in Southern Africa (Mozambique), others in East and Central Africa. Key to species provided by Kraus (1960) in German.

*Patinatius* Attems, 1928

14 species, all from eastern South Africa (Eastern Cape, KwaZulu-Natal, Mpumalanga, Northern Province). Key provided by Alderweireldt (1998).

*Prionopetalum* Attems, 1909

21 species, 1 in Southern Africa (Mozambique), others in East and Central Africa. Key to species provided by Kraus (1960) in German.

*Spinotarsus* Attems, 1909

About 96 species. Most (89) in South Africa (Eastern and Western Cape, Gauteng, KwaZulu-Natal, Mpumalanga, Northern Province, North-West Province, Botswana, Mozambique, Namibia, Swaziland, Zimbabwe), others in Angola and Congo. Key to species by Kraus (1960 1966) (German).

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