Taxonomic revision and Red List assessment of the 'red millipede' genus *Centrobolus* (Spirobolida: Pachybolidae) of South Africa

by

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PREFACE

The research contained in this dissertation was completed by the candidate while based in the Discipline of School of Life Sciences, of the College of Agriculture, Engineering and Science, University of KwaZulu-Natal, Pietermaritzburg, South Africa. The research was financially supported by the Natural Science Collection Facility (NSCF), which is funded by the Department of Science & Innovation and by a grant through the University of KwaZulu-Natal.

The contents of this work have not been submitted in any form to another university and, except where the work of others is acknowledged in the text, the results reported are due to investigations by the candidate.

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Signed: Supervisor

Date: 25 October 2021

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DECLARATION 1: PLAGIARISM

I, Raesetsa Portia Mailula, declare that:

(i) the research reported in this thesis, except where otherwise indicated or acknowledged, is my original work;

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(iii) this thesis does not contain other persons' data, pictures, graphs or other information, unless specifically acknowledged as being sourced from other persons or researchers; Where other written sources have been quoted, then:

a) their words have been re-written, but the general information attributed to them has been referenced;

b) where their exact words have been used, their writing has been placed inside quotation marks, and referenced;

(v) where I have used material for which publications followed, I have indicated in detail my role in the work;

(vi) this thesis is primarily a collection of material, prepared by myself, published as journal articles or presented as a poster and oral presentations at conferences. In some cases, additional material has been included;

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DECLARATION 2: CONFERENCE PROCEEDING AND DISCLAIMER

Please note that chapter two of this thesis was written as a standalone paper and therefore some repetition was unavoidable.

Mailula R.P., Munyai T.C. & Hamer M. "Taxonomic Revision of 'Red Millipede' genus *Centrobolus* (Spirobolida: Pachybolidae) of South Africa" Biodiversity Information Management Forum (BIMF) and Foundational Biodiversity Information Programme (FBIP) Forum, KwaZulu-Natal, Salt Rock Hotel and Beach Resort, 14-17 August 2017. Oral Presentation.

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ABSTRACT

There are over 500 described species of millipedes in southern Africa, as well as a large number of species that have not been discovered or described. One group of poorly studied millipedes is the genus *Centrobolus*, for which 39 species were previously described. The species in this genus and specimens are difficult to identify based on the existing literature and identification keys. The genus distribution is also not well known, but it is thought that most species have narrow ranges and may be threatened by habitat loss and degradation. This study revises the taxonomy of *Centrobolus*, and provides detailed species descriptions, an identification key and illustrations of the main characters. The distribution of each species is updated. An assessment of the threat status of each species according to the IUCN Red List criteria is also carried out.

The study used specimens deposited in Iziko and KwaZulu-Natal (Pietermaritzburg) Museums as well other material previously collected through field work. A total of 826 specimens were examined representing 28 *Centrobolus* species. Male gonopod structure, distribution of tarsal pads in male legs, colour pattern, female vulva structure and body sculpturing including scobinae were examined and illustrated. Where necessary, specimen localities were georeferenced and maps showing species' distributions were produced. The IUCN Red List categories and criteria were used to assess the threat status of each *Centrobolus* species.

Four possible new species have been identified; three of these are from KwaZulu-Natal, and the fourth is from the Eastern Cape. The two previously described subspecies are considered to be distinct species. The Red List assessment categorised most species as Data Deficient because of the poor knowledge of distribution, or Least Concern because the species are relatively widely distributed, or they are in less accessible and sparsely populated areas. Twelve species are considered threatened and this include nine Vulnerable and three Endangered species. Key areas for future research include additional surveys both to increase knowledge of distribution and habitat preferences, and to provide material for molecular studies.

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INTRODUCTION

1.1 **Rationale for the research**

Millipedes (Diplopoda) were amongst the earliest known terrestrial arthropods and evidence of this is provided by mid-Silurian fossils deposited in the Australian Museum (Garwood and Edgecombe 2011). Millipedes are the third most diverse class of arthropods and important ecologically, yet little is known about their diversity (Pitz and Sierwald 2010). Millipedes as detritivores are involved in nutrient cycling, one of the key processes for soil fertility (Smit and van Aarde 2001).

Apart from their ecological role, millipedes may have more direct importance to humans and other mammals. Huntly et al. (2003) suggested that millipedes could be included in ecotourism activities, and interesting facts about the use in traditional medicine could be presented to tourists. For example, the Bhotiya people use dried millipede smoke to treat piles (Negi and Palyal 2007), in South Africa millipedes are also used in traditional medicine (Herbert et al. 2003) and the Bobo tribe living in Burkina Faso consume millipedes as food. Primates such as monkeys and lemurs rub their fur with the toxin found in certain millipedes' secretions as an insect or parasite repellent (Enghoff et al. 2014).

Although this taxon plays a critical role in ecosystem processes (Vohland and Hamer 2013), it is understudied and it's taxonomy is inconsistent and there are geographic biases (Brewer et al. 2012). The Convention on Biological Diversity (CBD) is an international agreement that governs biological diversity protection and sustainable use (Solomon and Grange 2006). South Africa is a signatory to the Convention. The CBD has launched a Global Taxonomy Initiative (GTI) to address the taxonomic impediment. The Diplopoda are a group with many challenges related to nomenclature, taxonomy and knowledge of geographic distribution (Brewer et al. 2012).

The International Union for Conservation of Nature (IUCN) Red List is an inventory of species threatened with extinction, which indicates the status of biodiversity (SANBI 2010). Globally very few millipedes have been assessed using the Red List criteria (Karam-Gemael et al. 2020). In South Africa the only millipede genus that has been assessed is *Doratogonus* Attems, 1914 (Hamer 2000). Red List assessment is an accepted measure of prioritisation for conservation,

but it requires a sound knowledge of the taxonomy of the group as well as the distribution of species.

Millipede have a strong tendency to speciate and many species are confined to relatively small areas (Hopkin and Read 1992; Redman and Hamer 2003). These narrow distributions make many millipede species vulnerable to extinction and thus in need of prioritising for conservation (Mwabvu et al. 2013). In addition, an understanding of taxon distribution and factors that influence or contribute to diversity is becoming increasingly important in terms of the biodiversity crisis and conservation planning (Hamer and Slotow 2000; Govender 2007).

The distribution of millipedes is influenced by vegetation and climate and they are moisture dependent (Sridhar 2015). Millipedes are generally saprophagous and their distribution and abundance is also often related to the quality and quantity of decaying plant materials. The typical and most suitable habitats for millipedes are deciduous temperate, subtropical and tropical forests where the population density of these animals can reach 1000 individuals per square metre (Golovatch and Kime 2009; Bogyo et al. 2015). The actual geographical distribution of many millipede species is unknown because identification is difficult and distribution data are incomplete (Mwabvu et al. 2009). New distribution records could be revealed in unprocessed museum material or from unsurveyed localities. To understand the distribution patterns and factors, taxonomic reviews of millipede taxa need to be undertaken (Mwabvu et al. 2009).

Globally over 12 000 millipede species have been described in 16 orders (Brewer et al. 2012; Hamer 2013; Jorgensen 2013), with 7 753 valid species (Shear 2011). The estimation of actual millipede diversity has been scaled to a more moderate range of 15 000 to 20 000 (Brewer et al. 2012) as opposed to the 80 000 proposed by Hoffman (1980). Millipede taxonomic output has varied considerably throughout history but the current trend shows a decrease species being described each year (Brewer et al. 2012).

The millipede fauna of South Africa is relatively well known (Hoffman 1985; Redman and Hamer 2003) and it comprises 462 species in seven orders (Hamer 2013) with a very high level of endemism (Hamer and Slotow 2009). One diverse genus that has been identified as needing revision is *Centrobolus* Cook, 1897, an endemic southern African genus known to comprise 39 species (Hoffman 1971). The distribution range of this genus is from Mozambique to Cape Town, mostly along the eastern coastal belt. *Centrobolus* is mostly a coastal forest genus but some species are confined to Afrotemperate habitat.

1.2 **Justification**

There are about 462 millipede species described from South Africa, but there are many more undescribed species (Hamer et al. 2006). There are taxonomic problems for many groups and the distribution of most species is not well known (Hamer et al. 2006). A revision of the genus *Centrobolus* is required. This is an endemic southern African millipede belonging to order Spirobolida; family Pachybolidae with 39 known species. Previous studies (Attems 1928; Jeekel 1956; Lawrence 1967; and Hoffman 1971) have dealt with the systematics of this genus providing baseline knowledge about the genus and species. Despite this, there are still gaps in the information because some descriptions are incomplete and detailed illustrations are lacking. Distribution data are poor for many species (Lawrence 1967), and more recently collected material has not been included in distribution analyses. The last taxonomic treatment of *Centrobolus* was Hoffman's (1971) paper, which did not fully cover all species, and he recommended the inclusion of a modern systematics approach. Without accurate species descriptions and improved understanding of distribution, it is impossible to assess the threat status of species and adequately protect them.

1.3 **Taxonomic characters**

The main characters used in *Centrobolus* taxonomy are colour patterns, number of body segments, body sculpturing, number of legs with tarsal pads in the male, the shape of gonopods and the scobinae. The scobinae are present in most species and vary amongst species in size and shape. They have not been studied using Scanning Electron Microscopy (SEM) for the genus before. Colour combinations of body segments, head, legs, antennae and anal valves are useful for distinguishing species (Lawrence 1967), but there seems to be variation in some species. The significance of this need to be assessed by checking all other characters, and possibly also using molecular approaches.

The most important structure for identification of most millipedes, including the spirobolids, is the gonopod (Armstrong and Hamer 2015). This morphological structure is a genital apparatus of the male that is perceived as a lock and key mechanism for transferring sperm to the female genital opening (Cooper 1998). The gonopods are modified legs found between the seventh and eighth pair of legs. These structures have several diagnostic characters in millipedes. The gonopods of *Centrobolus* species have not been studied for all species using SEM, and this method has proved useful for showing details of important structures on both anterior and posterior gonopods (Wesener and Enghoff 2009; Likhitrakarn et al. 2010; Enghoff 2011; Marek et al. 2012; Likhitrakarn et al. 2015).

In addition to incomplete descriptions and illustrations, the angle at which the gonopods are placed when illustrated affects the appearance of the gonopods in the literature, which means that it can be difficult to match material to illustrations in descriptions. Colour pattern has also caused confusion because some species have similar colouration but different gonopods, while others have similar gonopods but different colouration (Hoffman 1971).

1.4 Purpose of the study

1.4.1 **Aims**

The main aim of the research is to improve our understanding of the taxonomy, distribution and threat status of species in the genus *Centrobolus* in southern Africa.

1.4.2 **Objectives**

The main objectives of the research are to:

- Redescribe/describe the main characters of all *Centrobolus* species and review their taxonomic status,
- Review the distribution of *Centrobolus* species, including previously unidentified or undocumented material,
- Assess the threat status of *Centrobolus* species using Red Listing criteria in Southern Africa.

1.5 **Outline of dissertation structure**

To achieve the aim and objectives of the current study, the dissertation is structured as follows:
Chapter 1 includes the background and motivation for the study,
Chapter 2 provides a review of the existing knowledge of the genus, revision of known species and description of new species, description of the distribution of each species as well as an identification key to the *Centrobolus* species and an assessment of the threat status of species according to the IUCN Red List criteria and categories and lastly is an overall discussion and conclusions.
The Reference List is included at the end of the dissertation and includes all references used in chapters.

CHAPTER 2
TAXONOMIC REVISION OF THE SOUTHERN AFRICAN GENUS *CENTROBOLUS*

2.1 Introduction

The order Spirobolida was first proposed by Cook (1895) and is a species-rich order (Hoffman 1988), with 12 families (Wesener et al. 2009). One of these families is Pachybolidae, with 48 genera, which occur throughout the tropics but mostly in the Southern Hemisphere (Wesener et al. 2009).

Members of the Pachybolidae usually have complex posterior gonopods connected by a sclerotized sternite, anterior gonopods without an apodeme, or a small apodeme and tracheal apodemes of the posterior gonopods large, sometimes as large as the gonopods (Wesener et al. 2009). The coxa and telopodite of the posterior gonopods are fused into a singlestructure (Hoffman 1971). The apical part of the first basal joint of the mandible is visible (Wesener et al. 2009).

Four genera of Pachybolidae have been recorded from Southern Africa, namely *Microbolus* Lawrence, 1967, *Epibolus* Cook, 1897*, Hadrobolus* Cook, 1897 and *Centrobolus* Cook, 1897. The first three of these occur in East Africa, including Mozambique and are included in the tribe Pachybolini by Enghoff (2011). The fourth genus is *Centrobolus*, which is the focus of this study. This genus is known to include 39 species distributed in the southern African sub-region (Lawrence 1967), and has been placed in its own subfamily, Centrobolinae Hoffman, 1980 according to the Millibase checklist (www.millibase.org).

Centrobolus was initially described by Cook (1897) to accommodate a single species, *Spirobolus luctuosus* Peters, 1855 from Inhambane in Mozambique (Hoffman 1971). Species in the genus have been referred to as *Spirobolus* Brandt, 1841 and as *Chersastus* Attems, 1926. The type species of the latter genus was first described in the genus *Trigoniulus* Pocock, 1894 (*Trigoniulus braueri*) by Attems (1900). Later Hoffman (1971) revived the generic name *Centrobolus* for the southern African species assigned to *Chersastus* by Attems (1928; 1934), Jeekel (1956), Schubart (1966) and Lawrence (1967) based on the type species of *Chersastus*, *C. braueri* Attems (1900) from Seychelles which lacks ventral tarsal pads in the male that are present in *Centrobolus* and the number of body segments which is much higher in *Chersastus* (54 as opposed to 38-46). Furthermore, Cook's (1897) description of the telopodite of the

anterior gonopods of *S. luctuosus* differs from that of *C. braueri* (Hoffman 2001). Hoffman (1971) believed that the *Centrobolus* species from Mozambique is congeneric with the South African species based on geography, but he could not confirm this because the gonopods of the *C. luctuosus* type specimen were missing. Species in the genus *Chersastus* were assigned to *Centrobolus* in the checklist of southern African millipedes (Hamer 1998) based on Hoffman's (1971) assessment.

Hoffman (2001) confirmed his 1971 assumption after discovering drawings of the male genitalia of *S. luctuosus* produced by Cook during the 1890s at the United State National Museum (USNM). According to Hoffman (2001), although the gonopods of *S. luctuosus* are missing, the illustration gave an idea of the main attributes of this species that support its placement in a genus with the other species from South Africa. Despite this, the taxonomic status of the genus is still uncertain (Hoffman 1971), and the genus has not been revised, with the most complete work to date that of Lawrence (1967), which lacks detailed descriptions and illustrations for many species. In this chapter a taxonomic revision of *Centrobolus* is presented to address gaps in the existing descriptions and distribution data, and to describe four species thought to be new. An identification key based on morphological characters is also provided.

2.2 Red List assessment

Many millipede species have a narrow distribution range (Hamer and Slotow 2001) and they require conservation actions to ensure their survival as threats such as land transformation are increasing (McGeoch et al. 2011).

Habitat loss and destruction are the main causes of species extinction (IUCN 2019). The conservation status of most millipede taxa is poorly known and in South Africa only species in the genus *Doratogonus* Attems, 1914 have been assessed according to the IUCN Red List criteria. *Centrobolus* was one of three millipede taxa that was listed as being of conservation concern (McGeoch et al. 2011), but before an assessment can be carried out the taxonomy must be relatively well known and there must be sufficient distribution data. A first attempt at Red List assessment is provided here for each of the *Centrobolus* species revised or described.

There is very little accurate data on population size for millipedes. It is difficult to determine population and changes in abundance because most millipedes are active on the surface only seasonally. The Red List criteria that are useful are for the geographic range (criteria B and D),

specifically the Area of Occupancy or AOO and the Extent of Occurrence or EOO, and the number of locations and how fragmented the distribution is.

The EOO is defined by the IUCN (2001) as "the area contained within the shortest continuous imaginary boundary that can be drawn to encompass all the known, inferred or projected sites of present occurrence of a taxon". The AOO is defined as the area within the EOO that is actually occupied by the species, and this measurement recognises that a species will usually be confined to a specific habitat and will not occur throughout the area where it is distributed. A location is defined as a "geographically or ecologically distinct area in which a single threatening event can rapidly affect all individuals of the taxon present. The size of the location depends on the area covered by the threatening event". A location is therefore different to a locality, which is usually a collection point, and a location can include several localities if these are relatively close together.

Table 1. Summary of the two criteria (B and D) used to evaluate *Centrobolus* species in an IUCN Red List threatened category. Reproduced from the IUCN Red List Criteria Summary Sheet (https://www.iucnredlist.org/resources/summary-sheet).

B. Geographic range in the form of either B1(Extent of Occurrence) AND / OR B2 (Area of Occupancy)			
	Critically Endangered	**Endangered**	**Vulnerable**
B1. Extent of occurrence (EOO)	<100km^2	<5000km^2	<20 000km^2
B2. Area of occupancy (AOO)	<10km^2	<500km^2	<2 000km^2
AND at least 2 of the following 3 conditions:			
a) Severely fragmented OR Number of locations	=1	≤5	≤10
(b) Continuing decline observed, estimated, inferred or projected in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent and/or quality of habitat; (iv) number of locations or subpopulations; (v) number of mature individuals			
(c) Extreme fluctuations in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) number of locations or subpopulations; (iv) number of mature individuals			
D. Very restricted population			
D2. Only applies to the VU category Restricted area of occupancy or number of locations with a plausible future threat that could drive the taxon to CR or EX in a very short time.	---	---	D2. typically: AOO < 20 km² or number of locations ≤ 5

2.3 Materials and methods

The study used specimens deposited in South African museums (KwaZulu-Natal Museum and Iziko South African Museum) and those collected over the last 25 years through field work that are yet to be deposited in a museum. In total 826 specimens were examined in this study.

All studied specimens were stored in 70% ethanol. Counts of body segments and number of legs with tarsal pads, and measurement of body diameter were made on entire or reconstructable specimens. The length and width of the body were measured with Vernier callipers. The total length was measured from the front of the head to the posterior margin of the anal valves. The number of body rings is presented as the number of rings including the collum + 0 (no apodous terminal segments in adult Spirobolida) + T (telson comprising preanal ring, anal valves and subanal scale). All measurements are given in millimetres. Descriptions of colour were based on preserved specimens with those that had lost least colour being used for this purpose.

Gonopods, vulva, gnathochilarium, mandible and scobinae were examined with a Nikon SM800 stereo microscope and photographed using an Olympus DSX110 microscope and camera attachement and a Phenom Pro scanning electron microscope (SEM). For study with SEM, the structures were air dried for 3-5 minutes and mounted on a stub. After viewing and imaging were complete, the gonopods, vulva, body ring, gnathochilarium and mandible were returned to ethanol with the original specimen.

The original descriptions and illustrations were used to identify or confirm the identification of specimens (Attems 1928; Jeekel 1956; Schubart 1966, Lawrence 1967; Hoffman 1970; 2001). The species descriptions or re-descriptions are based on all available specimens of the species and not exclusively on the holotype, especially in cases where type material was not available.

Terminology used follows Jeekel (1956), Attems (1928), Wesener et. al. (2009), and Enghoff (2011) and the format for taxonomic descriptions follows that of the journal African Invertebrates. The data for specimens are arranged in alphabetical order of country, followed by province and then by date of collection, and are presented as stated on the labels. Specimens that were without catalogue numbers have been referred to by the collector's name with designated number. All unaccessioned specimens will be deposited in KwaZulu-Natal Museum at the end of this study. The data for each specimen lot was captured into an Excel spreadsheet.

The following selected characters were used for distinguishing species and for species descriptions:

Colour: the arrangement of colour pattern, especially the head, collum, body rings, anal valves, antennae and legs, and the presence of spots and bands on the body rings.

Scobinae: these are a pair of small depressions on the front margin of the prozonites (Fig. 10C). They are present in most species and vary amongst species in size and shape.

Gonopods: these are modified legs on the seventh segment of the male and are used for transferring sperm during mating. The two pairs of legs on segment seven form the anterior and posterior gonopods, with the posterior gonopods being the sperm transferring structures. The diagnostic features of the posterior gonopods include the general shape, the efferent groove efferent groovewhich is a groove extending from the base of the telopodite to a point near its tip (Enghoff 2011) and the tibial process (Attems 1928; Jeekel 1956), the finger-like structure on the median margin of the telopodite (Fig. 6). The diagnostic features for the anterior gonopods include the shape and height of the sternum; the shape of the coxae and the number of parts and shape of the distal process of the telopodite (Fig. 5).

Tarsal pads: adhesive structures in male *Centrobolus* that aid with adhering to the female during mating (Cooper 1998). These may be prominent, inconspicuous or indistinct and they occur from the third pair of legs onwards (Fig. 96D). The number of posterior legs lacking tarsal pads may be a useful character in distinguishing species (Lawrence 1967).

Female second leg pair: the coxosternum has strong lateral extensions with angled or smooth margins (Enghoff 2011) (Fig. 11A).

Vulvae: these are placed in pouches behind the second pair of legs of the female, and consist of two valves and a basal small, oval operculum which is usually poorly sclerotized (Enghoff 2011). The two valves usually overlap and are diverse in shape and size (Figs 11B-D).

Specimen data for the description of the species' distribution were obtained from various sources including the literature (summarised in Hamer 1998), iNaturalist, and Iziko and KwaZulu-Natal Museums. Records for which the material was not examined and the localities appear to fall outside the range of the species are flagged as being unconfirmed.

Tools such as ArcMap, Google Earth and Google Maps were used to georeference the localities where necessary. Distribution maps were created using ArcMap and Google Earth.

In order to assess the extinction risk facing each *Centrobolus* species, the IUCN Red List categories and criteria were used. The main focus was on the geographic range. Data from

several museums (see the abbreviations below) and published records were used to determine the distribution of each species, and from this the number of locations from which a species has been recorded was counted, and the Extent of Occurrence (EOO) and the Area of Occupancy (AOO) were calculated using the Geocat tool (http://geocat.kew.org/). All the coordinates of the localities for each species were also plotted in Google Earth and this allowed confirmation of the EOO and the AOO using the polygon measurement tool and allowed an estimation of the extent to which the habitat where the species has been recorded had been developed or transformed. The extent of monoculture agriculture, industrial or housing developments or the density of rural developments relative to the area where the species had been recorded was estimated.

ABBREVIATIONS USED:

BMNH: The Natural History Museum, London, UK

MZLU: Lund Universites Zoologiska Museum, Sweden

NHMW: Naturhistorischen Museum, Wien, Austria

NHRS: Naturhistoriska Riksmuseet, Stockholm, Sweden

NMSA: KwaZulu-Natal Museum, Pietermaritzburg, South Africa

SAMC: Iziko South African Museums, Cape Town, South Africa

UKZN: University of KwaZulu-Natal, South Africa

ZMAN: Instituut voor Taxonomische Zoologie, Zoologisch Museum, Universiteit van Amsterdam, Netherlands

ZMHB: Museum für Naturkunde der Humboldt Universität, Berlin, Germany

ZML: Biological Museum, Lundt University, Sweden

ZMUH: Zoologische Institut und Zoologisches Museum, Univertät von Hamburg, Germany

Preanal ringPreanal ring**2.4. The genus *Centrobolus***

Taxonomy (from Millibase (www.milibase.org)

Class:	Diplopoda de Blainville in Gervais, 1844
Subclass:	Chilognatha Latreille, 1802/1803
Superorder:	Juliformia Attems, 1926
Order:	Spirobolida Bollman, 1893
Suborder:	Trigoniulidea Brölemann, 1913
Family:	Pachybolidae Cook, 1897
Subfamily:	Centrobolinae Hoffman, 1980

***Centrobolus* Cook, 1897**

Centrobolus Cook, 1897: 74; Schubart 1966: 72-73; Lawrence 1967: 645; Hoffman 1971: 142-162; Hamer 1998: 39-43; Hoffman 2001: 49-51.

Chersastus Attems, 1926; Attems 1928: 300-308; Attems 1934: 474-480; Jeekel 1956: 85-99; Schubart 1966:34-74; Lawrence 1967: 607-642.

Type species: *Spirobolus luctuosus* Peters, 1855:80-81, by original designation.

Generic description. This is a modified description based on Attems (1928), Lawrence (1967) and Hoffman (1971). *Dimensions:* Moderate in size, with length of about 40mm to 60 mm; 38-46 body segments. *Colour*: Mostly red in colour with black/red/yellow spots or bands, some are mostly brown or blackish with red or orange markings. *Head and body*: Ozopores starting on segment six and located on mesozona (Fig. 2); antennae long, reaching up to second segment; relative length of antennomeres: 1 > 2 > 3 = 4 < 5 > 6 with cylindrical joints, apical disc bearing four large sensory cones, fifth antennomere latero-apically with a field of more than 20 rows of *sensilla basiconica* (Fig. 3); eyes with 30-50 ommatidia; clypeus with setae along the margin (Fig. 9D). *Gnathochilarium*: Terminology after Wesener et al. (2009): *Lamella lingualis* each with two setae (Figs 7A, B); stipites laterally slightly excavated, with three apical setae each (Figs 7A, B); mentum and stipites with several transverse ridges in basal half (Figs 7A, B); palpi of gnathochilarium with numerous sensilla; hypopharyngeal crest with a field of spine-like structures; central pads of endochilarium divided by a groove and a ridge into two separated distinct regions; a group of 7-10 sensilla in a circular arrangement located in the region close to endochilarium; medial palps with a large group of sensilla each, located towards the hypopharyngeal crest (Fig. 7D). *Mandible*: External tooth simple, rounded (Fig. 9); internal tooth with four cusps, laterally an additional, isolated, simple tooth (Fig. 9); number of pectinate lamellae 4-5; mesal margin of pectinate area with around three irregular rows of small, slender spines, spine-row continued along mesal margin of otherwise smooth intermediate area; molar plate with eight transverse furrows (Fig. 9). *Legs*: Vary in length, some with short legs (not reaching lateral margins of body rings when extended) and others with long legs (reaching or exceeding the lateral margin of body rings when extended); prominent tarsal pads in male; anterior coxae of males without distinct lobes; tibia of legs with one or two apical bristles. *Scobinae*: Usually present but may be very small or absent. *Anterior gonopods*: Sternum generally more or less triangular, but apical region of median extension variously shaped (Fig. 4); coxal endite lobe prominent, usually as long as the telopodite (Fig. 5); telopodite process (= distal process) on posterior surface relatively small, partly concealed

behind coxal endite lobes in anterior view; either sub-globose and thickened or flattened and angular; a basal acute or blunt triangular or finger or lappet-shaped, laterally directed process may be present; parts of distal process usually covered with widely spaced, minute spines (Figs 30C, 68C, 19C); coxa abruptly cut off on the posterior side (Fig. 5). *Posterior gonopods*: (Fig. 6) Completely concealed inside the anterior gonopods, large and robust; the coxa fused to the telopodite basally; coxa elongate, nearly equal length or shorter than the telopodite; tibial process located halfway along median margin, efferent grooveefferent groove runs lengthways, curves around to the medial side and terminates almost at the end of the telopodite; inflated basal lobe may be present.

Generic diagnosis. *Centrobolus* differs from other genera of Pachybolidae by the following combination of taxonomic characters reduced number of body rings, numbering less than 45 (excluding the telson); male legs six and seven without coxal lobes; tibia of the male leg with one or two apical bristle(s); posterior gonopod telopodite fused with coxa; space at the distal end and tibial process of posterior gonopod filled with membranous lamellae; efferent grooveefferent groove of posterior gonopod well developed; tibial process of posterior gonopod usually short and broad in most species; coxa of anterior gonopod elongated; telopodite of anterior gonopod with distal process composed of one or two parts, the proximal part, when present, smaller than distal part..

Generic distribution. The distribution of *Centrobolus* is illustrated in Figure 1. *Centrobolus* is widely distributed along the eastern part of South Africa, including the provinces of KwaZulu-Natal, Eastern Cape, Western Cape, Limpopo and Mpumalanga and has also been recorded from Swaziland, and northwards into Zimbabwe and Mozambique. The genus appears to be mostly associated with forest including Afrotemperate, Mistbelt, Scarp and Coastal Forest, and generally follows the distribution of this biome along the coast and inland to the mountain chain forming the escarpment. *Centrobolus* is most diverse in KwaZulu-Natal (Fig. 1), although this might reflect the level of sampling rather than a real pattern because the Eastern Cape and Western Cape forests have not been well surveyed.

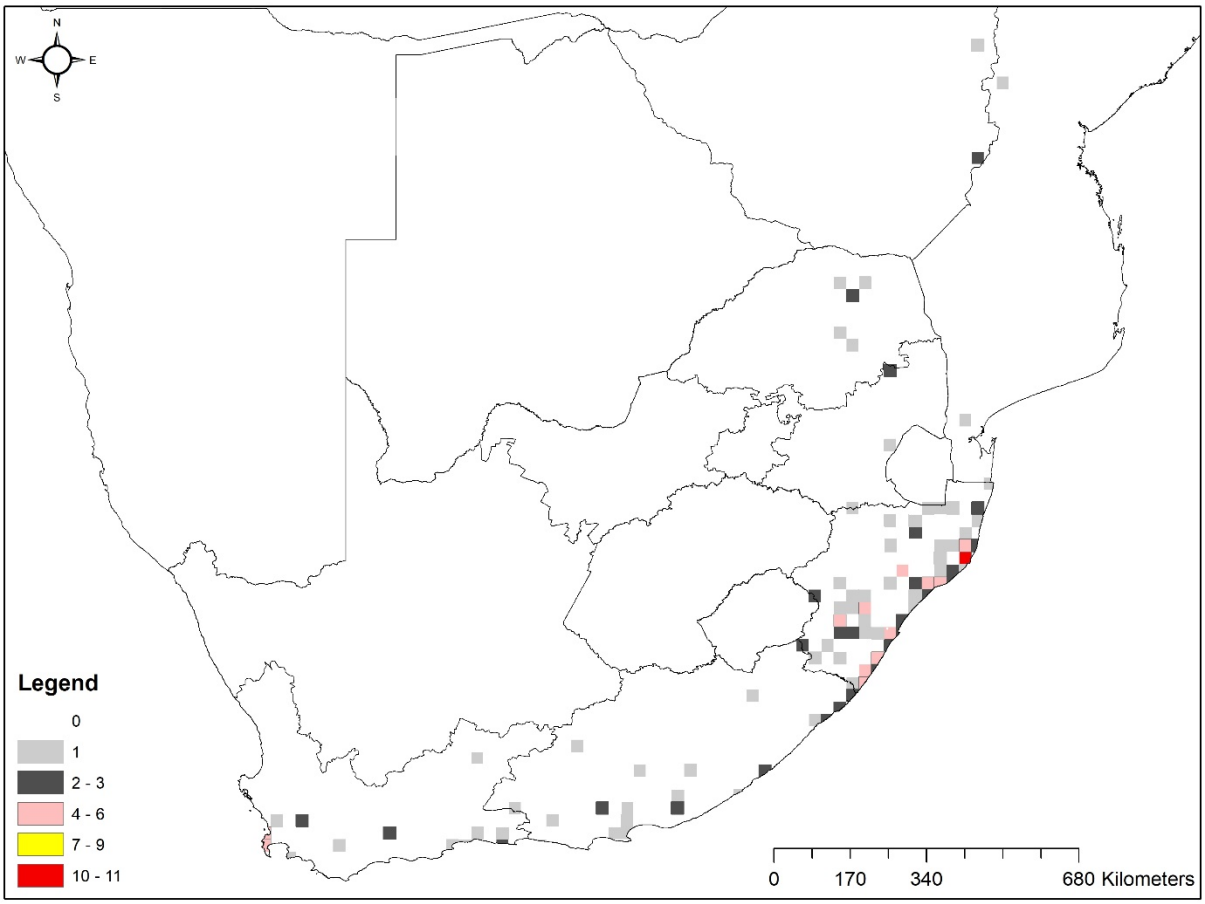
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Figure 2. Lateral side of the anterior body of *Centrobolus digrammus*. Abbreviations: oz – ozopore. Scalebar: 1.0 mm.

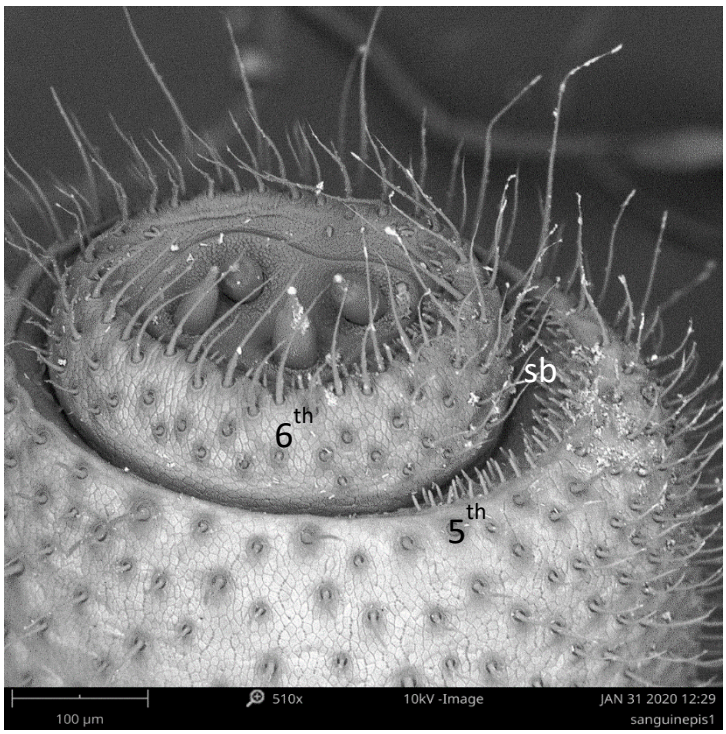

Figure 3. Antenna of *Centrobolus sanguinipes* (Oribi Gorge Nature Reserve, KwaZulu-Natal). 5th antennomere with *sensilla basiconica* (sb), 6th antennomere with four sensory cones apically.

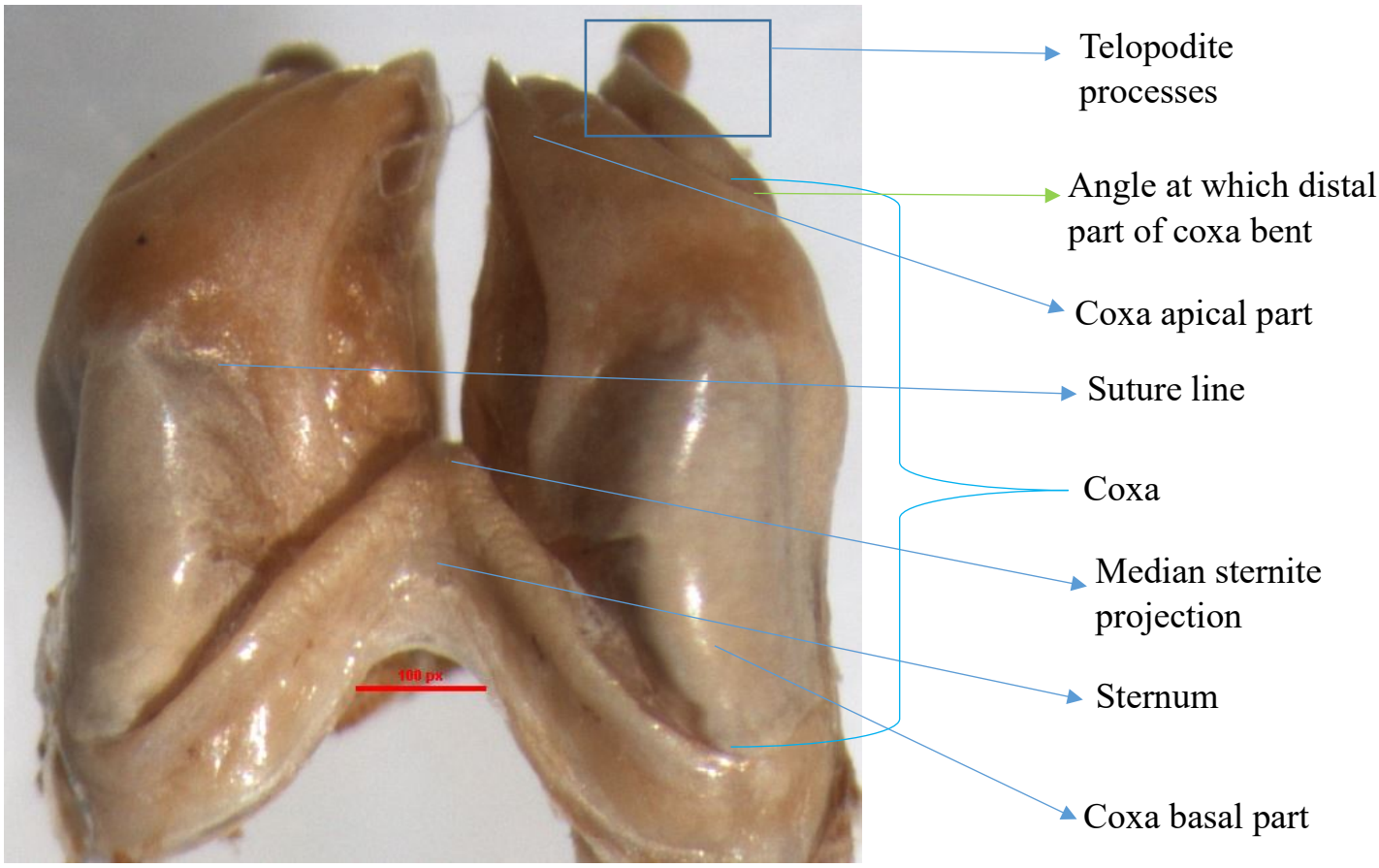

Figure 4. Anterior gonopods (anterior view) of *Centrobolus rugulosus* (Hluhluwe Game Reserve, KwaZulu-Natal). Scalebar: 1.0 mm.

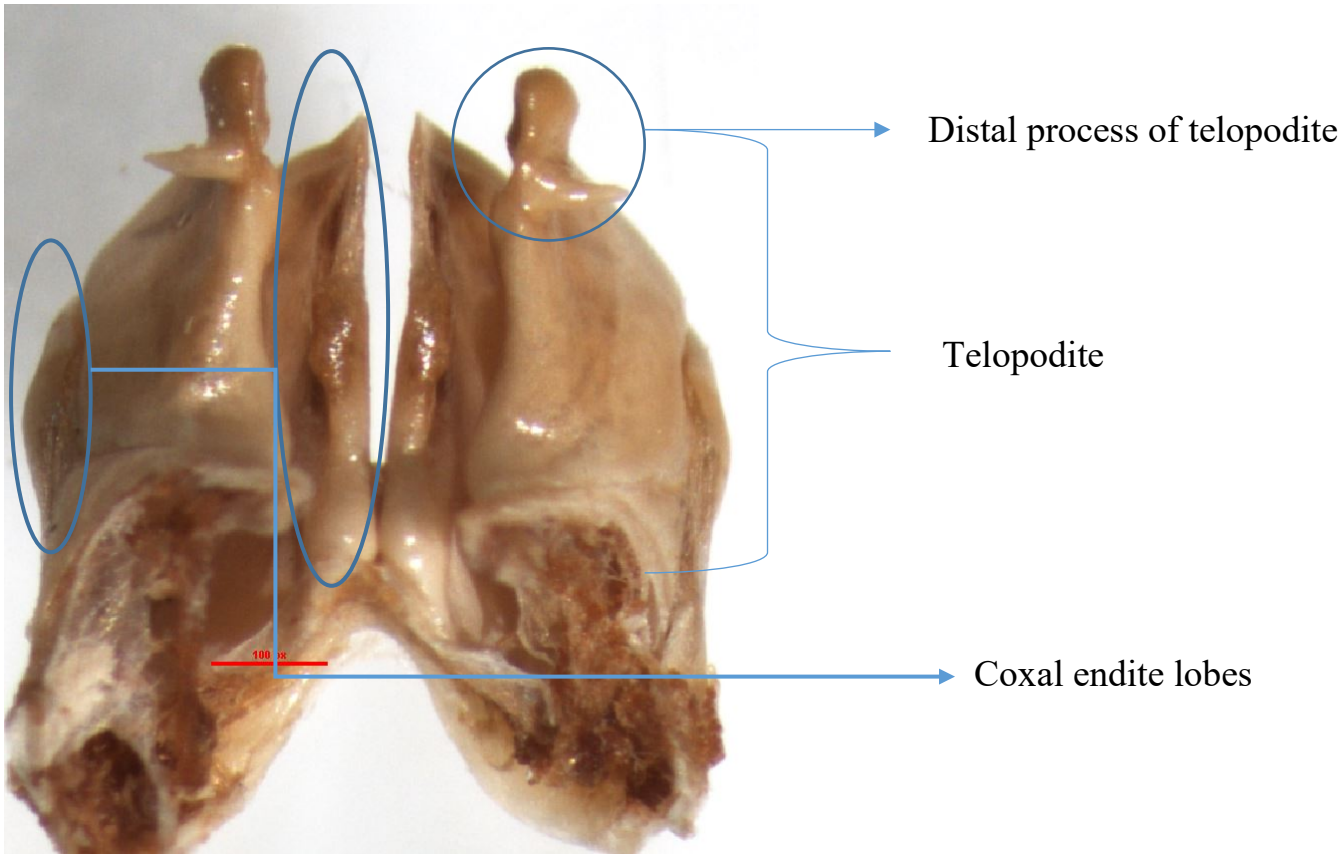

Figure 5. Anterior gonopods (posterior view) of *Centrobolus rugulosus* (Hluhluwe Game Reserve, KwaZulu-Natal). Scale bar: 1.0 mm.

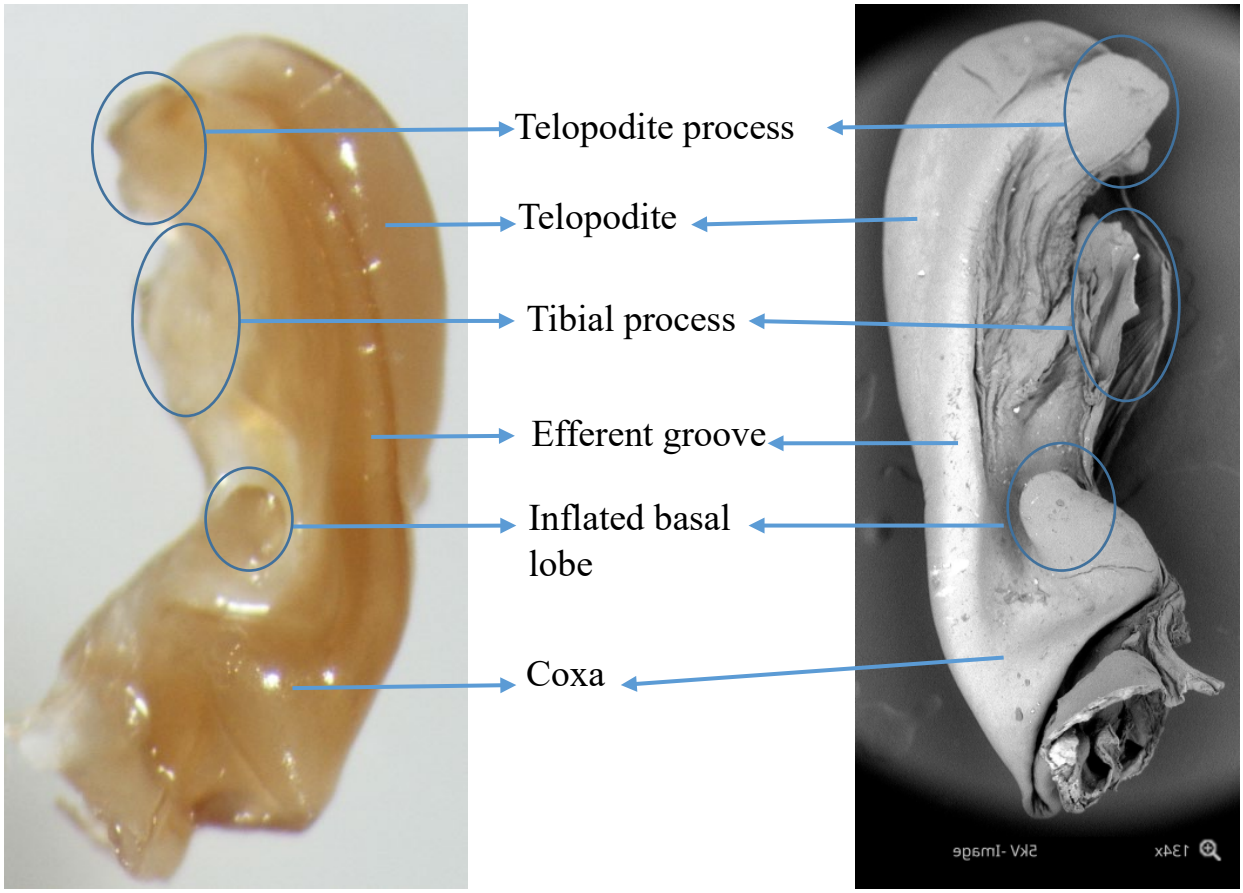

Figure 6. Posterior gonopod of *Centrobolus rugulosus* (Hluhluwe Game Reserve, KwaZulu-Natal). Scale bars: 0.5 mm.

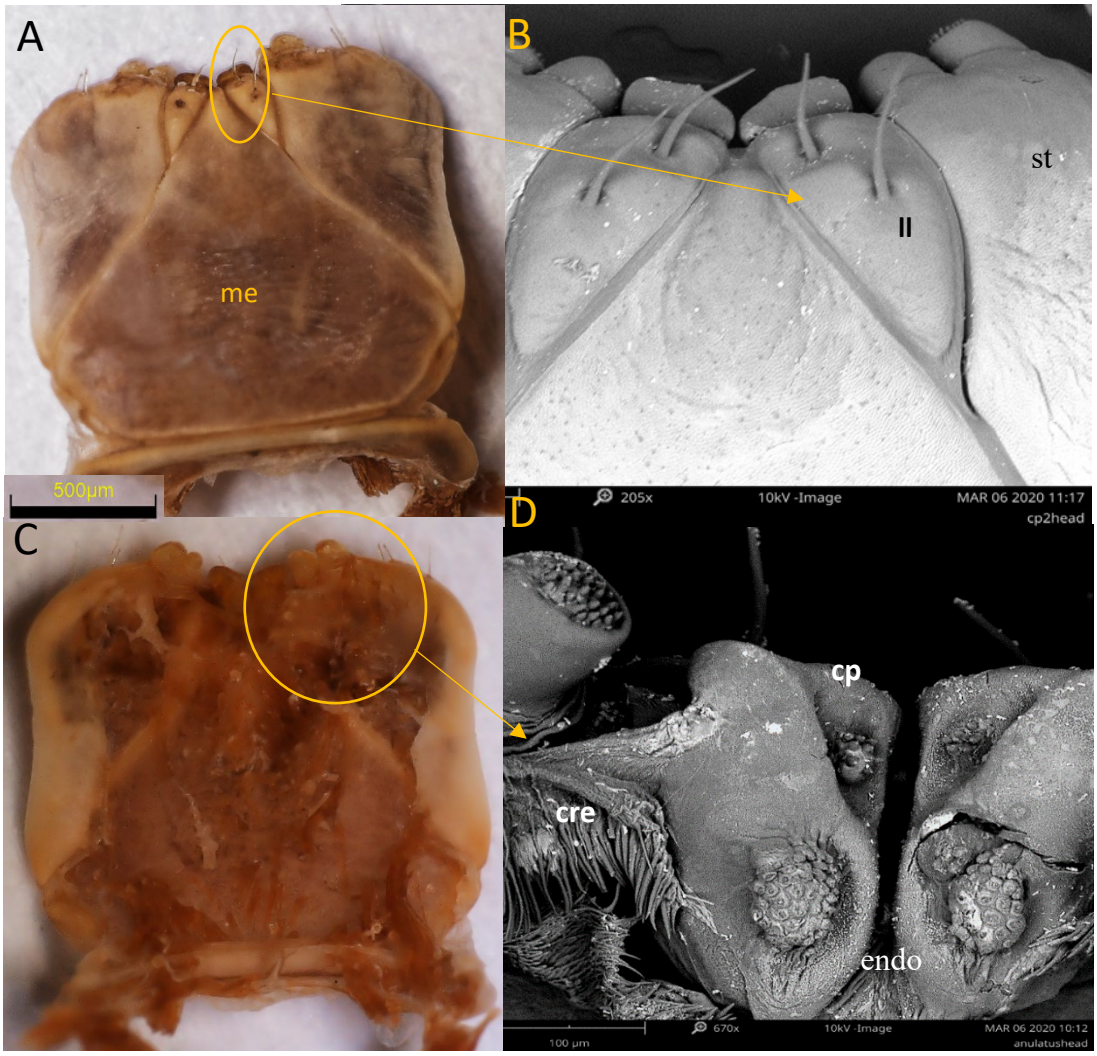

Figure 7. *Centrobolus fulgidus* gnathochilarium **A-B** ventral side, **C** dorsal (inner) side. Abbreviations: cp – central pads; cre – hypopharyngeal crest; endo – endochilarium; ll – lamellae lingualis; me – mentum; st – stipes. **A** & **C** Scale bar: 1.0 mm. **B** Scale bar: 0.3 mm.

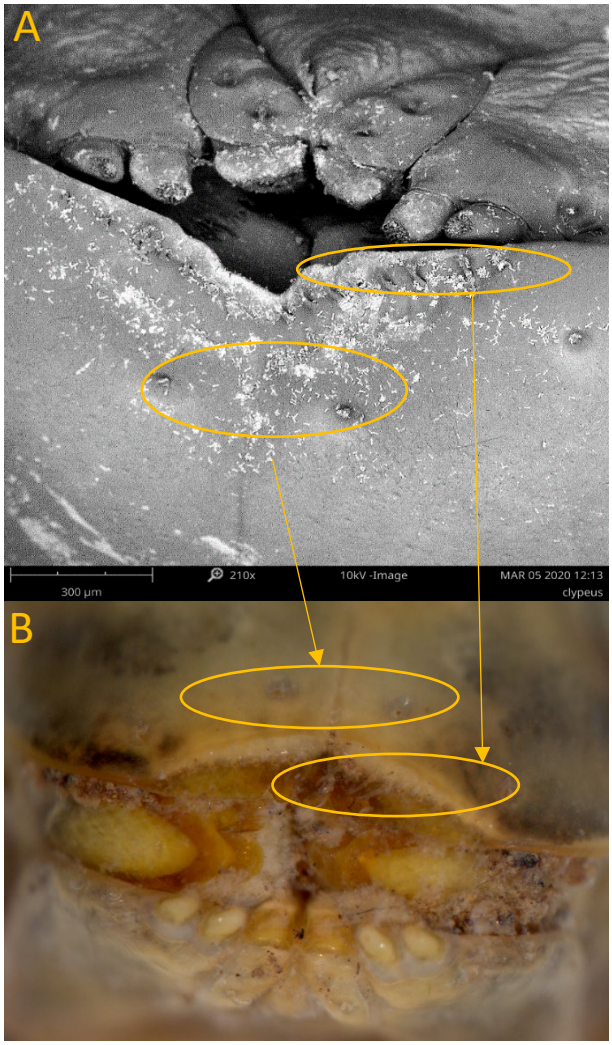

Figure 8. *Centrobolus fulgidus* gnathochilarium **A-B** anterior view.. A-SEM photograph; B-stereo microscope photograph.

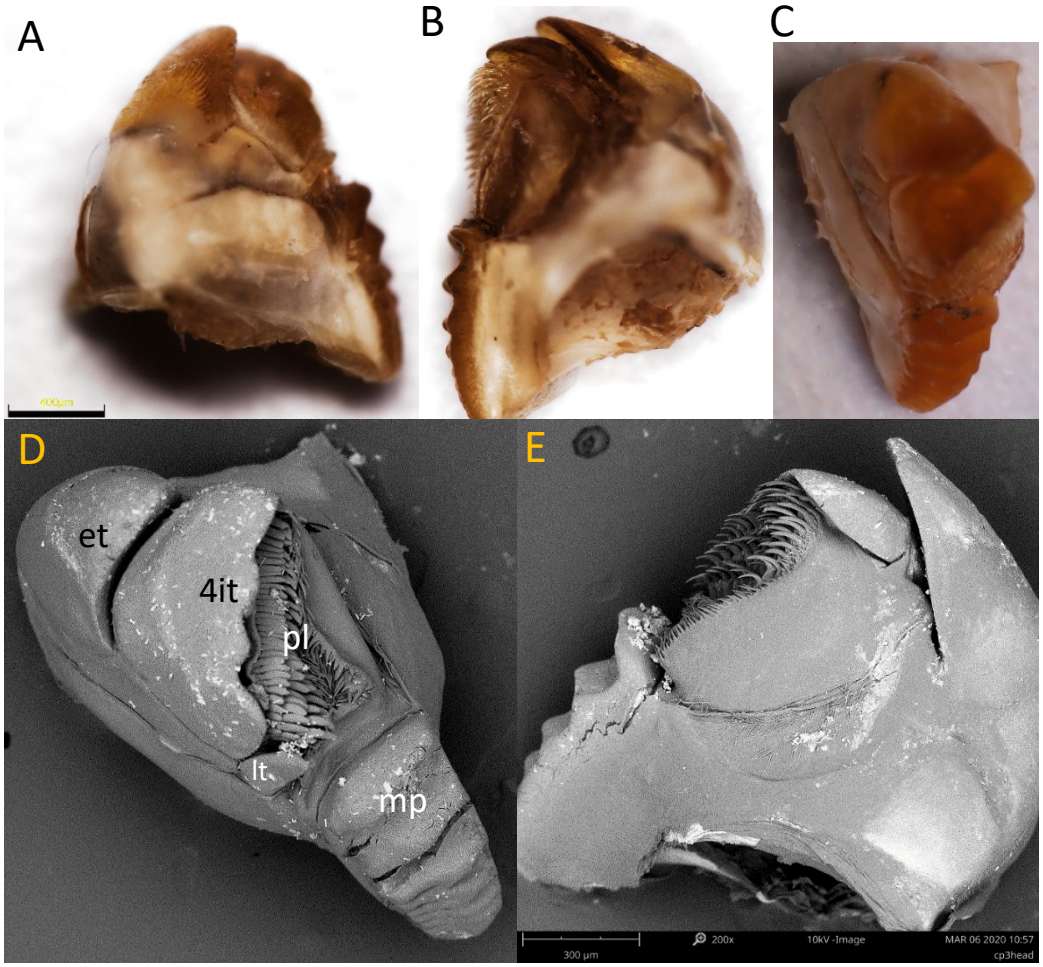

Figure 9. *Centrobolus anulatus* left mandible **A** anterior view, **B, E** posterior view, C, D median view. Abbreviations: et – external tooth; lt – lateral tooth; mp – molar plate; pl – pectinate lamellae; 4it- four internal teeth. **A-C** Scale bar: 0.4 mm. **D** & **E** Scale bar: 0.3 mm.

2.5. Key to the species of *Centrobolus*

1a. Distal process of anterior gonopod telopodite with one part only, lacking a proximal finger or lappet shaped part…….. 2

1b. Distal process of anterior gonopod telopodite with two distinct parts, a distal lobe, and a proximal/basal lappet or finger shaped part ……... 7

2a. Distal process of anterior gonopod telopodite distally rounded, with lateral margin forming a pointed extension……. 3

2b. Distal process of anterior gonopod telopodite an angular, longitudinally directed structure, without lateral extension…… 6

3a. Legs black, with distinct white/cream tarsi…….. ***albitarsis***

3b. Legs yellowish, uniform colour…… 4

4a. 46 body segments……. ***atrophus***

4b. 41 or fewer body segments……. 5

5a. Distal process of telopodite of anterior gonopods prominent and projecting beyond distal telopodite margin; sternum of anterior gonopods notably short; 41 body segments ……***transvaalicus***

5b. Distal process of telopodite of anterior gonopods not projecting beyond distal margin of telopodite; sternum of anterior gonopods notably large and robust; 39 body segments ……...***inyanganus***

6a. Sternum of anterior gonopods slender and triangular, with narrow apex……. ***litoralis***

6b. Sternum of anterior gonopods broad, with wide apex……. ***lugubris***

7a. Sternum of anterior gonopods very short, reaching only about a third or less height of gonopods…..... 8

7b. Sternum of anterior gonopods not notably short, reaching beyond a third height of gonopods…… 9

8a. Distal process of telopodite large, longitudinally oriented and rectangular, the proximal part distanced from the distal part, small and pointed…..... ***sagatinus***

8b. Distal part of anterior gonopod telopodite large, roughly square-shape with proximal part basally thick but tapered to a slightly hooked and acute apex and projected laterally……... ……. ***decoratus***

9a. Sternum of anterior gonopods reaching half the height of gonopods…… 10

9b. Sternum of anterior gonopods reaching beyond half height of gonopods…….. 11

10a. Posterior gonopods with inflated basal lobe……. ***rugulosus***

10b. Posterior gonopods without inflated basal lobe…….. **n.sp4**

11a. Shape of sternum pentagonal, not triangular……. 12

11b. Shape of sternum more or less triangular…….. 13

12a. Last 9 pairs of legs without tarsal pads…….. ***angelicus***

12b. Last 6 pairs of legs without tarsal pads…….. ***lawrencei***

13a. Scobinae present……... 14

13b. Scobinae absent…… 15

14a. Body red with posterior half of the body with six transverse black bands at intervals of four body rings…… ***vastus***

14b. Body uniformly red……. **n.sp3**

15a. Coxa of anterior gonopods reduced…….. 16

15b. Coxa of anterior gonopods almost covers the entire telopodite…… 17

16a. Posterior gonopods curved with visible suture line…….. **n.sp1**

16b. Posterior gonopods straight without suture line…….. ***splendidus***

17a. Distal part of anterior gonopods telopodite rounded and bulbous with proximal part small and finger-like…….. 18

17b. Distal part of anterior gonopods telopodite triangular with thick laterally directed proximal part……... 19

18a. Legs black with whitish gloss; head and antennae black…….. ***ruber***

18b. Legs yellowish-orange; head and antennae red……. ***vulpinus***

19a. Posterior gonopods without inflated basal lobe…… 20

19b. Posterior gonopods with inflated basal lobe……. 21

20a. Preanal ring red with black spot/band; posterior gonopods slender and straight …… ***silvanus***

20b. Preanal ring red; posterior gonopods with a stout shape…… ***richardi***

21a. Distal part of anterior gonopods roundish with thick lateral proximal part……. 22

21b. Distal part of anterior gonopods rectangular with thick lateral proximal part…… 26

22a. Scobinae indistinct…..……..... 23

22b. Scobinae prominent……..... 27

23a. Scobinae horseshoe shaped……. 24

23b. Scobinae triangular shaped…….. 25

24a. Body yellowish-orange with black metazonites; legs pinkish…….. ***fulgidus***

24b. Body in general olive brown with reddish tinge; legs reddish brown/orange….. ***inscriptus***

25a. Collum red with thick black band in the middle; all legs with tarsal pads..... ***sanguineomarginatus***

25b. Collum red with a faint dark band in the middle; last 16 pairs of legs without tarsal pads……... ***anulatus***

26a. Body black.....……... **n.sp2**

26b. Body in general transversely banded in three colours (red, black, light brown)…… ***tricolor***

27a. Posterior gonopods broad……. 28

27b. Posterior gonopod slender…… 31

28a. Tibial process of posterior gonopod broad…… 29

28b. Tibial process of posterior gonopod narrow…… 30

29a. Body deep purple-black; legs bright scarlet…….. ***sanguinipes***

29b. Body dark brown with reddish bands; legs dark brown……. ***rubricollis***

30a. Distal part of anterior gonopod large, oval-shaped with short, thick lateral proximal part…….. ***pusillus***

30b. Distal part of anterior gonopod flat, oval with long, lateral proximal part, slightly down-turned…… ***bifidus***

31a. Body in general blackish-grey; distal process of telopodite of posterior gonopod with finger-like projections at the apex…… ***digrammus***

31b. Body in general red; distal process of telopodite of posterior gonopod forked/tapered apically……... ***immaculatus***

***Centrobolus albitarsis* (Lawrence, 1967)**

Figs 10-17

Hamer 1998: 39.

Chersastus albitarsis Lawrence, 1967: 622.

Diagnosis. Differs from congeners in the following combination of character states: distal process of the telopodite of anterior gonopods with a straight median margin, simple, apical margin broad and slightly convex, with prominent, broadly triangular lateral projection (Figs 14C-D); legs black with distinctly white tarsi (Figs 12C; 11A-C).

Redescription. *Measurements*: ♂ Total length 35-40mm, greatest width 5.2mm, 41+0+T body rings, n=2. ♀ Total length 48mm, greatest width 5.6mm, 41+0+Tbodyrings, n=1.

Body sculpturing: body shiny with numerous close transverse striations and microscopic punctures; scobinae present and well defined with isosceles trapezoid shape, 2-3 times as long as wide, distance between scobinae approximately equal to width of scobina (Figs 13A & C).

Legs: legs of male and female long, reaching lateral margin of body rings when extended; in male all legs with prominent pads excluding the first two pairs; tibia condensed (long as wide) with two bristles (Fig. 15A).

Colour: (after 19 years in ethanol): the body in general reddish (Figs 11; 12); head, antennae and legs black, the latter with light white tarsi (Figs 11; 12C); collum red with a faintly darker central area (Figs 11B-C; 12A); body rings with reddish metazonites, mesozonites black-brown in the dorsal region but this fading to reddish laterally, giving the body the appearance of

incomplete black bands alternating with red bands; prozonites light brown/pale (Fig. 12A); preanal ring and anal valves reddish (Fig. 12D).

Gonopods: *Anterior gonopods*: sternum of the anterior gonopods in anterior view short (reaching approximately half height of the coxal part of the gonopods) and with distal half narrowly triangular, with blunt apex; lateral margin of proximal half of coxal region straight, margin of distal half bent inwards at an angle of about 45° (Figs 14A, D); median margin of telopodite straight, distal telopodite process simple, broad, convex distal margin, with laterally directed, triangular projection; surface of this with reticulate sculpturing and small, scattered spines and a few short setae (Figs 14B-D).

Posterior gonopods: Tibial processes broad and long with sperm duct opening at the distal end; longitudinal efferent grooveefferent groove strongly developed; distal processes of telopodite with a rectangular lappet-like process, and with rounded broad lamella; coxa broad with coxite branch; telopodite and coxite branch separated by a membrane (Fig. 15).

Female sexual characters: Distal margin of lateral extensions of second pair of legs coxosternum rounded. Vulva with both plates sub-equal in size and shape; operculum poorly sclerotized; both vulval plates with one to two rows of setae basally towards the operculum; setae weakly developed (Fig. 17).

Type locality: SOUTH AFRICA: *Mpumalanga*: Lochiel.

Type material. Syntypes (not examined): 1♂ 1♀ SOUTH AFRICA: Mpumalanga, Lochiel, 1939-01, Lawrence R.F. (NMSA-2298).

Paratypes: SOUTH AFRICA: 3♂ same as the syntypes.

Material examined. SOUTH AFRICA: *KwaZulu-Natal*: 1♂ Tugela Valley, Farm Mielietuin 1027, forest, closed canopy, after heavy rain, on tree trunks; 28°55'30"S, 29°59'10"E, 1040 A.S.L, 1999-12, Bourquin S. (SB 51, UKZN); 1♂ 1♀, same collection data as for preceding specimens, (SB 52, UKZN).

Distribution. This species has only been recorded from the type locality in Mpumalanga and from the Tugela Valley in KwaZulu-Natal, but it is possible that it also occurs between these two localities. Photographs posted on iNaturalist (https://www.inaturalist.org/observations/14540831) from Swaziland (Eswatini), Mlawula Nature Reserve have very distinct white tarsi and are reddish in colour. These may represent additional records of the species.

Habitat. Lawrence (1967) did not provide any information on the habitat of this species, but the Tugela Valley specimens were collected from Scarp forest.

Remarks. Lawrence (1967) designated a male and a female specimen as the "Holotype", but since there are two specimens, these are referred to here as syntypes. Lawrence (1967) did not

provide a written description of the gonopods or an illustration of the posterior gonopods for this species, and his illustrations of anterior gonopods are not very detailed, but the Tugela Valley (KZN) specimens do match all characters that were described. The gonopods of *C. albitarsis* are very similar to those of *Centrobolus transvaalicus* (Lawrence, 1967), and both species share the same number of body segments and number of leg pairs with tarsal pads, but they can be distinguished by the colour of the tarsi, as well as by size of the scobinae (much larger in *albitarsis*), and the unsclerotised operculum of the vulva in *albitarsis.*

Conservation assessment

This species is only known from two localities, both outside of protected areas, and which are separated by a distance of 305 km. Photographs posted on iNaturalist from Eswatini, Mlawula Nature Reserve have very distinct white tarsi which may represent additional records of the species but this cannot be confirmed without examining specimens.

It is likely that the species occurs in forest or dense woodlands and that it is also distributed in patches of these habitats between the two known localities but this area is not well sampled. Much of the habitat around the Mpumalanga locality is transformed due to agriculture, and the habitat where the species was first collected in 1939 may be transformed. There is also some agriculture in the Tugela Valley area, but the thicker vegetation on cliffs is not affected. The material from this locality was collected in 1999 as part of an assessment for the construction of a dam and so there may be future threats to the habitat.

Because of the uncertainty about the distribution of the species, it is not possible to confidently calculate the EOO, but it is potentially about 35 000km². The AOO cannot be estimated and the number of localities is also uncertain. This means that there is insufficient information to make an assessment of this species and so it is categorised as Data Deficient (DD) on the basis of distribution.

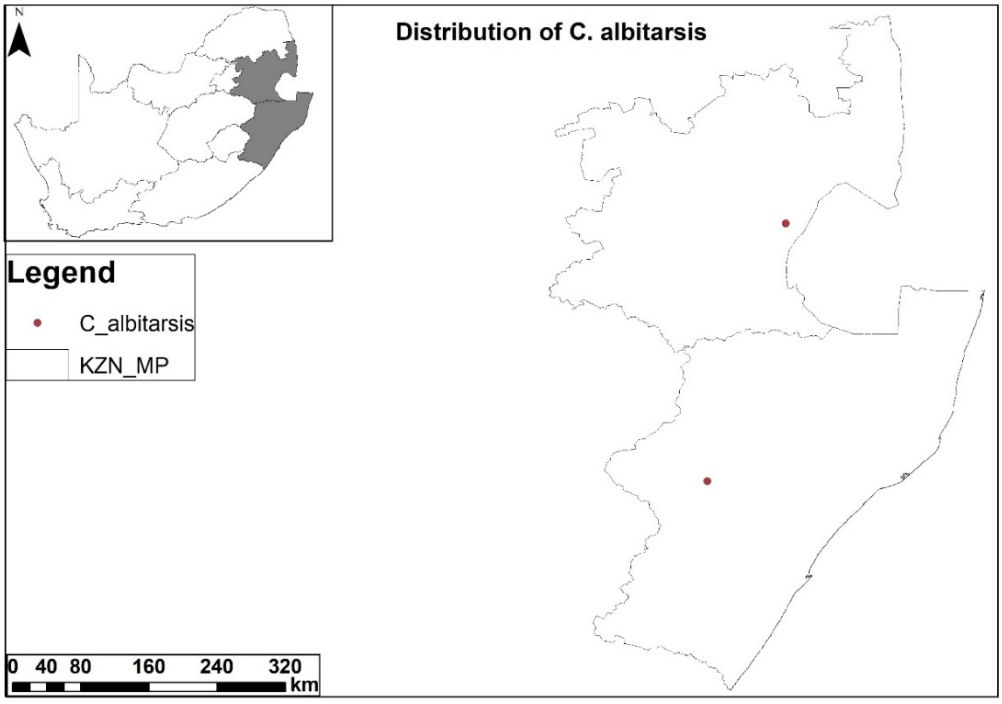

Figure 10. Distribution of *Centrobolus albitarsis* in South Africa. KZN = KwaZulu-Natal and MP = Mpumalanga province.

Figure 11. *Centrobolus albitarsis* **A-B:** Mlawula Nature Reserve, Eswatini. Photographer: Kate Braun (CC-BY-NC), **C:** Lubombo, Eswatini. Photographer: Linda Loffer (CC-BY-NC). Source iNaturalist.

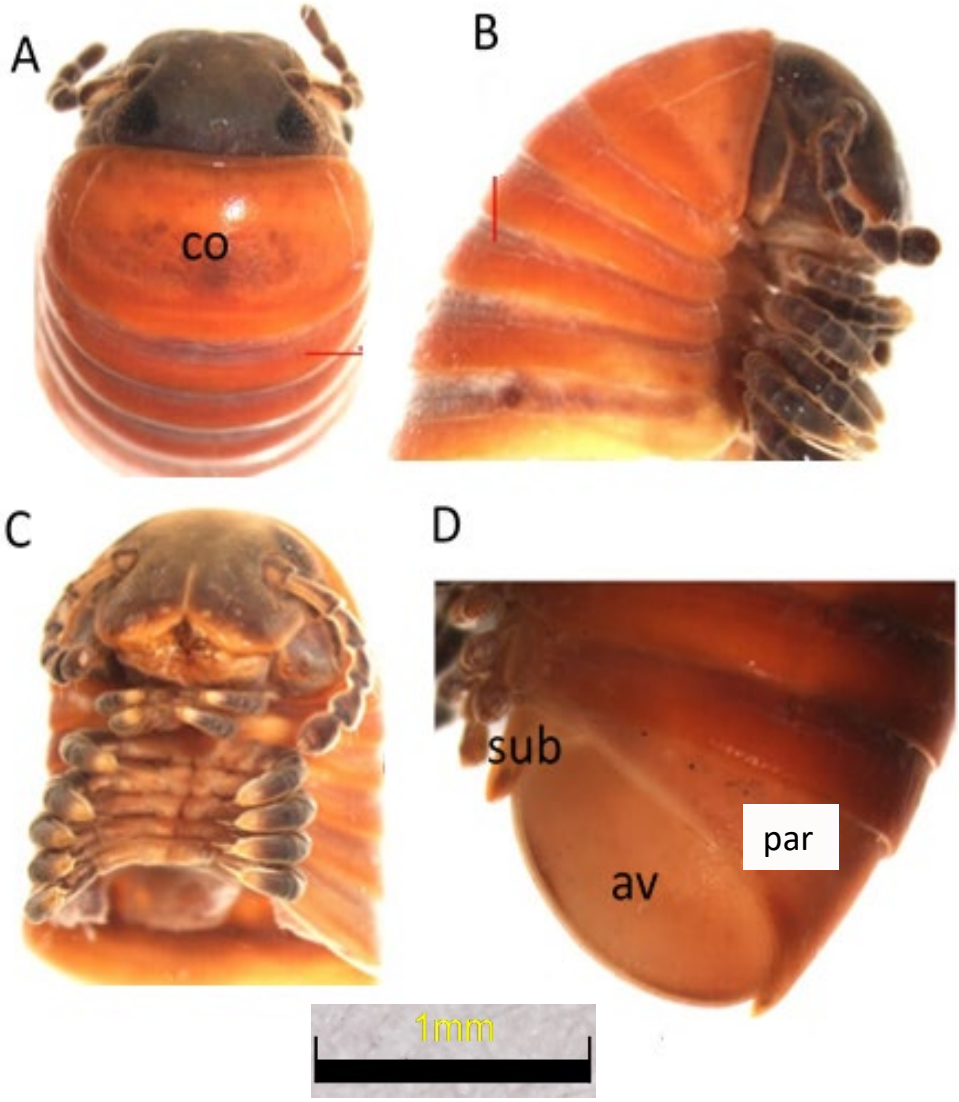

Figure 12: *Centrobolus albitarsis* (Tugela Valley, Farm Mielietuin, KwaZulu-Natal) ♂ body (SB52). **A** anterior view of head and collum, **B** lateral view and **C** ventral view showing legs and head**, D** terminal region of body. Abbreviations: av - anal valve; co – collum; par - preanal ring; sub - subanal scale. Scale bar: 1 mm.

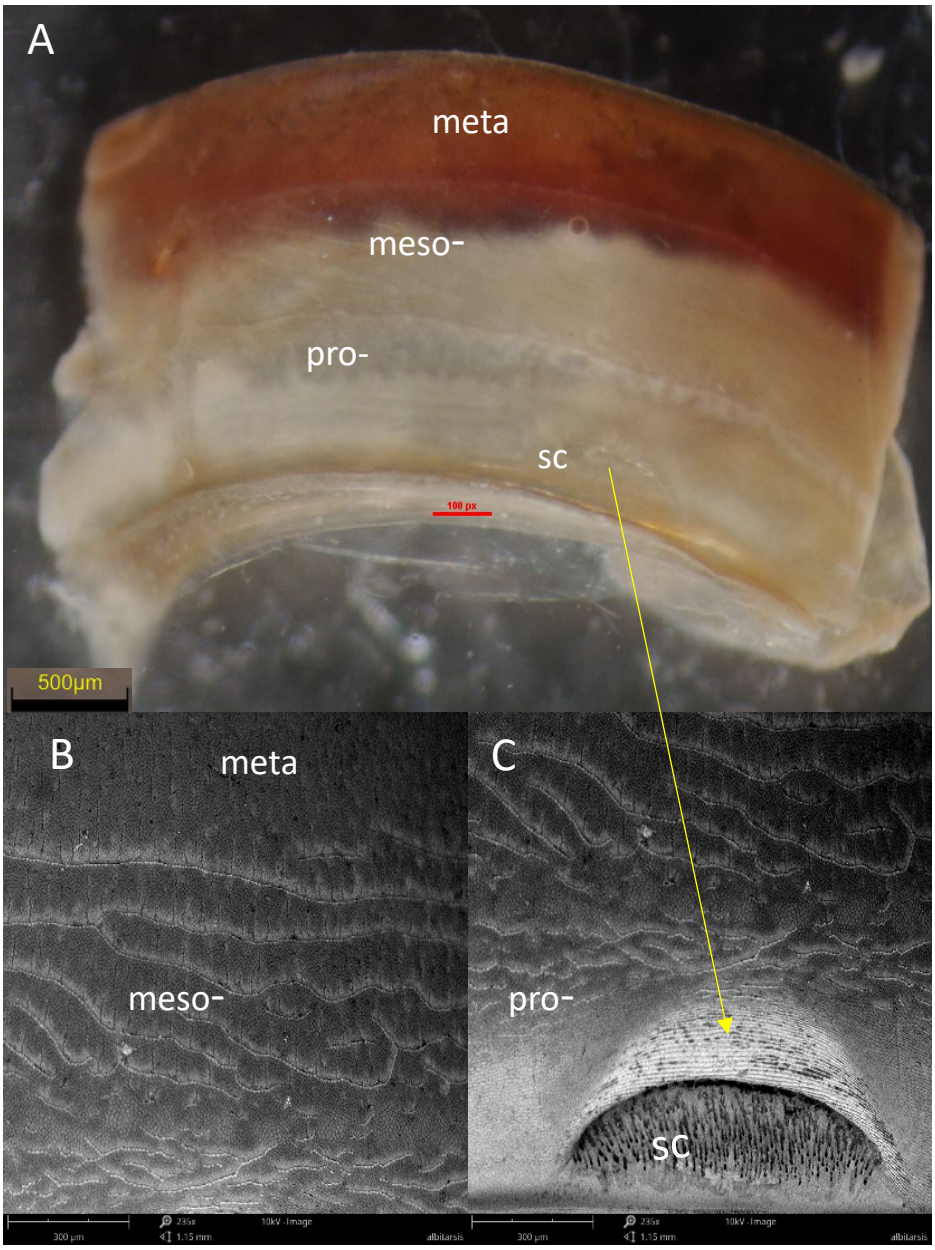

Figure 13: *Centrobolus albitarsis* ♂ (SB52). **A-C** body ring. Abbreviations: meso – mesozonite; meta – metazonite; pro – prozonite; sc - scobina. Scale bar: 1.0 mm (**A**); 0.3 mm (**B-C**).

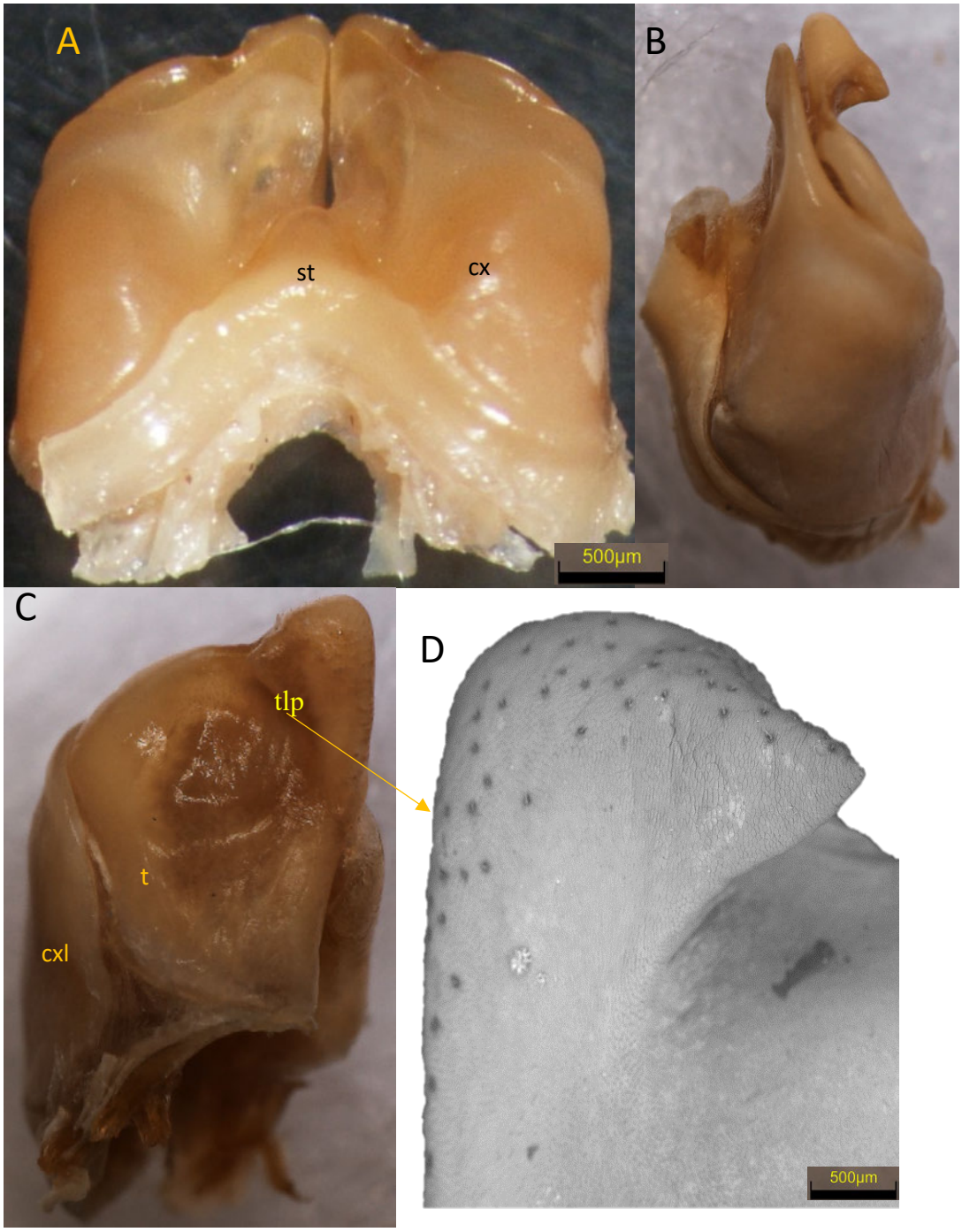

Figure 14: *Centrobolus albitarsis* ♂ (SB52). Anterior gonopods, **A-B** anterior view, **C-D** posterior view. Abbreviations: cx – coxa; cxl - coxal endite lobe; st – sternum; tl – telopodite; tlp - telopodite process. Scale bar: 0.5 mm.

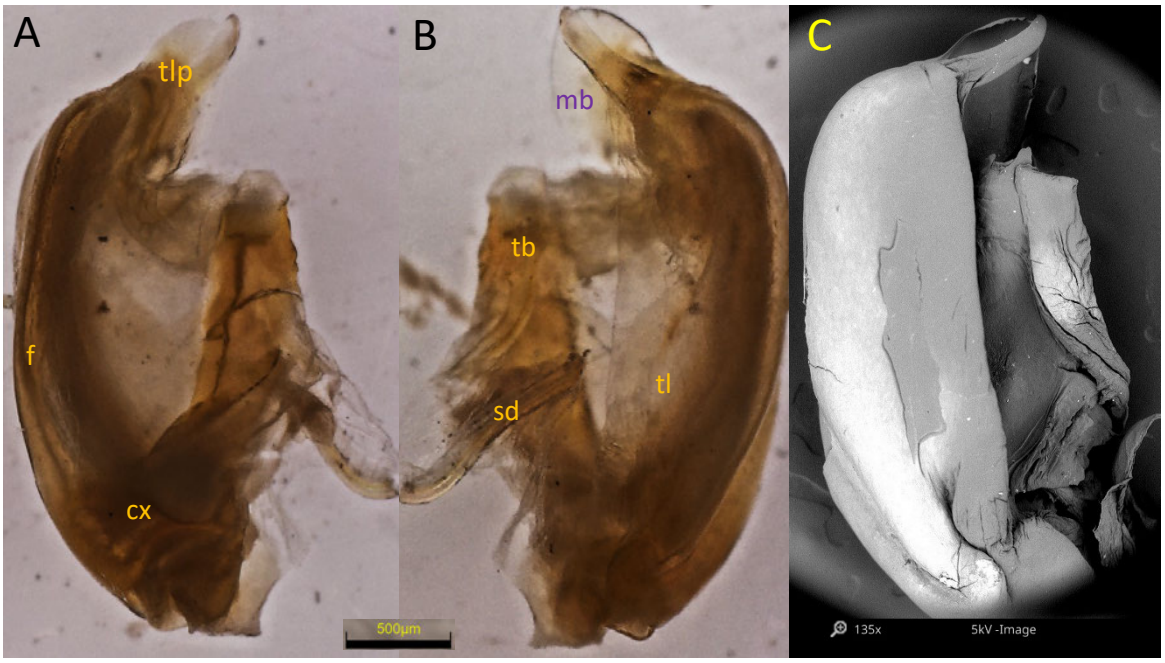

Figure 15: *Centrobolus albitarsis* ♂ (SB52). **A-C** posterior gonopod, **B**, **C** anterior view, **A** posterior view. Abbreviations: cx – coxa; f - efferent groove; mb – membrane; sd - sperm duct; tb - tibial process; tl – telopodite; tlp - telopodite process. Scale bar: 0.5 mm.

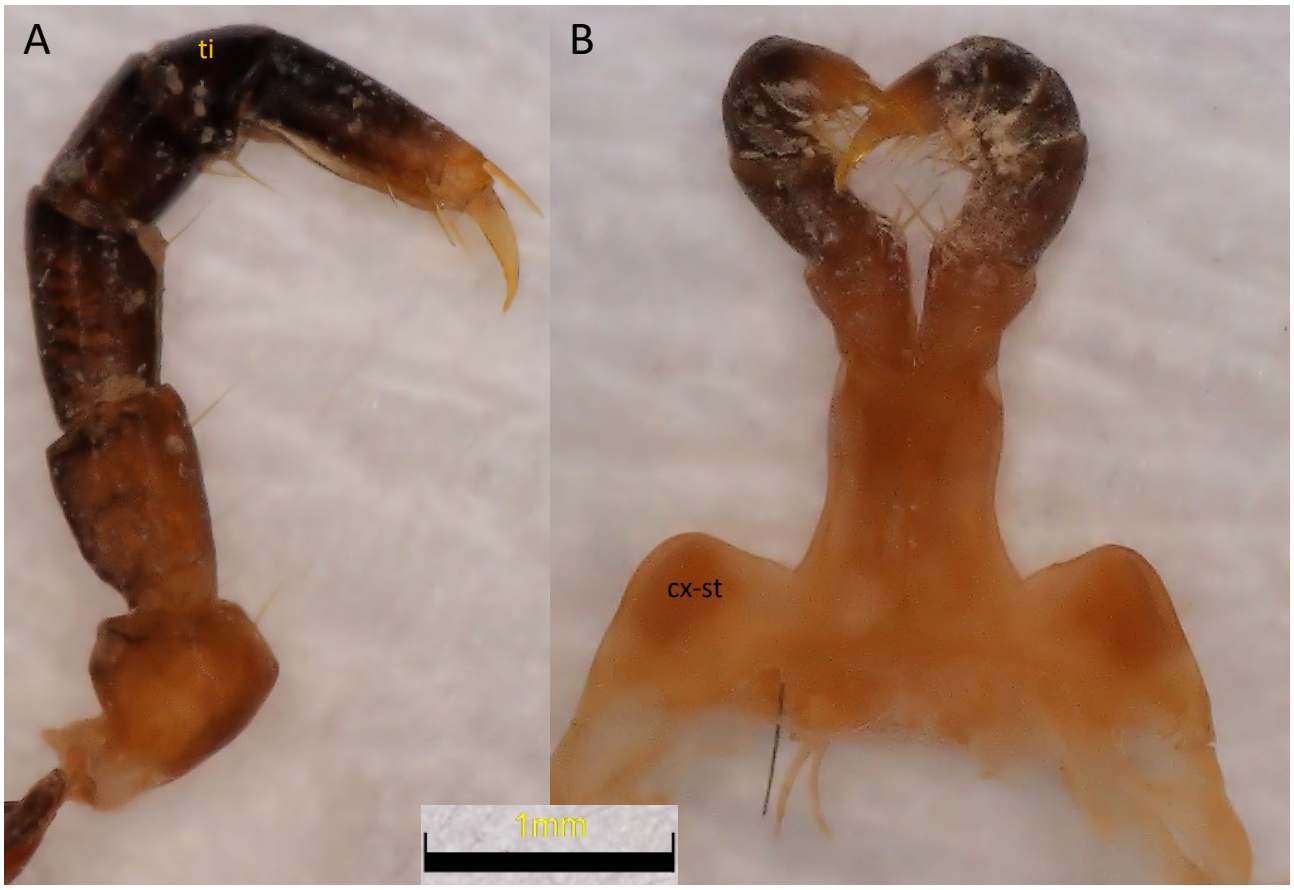

Figure 16: *Centrobolus albitarsis* ♂ (SB52). **A** male leg, **B** female second leg pair. Abbreviations: cx-st – coxosternite; ti – tibia. Scale bar: 1mm.

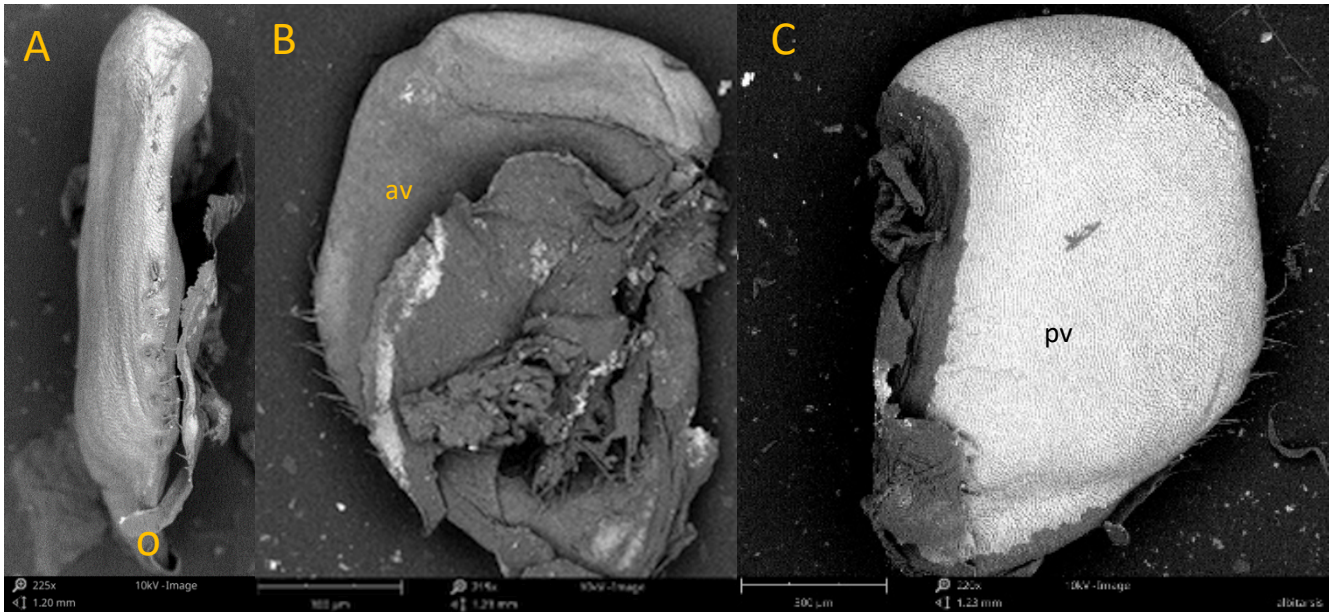

Figure 17: *Centrobolus albitarsis* ♀ (SB52). **A – C** vulva, **A** lateral view, **B** anterior view, **C** posterior view. Abbreviations: av – anterior valve; o – operculum; pv – posterior valve. Scale bars: 1.2 mm (**A**); 0.3 mm (**B-C**).

***Centrobolus angelicus* (Jeekel, 1966)**

Figs 18-22

Hamer 1998: 39.

Chersastus angelicus Jeekel, 1956: 86; Schubart 1966: 44.

Diagnosis. Differs from congeners in the distal process of the telopodite of anterior gonopods being club-shaped and with slender finger-like proximal part separated from club part by a raised roundish area (Figs 20B & C).

Redescription. *Measurements*: ♂ total length 34-45mm; greatest width 4.4-5.9mm, 41+0+T body rings, n=22. ♀ greatest width 5.6mm; 41+0+T body rings, n=1.

Body sculpturing: Body rings smooth and shiny with few, uneven transverse striae and minute punctures; scobinae present and well defined with a shape of an isosceles trapezoid (Figs 19E-F).

Legs: fairly long, reaching lateral margin of the body rings when extended; all legs with prominent pads excluding the first two and the last nine pairs; tibia condensed with two bristles (Fig. 22D).

Colour: (after 11 years in ethanol): body in general with reddish-brown and dark brown banded appearance; head, antennae and legs dark brown and collum deep red with a dark brown band towards the posterior margin (Figs 19A-C.); body rings reddish brown with dark brown metazonites and light brown at the edges, brown mesozonites and prozonites (Fig. 19E.); preanal ring and anal valves light brown (Fig. 19D).

Gonopods: *Anterior gonopods*: sternum of the anterior gonopod reaching two-thirds height of coxa, proximal half with straight lateral margins, slightly inwardly directed and tapered, distal half distinctly narrower, and apically rounded (Fig. 20A). Distal process of telopodite club-shaped and with slender finger-like part process separated from club part by a raised roundish area, covered with scattered small spiniform setae (Figs 20B-C).

Posterior gonopods: tibial process short and broad with seminal duct opening at its base; efferent groove longitudinal and well developed; inflated lobe present at base of telopodite; coxa completely fused with the telopodite; distal processes of the telopodite smoothly rounded with broad attached lamella (Fig. 21).

Female sexual characters: distal margin of lateral extension of coxosternum of second pair of legs rounded, but not especially prominent. Vulva simple, broadly bean-shaped; plates sub-

equal and with two to three irregular rows of strong setae basally towards the operculum; operculum poorly sclerotized (Figs 22A-C).

Type locality: SOUTH AFRICA: *Eastern Cape*: Pluto's Vale near Grahamstown.

Type material (not examined): Holotype: ♂ SOUTH AFRICA: Eastern Cape, Pluto's Vale near Grahamstown, 1938-09, Engel H (ZMAN).

Material examined. SOUTH AFRICA: *Eastern Cape*: 1♂ Prentjiesberg, 31.04056°S, 28.20691°E, 2005-12, Hamer M. (MDTP UKZN 4679); 1♂ same collection data as the preceding, (MDTP UKZN 0699); 1♂ same as the preceding, (MDTP UKZN 9692); 1♂ 1♀, Rhodes University, Olive Schreiner Residence, 2006-04, Vermeulen B.M. (Ref no: 2, UKZN): *KwaZulu-Natal*: 2♂ Umkomaas Valley, Lundies Hill, 1951-11, Lawrence R.F. (NMSA 07097); 4♂ Deepdale, 15 miles from Bulwer, 1964-10, Lawrence R.F. (NMSA-09287); 1♂ St Bernard's Peak, 30.07208°S, 29.11875°E, 2007-01, Hamer M. (MDTP UKZN 95965); 1♂ 1♀ same collection data as preceding (MDTP UKZN 971641); 1♂ same collection data as the preceding (MDTP UKZN 94143); 1♂ Lotheni, 29.41540°S, 29.48062°E, 2006-02, Hamer M. (MDTP UKZN 62490); 1♂ Mount Currie Nature Reserve, 30 28'07.816"S, 29 22'47.190"E, 2001-01, Armstrong A.J. & Ndlovu T. (Ref no: 1391, UKZN); 2♂ Impendle Nature Reserve, 29 42'58.70"S, 29 53'7.16"E, 2002-11, Armstrong A.J. (NMSA 22795); 1♂ same collection data as the preceding specimen, (NMSA 22743); 1♂ Igxalingenwa Nature Reserve, 30° 00' 39.87"S, 29° 38' 37.59"E, 2003-01, Armstrong A.J. (NMSA 22728); 1♂ Drakensberg, Swartberg area, Little Stream Farm, near tarn, 1998-03, Hamer M. (NMSA 15706).

Distribution: This species is restricted to the higher altitude parts of southern KwaZulu-Natal and northern Eastern Cape, including localities in the Drakensberg and the foothills of these mountains. Somespecimens were collected from forest, but others were collected in grassland.

Remarks: This species is similar in colour to *Centrobolus rubricollis* (Schubart, 1966) and *C. lawrencei* . The three species are distinguished by the number of pairs of legs that lack tarsal pads (last 15 pairs in *C. rubricollis*, last nine pairs in *C. angelicus* and last six pairs in *C. lawrencei*) and the detailed structure of the telopodite is distinct.

Conservation assessment

This is a South African species described from two localities in the Eastern Cape, and several in the higher altitude parts of southern KwaZulu-Natal.

The habitat appears to be mainly Afrotemperate forest and grassland. It has also been recorded from the small town of Grahamstown, so it appears to survive some development. There has been some agricultural development in the areas where this species occurs, but this is small

relative to the overall distribution of the species, and much of the habitat of this species is not easily accessible. EOO = 25 000 km^2 and EOO = 132 km^2, with 11 locations.

The species has been recorded from four protected areas, the Lotheni Nature Reserve which is part of the Drakensberg World Heritage Site, and three smaller and less formally protected areas, Mt Currie Nature Reserve, Igxalingenwa Nature Reserve and Impendle Nature Reserve There is no evidence that the EOO or the AOO or the number of locations have declined or are continuing to decline. The AOO and the number of locations are probably higher than currently known. Based on the EOO and the number of locations, *C. angelicus* was assessed as Least Concern (LC).

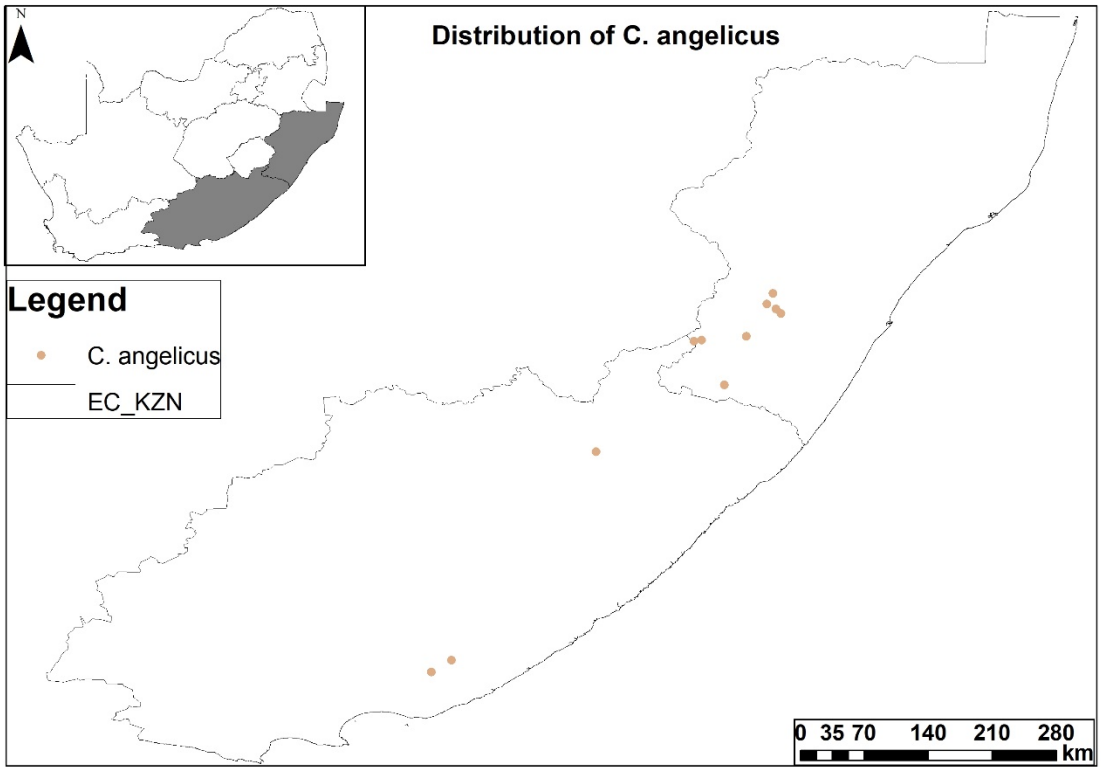

Figure 18: Distribution of *Centrobolus angelicus* in South Africa. EC = Eastern Cape, KZN = KwaZulu-Natal.

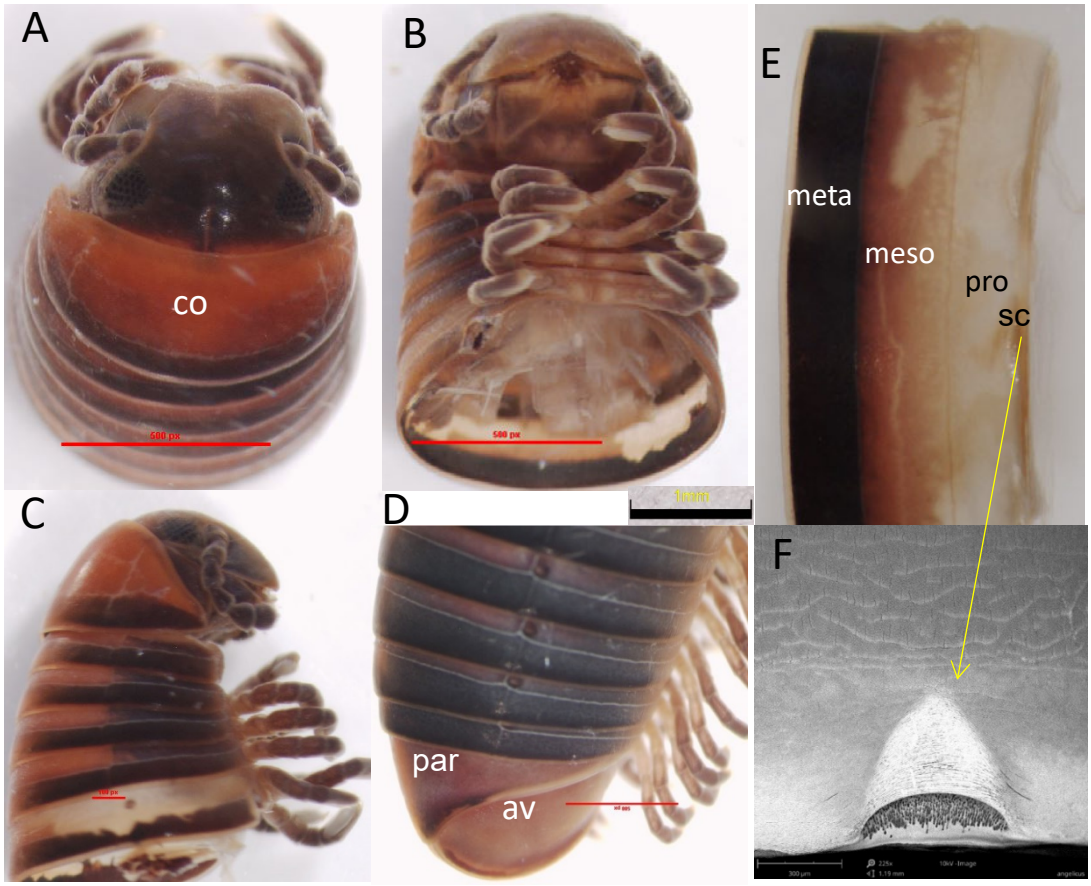

Figure 19: *Centrobolus angelicus* (St Bernard's Peak, KwaZulu-Natal) ♂ (MDTP. 94143). **A** anterior view of the head and collum, **B** ventral view, **C** lateral view of the head and legs, **D** terminal region of body, **E-F**body ring. Abbreviations: av - anal valve; co – collum; meso – mesozonite; meta – metazonite; par – preanal ring; pro – prozonite; sc - scobina. Scale bars: 1.0 mm (**A-E**); 0.3mm (**F**).

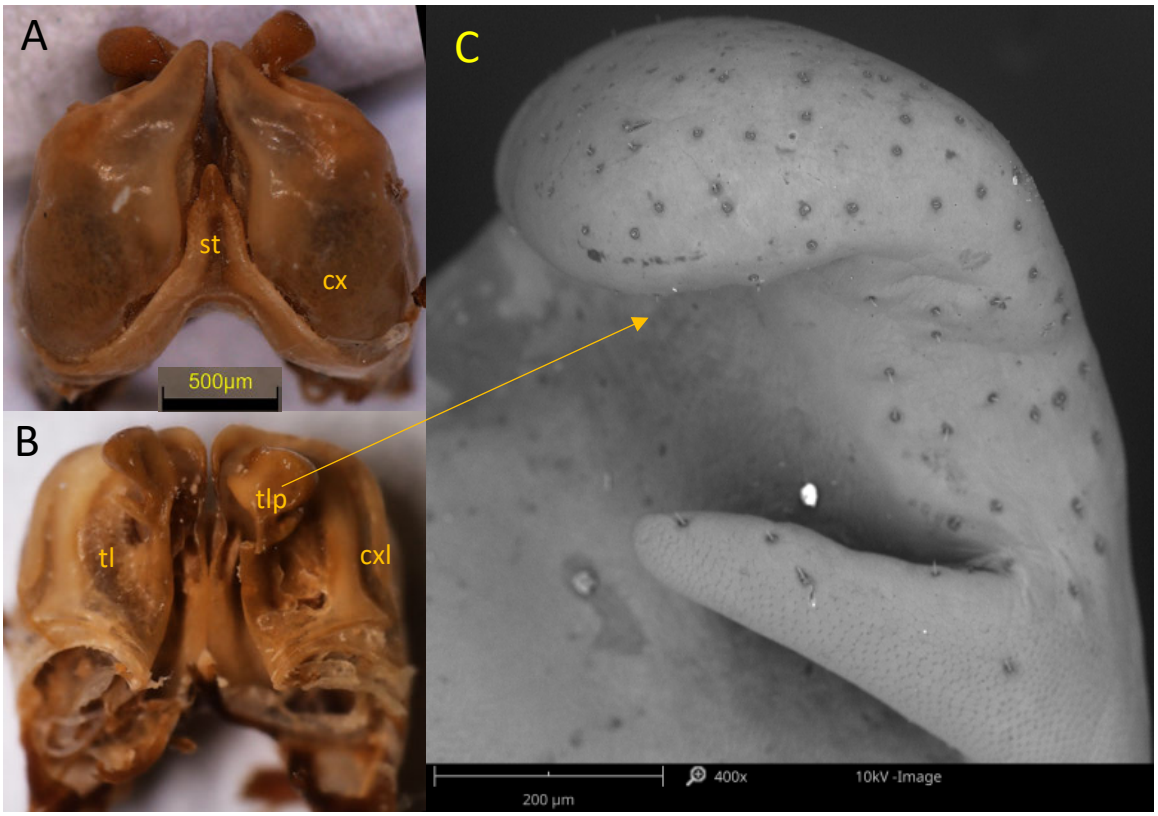

Figure 20: *Centrobolus angelicus* ♂ (MDTP. 94143). **A-C** anterior gonopods; **A** anterior view **B-C** posterior view. Abbreviations: cx – coxa; cxl - coxal endite lobe; st – sternum; , tl – telopodite; tlp - telopodite process. Scale bars: 1.0 mm (**A-B**); O.2 mm (**C**).

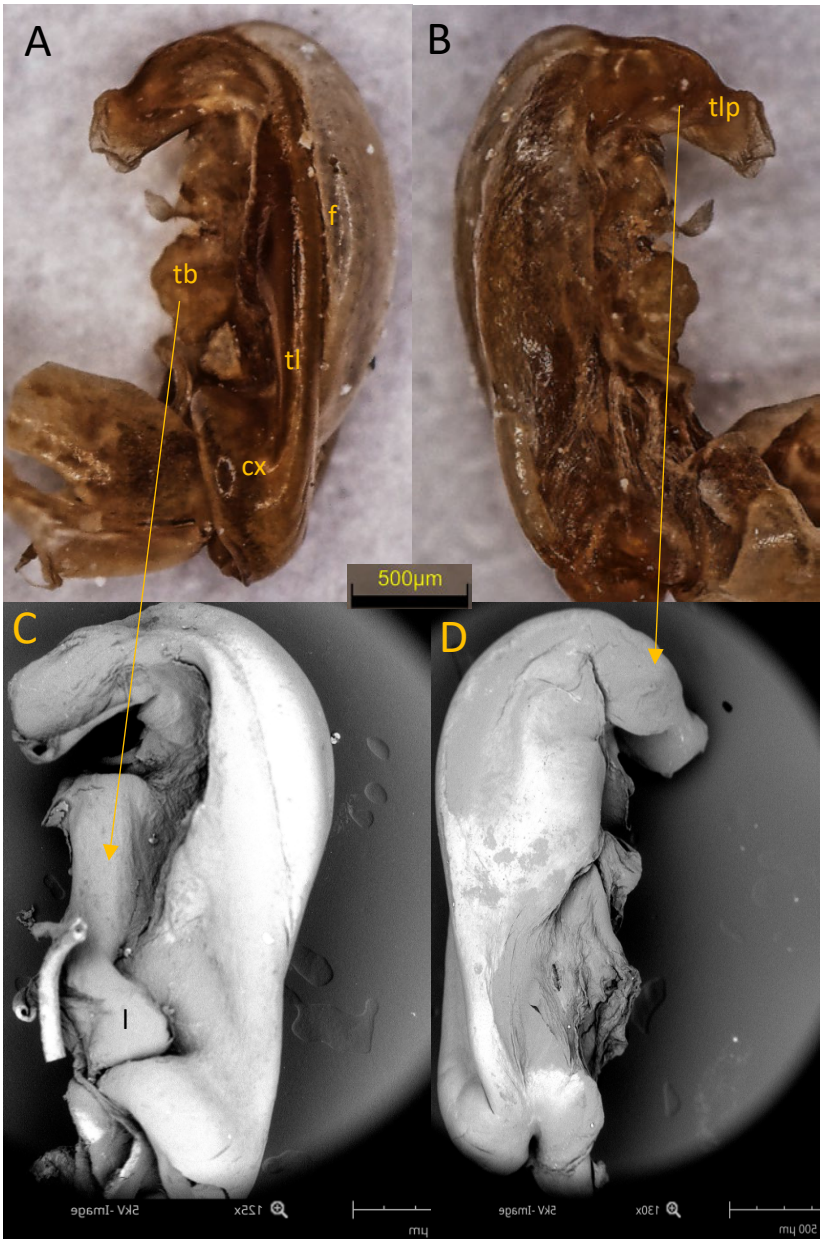

Figure 21: *Centrobolus angelicus* ♂ (MDTP. 94143). **A-D** posterior gonopod; **A** & **C** anterior view; **B** & **D** posterior view. Abbreviations: cx – coxa; f– efferent groove; l – inflated lobe; sd – seminal duct; tb – tibial process; tl – telopodite; tlp – telopodite process. Scale bars: 0.5 mm.

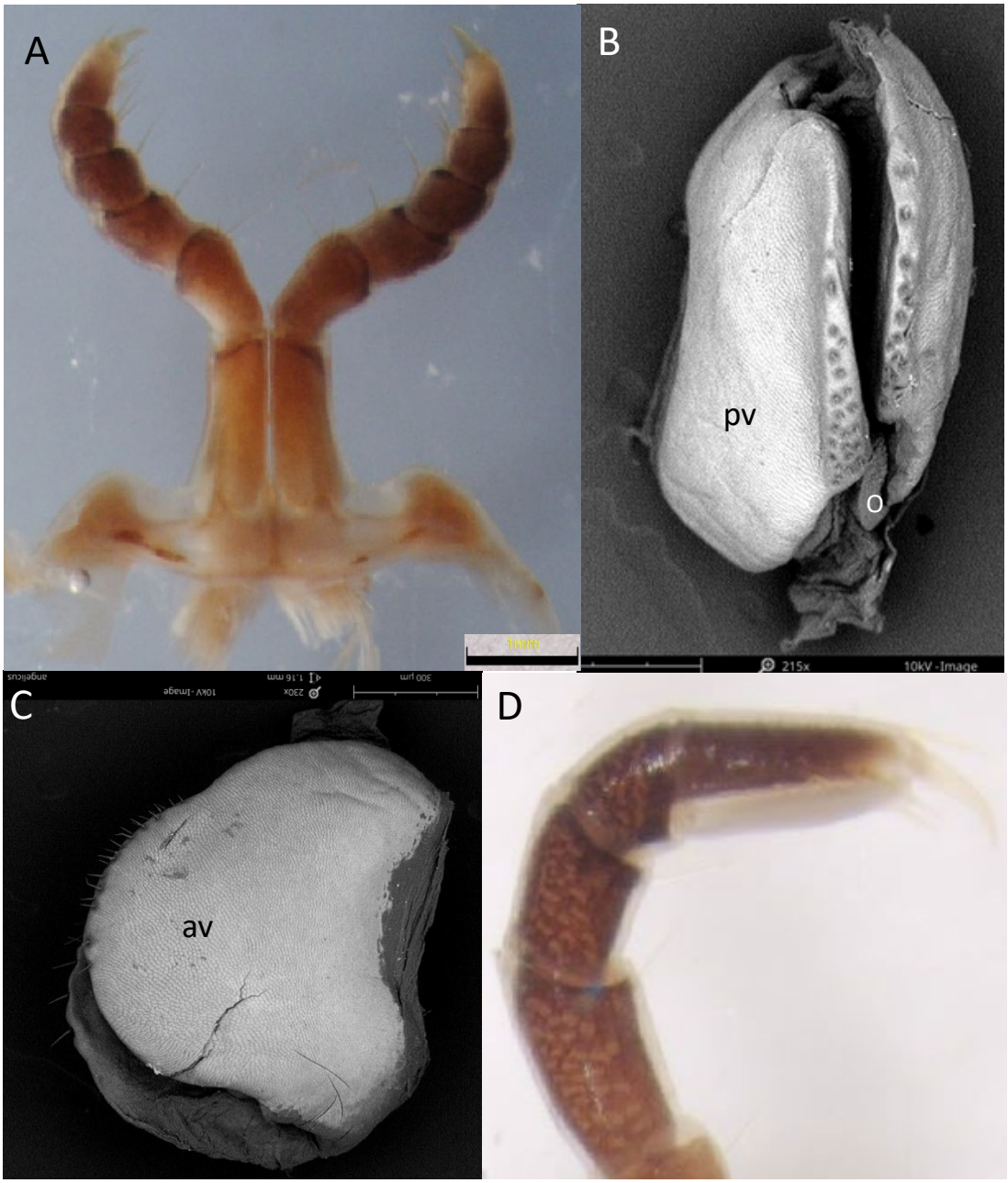

Figure 22: *Centrobolus angelicus* ♀ (MDTP. 94143). **A** female second leg pair, **B-C** vulva, **D** male leg, **B** lateral view, **C** anterior view. Abbreviations: av - anterior valve; o- operculum; pv - posterior valve. Scale bars: 1.0 mm (**A** & **D**); 0.3 mm (**B-C**).

***Centrobolus anulatus* (Attems, 1934)**

Figs 23-28

Hamer 1998: 39; Hoffman 1971: 153-155.

Spirobolus elegans (nec Brandt, 1841); Porat, 1872: 19; Attems 1928: 308; Jeekel 1956: 95; Hoffman 1971: 153-155.

Chersastus anulatus Attems, 1934: 478; Jeekel 1956: 85; Schubart 1966: 39; Lawrence 1967: 633.

Chersastus elegans Schubart, 1966: 40.

Diagnosis. Differs from congeners in the anterior gonopods having distal telopodite process with two parts, the distal most one with a folded/swollen appearance, and the proximal one being a laterally directed, slender, finger-like structure (Figs 26B-C). In addition, *C. anulatus* is distinct in terms of the black head, antennae and legs, and the black and red transverse banding, with the metazonites red and mesozonites black, the absence of tarsal pads on the last 16 pairs of legs and very small scobinae.

Redescription. *Measurements*: ♂ total length 40-53mm, greatest width 4.5-6.0mm, 41+0+T or 43+0+Tbody rings, n= 21. ♀ Total length 42-67mm, greatest width 5-7mm, 42+0+T or 43+0+Tbody rings, n=16.

Body sculpturing: body very smooth and polished with transversely annulated trunk and few transverse striae with microscopic punctures (Figs 24-25); scobinae present and obscure (Figs 25E-F).

Legs: legs long for both ♀ and ♂, reaching lateral margin of the body rings when extended; the first two and the last 16 pairs of legs lack tarsal pads; tarsal pads inconspicuous; tibia standard length and width with two apical bristles (Fig. 28A).

Colour **(**after 6 years in ethanol): the body in general red and black with distinct transverse bands; head, antennae and legs black (Figs 24, 25B-C); collum red with a faint dark band in the middle (Figs 24, 25A); body rings with dark red metazonites, black mesozonites and reddish-brown prozonites (Fig. 25E); preanal ring and anal valves red (Fig. 25D).

Gonopods: *Anterior gonopods*: sternum of the anterior gonopod with the distal half strongly tapered and apically narrow and sharply pointed (Fig. 26A). Lateral margins of coxae almost straight, coxae broad and with median corner acute. Distal process of telopodite with two parts, the apical one with a folded/swollen appearance, and the proximal one a laterally directed finger-like process. Telopodite process covered with sparse, small spiniform setae (Figs 26B-C).

Posterior gonopods: Tibial process short and broad with seminal duct opening on its distal end; inflated basal lobe absent; coxa not broad or robust and fused with telopodite; efferent groove well developed; telopodite slightly curved with distal processes indented (Fig. 27).
Female sexual characters: Distal margin of the lateral extensions of the coxosternum of second pair of legs prominent, narrowly rounded. Vulva simple and more or less oval, with indentation on margin just above the setae region; anterior valve slightly overlapping posterior valve; each valve with two-three rows of setae; operculum poorly sclerotized (Figs 28B-C).
Type locality: SOUTH AFRICA: *KwaZulu-Natal*: Ifafa.

Type material. According to Hoffman (1971) the type material for *C. anulatus* is dispersed, with syntypes in the NHMW, and a female is in the KZN Museum. The type material was not examined.

Material examined. SOUTH AFRICA: *KwaZulu-Natal*: 1♂ 1♀ Durban Bluff, off Berea Rd., 1995-10, Miller R. (NMSA-15541); 1♂ 1♀ Hawaan Forest, 1995-12, Hamer M. (NMSA-15551); 1♂ same collection data as preceding (NMSA-15605); 1♂ 1♀ Harold Johnson Nature Reserve, 1996-12, Hamer M. (NMSA-15571); 1♂ Pigeon Valley Park,1995-01, Hamer M. (NMSA-15655); 2♂ Mtunzini Forest, 1996-12, Cooper M. (NMSA-15729); 2♂ 2♀ same collection data as preceding, (NMSA 22999); 2♀ Durban, Westville area, Palmiet Nature Reserve, 1998-01; Hamer M. (NMSA-16353); 2♂ Kranzkloof Nature Reserve, 29° 47'S, 30° 50'E, 1985-11, Griswold C. & Meikle T. (NMSA-16491); 1♂ same locality as the preceding, 1999, James S. (SJ47, UKZN); 1♀ Mabengu Forest, 29°23'54.96"S/31°19'10.8"E, 2013-11, Armstrong A.J. & Gomez A. (NMSA-25977); 1♀ same collection data as the preceding (NMSA-25974); 1♀ same collection data as the preceding (NMSA-25976); 1 ♂ same collection data as the preceding (NMSA-25978); 1♀ same collection data as the preceding (NMSA-25979); 1♂ Vernon Crookes Nature Reserve, 30°16'43S, 30°35'45.00E, 2013-11, Armstrong A.J. & Gomez A. (NMSA-25992); 1♂ 1♀ same collection data as preceding (NMSA-22994); 1♀ same collection data as preceding (NMSA-22995); 1♀ Blythedale Beach, 2010, Armstrong A.J. (NMSA-Myr 25910); 2♂ 1♀ same data as the preceding, Armstrong A.J., Tarrant J., Ruikers D., Coulon P., Roberts G. & Mbonambi D., 2012-11; 1♀ Bluff Nature Reserve, 2012, Armstrong A.J. & Murray H. (NMSA.Myr-25930); 1♂ same collection data as the preceding (Ref. no: 1747, UKZN); 1♂ Amatikulu Nature Reserve, 2001-12, Brown M. (MB55, UKZN); 2♂ South Coast, St Winifreds, just off Eston, Kingsborough Rd, +/- 2km wd N2, Suburban garden, 1999-12, Jones A. (AJ1, UKZN).

Distribution: This species has only been recorded from a relatively narrow part of the KwaZulu-Natal coast, from Mtunzini in the north to Mbengu Forest in the south, and inland to

Westville, which is about 10km inland. Photographs of specimens almost certainly of *C. anulatus* have been posted on iNaturalist and provide records from the Scottburgh area of the south coast of KwaZulu-Natal. https://www.inaturalist.org/observations?verifiable=true&taxon_id=714505&place_id=&preferred_place_id=&locale=en-US.

Remarks: The status of a species described as *Julus* (*Spirobolus*) *elegans* Brandt, 1841 from Cape of Good Hope was considered as uncertain by Attems (1928), but Von Porat (1872) provided a redescription of what he considered to be the same species as that described by Brandt (1841), and from material collected by Wahlberg with the locality stated as "Caffraria". Hoffman (1971) examined a probable type and found that this did not represent an African spirobolid, but he recognised that Porat had obviously examined material representing a South African member of the order. Attems (1928) considered *elegans* to be *incertae sedis*, but based on Porat's (1872) description, Jeekel (1956) suggested that it was possibly the same species as *C. anulatus*. Schubart (1966) listed *elegans* separately. Hoffman (1971) formalised the synonomy of *elegans* as described by Van Porat (1872).

Attems (1934) did not give a full description of the species and did not illustrate the gonopods and only described them as "like those of *C. vastus*". Hoffman (1971) pointed out that this is not a useful statement. Lawrence (1967) too did not illustrate the gonopods, but he did provide descriptions of other characters. Hoffman (1971) provided useful illustrations of the posterior view of the anterior gonopods, and he stated that the posterior gonopods match Schubart's (1966) illustration for *C. rubrofasciatus*. The material examined in this study matches the latter illustration, and that of the coxae of the second pair of legs. Schubart (1966) did not illustrate the anterior gonopods of *C. rubrofasciatus*. It is likely that *C. rubrofasciatus* is a synomym of *C. anulatus*, but Schubart's type material needs to be examined to confrirm this. The type locality of *C. rubrofasciatus* is within the range of *C. anulatus*.

This species is similar to *Centrobolus richardi* (Lawrence, 1967) in terms of the shape of the anterior gonopods, especially the distal process of the telopodite of the anterior gonopods, but the colour of the two species is different, and *C. richardi* has a red head, legs and antennae, and has the last nine to 22 pairs of legs lacking tarsal pads.

Conservation assessment

This South African species is locally common but has only been recorded from a relatively small area along the coast of KwaZulu-Natal. The species is known to occur mostly in coastal forest. *Centrobolus anulatus* is relatively common in the habitat that remains. The area where

C. anulatus has been recorded has undergone almost complete loss or degradation of habitat due to urbanisation in the form of high-density housing and tourism development, as well as agriculture such as sugar cane and timber, and industry such as factories. The remaining habitat is degraded by alien invasive plants and pollution. The species survives in small fragments of protected areas, in degraded open spaces and in suburban gardens. These fragments are separated by areas with intensive housing or industry or intensive agriculture.

Centrobolus anulatus occurs in a number of small nature reserves, including Harold Johnson, Umlalazi, Bluff, Krantzkloof, Amatikulu, and Vernon Crookes Nature Reserves as well as Hawaan Forest and Pigeon Valley Park. All of these reserves are surrounded by transformed habitat and they have problems with alien invasive plant species.

EOO = 2500km² and AOO = 56km². Number of locations=14.

Centrobolus anulatus meets the criteria for Endangered in terms of EOO (<5000km²) and AOO (<500km²), the decline in both EOO and AOO is continuing as the remaining habitat becomes increasingly degraded or developed, and the known locations are highly fragmented (EN B1ab (i, ii, iii).

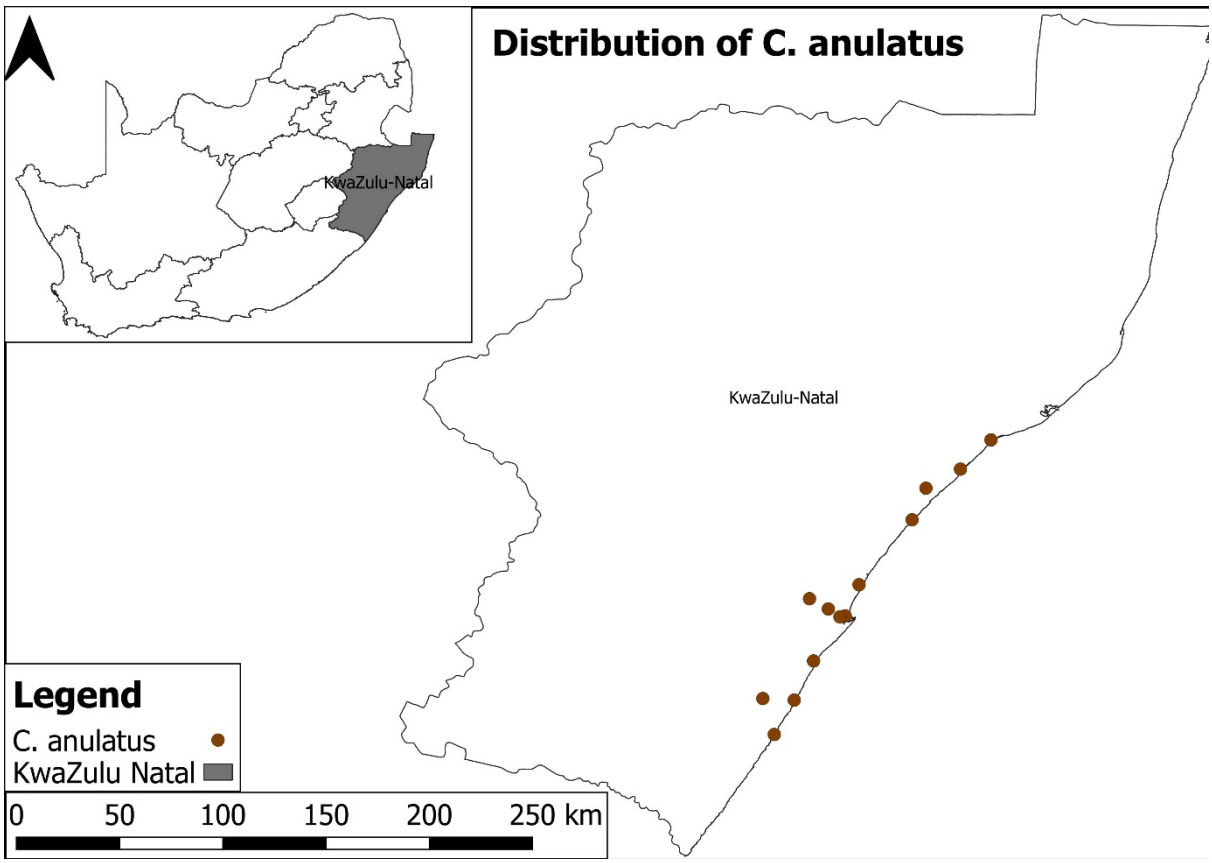

Figure 23. Distribution of *Centrobolus anulatus* in South Africa, KwaZulu-Natal.

Figure 24: *Centrobolus anulatus* from Scottburgh KwaZulu-Natal. Photographer: Peter Vos (CC-BY-NC). Source iNaturalist.

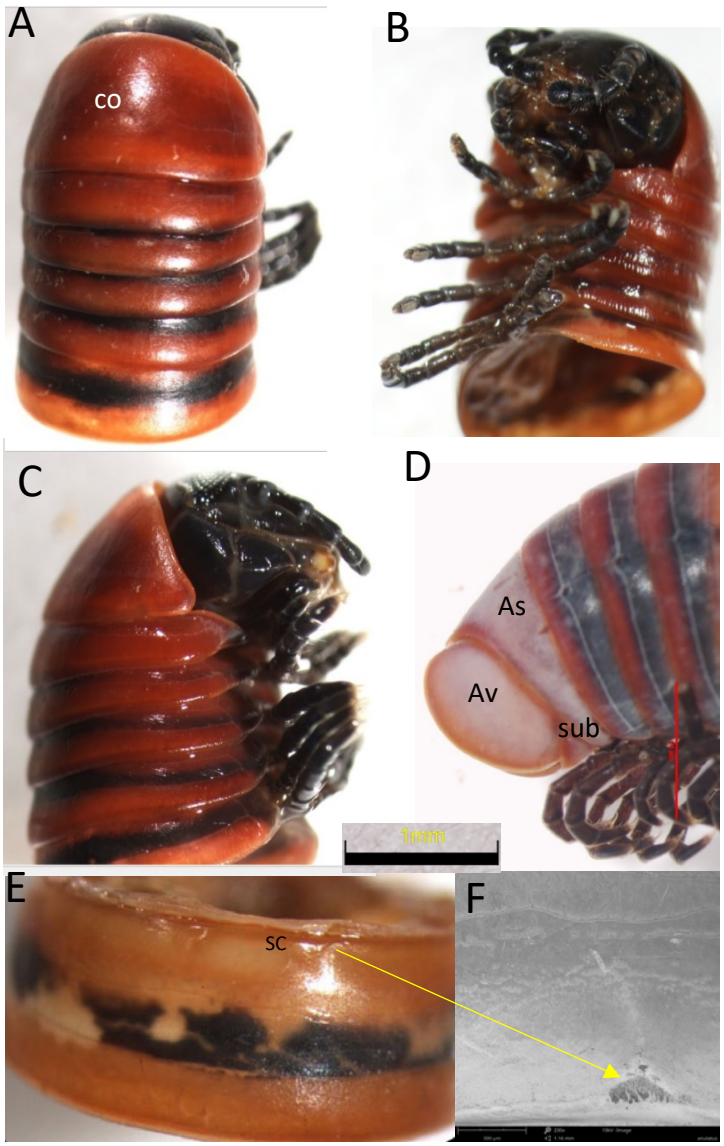

Figure 25: *Centrobolus anulatus* **(**Amatikulu Nature Reserve, KwaZulu-Natal) ♂ (MB55). **A** dorsal view of the head and collum, **B** lateral view, **C** ventro-lateral view of the head and legs, **D** terminal region of body, **E-F** body ring. Abbreviations: av - anal valve; co – collum; meta – metazonite; meso – mesozonite; par - preanal ring; pro - prozonite; sc – scobina; sub - subanal scale. Scale bars: 1.0 mm (**A**-**E**); 0. 3 mm (**E**).

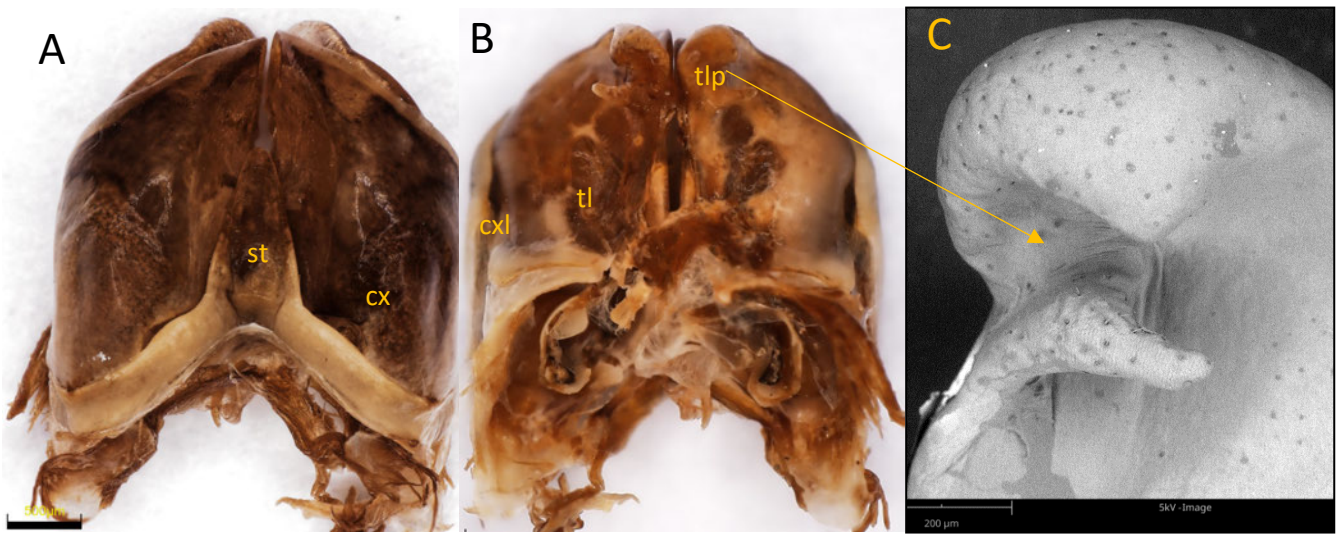

Figure 26: *Centrobolus anulatus* ♂ (MB55). **A-C** anterior gonopods. **A** anterior view, **B-C** posterior view. Abbreviations: cx – coxa; cxl - coxal endite lobe; st – sternum; tl – telopodite; tlp - telopodite process. Scale bars: 0. 5 mm (**A-B**); 0.2 mm (**C**).

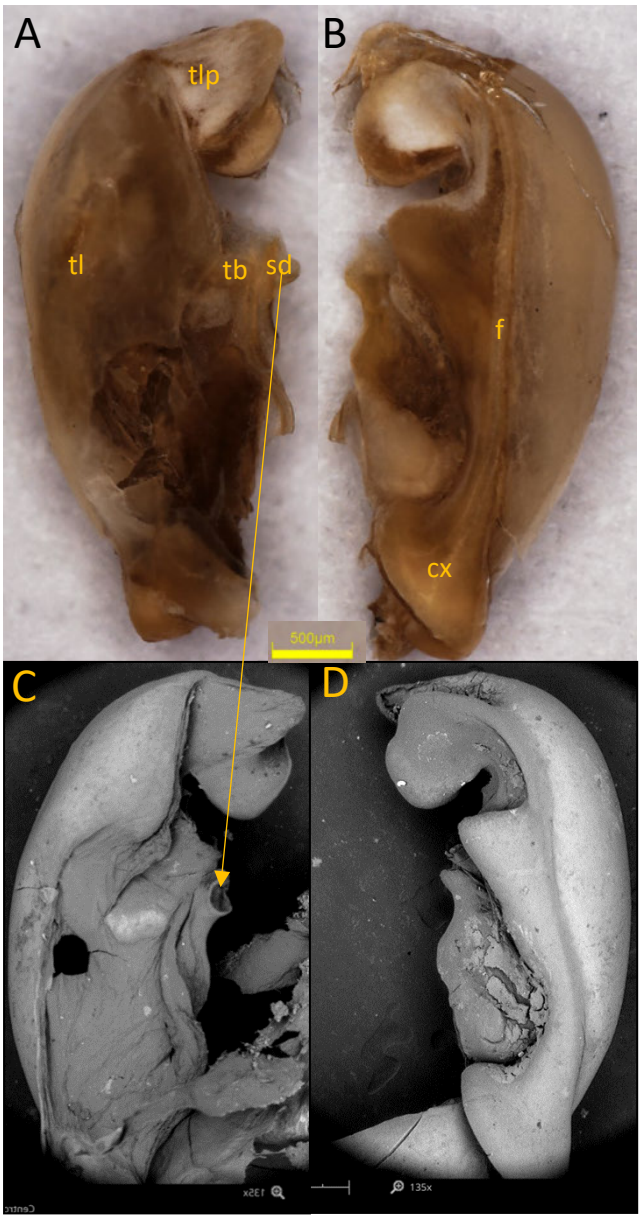

Figure 27: *Centrobolus anulatus* ♂ (MB55, UKZN). **A-D** posterior gonopod; **A** & **C** posterior view, **B** & **D** anterior view. Abbreviations: cx – coxa; f - efferent groove; sd - seminal duct; tb - tibial process; tl – telopodite; tlp - telopodite process. Scale bars: 0.5 mm.

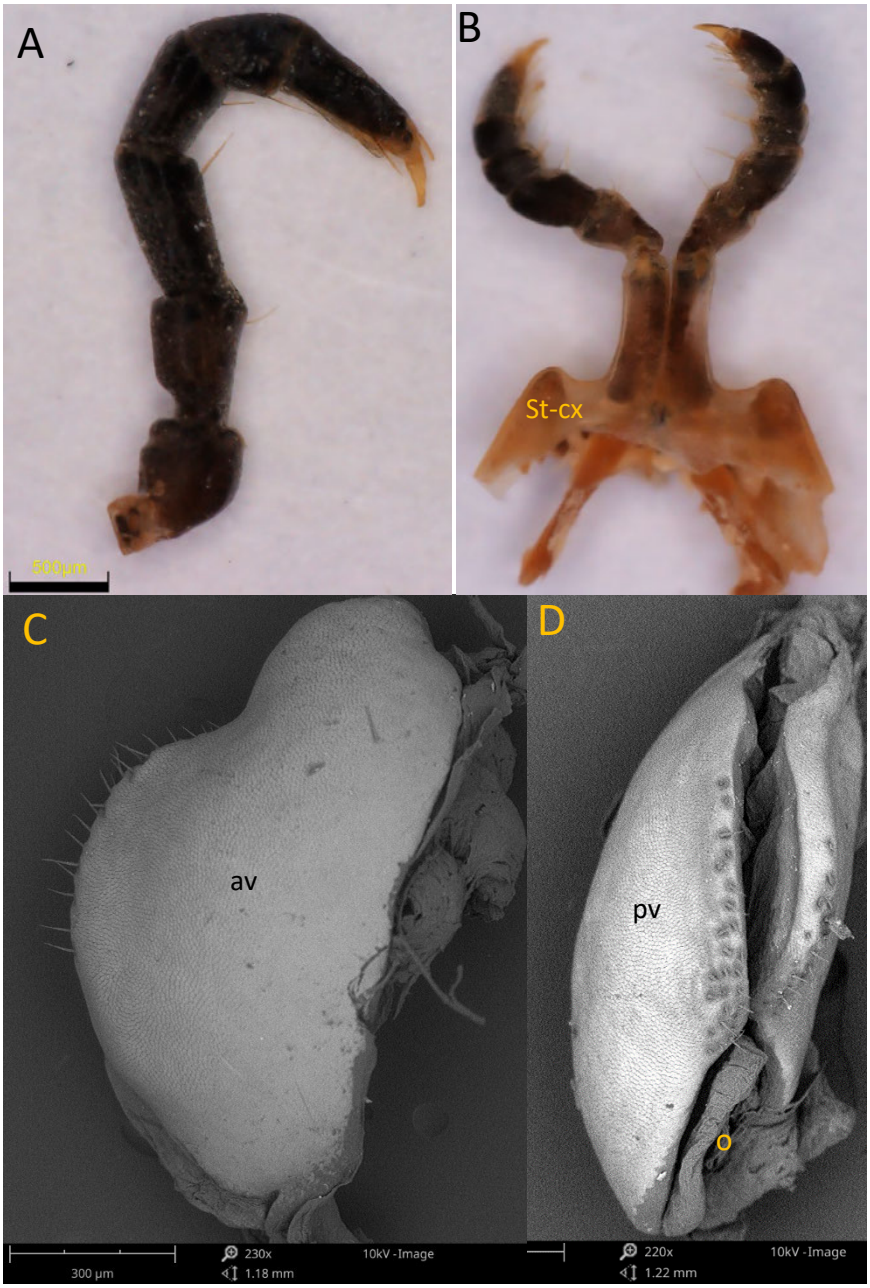

Figure 28: *Centrobolus anulatus* (South coast, KZN) ♀ (AJ1, UKZN). **A** male leg, **B** female second pair legs, **C-D** vulva, **C** lateral view, **D** anterior view. Abbreviations: av –anterior valve; o – operculum; pv – posterior valve; st-cx – coxosternite. Scale bars: 0.5 mm (**A**); 0.3 mm (**B**, **C**).

***Centrobolus atrophus* (Attems, 1928)**

Figs 29-33

Hamer 1998: 39.

Chersastus atrophus Attems, 1928: 306-307; Schubart 1966: 45; Hoffman 1971: 150-152.

Diagnosis. Differs from congeners in having the following combination of character states: distal process of telopodite of anterior gonopods with one round part, with lateral corner extended to form a beak-like projection (Figs 31C-D); presence of tarsal pads on all legs except first two pairs, absence of scobinae.

Redescription. *Measurements*: ♂ Total length 13-15mm, greatest width 2.5mm, 43+0+Tor 45+0+T body rings n= 6. ♀ Total length 10-13mm, greatest width 6mm, 45+0+T body rings, n=7.

Body sculpturing: Body shiny with transverse striation on the prozonites and with longitudinal, parallel, short striae with fine punctuation on the meso-metazonite area; scobinae absent (Fig. 30E).

Legs: Legs short; all legs with prominent tarsal pads except the first two pairs; tibia condensed with one apical bristle (Fig. 33).

Colour (after 121 years in ethanol): The body in general yellowish; head, antennae, legs, anal valves and preanal ring yellowish; body rings with yellowish metazonites, and prozonites (Figs 30A-D).

Gonopods: *Anterior gonopods*: Sternum of the anterior gonopods long, broad and rounded at the apex (Figs 31A-B). Lateral margin of coxa convex; distal part bent at about 45°; distal process of telopodite with one large, rounded part with lateral corner extended to form a beak-like projection (Figs 31C-D).

Posterior gonopods: Short and transparent; tibial process short, broad and smooth with seminal duct opening on its distal end; longitudinal efferent groove runs sideways with the telopodite and transparent; inflated basal lobe absent; distal process of telopodite short and pointed laterally (Fig. 32).

Female sexual characters: Unknown.

Type locality: SOUTH AFRICA: *Western Cape*: Orange Kloof Nek, Hout Bay, Cape Peninsula.

Type material (examined). Syntypes: 5♂ 4♀ SOUTH AFRICA: Western Cape, Orange Kloof Nek, Hout Bay, Cape Peninsula, 1898-04, Lightfoot R.M. (SAM-EWN-X007649)

Other material examined. SOUTH AFRICA: *Western Cape*: 1♂ Wellington, 1903-10, French G. (SAM-EWN-X013498). *Eastern Cape*: 3♀ Doornnek, Zuurberg Range, Alexandria Div., Drege J.L. (SAM-EWN-X007415).

Distribution: This species has been recorded from the Western and Eastern Cape provinces.

Remarks: Jeekel (1956) suggested that *C. atrophus* may be a synonym of *C. pococki* (Porat, 1893), and Schubart (1966) synonymised *atrophus* under *pococki*. However, Hoffman (1971) examined the lectotype of *pococki* and stated that the types of *atrophus* needed to be checked against his redescription of *pococki* before this synonomy could be confirmed, as there were some differences including the number of legs without tarsal pads (last six to eight pairs lacking in *atrophus*, while all legs have pads in *pococki*), and the absence of small denticles on the distal process of the telopodite in *pococki* while these structures were illustrated by Attems (1928) in his description of *atrophus*. Hoffman (1971) did provide an illustration of the gonopods of *C. pococki*, and both the anterior and posterior gonopods of the material of *atrophus* match these, with the exception of the small denticles. The type material of *atrophus* examined has tarsal pads on all the legs except the first two pairs, which does not match the original description, but Hoffman (1971) did state that the tarsal pads on the last six pairs of legs were reduced in the *pococki* specimen examined, and this could lead to them being overlooked, and this may be the case with Attems' (1928) description. Given the overlap in the distribution of *pococki* and *atrophus*, it would seem likely that these names represent a single species, but it would be useful to examine more material from the type locality to confirm this.

It was difficult to dissect the vulva of the female and so it could not be illustrated. The gonopods are very brittle, making it difficult to separate the posterior gonopods. The gonopods of the secondary type SAM-EWN-X007649 are missing. Attems (1928) did not designate a holotype however he gave three different locations with catalogue numbers.

Conservation assessment

This is a South African species described from the Cape Peninsula, Western Cape from material collected in 1898, and from a second locality in the mountainous Wellington area in 1903. Material from a third locality in the Eastern Cape, probably collected in the early 1900's, only includes female specimens and so this may not be a valid identification. The species has not been collected since 1903. The exact habitat of this species is uncertain, but it is probably forest. There has been recent collecting of millipedes in the forests on Table Mountain which is less

than 5km from the Orange Kloof locality but no specimens of *C. atrophus* were collected. The species could occur in the forests around Wellington but this area has not been well surveyed for millipedes.

If only the two known locations are considered the EOO would be about 3000km^2 and the AOO would be about 10km^2. Number of locations=2.

There has been extensive habitat loss on the Cape Peninsula through urbanisation, but Orange Kloof is a nature reserve and the Table Mountain forests are protected as well. In the Wellington area the lowlands have been transformed by agriculture but the mountainous areas have been minimally impacted. Natural disasters such as wildfire and drought are common in the Western Cape and may have impacted on *C. atrophus* populations.

Because there has been limited recent collecting of millipedes in the mountainous areas outside Cape Town, and the type locality has not specifically been sampled, it is difficult to assess the conservation status of this species. Its habitat may not be undergoing further degradation and the EOO and AOO may not decline, but it would qualify as Vulnerable on the basis of the small number of locations and the area covered by these (VU D2). More evidence is required to support this, and so *C. atrophus* is considered to be Data Deficient (DD).

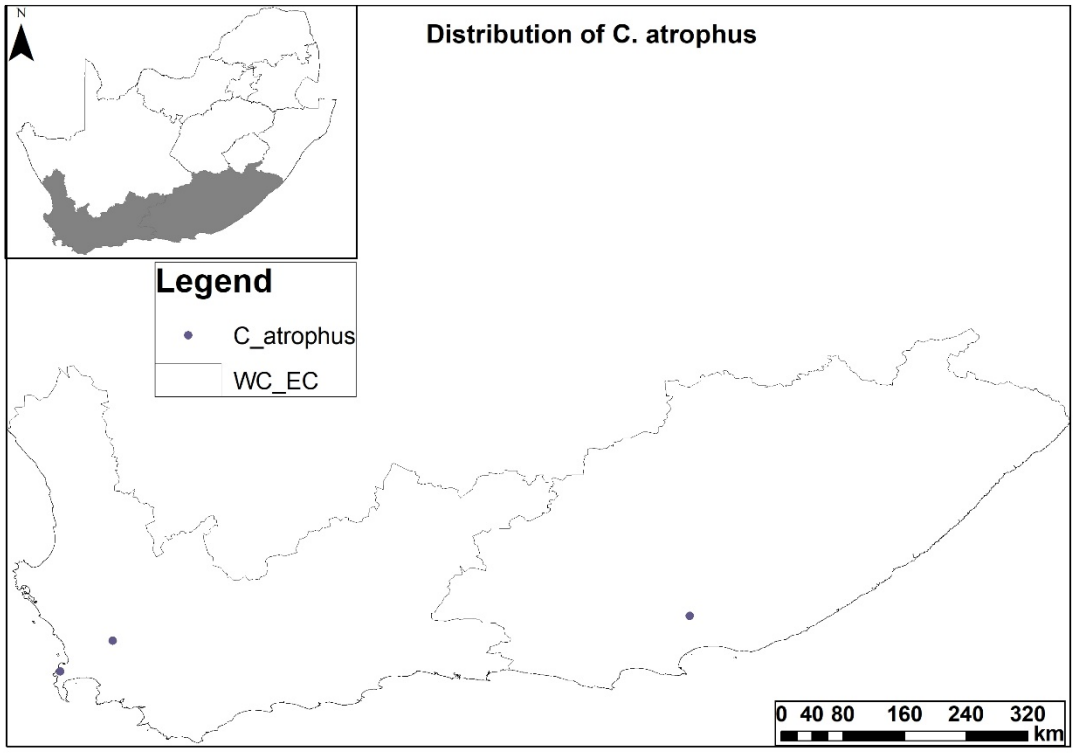

Figure 29: Distribution of *Centrobolus atrophus* in South Africa. EC-Eastern Cape, WC-Western Cape.

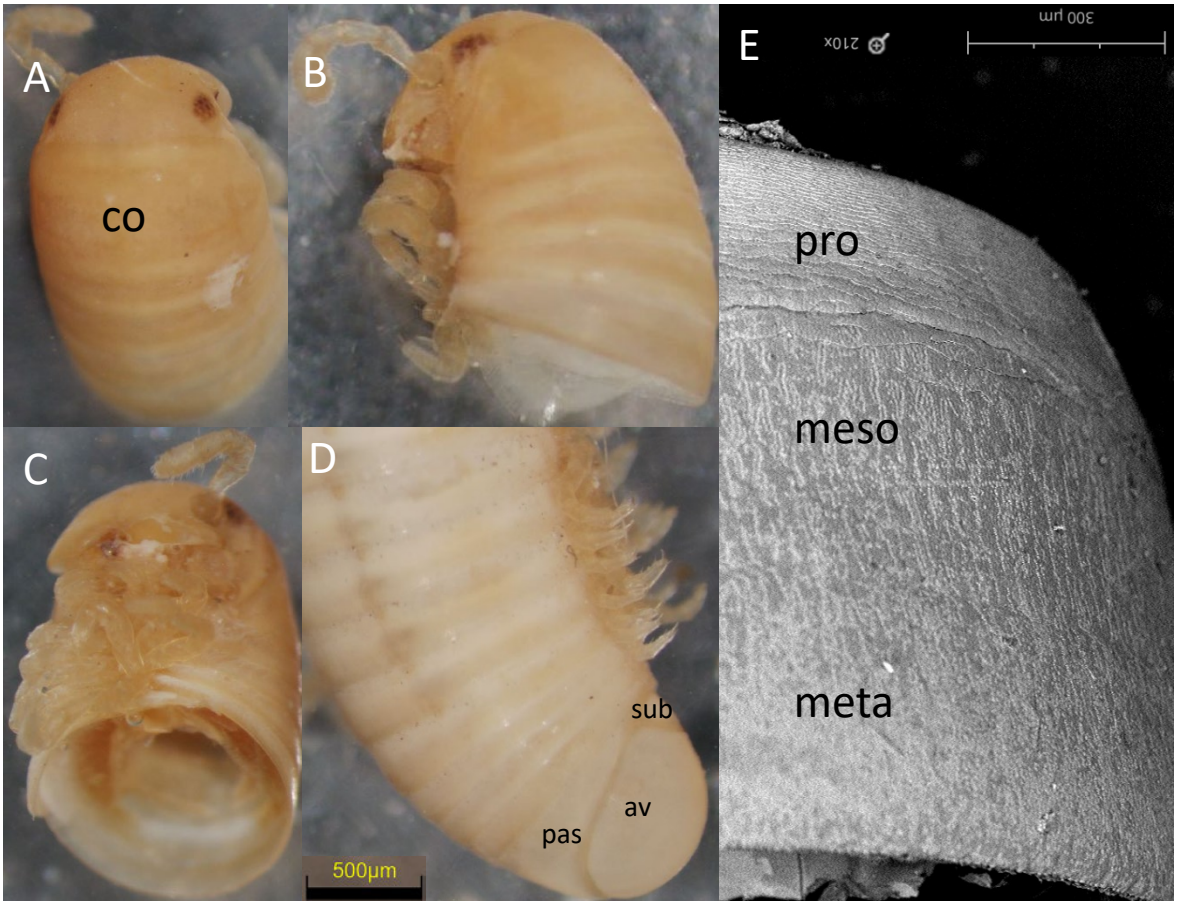

Figure 30: *Centrobolus atrophus* (Wellington, Western Cape) ♂ (SAM-ENW-X013498). **A** anterior view of the head and collum, **B** lateral view, **C** ventral view of the head and legs, **D** terminal region of body, **E** terminal region of body. Abbreviations: av - anal valve; co – collum; meta – metazonite; meso – mesozonite; par - preanal ring; pro – prozonite; sub - subanal scale . Scale bars: 0.5 mm (**A-D**); 0.3 mm (**E**).

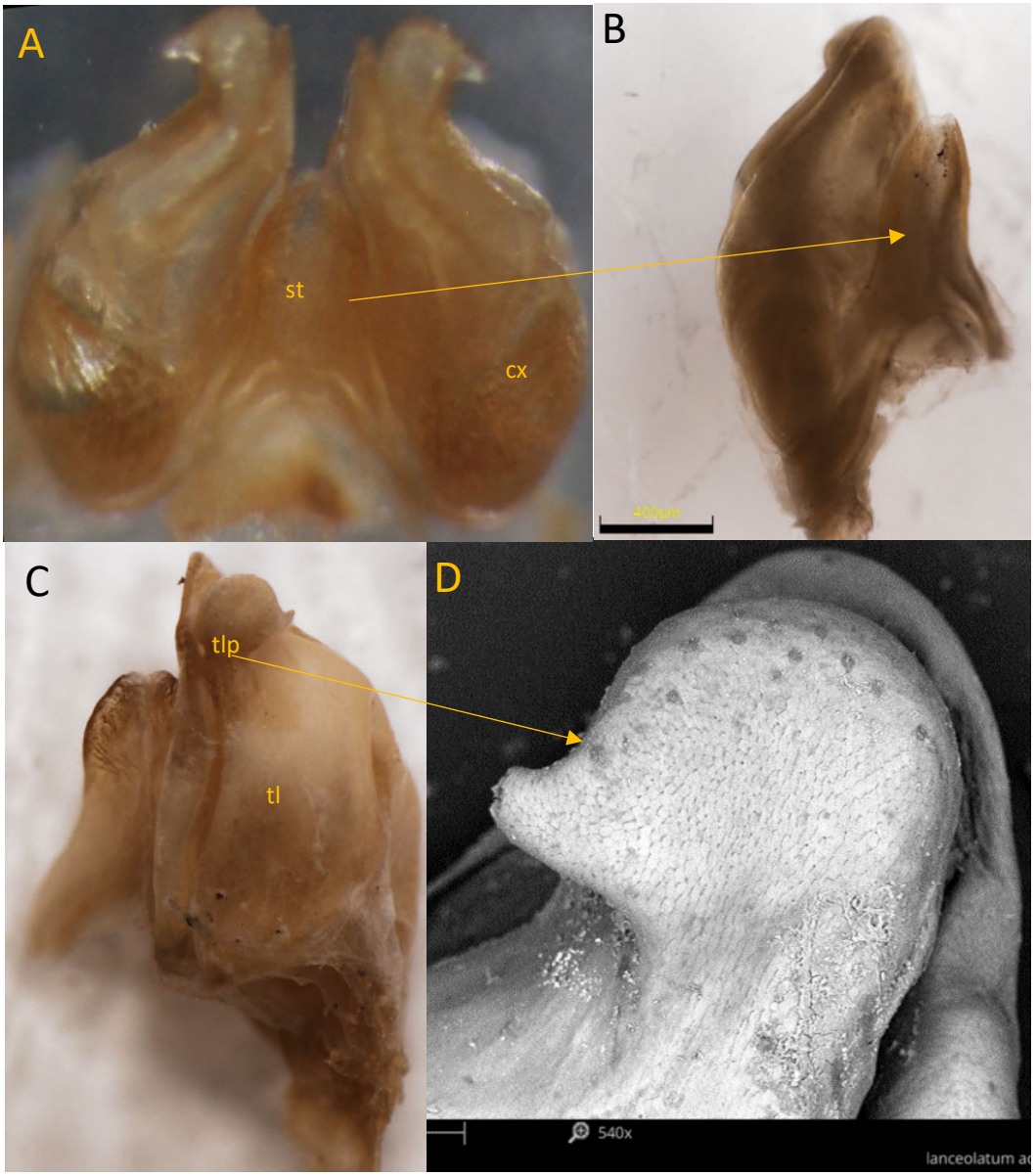

Figure 31: *Centrobolus atrophus* ♂ (SAM-ENW-X013498). **A-D** anterior gonopods, **A-B** anterior view, **B-E** posterior view. Abbreviations: cx – coxa; st – sternum; tl –telopodite; tlp - telopodite process. Scale bars: 0.4 mm (**A-C**); 0.001 mm (**D**).

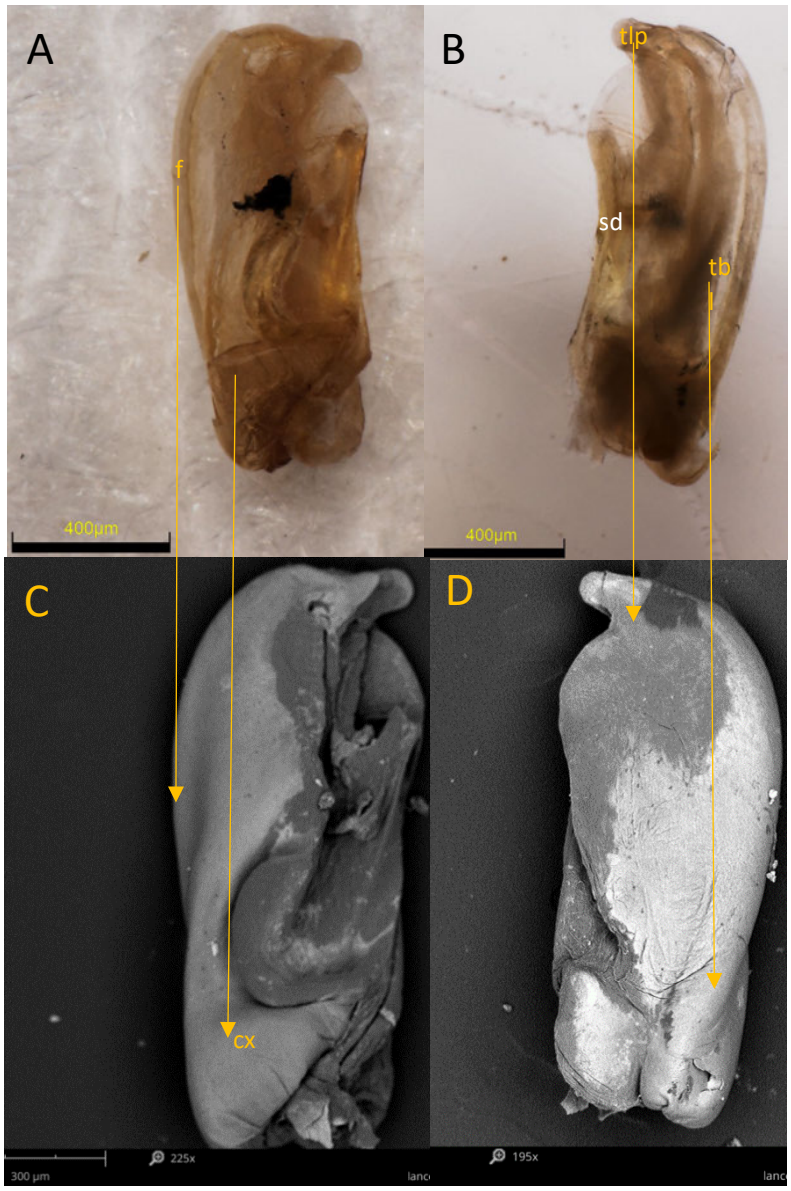

Figure 32: *Centrobolus atrophus* ♂ (SAM-ENW-X013498). **A-D** posterior gonopod; **A** & **C** anterior view, **B** & **D** posterior view. Abbreviations: cx – coxa; f - efferent groove; sd - seminal duct; tb - tibial process; tl – telopodite; tlp - telopodite process. Scale bars: 0.4 mm (A-B): 0.001 mm (**C-D**).

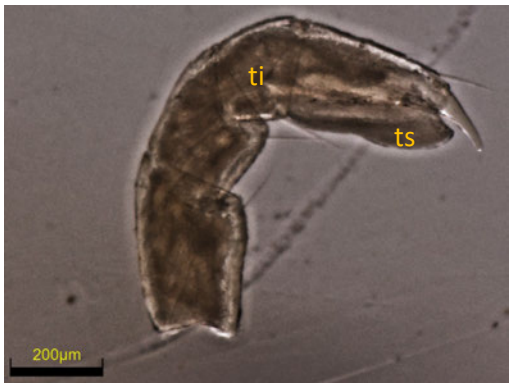

Figure 33: *Centrobolus atrophus* ♂ (SAM-ENW-X013498). Male leg. Abbreviations: ti – tibia; ts – tarsal pad.

***Centrobolus bifidus* (Lawrence, 1967)**

Figs 34-39

Hamer 1998: 39.

Chersastus bifidus Lawrence, 1967: 622.

Diagnosis. Differs from congeners in the anterior gonopods having the distal process of telopodite with a very long, thick, laterally directed process that is slightly down-curved (Figs 37C-D), and a large, broad and apically bifid sternum, and posterior gonopods with a prominent triangular distal telopodite process.

Redescription: *Measurements*: ♂ Total length 39-47mm, greatest width 5.6mm, 41+0+T body rings, n=6. ♀ Total length 45mm, greatest width 6mm, 41+0+T body rings, n=4.

Body sculpturing: Body shiny with microscopic punctures and minute striae; scobinae present but small (Figs 36E-F).

Legs: Legs long, extending beyond lateral margin of body rings; all legs with prominent tarsal pads except the first two pairs; tibia condensed with two apical bristles (Fig. 39A).

Colour (after 19 years in ethanol): The body in general reddish brown with blackish transverse bands; head and antennae black-brown (Figs 36A-B); collum reddish with posterior black/brown band (Fig. 36A), legs yellowish (Fig. 36C); preanal ring and valves reddish brown (Fig. 36D); body rings with black metazonites that gradually become reddish orange towards the suture, mesozonite reddish and yellow/light brown prozonites (Fig. 36E).

Gonopods: *Anterior gonopods*: Sternum of the anterior gonopod long, and reaching about three quarters height of coxae, broad and bluntly bifid at the apex (Figs 37A); lateral margin of the coxa concave, with coxal process broad and not entirely covering telopodite. Distal process of telopodite with two parts, apical one, flat and oval with few short setae and proximal one long, laterally directed and slightly down-turned (Figs 37B-C).

Posterior gonopods: Tibial process very narrow with uneven margins; seminal duct opens on the distal end of the tibial process; inflated basal lobe present; longitudinal efferent groove well developed and running entire length of gonopod, ending at the apex of the telopodite; distal process of telopodite prominent, narrow and apically acute, with attached membrane on its base (Fig. 38).

Female sexual characters: Distal margin of the lateral extensions of the coxosternum of second pair of legs broadly rounded, and moderate sized. Vulva simple, anterior valve overlaps

posterior one; posterior valve with distinct indentation on convex margin; both valves basally with two rows of setae; operculum poorly sclerotized (Figs 39B-C).

Type locality: SOUTH AFRICA: *KwaZulu-Natal*: Nkandla forest.

Type material (examined): *Holotype*: 1♂; Paratype 1♂ SOUTH AFRICA: KwaZulu-Natal, Nkandla forest, 1943-12, Lawrence R.F. (NMSA 4040).

Other material examined. SOUTH AFRICA: *KwaZulu-Natal*: 1♂ 1♀ Entumeni Nature Reserve, above trail near main (third) fall, Ngoje falls, in dry stream bed, 28°31'26.8"S, 31°13'14.5"E, Jun. 2000, Armstrong A.J. (NMSA-15956); 2♂ 2 ♀ Nkandla Forest Reserve, 2000-09, Armstrong A.J. (NMSA-15957); 1♂ 1♀ same data as the preceding specimen (NMSA-15958); 1♂ same data as the preceding specimen, 28°44'43.3"S, 31°08'08.7"E, 2003-10, (NMSA-22742); 1♂ same data as the preceding specimen (NMSA-25951).

Distribution. This species has only been recorded from two forests in northern KwaZulu-Natal.

Remarks. Lawrence (1967) did not provide a description of gonopods but he did illustrate these.

Conservation assessment

This is a South African species restricted to two localities in KwaZulu-Natal. Both localities have large scarp forests. The region is relatively well surveyed and so it is unlikely that *C. bifidus* is much more widely distributed. Based on the number of specimens collected since its discovery in 1943, it is unlikely to be very abundant.

Grazing and browsing by livestock in forests, alien invasive plants and harvesting of plants for medicines and timber may result in degradation of the habitat, but this is not a major risk since both known localities are in protected areas (Nkandla and Entumeni Nature Reserves). Because of the small number of known localities, the species is vulnerable to catastrophes such as fire. EOO = 230km^2 and AOO = 50km^2. Number of locations = 2.

Centrobolus bifidus meets the requirements for Vulnerable based on the number of locations being less than five (VU D2).

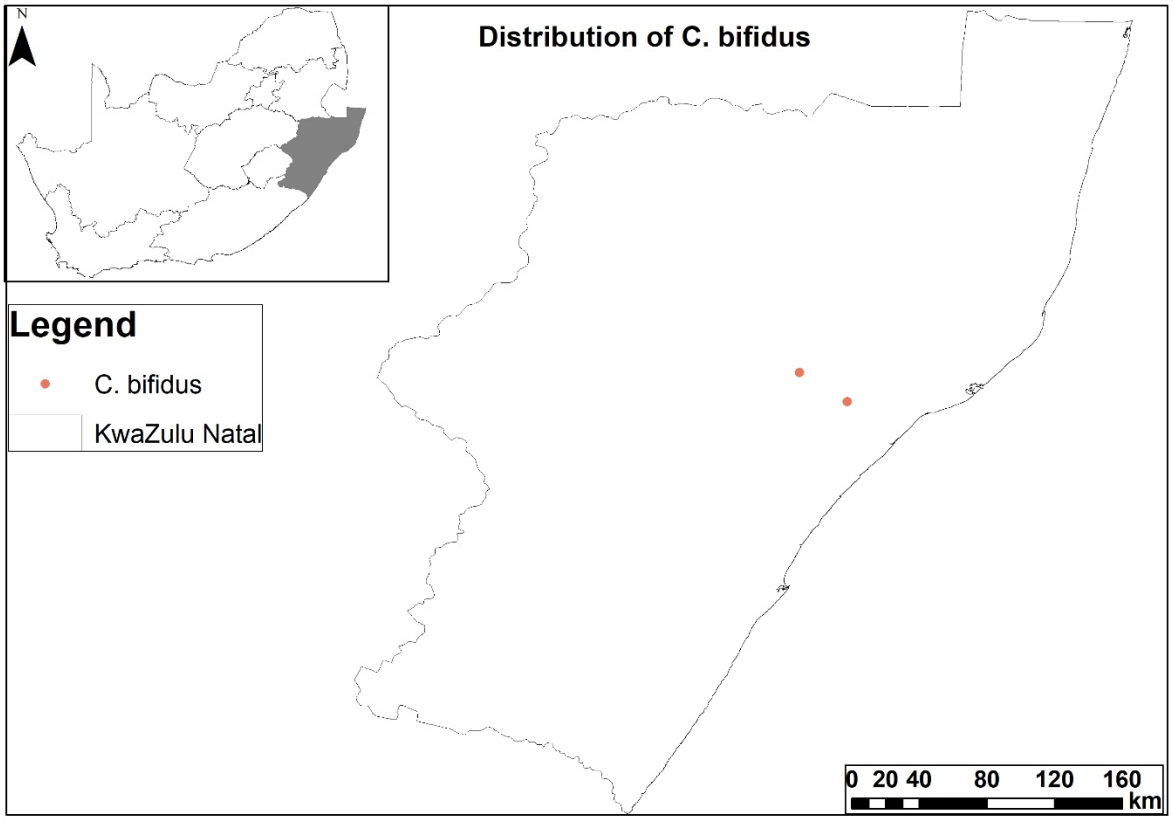

Figure 34: Distribution of *Centrobolus bifidus* in South Africa, KwaZulu-Natal.

Figure 35: *Centrobolus bifidus.* Photographer: Adrian Armstrong..

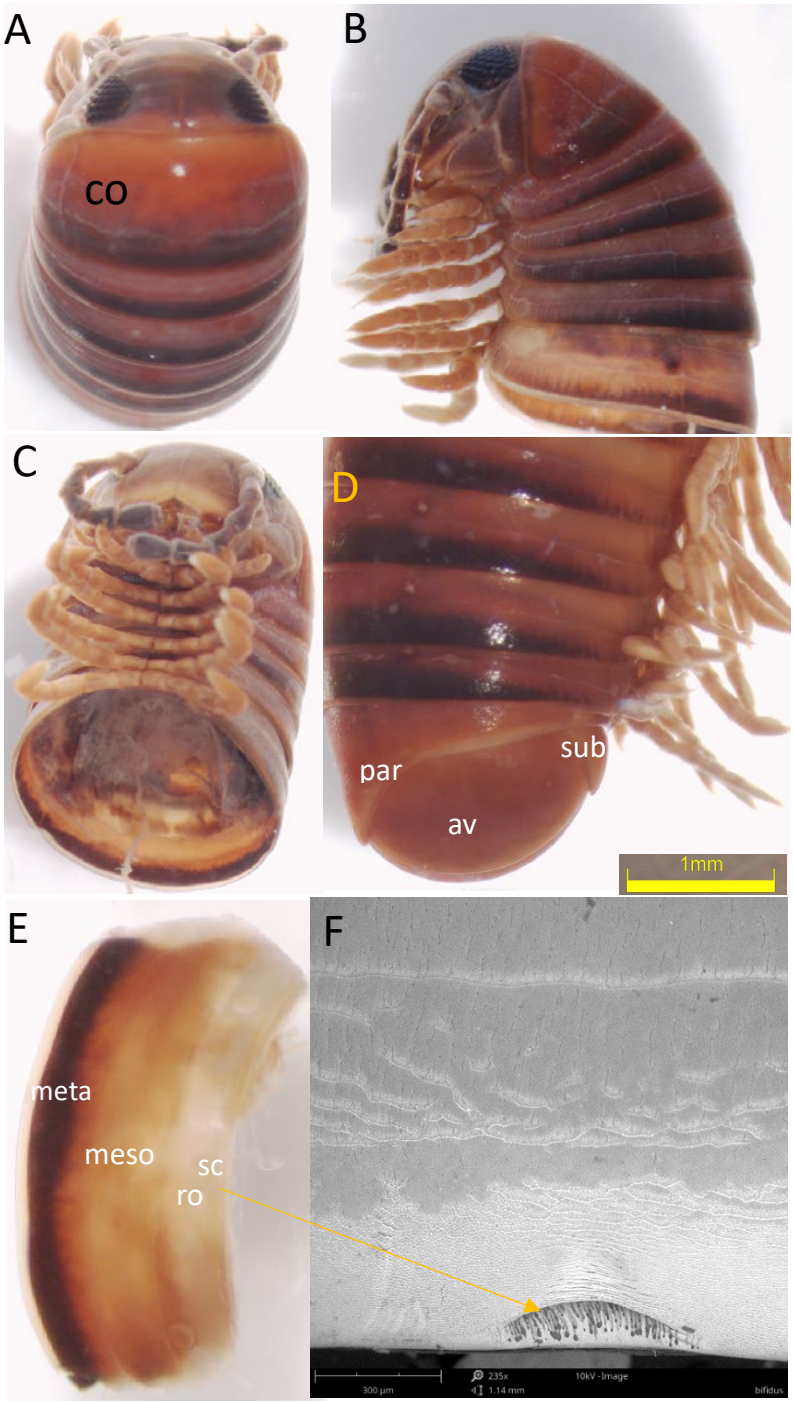

Figure 36: *Centrobolus bifidus* (Nkandla Forest Reserve, KwaZulu-Natal) ♂ (NMSA-15957). **A** anterior view of the head and collum, **B** lateral view, **C** ventral view of the head and legs, **D** terminal region of body, **E-F** body ring. Abbreviations: av - anal valve; co – collum; meta – metazonite; meso – mesozonite; par - preanal ring; pro – prozonite; sc – scobina; sub - subanal scale. Scale bars: 1.0 mm (**A-D**); 0.3 mm (**F**).

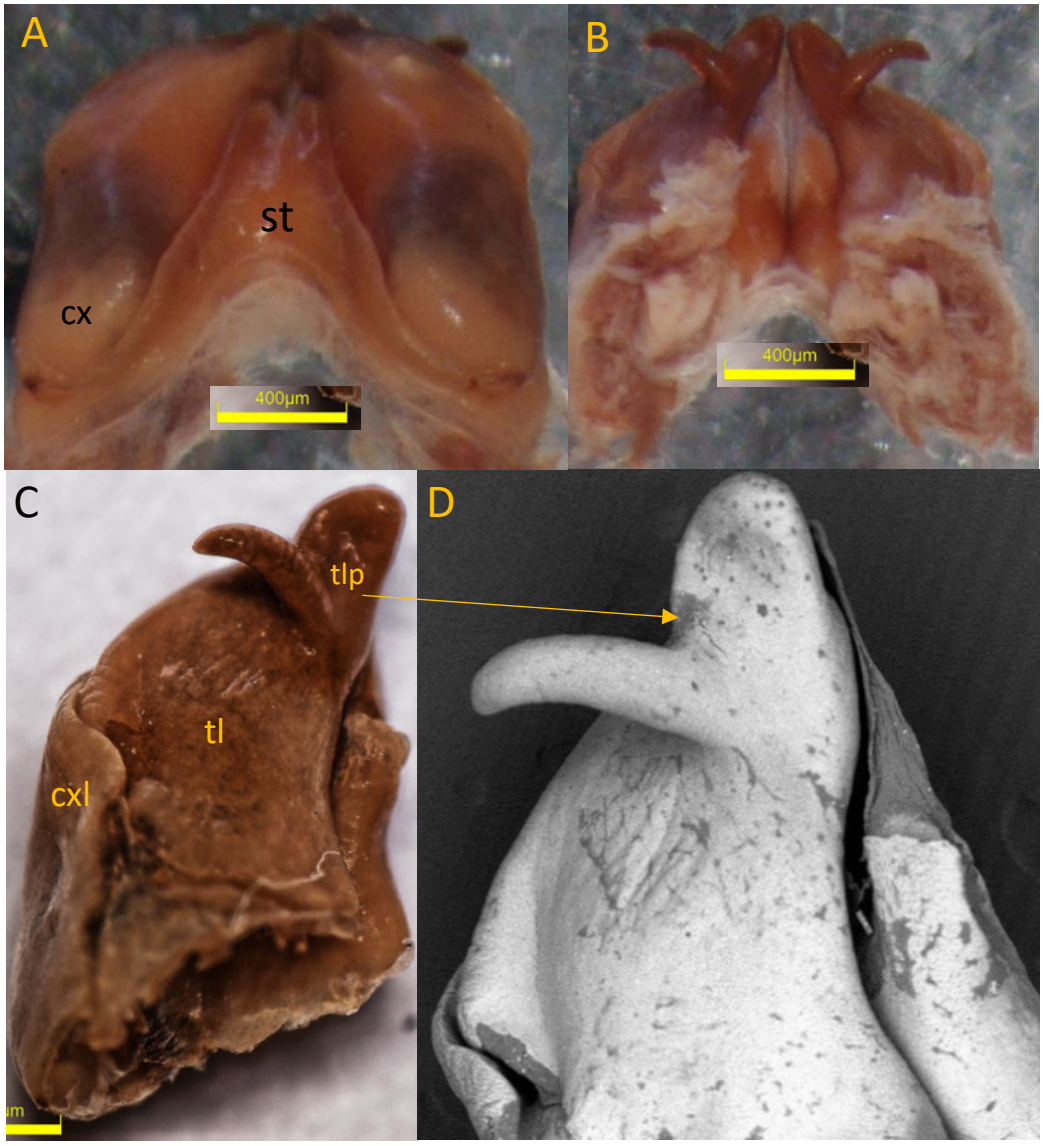

Figure 37: *Centrobolus bifidus* ♂ (NMSA-15957). **A-D** anterior gonopods, **A-B** anterior view, **C-D** posterior view. Abbreviations: cx –coxa; cxl - coxal endite lobe; st – sternum; tl – telopodite; tlp - telopodite process. Scale bars: 0.4 mm (**A-C**); 0.3 mm (**D**).

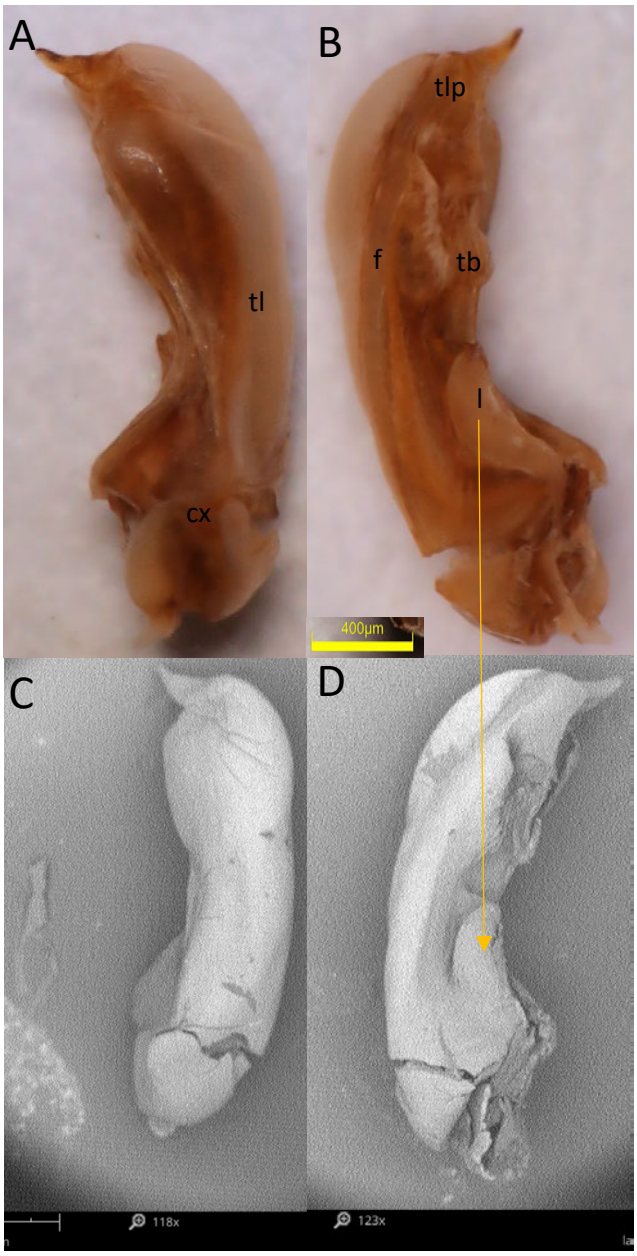

Figure 38: *Centrobolus bifidus* ♂ (NMSA-15957). **A-D** posterior gonopod; **B** & **D** anterior view, **A & C** posterior view. Abbreviations: cx – coxa; f -efferent groove; l – inflated basal lobe; tb - tibial process; tl – telopodite; tlp - telopodite process. Scale bars: 0.4 mm.

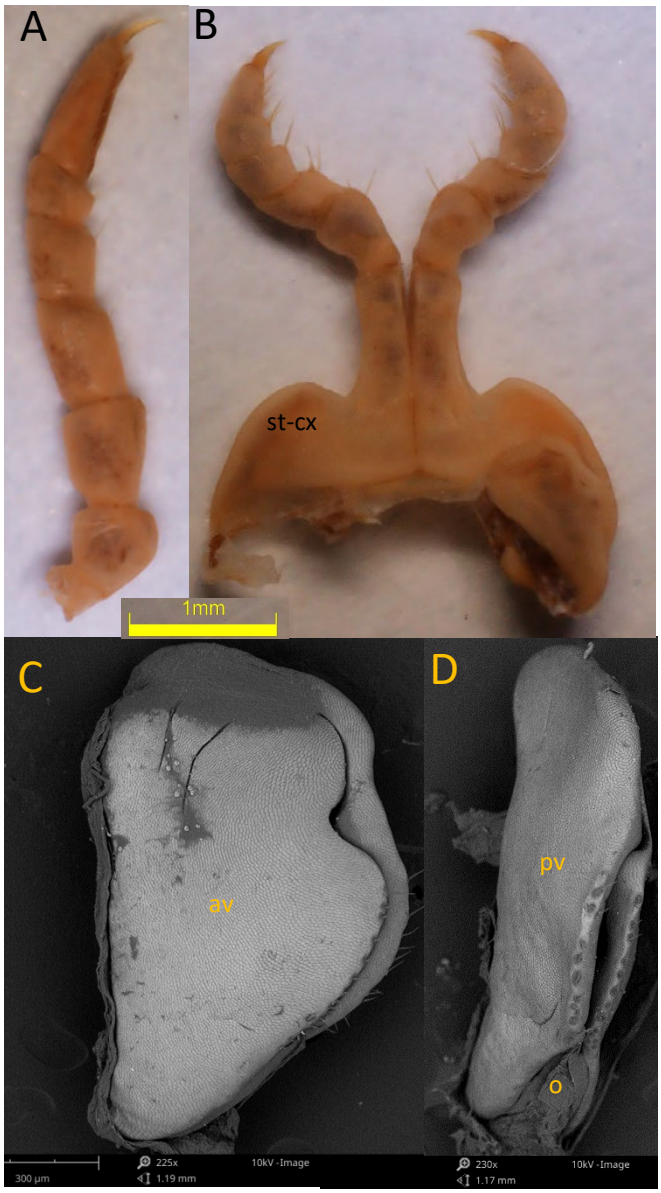

Figure 39: *Centrobolus bifidus* ♀ (NMSA-15757). **A** male leg, **B** female second leg pair, **C-D** vulva, **D** lateral view, **C** posterior view. Abbreviations: av - anterior valve; o – operculum; pv - posterior valve; st-cx- coxosternite. Scale bars: 1.0 mm (**A-B**); 0.3 mm (**C-D**).

***Centrobolus coriaceus* (Porat, 1872)**

Hamer 1998: 39-40.

Spirobolus coriaceus Porat, 1872: 19-20; Attems 1928: 308; Jeekel 1956: 95.

Chersastus coriaceus Schubart 1966: 62.

Description. Original description by Porat (1872): ♀ Total length 58mm, greatest width 6.2mm, 42 body rings.

Body sculpturing: eyes with 55 ommatidia; striations concentric

Colour: body reddish-black with grey-black spots; head and antennae black; preanal ring and anal valves reddish-brown; legs rusty-brown.

Remarks. The description was based on a female type and no illustration was provided. The distribution was stated as "Caffraria" and there is no precise locality provided. According to Jeekel (1956), *C. coriaceus* cannot be separated from *C. vulpinus* but without male specimens, synonomy cannot be confirmed and so this species is considered *incertae sedis*.

***Centrobolus decoratus* (Lawrence, 1967)**

Figs 40-44

Hamer 1998: 40.

Chersastus decoratus Lawrence, 1967: 616.

Diagnosis. Differs from congeners in having distal process on the anterior gonopod telopodite with two parts; the distal most one a large, roughly rounded triangular shape, whilst the proximal one projects laterally, basally thick but tapered to a slightly hooked and acute apex (Figs 42C-D); a relatively short and apically bifid sternum of the anterior gonopods; the posterior gonopods with small inflated basal lobe; all legs except the first two pairs with large tarsal pads in male, and large scobinae present.

Redescription: *Measurements*: ♂ Total length 43mm, greatest width 4.5mm, 41+0+T body rings, n=3. ♀ Total length 31mm, greatest width 4.2mm, 41+0+Tbody rings, n=1.

Body sculpturing: Body shiny and smooth with minute punctuation and longitudinal parallel striae; scobinae present, large and deeply impressed with a triangular shape (Figs 41E-F).

Legs: Legs fairly long, reaching the edge of the body rings when extended; all legs with prominent tarsal pads except the first two pairs; tibia very condensed with two apical bristles (Fig. 44).

Colour ♂ (after 59 years in ethanol): The body in general blackish to brownish; head, antennae, anal valves and preanal ring blackish-brown; legs yellowish (Figs 41A-D); body rings with black metazonites, brownish mesozonites and light brown prozonites (Fig. 41E).

Gonopods: *Anterior gonopods*: Sternum short with a bifid apex (Figs 42A-B); lateral margin of coxa convex, with coxal process broad and not entirely covering telopodite; distal process on the anterior gonopod telopodite with two parts; the distal most one a large, roughly rounded triangular shape, whilst the proximal one projected laterally, basally thick but tapered to a slightly hooked and acute apex (Figs 42C-D).

Posterior gonopods: Slender; tibial process short, broad and smooth with seminal duct opening on its distal end; longitudinal efferent groove runs along the length of the telopodite; transparent, inflated basal lobe present but small; distal process of telopodite short and pointed laterally (Fig. 43).

Female sexual characters: Unknown

Type locality: SOUTH AFRICA: *KwaZulu- Natal*: Ngome Forest.

Type material (examined). *Syntypes*: 1♂ 1♀ SOUTH AFRICA: KwaZulu-Natal, Ngome Forest, near Nongoma, 1960-12, Lawrence R.F. (NMSA-08156).

Other material examined: SOUTH AFRICA: *KwaZulu-Natal*: 2♂, same data as the syntypes.

Distribution: This species has only been recorded from one forest locality in KwaZulu- Natal. Two surveys at Ngome Forest in the 1990s did not provide any specimens of this species, and so it is probably uncommon (Hamer, pers. comm).

Remarks: Lawrence (1967) designated one male and one sub-adult female as the "Holotypes"; but since there are two specimens, these are reffered to here as syntypes. The vulva of female cannot be dissected because of the type status of the one female specimen, and this is not fully mature and so is unlikely to have fully developed vulvae. No other females of this species have been collected. Lawrence (1967) did not illustrate the posterior gonopods of this species nor give descriptions of the gonopods, but he did illustrate the anterior gonopods. The tibia of the legs were found to have two bristles as opposed to Lawrence' s (1967) description.

Conservation assessment

This is a South African species only known from Ngome Forest in KwaZulu-Natal. While it is possible that this species occurs in other forests in northern KwaZulu-Natal, the region is relatively well surveyed. Ngome Forest is known to have a number of narrow range endemics, including the millipede *Doratogonus avius* Hamer, 2000 and so it is possible that this is the only locality for *C. decoratus*.The population size is unknown, but this species is probably not abundant. Only four specimens of mature individuals were available in collections for this study. There is no immediate threat to the Ngome Forest and it does have protected status, although forest margins may be degraded by alien invasive species, grazing by cattle and fire. Surrounding areas have large scale commercial timber plantations but these are not a direct threat to the forest habitat.

The AOO is likely to be < 20 km² (estimated to be 16 km²) and *C. decoratus* is only known from one location. It is therefore qualifies as Vulnerable (VU D2).

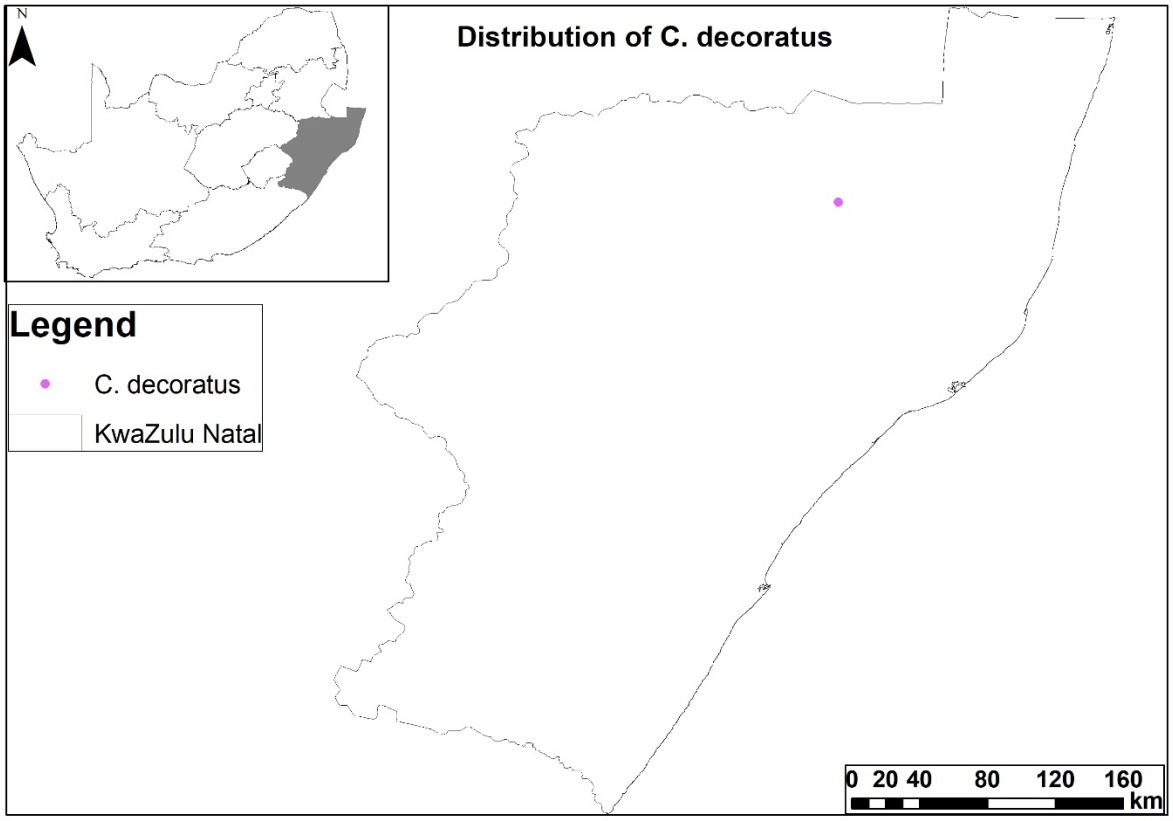

Figure 40: Distribution of *Centrobolus decoratus* in South Africa, KwaZulu-Natal.

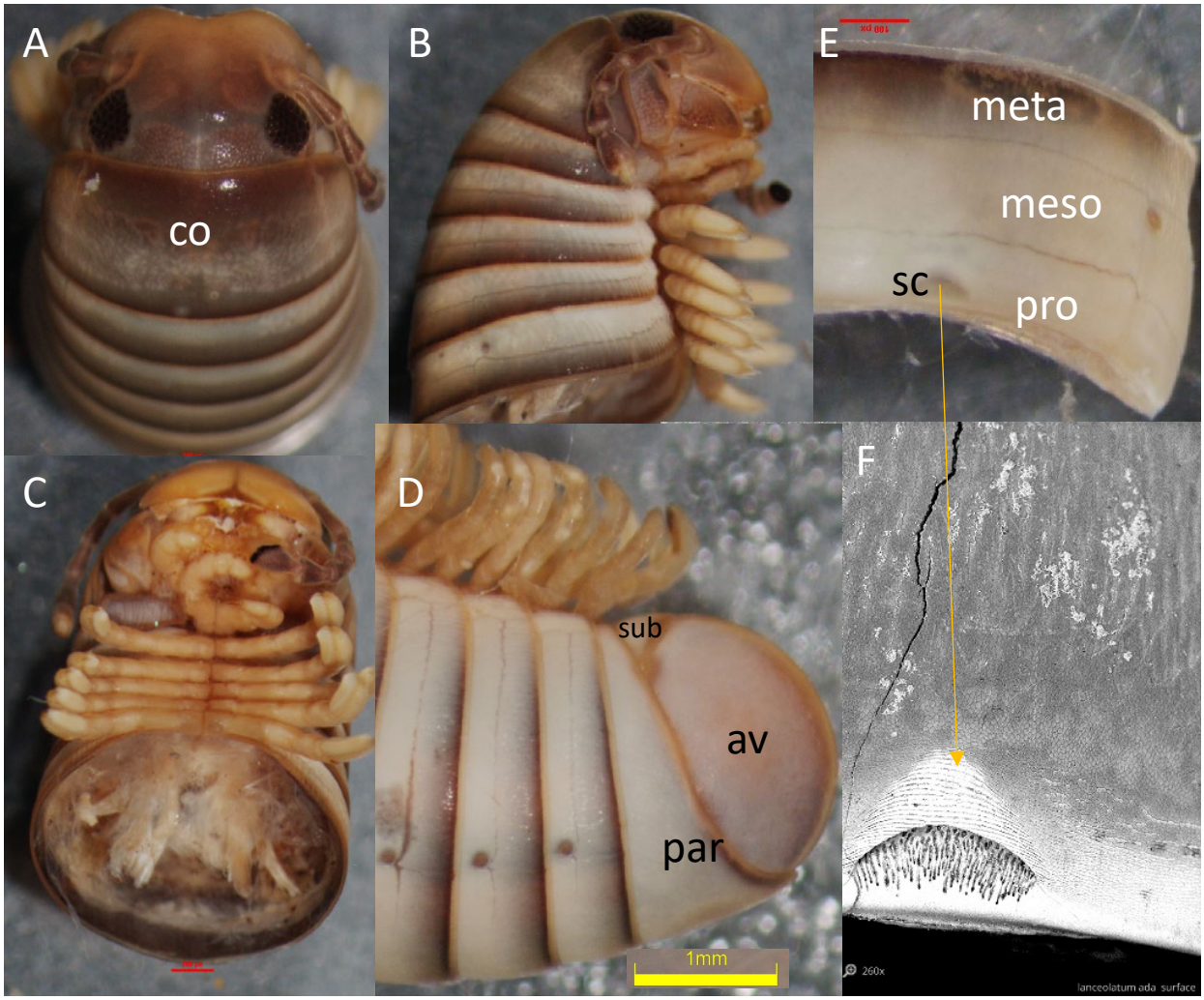

Figure 41: *Centrobolus decoratus* (Ngome Forest, KwaZulu-Natal) ♂ (NMSA-8156). **A** anterior view of the head and collum, **B** lateral view, **C** ventral view, D terminal region of the body, **E-F** body ring. Abbreviations: av - anal valve; co – collum; meta –metazonite; meso – mesozonite; par - preanal ring; pro – prozonite; sc – scobina; sub - subanal scale. Scale bars: 1.0 mm (**A-E**); 0.3 mm (**E**).

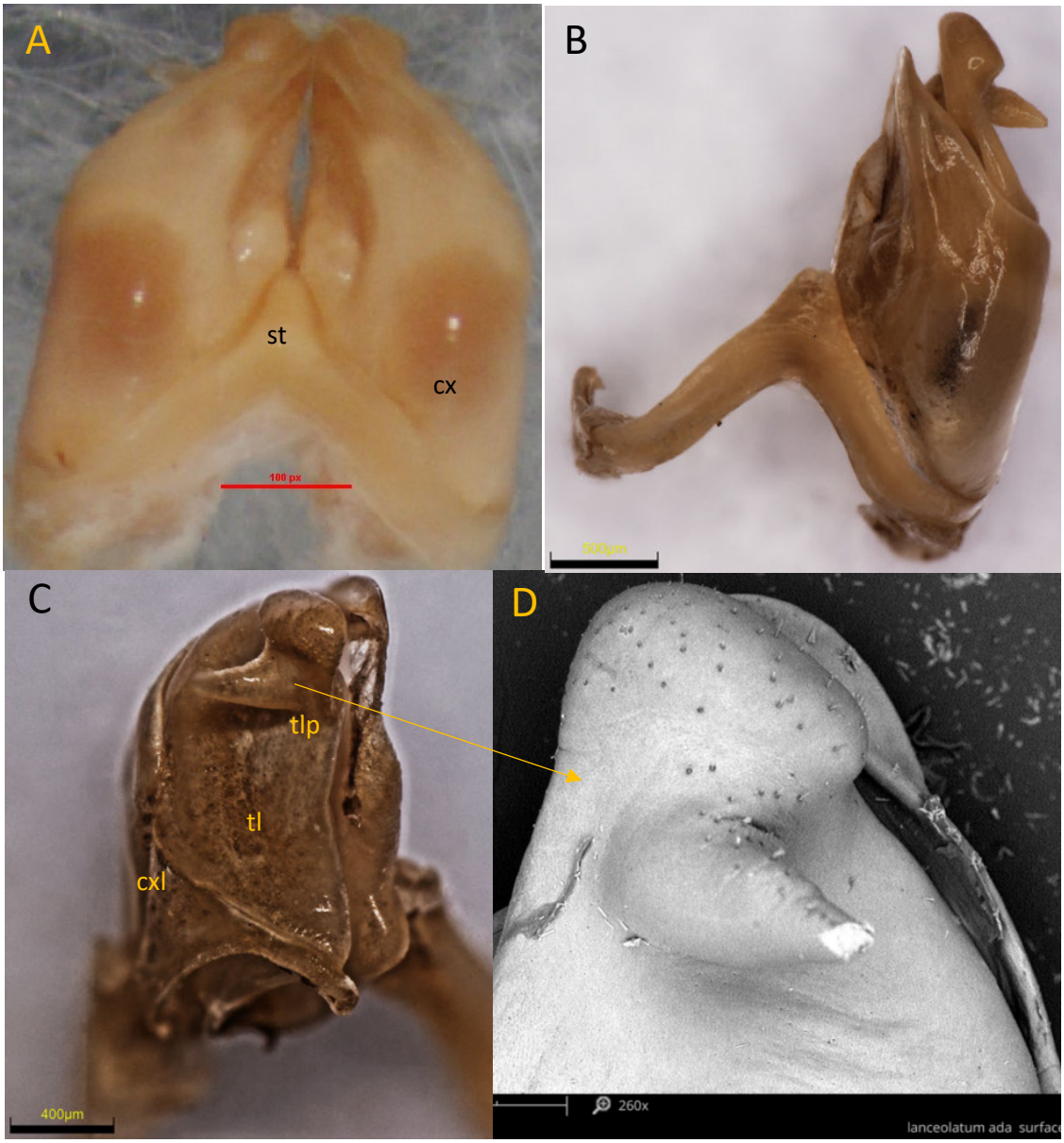

Figure 42: *Centrobolus decoratus* ♂ (NMSA-8156). **A-D** anterior gonopods; **A-B** anterior view, **C-D** posterior view. Abbreviations: cx – coxa; cxl - coxal endite lobe; st – sternum; tl – telopodite; tlp - telopodite process. Scale bars: 1.0 mm (**A**, **B**, **D-F**); 0.3 mm (**C**).

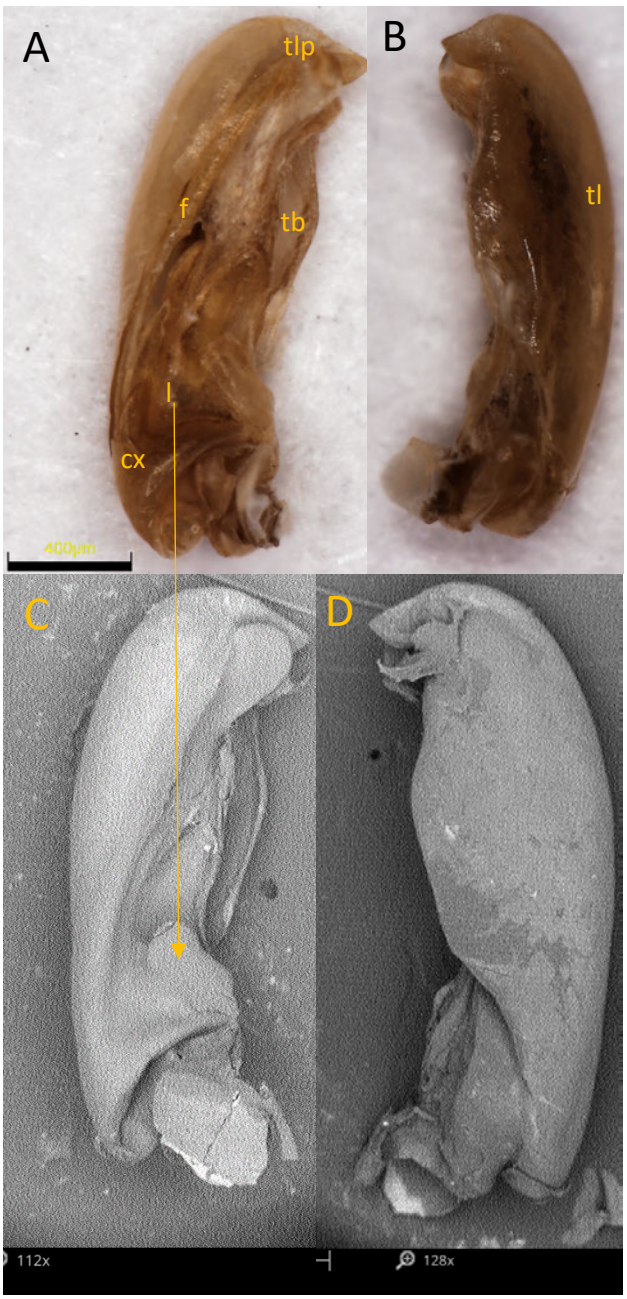

Figure 43: *Centrobolus decoratus* ♂ (NMSA-8156). **A-D** posterior gonopod; **A** & **C** posterior view, **B** & **D** posterior view. Abbreviations: cx – coxa; f - efferent groove; l – inflated basal lobe; tb - tibial process; tl – telopodite; tlp - telopodite process. Scale bars: 0.5 mm.

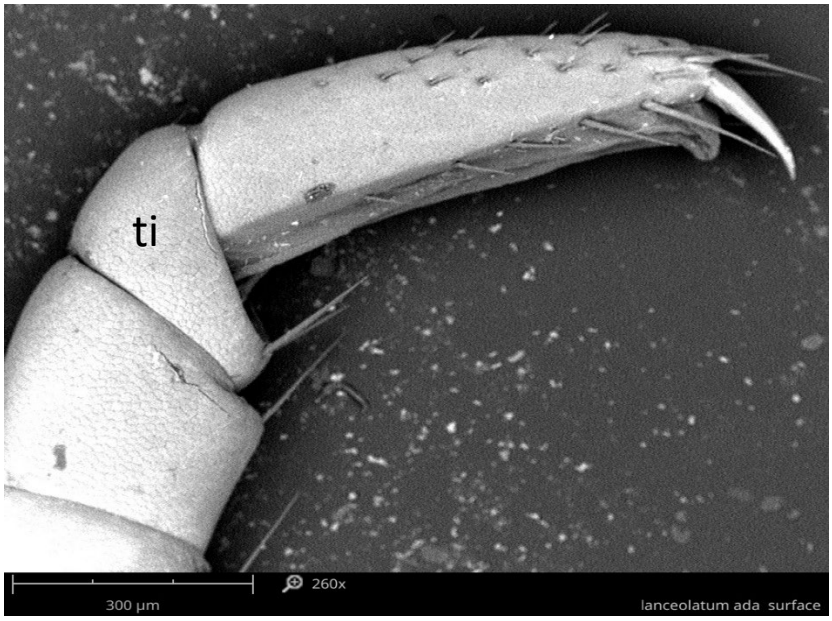

Figure 44: *Centrobolus decoratus* ♂ (NMSA-8156). Male leg. Abbreviation: ti –tibia. Scale bar: 0.3 mm.

***Centrobolus digrammus* (Pocock, 1893)**

Figs 45-49

Hamer 1998: 40.

Spirobolus digrammus Pocock, 1893: 138-139.

Spirobolus sabulosoides Porat, 1893: 33.

Chersastus fasciatus Attems, 1928: 301-302; Attems 1934: 476; Jeekel 1956: 93, 96.

Chersastus digrammus Schubart, 1966: 57-62; Lawrence 1967: 636.

Diagnosis. Differs from congeners in having a combination of the following character states: all legs except first two with tarsal pads; two rows of dorso-median red spots along the body; collum with anterior and posterior red "M" shapes on a blackish background; anterior gonopods rectangular in anterior view, with median corner of coxae narrowly extended; telopodite process distally extended and apically rounded, with swollen distal region forming oval protuberance with lateral corner pointed; proximal part present, short and broadly triangular (Figs 47B-C).

Redescription. *Measurements*: ♂ Total length 39-47mm, greatest width 5.6mm, 41+0+Tbody rings, n=6. ♀ Total length 30-45mm, greatest width 6mm, 41+0+T body rings, n=4.

Body sculpturing: Body shiny with microscopic punctures and minute striae; scobinae present, small and narrow (Fig. 46E).

Legs: Legs long, extending beyond lateral margin of the body rings; all legs with prominent tarsal pads except the first two pairs; tibia standard length and width, with one apical bristle (Fig. 49A).

Colour (after 19 years in ethanol): The body in general blackish-grey with two dorso-median rows of large red spots arranged longitudinally; anterior part of head yellowish and black posterior half; antennae reddish brown (Figs 46A-C); collum black with reddish markings at the anterior and posterior margins forming an M-shape (Fig. 46A); legs yellowish; preanal ring and anal valves reddish brown (Fig. 46D); body rings with black metazonites with red spots, gradually becoming reddish-orange towards the suture, mesozonites greyish with two large red spots; yellow/light brown prozonites (Fig. 46).

Gonopods: *Anterior gonopods*: Sternum of the anterior gonopod long, reaching the third quarter of the anterior gonopods, apically blunt and slightly bifid (Fig. 47A). Shape of anterior gonopods roughly rectangular in anterior view, with robust coxae, with lateral margins slightly convex, distal part of coxae bent inwards at about 30° angle and with median corners extended into acute point (Figs 47A). Distal process of telopodite with two parts, distally extended and

apically rounded, with swollen distal region forming oval protuberance with lateral corner pointed; proximal part, short and broadly triangular (Figs 47B-C).

Posterior gonopods: Telopodite bent inwards; tibial process short, broad and smooth with seminal duct opening on its distal end; longitudinal efferent groove runs parallel to the length of the telopodite; transparent; inflated basal lobe absent; distal process of telopodite with finger-like projections at the apex (Fig. 48).

Female sexual characters: Second pair of legs with distal margin of lateral extension of coxosternum slightly narrowed and triangular (Figs 28A). Vulva extremely small; roughly bean-shaped; both valves basally with one row of setae; operculum poorly sclerotized; anterior valve slightly overlaps the posterior one (Figs 49B-C).

Type locality: SOUTH AFRICA: *Western Cape*: Hout Bay.

Type material (not examined): *Holotype*: ♂ SOUTH AFRICA: Western Cape, Simon`s Bay, 1893, Pocock R.I. (BMNH).

Material examined. SOUTH AFRICA: *Western Cape*: 3♂ 4♀ Table Mountain, Skeleton Gorge Forest, 1985-10, Griswold C., Griswold T.M. & Doyen J. (NMSA-15568); 2♂ Plattenberg, Kogelberg, Cooper M. (NMSA-15717); 1♂ 1♀ Hout Bay Valley, leaf litter, 1997-04, Cooper M. (NMSA-15730); 4♀ 5 juveniles, Philadelphia, 1978-05, Prins A.J. (SAM-ENW-002944); 2♂ River Zonde Ende, Caledon, 1933-09, Hesse R.F. & Thorne A.J. (SAM-ENW-B8361).

Distribution: This species has been recorded from the Western Cape province but there were specimens identified as *fasciatus* from Durban but this material only included females hence this locality was questioned by Attems (1928). There were also localities from the Eastern Cape listed by Attems (1928) for *fasciatus* (Grahamstown, Graaf-Reinett and East London). This material is lodged in the SAM under *Chersastus fasciatus*. Lawrence (1967) had questioned the localities for *digrammus* in the Karoo (Graaf-Reinett, Prince Albert and Cookhouse) as doubtful, but he stated that he had examined material from Alexandria Forest near Port Elizabeth and he identified this as *digrammus* but as a darker form of the species.

Remarks: The type material for *digrammus, fasciatus* and *sabulosoides* is housed in institutions overseas and so it was not examined, but the synonymy was confirmed by Hoffman (1971). It is possible that *C. promontorius* (Schubart, 1966), which was described from Hout Bay, the type locality of *C. fasciatus*, is also a synonym of *digrammus*, but without examining the type material, this cannot be confirmed. The illustrations of C. *fasciatus* gonopods by Attems (1928) and Schubart (1966) are very poor. There is uncertainty about whether the type

locality of *C. digrammus* is Hout Bay, as stated by Hoffman (1971) or Simons Town as stated by Pocock (1893).

Conservation assessment

This is a South African species described from Western Cape in 1893. The species is relatively common in tAfromontane forest in the Western Cape. *Centrobolus digrammus* has been recorded from Skeleton Gorge on Table Mountain which is a protected area. The other localities are not protected and there are no conservation actions in place for this species. The population size is unknown, but appears to be fairly abundant based on two ecological studies carried out over the last 15 years (Pryke 2008; Uys 2012).The threats for this species include loss of habitat due to urbanisation and wild fires are also a threat.

If only the confirmed localities in the Western Cape are considered, the EOO is approximately 5 000 km² and the AOO is approximately 24 km², although this is difficult to determine with any certainly. The number of confirmed locations is six. This species has almost certainly lost habitat due to high density, large scale urbanisation and agriculture, but without knowledge of the exact locations or the EOO, it is not possible to know whether the loss is ongoing. While *C. digrammus* may qualify as Vulnerable (B1, B2, a,b,I,ii,iii), the uncertainty means that it has to be categorised as Data Deficient (DD).

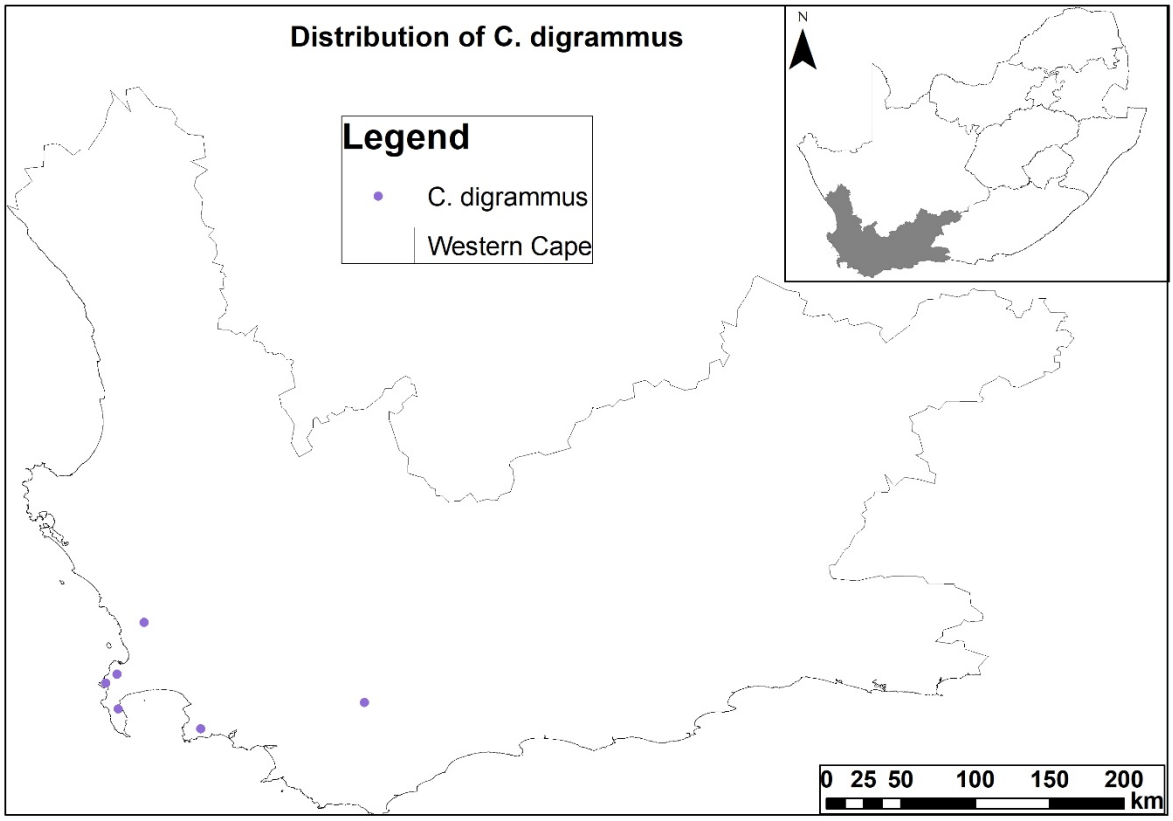

Figure 45: Distribution of *Centrobolus digrammus* in South Africa, Western Cape.

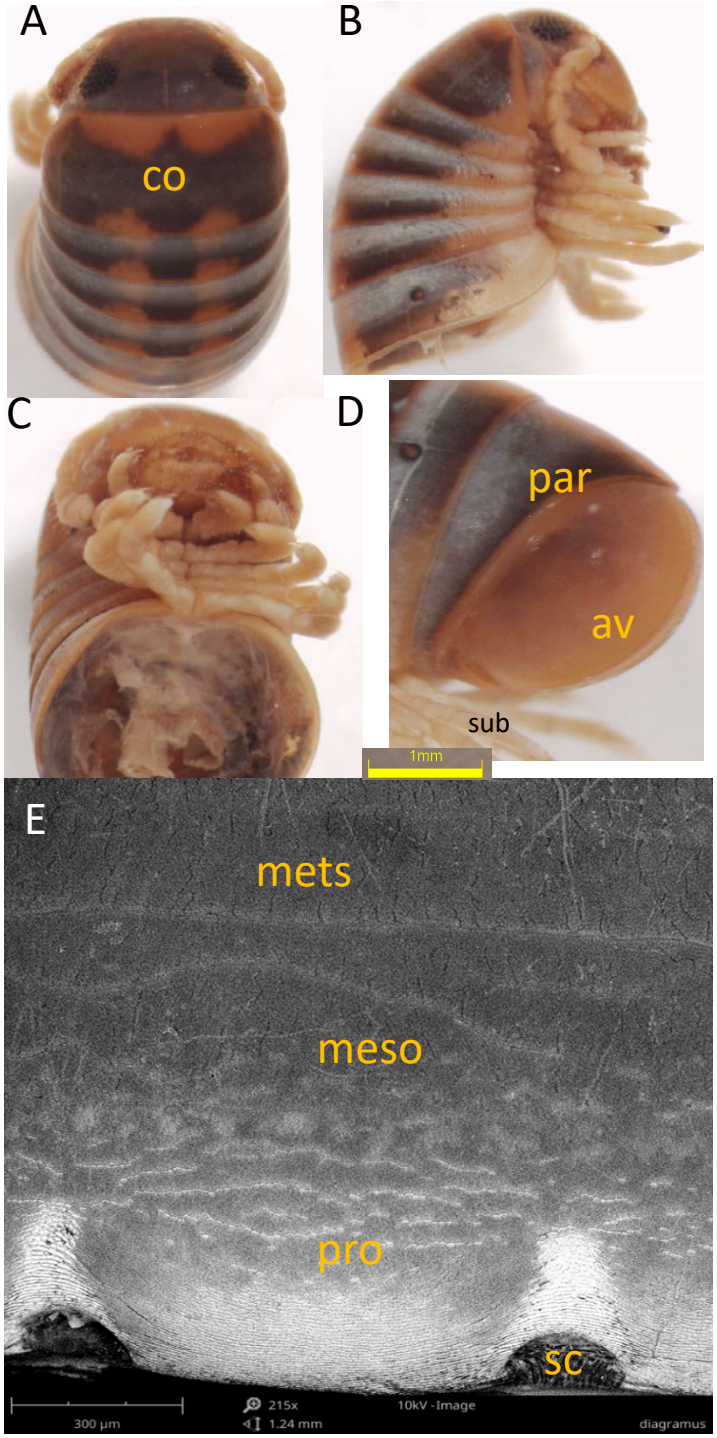

Figure 46: *Centrobolus digrammus* (Table Mountain, Skeleton Gorge Forest, Western Cape) ♂ (NMSA 15568). **A** anterior view of the head and collum, **B** lateral view, **C** ventral view, **D** terminal region of body, E terminal region of body. Abbreviations: av - anal valve; co – collum; meta – metazonite; meso – mesozonite; par - preanal ring; pro – prozonite; sc – scobina; sub - subanal scale. Scale bars: 1.0 mm (**A-D**); 0.3 mm (**E**).

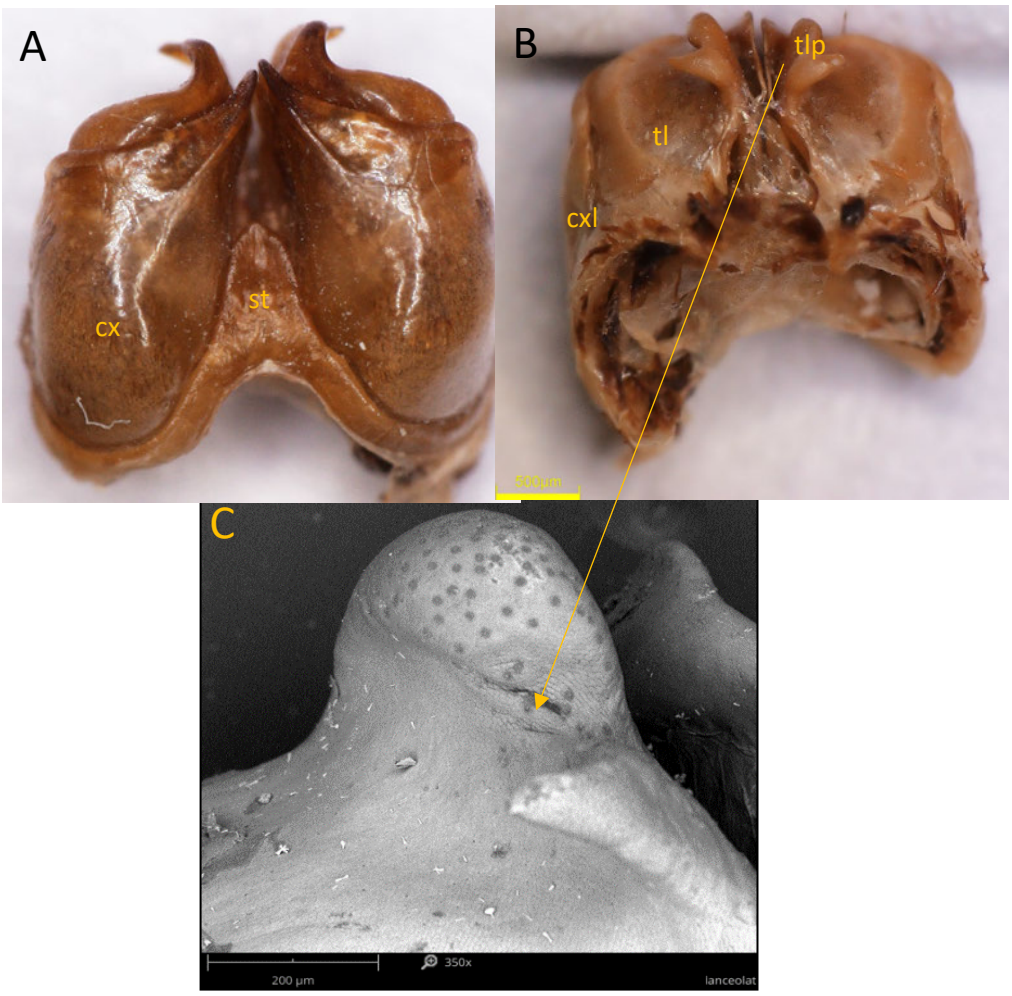

Figure 47: *Centrobolus digrammus* ♂ (NMSA-15568). **A-C** anterior gonopod; **A** anterior view, **B-C** posterior view. Abbreviations: cx – coxa; cxl - coxal endite lobe; st – sternum; tl – telopodite; tlp - telopodite process. Scale bars: 0.5 mm (**A-B**); 0.2 mm (**C**).

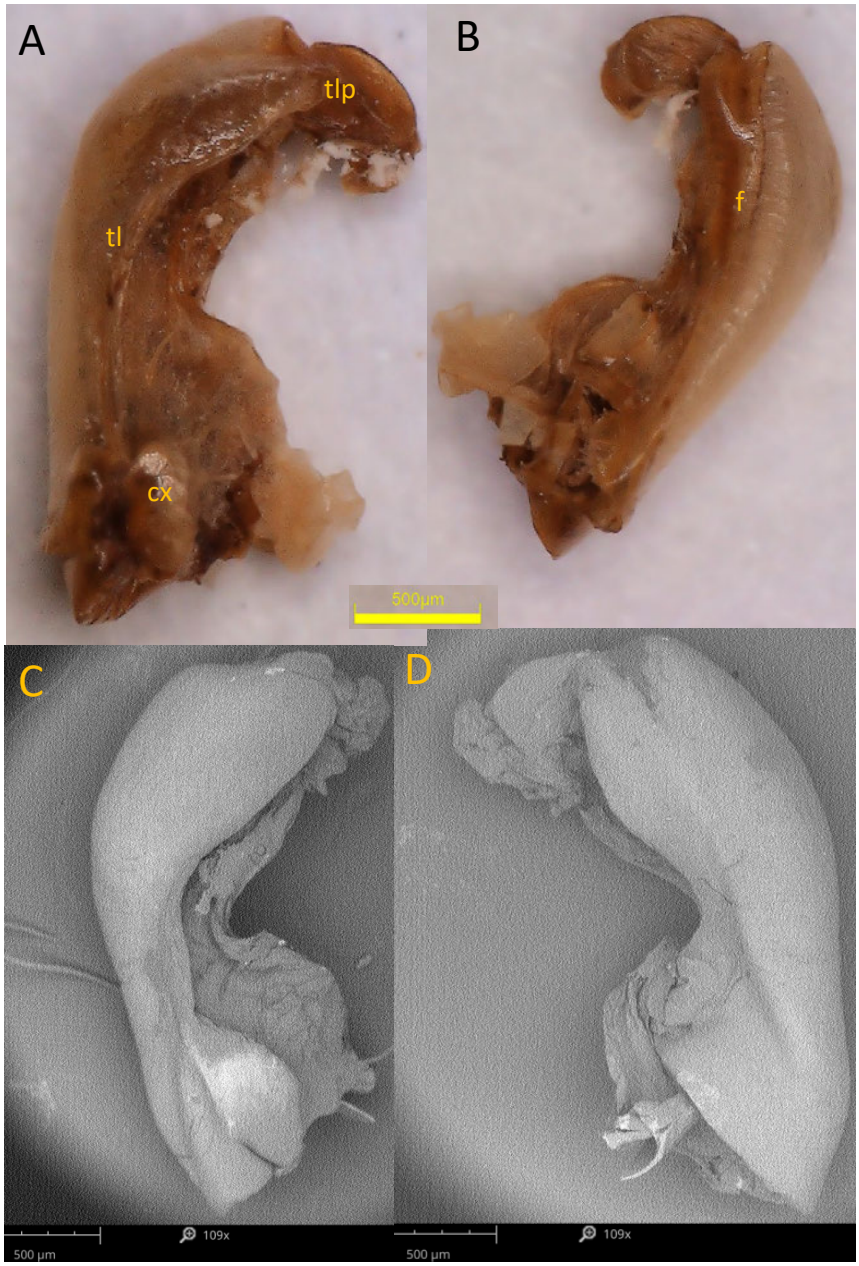

Figure 48: *Centrobolus digrammus* ♂ (NMSA-15568). **A-D** posterior gonopod; **A** & **C** posterior view, **B** & **D** posterior view. Abbreviations: cx – coxa; f - efferent groove; tl – telopodite; tlp - telopodite process. Scale bars: 0.5 mm.

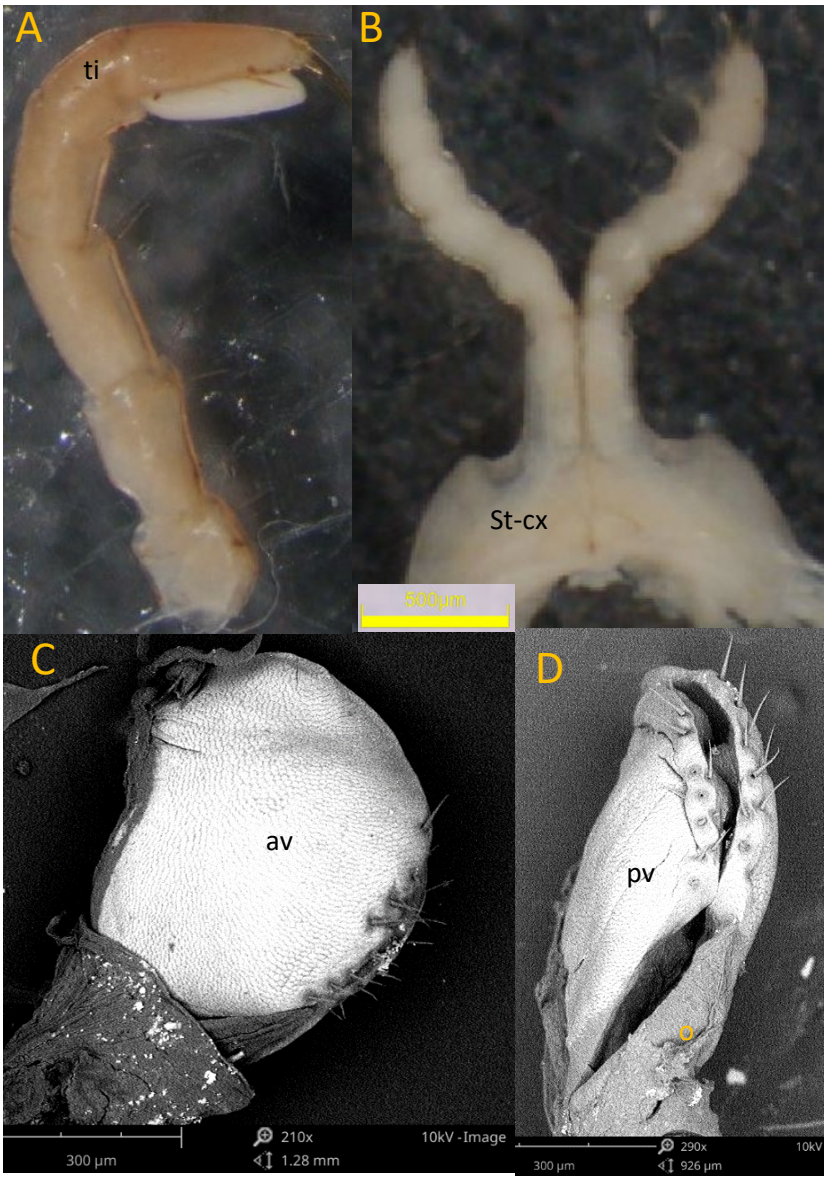

Figure 49: *Centrobolus digrammus* ♀ (NMSA-15568). **A** male leg, **B** female second leg pair, **C-D** vulva, **D** lateral view, **C** anterior view. Abbreviations: av - anterior valve; o – operculum; st-cx – coxosternite; pv - posterior valve; ti –tibia. Scale bars: 0.5 mm (**A-B**); 0.3 mm (**C-D**).

***Centrobolus dubius* (Schubart, 1966)**

Fig. 50

Hamer 1998: 40

Chersastus dubius Schubart, 1966: 38-39

Description. Original description by Schubart (1966) translated using Google Translate: ♂ Total length 35-55mm, greatest width 4.7-4.9mm, 44+0+T bodyrings, n=4. ♀ Total length 48-55mm, greatest width 5.6-6.2mm, 43+0+T body rings, n=4.

Body sculpturing: Matches *C. digrammus* except the lines on metazonites of *C. dubius* are a little closer.

Colour: Body black-grey; head grey-black with a brownish clypeus in front of the brown labrum darkened; antennae and legs brown to reddish brown; collum black-grey, dark brown to brownish red at the margins; body rings with yellow-brown prozonites, black-grey mesozonites and red-brown metazonites with 3 dark long bands, one in the middle and one on each side; preanal ring with narrow, light brown margins, anal valves brown to yellow-brown with darkened side and lighter margins.

Type material (not examined). *Paratype*: 1♂ SOUTH AFRICA: Western Cape, Fransches Kraal near Gans Bay, 1912-05, Skoog H. (ZML).

Remarks. Schubart (1966) emphasised that the gonopods of *C. dubius* (Fig. 50) are completely similar to those of *C. digrammus* but he did not give a description and only illustrated the posterior gonopod. He further stated that the two species might be one species or subspecies and suggested that further field work with special consideration of the ecological conditions should be conducted to confirm/resolve this.

Conservation assessment

This species is Data Deficient (DD), on the basis of the uncertain status.

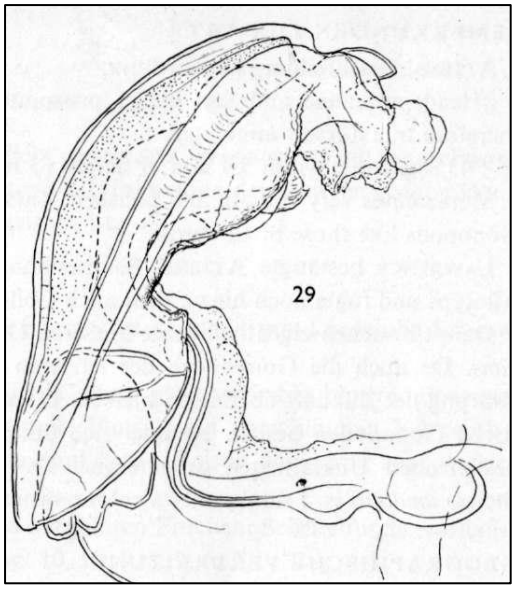

Figure 50: *Centrobolus dubius* ♂. Posterior gonopod, taken from Schubart (1966).

***Centrobolus formosus* (Porat, 1872)**

Hamer 1998: 40.

Spirobolus formosus Porat, 1872: 18-19; Attems 1928: 308; Jeekel 1956: 95.

Chersastus formosus Schubart 1966: 67-68.

Description. Original description by Porat (1872): ♀ Total length 62mm, greatest width 6.0mm, 42 body segments.

Body sculpturing: eyes with 44 ommatidia. Striation concentric.

Colour: Preanal ring and collum black, valves red. Body with longitudinal band.

Remarks. The description was based on a female specimen and no illustration was provided. The distribution was labelled "Caffraria" and there is no precise locality provided. This species is considered *incertae sedis*.

Conservation assessment

This species is Data Deficient (DD), on the basis of the uncertain status.

***Centrobolus fulgidus* (Lawrence, 1967)**

Figs 51-57

Hamer 1998: 40.

Chersastus fulgidus Lawrence, 1967: 627.

Diagnosis. Differs from congeners in having the following combination of character states: distal process of the telopodite of anterior gonopods with two parts, the distal most one bulbous and more angular than round, the proximal one prominent, thick and conical (Figs 55B-C); head, antennae collum and legs yellowish orange; head with two brownish shapes between the eyes (Fig. 53A); collum with dark brown median transverse band extending to posterior margin; body reddish, with one dorso-median row and two dorso-lateral rows of black spots down length of body; last 14 pair of legs lacking tarsal pads.

Redescription: *Measurements*: ♂ Total length 40-55mm, greatest width 5-7mm, 42+0+T body rings, n=26. ♀ Total length 40-69mm, greatest width 6-9.5mm, 42-43+0+Tbody rings, n=17.

Body sculpturing: Body very smooth and shiny with few transverse striae and microscopic punctures; scobinae present, large and half-circle shaped (Figs 54A & C)

Legs: long, reaching lateral margin of the body rings when extended; the first two and the last 14 pairs of legs without tarsal pads; tarsal pads prominent; tibia condensed with two bristles (Fig. 57A).

Colour (after 18 years in ethanol): Body in general with glittering appearance, reddish, with one dorso-median row and two dorso-lateral rows of black spots down length of body; antennae, legs and head yellowish orange; head with two brownish shapes between the eyes (Figs 52,53A); collum orange with dark brown transverse median band extending to posterior margin (Fig. 53A); body rings with dark brown/black metazonites, orange mesozonites and yellow prozonites (Fig. 54A); preanal ring and anal valves yellow to orange (Figs 52, 53D).

Gonopods: *Anterior gonopods*: Sternum about half height of the anterior gonopods, with broad base and strongly tapered to thin distal region (Fig. 55A). Coxae with straight lateral margins, distal half angled at about 45°. Distal process of telopodite with two parts, apical large, bulbous and more-or-less angular with rounded corners, with scattered minute setae, proximal part thick and conical, large and projected laterally (Figs 55B-C).

Posterior gonopods: Tibial process short, broad; inflated basal lobe present and well developed; seminal duct opens at the base of tibial process; longitudinal efferent groove well developed and runs straight along lateral surface of telopodite (Fig. 56).

Female sexual characters: Distal margin of the lateral extensions of the coxosternum of second pair of legs narrow, bluntly triangular shape (Fig. 57B). Vulva simple and half-oval shaped; anterior valve overlapping the posterior one; both valves with one row of large and widely spaced setae; operculum not sclerotized (Figs 57C-D).

Type locality: SOUTH AFRICA: *KwaZulu-Natal*: Richards Bay.

Type material (examined). *Syntypes*: 1♂ 1♀ SOUTH AFRICA: KwaZulu-Natal, Richards Bay, 1934-12, Lawrence R.F. (NMSA-9630).

Paratypes: SOUTH AFRICA: 4 ♂, same data as for syntypes.

Other material examined. SOUTH AFRICA: *KwaZulu-Natal*: 7♂ Mapelane, along Mfolozi, 1995-12, Hamer M. (NMSA-15521); 1♀ Mapelane, Richard's Bay, Cooper M. (NMSA-15719); 1♂ 2♀ same collection data as preceding, Cooper M. (NMSA-15726); 4♂ 4♀ St Lucia, coastal Acacia forest, 1995-01, Hamer M. (NMSA-15525); 1♂ Kranskop Forest, 1994-12, Hamer M. (NMSA-15526); 1♂ same data as the preceding, 1996, (NMSA-15569); 9♂ 3♀ 11 juveniles St Lucia, Eastern Shores, Mziki trail, 1996-01, Hamer M. (NMSA-15528); 1♂ same collection data as preceding, 1998-12, Bourquin O. (NMSA-15832); 1♂ Empangeni, 1997-11, Reavell P. (NMSA-15537); 3♂ Richard's Bay, 1996-12, Green E. (NMSA-15540); 3♂ same collection data as the preceding, 1995, Reavell P. (NMSA-15701); 3♂ 1♀ Hawaan Forest, 1995-12, Hamer M. (NMSA-15550); 1♂ Dukuduku Forest, trail from NPB picnic site, 1996-01, Hamer M & Herbert D. (NMSA-15556); 2♂ Cape Vidal, 1997-10, Wahlberg (NMSA-15754); 2♂ 2♀ 1 juvenile Ongoye Forest, 1997, Herbert D. (NMSA-15779); 2♀ same data as the preceding, 2005, Davis G. (NMSA-20562); 1♂ Richmond area, Hella Hella banks, Umkomaas River, 1998-12, Hamer M & Slotow R. (NMSA-15829); 4♂ 2♀ Umtamvuna Gorge, 1995-11, Hamer M. (NMSA-16148); 1♂ Umtamvuna Nature Reserve, 1997-12, James S. (NMSA-16191); 1♂ same data as the preceding, 1994, Lucas D. (NMSA-16492); 1♀ Nkandla Forest Reserve, Armstrong A.J. (NMSA-25950); 1♂ Entumeni Nature Reserve, Entumeni Forest, 28 52'41"S, 31 22'07"E, 2000-10, Armstrong A.J. (Ref: 1668, UKZN); 2♂ 1♀ Karkloof, Q-block forest-grassland complex (Shafton Plantation), 29.40749°S, 30.29510°E, 2004-12, Hamer M. (MH63, UKZN); 1♂ Umlazi Nature Reserve, along Siyayi Trail, 28°57'43.6"S, 31° 45'51.7"E, 2000-12, Hamer M. (Ref: 1371, UKZN); 1♂ same data as the preceding, Armstrong A.J. (Ref: 1722, UKZN); 1♂ 1♀ Mpenjati Nature Reserve, 30° 58'06.275"S, 30° 17'06.054"E, 2001-03, Hamer M. (Ref: 1386, UKZN).

Additional material from Lawrence (1967): SOUTH AFRICA: *KwaZulu-Natal*: 2♂, Ngoye forest, 1953-02, R.F. Lawrence, (NMSA-5040); 3♂, 1♀, Hluhluwe Game Reserve, 1953-10,

R.F. Lawrence, (NMSA-263); 1♂, 2♀, St. Lucia Bay, 1935-11, W.G. Rump, (NMSA-9618); 2♂, 2♀, Kranskop, 1954-11, R.F Lawrence, (NMSA-6223).

Distribution: This species has only been recorded from KwaZulu-Natal Province, and is largely restricted to forest habitats, including those along the coast, from Mtumvuma in the south to Cape Vidal in the north, and inland to the Ngoye, Nkhandla, Karkloof and Kranskop Forests. In addition to the material examined, photographs posted on iNaturalist provide the following localities: Mtunzini, Isimangaliso and Scottburgh.
(https://www.inaturalist.org/observations/19130015,
https://www.inaturalist.org/observations/9909122,
https://www.inaturalist.org/observations/10553421)

Remarks: Lawrence (1967) designated a male and a female specimen as the "Holotype", but since there are two specimens, these are referred to here as syntypes. Lawrence (1967) did not illustrate the posterior gonopods for this species, and his illustrations of posterior gonopods are not very detailed. He also did not provide a written description of the gonopods.

Centrobolus fulgidus is similar to *C. inscriptus* in terms of the number of body rings, the number of legs without tarsal pads, the shape of the vulva, the anterior gonopod sternum and the anterior gonopod telopodite process, and the distribution of the two species overlaps. In *C. inscriptus*, however, the proximal part of the telopodite process has two small and a large tooth on the distal margin, while in *C. fulgidus* the proximal part is more conical and lacks teeth. The overall colour of the two species is also distinct.

Conservation assessment

This is a South African species described from KwaZulu-Natal in 1967 and first collected in 1934. The species is relatively widespread in KwaZulu-Natal and has been recorded from several protected areas including iSimangaliso Wetland Park, a World Heritage site, and Entumeni, Umlalazi, Mapelane and Umtamvuma Nature Reserves, and Ngoye and Nkandla Forests. The species is known to occur in coastal, scarp and Afromontane forest. No specific conservation actions are in place for this species.

The major threats include, loss of habitat due to urbanization and industrialisation along the KwaZulu-Natal coast, dune mining, wood harvesting for curios, clearing of natural habitat for informal settlements and subsistence farming. This species may be illegally collected for the international pet trade. Habitat has been lost, especially along the coast, and this is likely to continue in the future outside of protected areas.

The EOO is estimated to be 30 000 km², and the AOO = 300-500 km². There are more than 10 locations, but these are highly fragmented. This species is therefore categorised as Endangered, (EN B2a, bii,iii,iv).

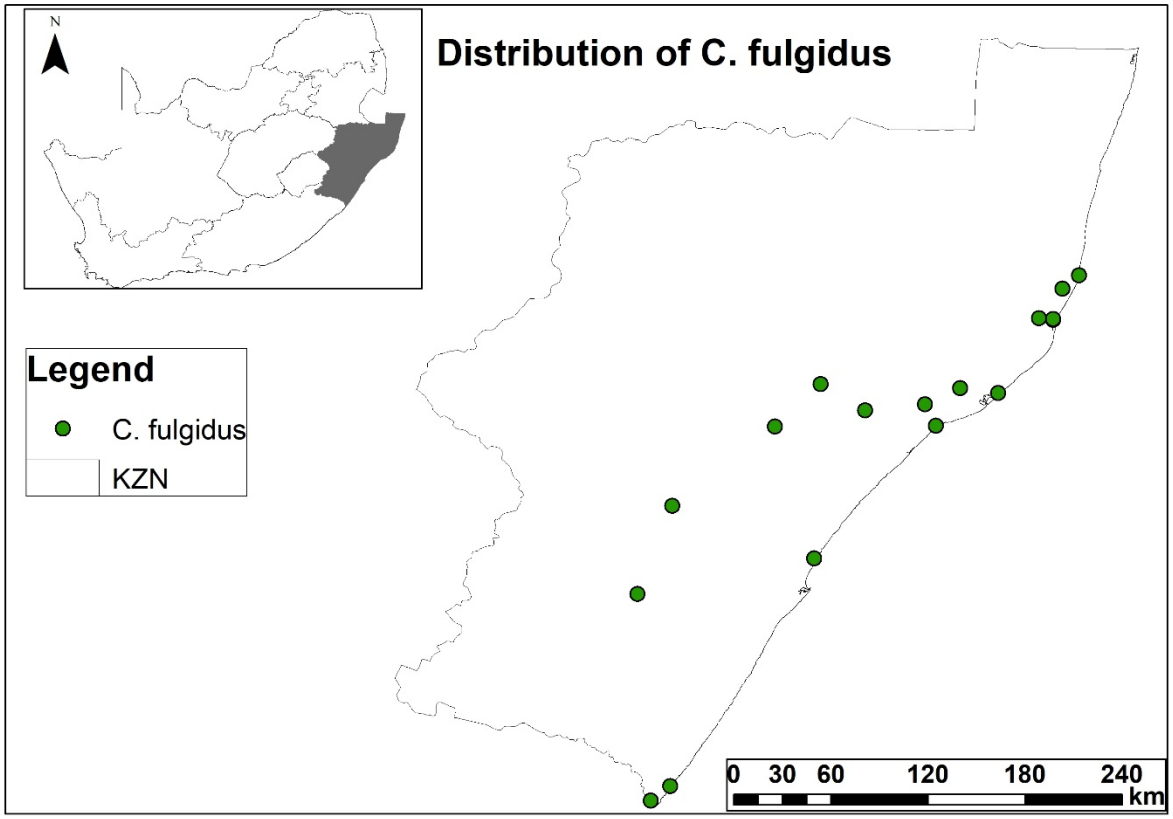

Figure 51: Distribution of *Centrobolus fulgidus* in South Africa. KZN- KwaZulu-Natal.

Figure 52: *Centrobolus fulgidus*. **A** St Lucia, **B** iSimangaliso KwaZulu-Natal, South Africa. Photographer: Magdastlucia (CC-BY-NC). Source iNaturalist.

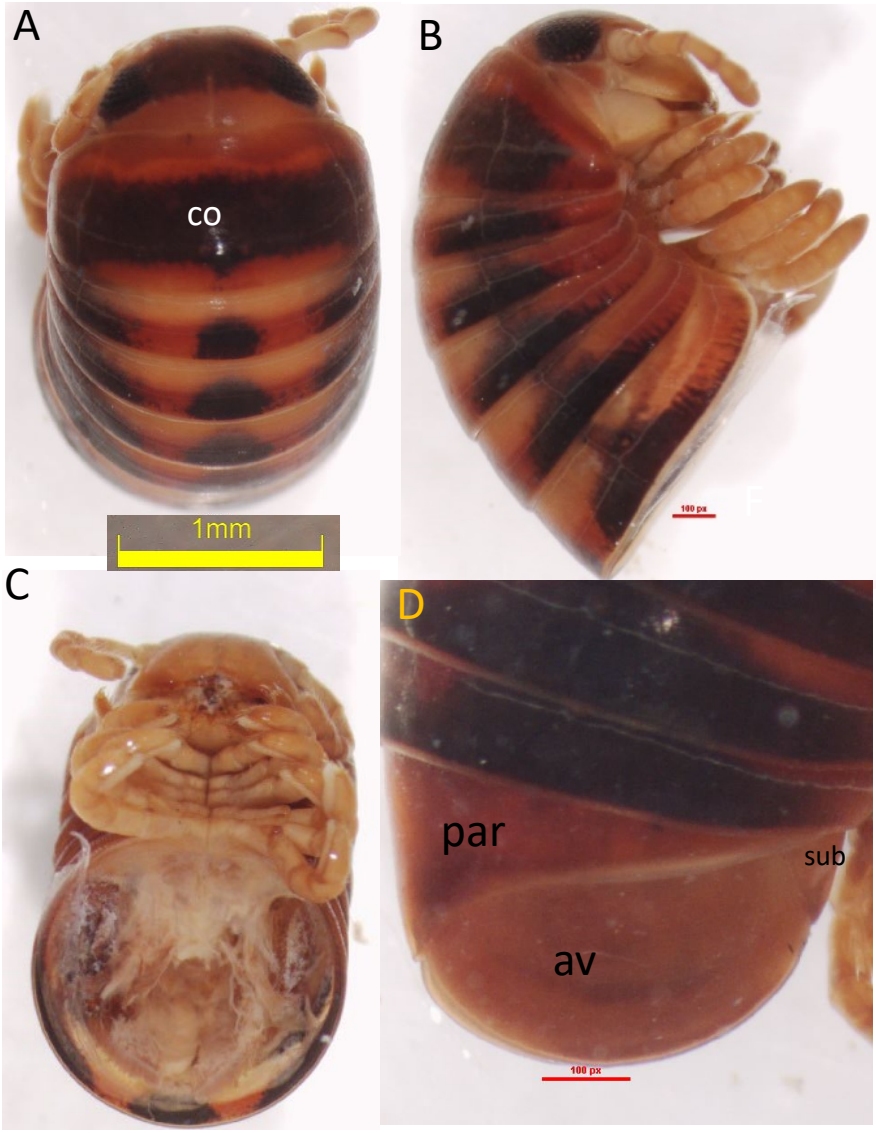

Figure 53: *Centrobolus fulgidus* **(**Umlazi Nature Reserve, along Siyayi Trial, KwaZulu-Natal) ♂ (Ref 1722). **A** anterior view of the head and collum, **B** lateral view, **C** ventral view, **D** terminal region of body. Abbreviations: av - anal valve; co – collum; par - preanal ring; sub - subanal scale. Scale bar: 1.0 mm.

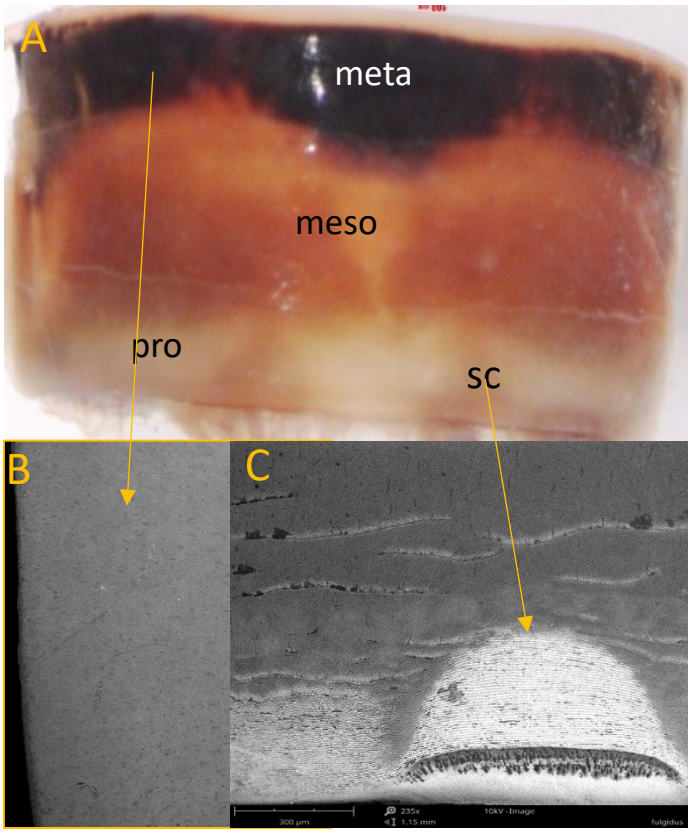

Figure 54: *Centrobolus fulgidus* **(**Umlazi Nature Reserve, along Siyayi Trial, KwaZulu-Natal) ♂ (Ref 1722). **A-C** body ring. Abbreviations: meso – mesozonite; meta – metazonite; pro – prozonite; sc - scobina. Scale bars: 0.3 mm.

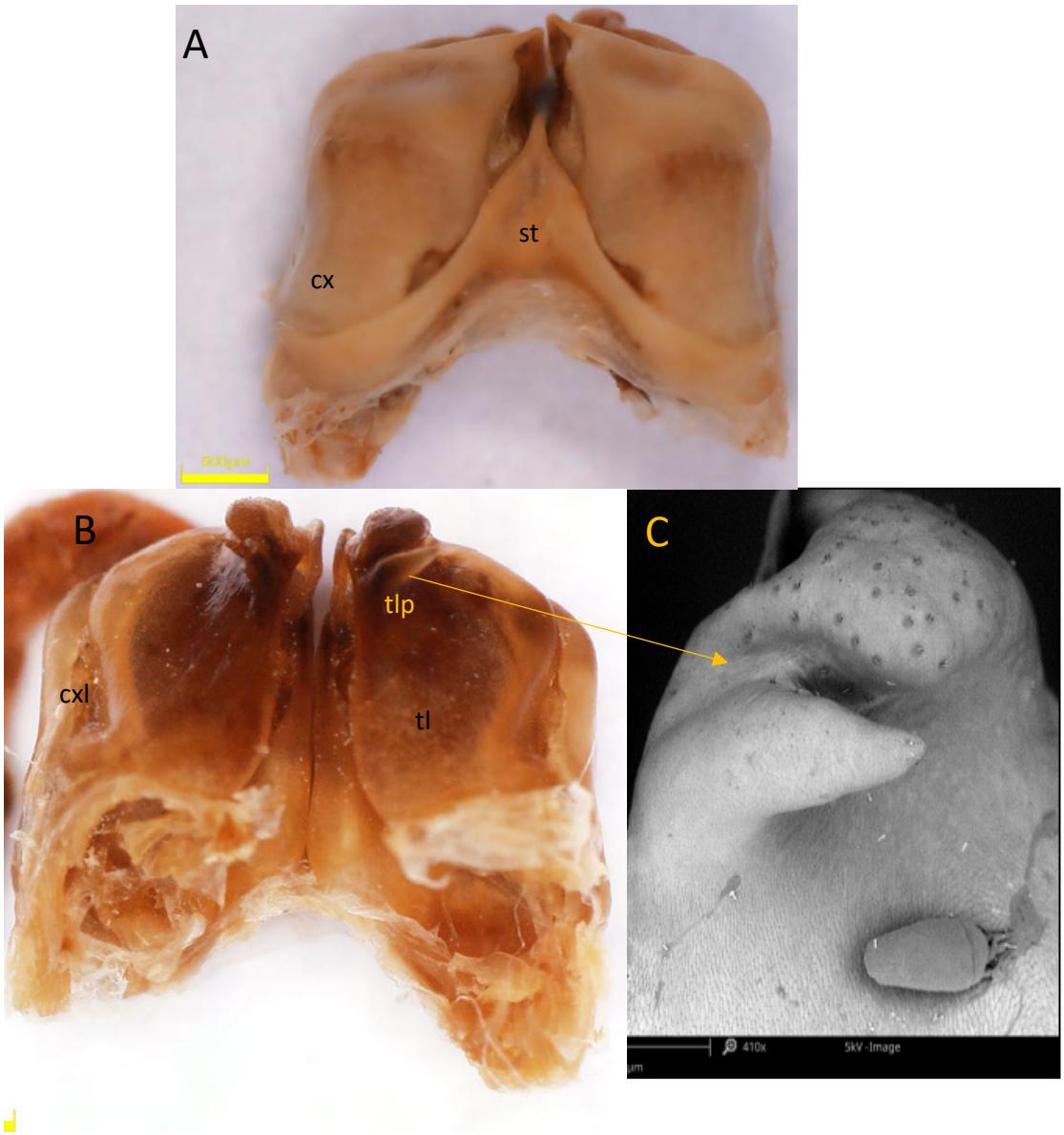

Figure 55: *Centrobolus fulgidus* ♂ (Ref 1722). **A-C** anterior gonopod; **A** anterior view, **B-C** posterior view. Abbreviations: cx – coxa; cxl - coxal endite lobe; st – sternum; tl – telopodite; tlp - telopodite process. Scale bars: 0. 5 mm (**A-B**); 0.2 mm (**C**).

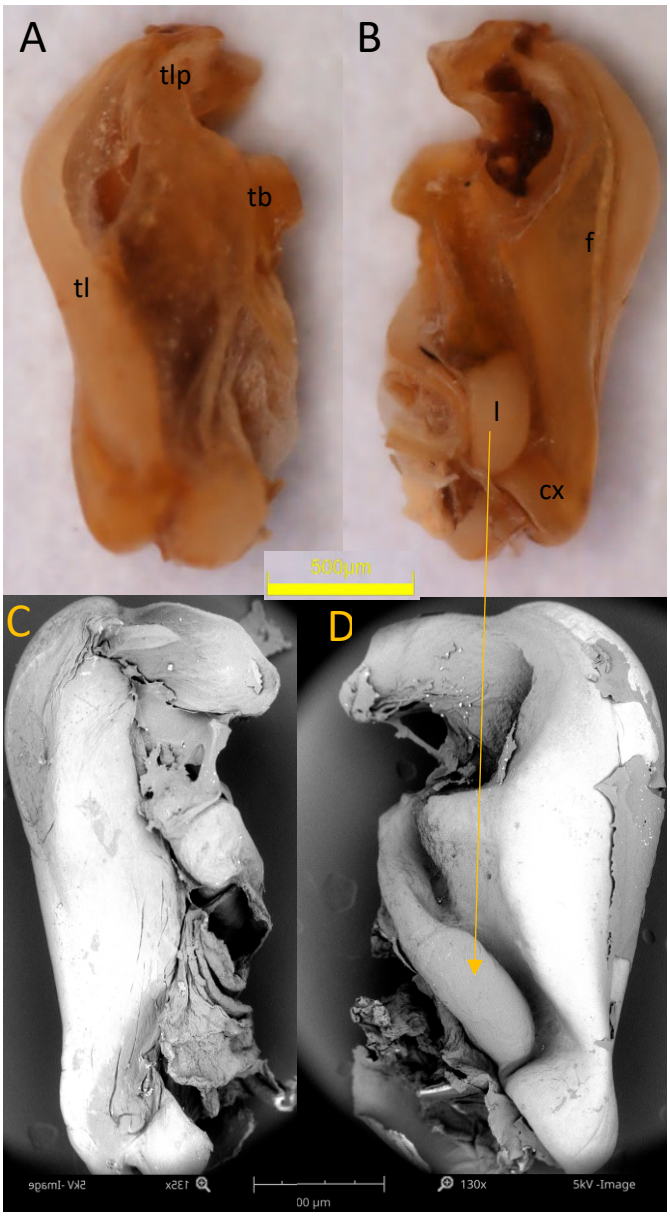

Figure 56: *Centrobolus fulgidus* ♂ (Ref 1722). **A-D** posterior gonopod, **A** & **C** posterior view, B & D anterior view. Abbreviations: cx – coxa; f - efferent groove; l – inflated basal lobe; tb - tibial process; tl – telopodite; tlp - telopodite process.
Scale bars: 0.5 mm.

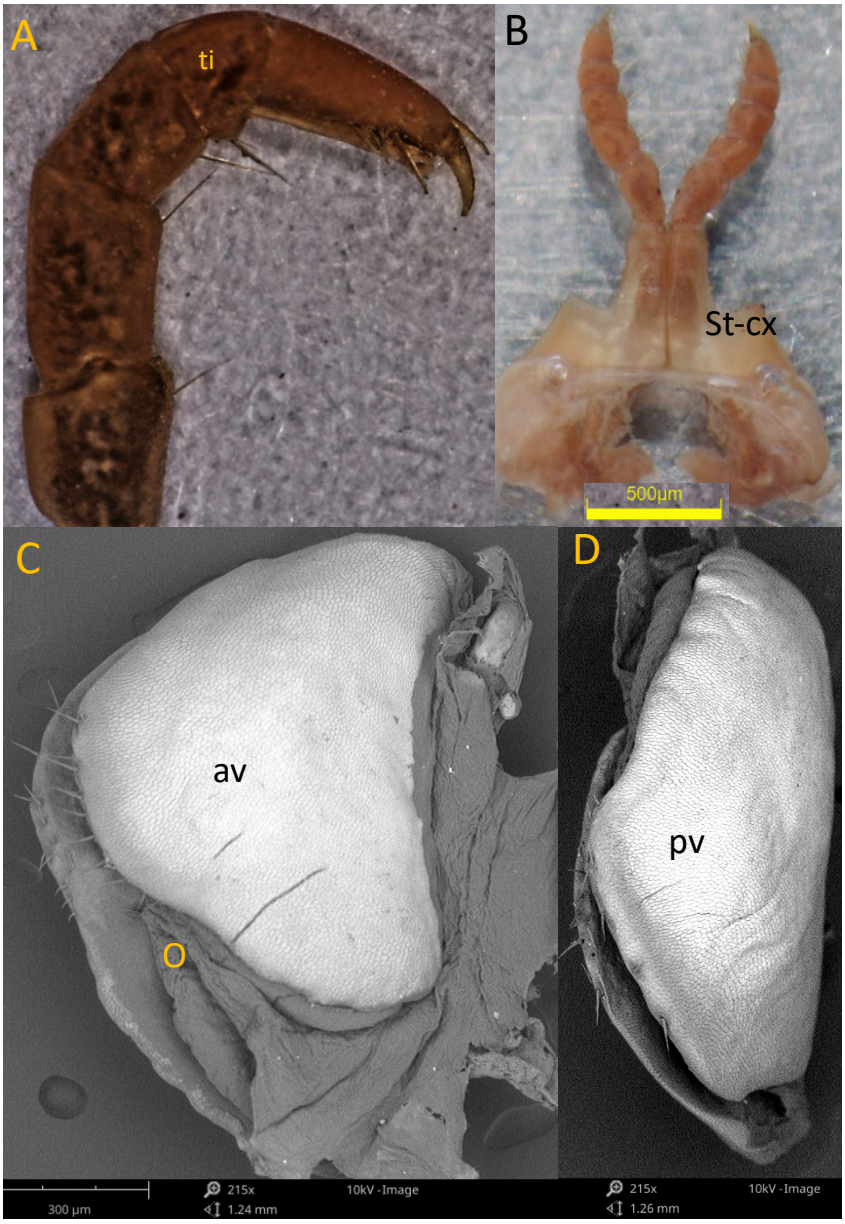

Figure 57: *Centrobolus fulgidus* (Mpenjati Nature Reserve, KwaZulu-Natal) ♀ Ref: 1386. **A** male leg, **B** female second pair leg, **C-D** vulva, **D** lateral view, **C** anterior view. Abbreviations: av - anterior valve; o – operculum; pv - posterior valve; st-cx – coxosternite; ti –tibia. Scale bars: 0.5 mm (**A-B**); 0.3 mm (**C-D**).

***Centrobolus immaculatus* (Lawrence, 1967)**

Figs 58-63

Hamer 1998: 40.

Chersastus immaculatus Lawrence, 1967: 613.

Diagnosis. Differs from congeners in having the following combination of character states: coxae of anterior gonopods with distal lobes slender and not covering telopodite; distal process of telopodite a relatively slender and bluntly rounded extension with a basal thick, laterally and slightly distally directed projection (Figs 61C-D); entire body, head and collum red, legs and antennae yellowish-orange; last eight pairs of legs in male without tarsal pads.

Redescription *Measurements*: ♂ Total length 38-47mm, greatest width 5mm, 38+0+Tbody rings, n=3. ♀ Total length 40-53mm, greatest width 5.2-7mm, 39+0+T body rings, n=3.

Body sculpturing: Body smooth and shiny; scobinae present, but weak, with small semi-circular area behind which a narrow and vague impression (Figs 60E-F).

Legs: Legs long (extending beyond the lateral margin of body rings) with prominent tarsal pads; all except the first two and the last eight pairs without tarsal pads; tibia standard length and with one apical bristle (Fig. 62D).

Colour (after 59 years in ethanol): The body in general red; head, collum and preanal ring and anal valves red (Figs 59, 60A-D); antennae and legs yellowish orange (Fig. 58); body rings with darker red metazonites than meso and prozonites (Fig. 60E).

Gonopods: *Anterior gonopods*: Sternum of the anterior gonopod broadly triangular, robust and slightly bifid at the apex (Figs 61A-B); lateral margin of coxa concave, with coxal process slender and not entirely covering telopodite. Distal process of telopodite with two parts, apical part flat (not inflated) and oval and covered with scattered short setae, proximal part short, slender and laterally and slightly distally directed (Figs 61C-D).

Posterior gonopods: Tibial process very broad and protruding outwards; seminal duct opens at the apex of the tibial process; longitudinal efferent groove present and well developed; distal process of telopodite forked/ tapered apically with an attached rounded membrane/lamella; coxite broad and fused with the telopodite (Figs 62A-C).

Female sexual characters: Second pair of legs with distal margin of lateral extension of coxosternum with narrowly rounded bulge. Vulva small and simple; roughly rectangular in shape; anterior valve overlapping the posterior one; both valves with 1-2 rows of setae; operculum poorly sclerotized (Fig. 63).

Type locality: MOZAMBIQUE: Garuso.

Type material (examined). Syntypes: 1♂1♀ MOZAMBIQUE: Garuso, 1960-12, Broadley D.G. (NMSA-9339).

Paratypes: MOZAMBIQUE: 5♂ 5♀ same data as for syntypes.

Other material examined: ZIMBABWE: 1♂ Chirinda Forest, 1961, Broadley D.G. (NMSA-08195); 5♂ Mount Selinda, 1963 (NMSA-08958); 1♂; same locality data as the preceding, 1948, Lawrence R.F. (NMSA-4968); 2♂ 2 ♀ same locality data as the preceding, 1959, van Bruggen A.C. (NMSA-6243).

Additional records from Lawrence (1967): MOZAMBIQUE: Gorongoza, (NMSA-6791; NMSA-9340). **ZIMBABWE:** Chirinda forests, Mt Silinda, (NMSA-4969; NMSA-8947); Chimanimani Mt, (NMSA-7224). MOZAMBIQUE: Gorongoza, (NMSA-6791; NMSA-9340).

Distribution: This species has only been recorded from forest in the highlands of central western Mozambique (Gorongoza and Amatonga Forest near Vila Pery) and at two localities in the eastern highlands forests in Zimbabwe (Chirinda Forest at Mt Selinda and Chimanimani). The localities seem to indicate that the species probably occurs along a chain of mountains that run north-eastwards into Mozambique from Chimanimani rather than northwards along the eastern highlands of Zimbabwe.

Remarks: Lawrence (1967) designated a male and a female specimen as the "Holotype", but since there are two specimens, these are referred to here as syntypes. Lawrence (1967) did not illustrate the posterior gonopods for this species, and his illustrations of anterior gonopods are not very detailed. He also did not provide a description of the gonopods. The gonopods of this species resemble those of the type of this genus, *C. luctuosus* (Peters, 1855).

Conservation assessment

This is a southern African species described from Mozambique in 1967 and collected in 1960 by D.G. Broadley. *Centrobolus immaculatus* has been recorded from Chirinda Forest and Gorongoza and these are both protected areas. Chirinda Forest is tropical rainforest (BirdLife International, Data Zone), and while it is protected, it is surrounded by rural settlements, subsistence agriculture and plantations, and is considered as being under pressure by BirdLife (BirdLife DataZone), Chimanimani Mountain is also a protected area in Zimbabwe, but habitats may be threatened by the activities of large numbers of artisanal gold miners (Timberlake et al. 2016). In Mozambigue, the Amatonga Forest locality cannot be identified with certainty, but most of the Villa Pery area is covered by high density housing and crops and little natural vegetation can be seen on Google Earth. Gorongosa is a large area, much of which is now protected. The exact collection locality for *C. immaculatus* is unknown, but it

may have been Mount Gorongosa, which has rainforest habitat. This may have been impacted by human activities, but the extent is unknown and is not obvious on Google Earth. The exact Garuso locality is also uncertain but it is likely to be in forest on the slopes of a mountain outside of the town. This forest is surrounded by subsistence agriculture and it is possible that habitat has been and will continue to be impacted by clearing and timber extraction.

The estimated EOO is 10 000 km² and the AOO is estimated at 250-300 km². The species is known from four locations, but may also occur in an additional three to five locations that have similar habitat. Based on the specialised habitat type of *C. immaculatus*, the number of locations is likely to be less than 10. The threats for this species include loss of habitat due to clearing for agriculture and housing as well as removal of timber. Habitat has probably been lost and will continue to be lost in future, impacting on the survival of this species. It therefore qualifies as Vulnerable (VU) B1, B2, a, bi, ii, iii.

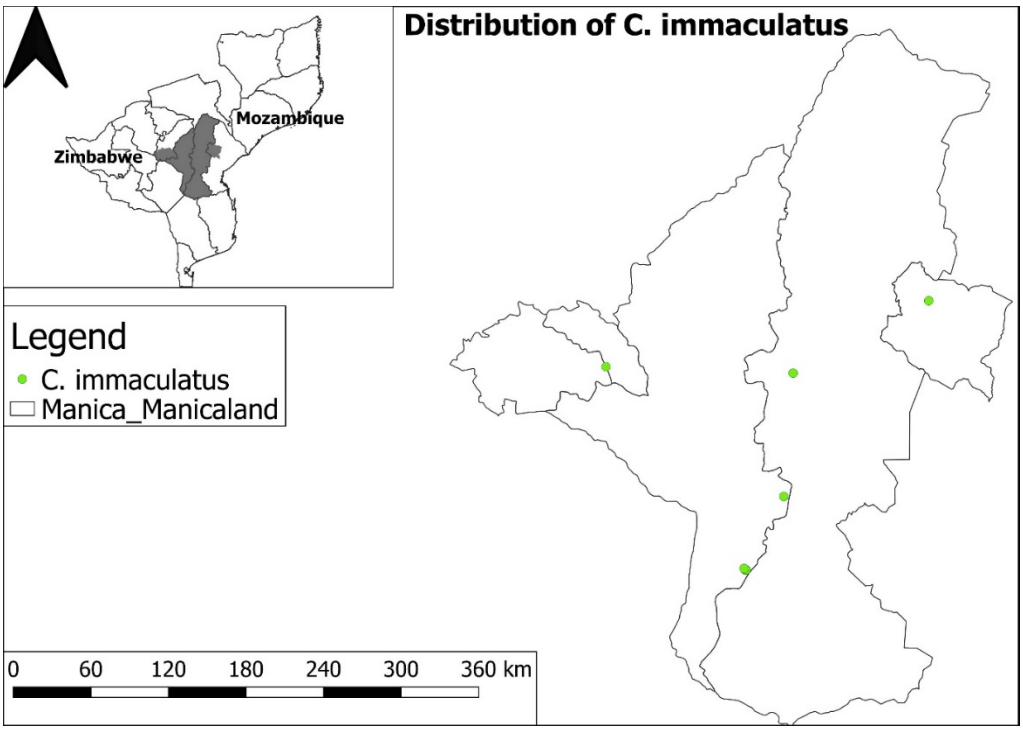

Figure 58: Distribution of *Centrobolus immaculatus* in Mozambique and Zimbabwe.

Figure 59: *Centrobolus immaculatus* from Chimanimani, Manicaland, Zimbabwe. Photographer: Brian Gratwicke (CC-BY-NC). Source iNaturalist.

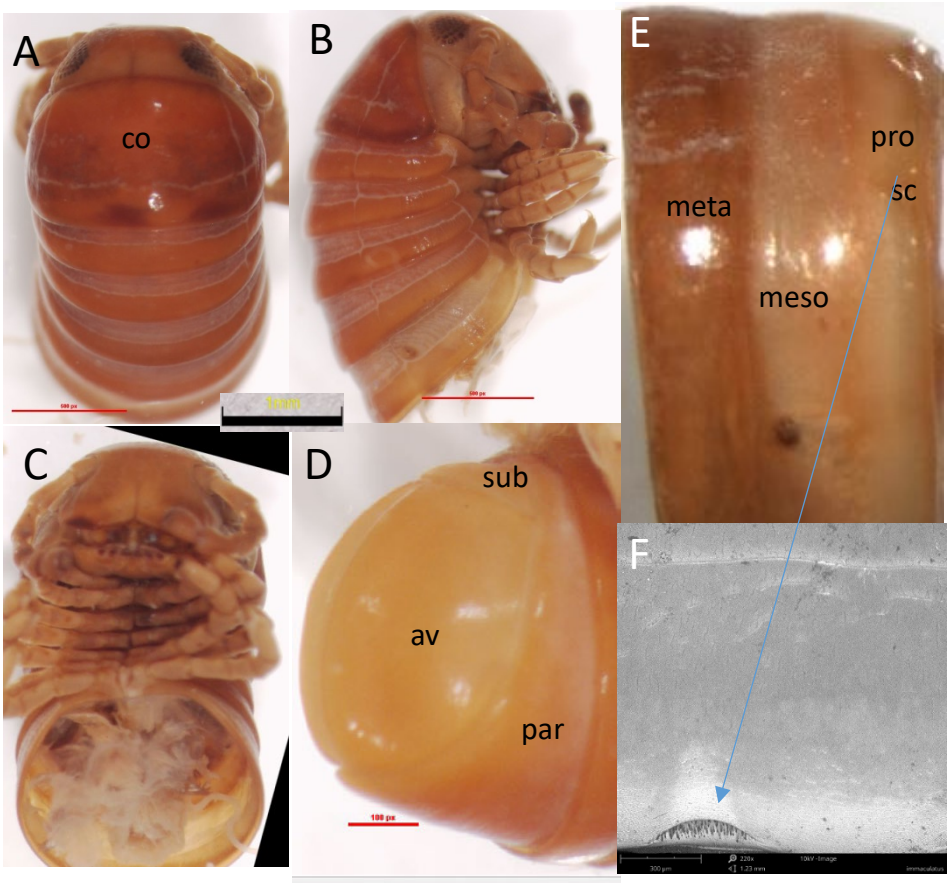

Figure 60: *Centrobolus immaculatus* (Mount Selinda, Chirinda Forest, Zimbabwe) ♂ (NMSA-6243). **A** anterior view of the head and collum, **B** lateral view, **C** ventral view, **D** terminal region of body, **E-F** body ring. Abbreviations: av - anal valve; co – collum; meso – mesozonite; meta – metazonite; par - preanal ring; pro - prozonite; sc – scobina; sub - subanal scale. Scale bars: 1.0 mm (**A-E**); 0.3 mm (**F**).

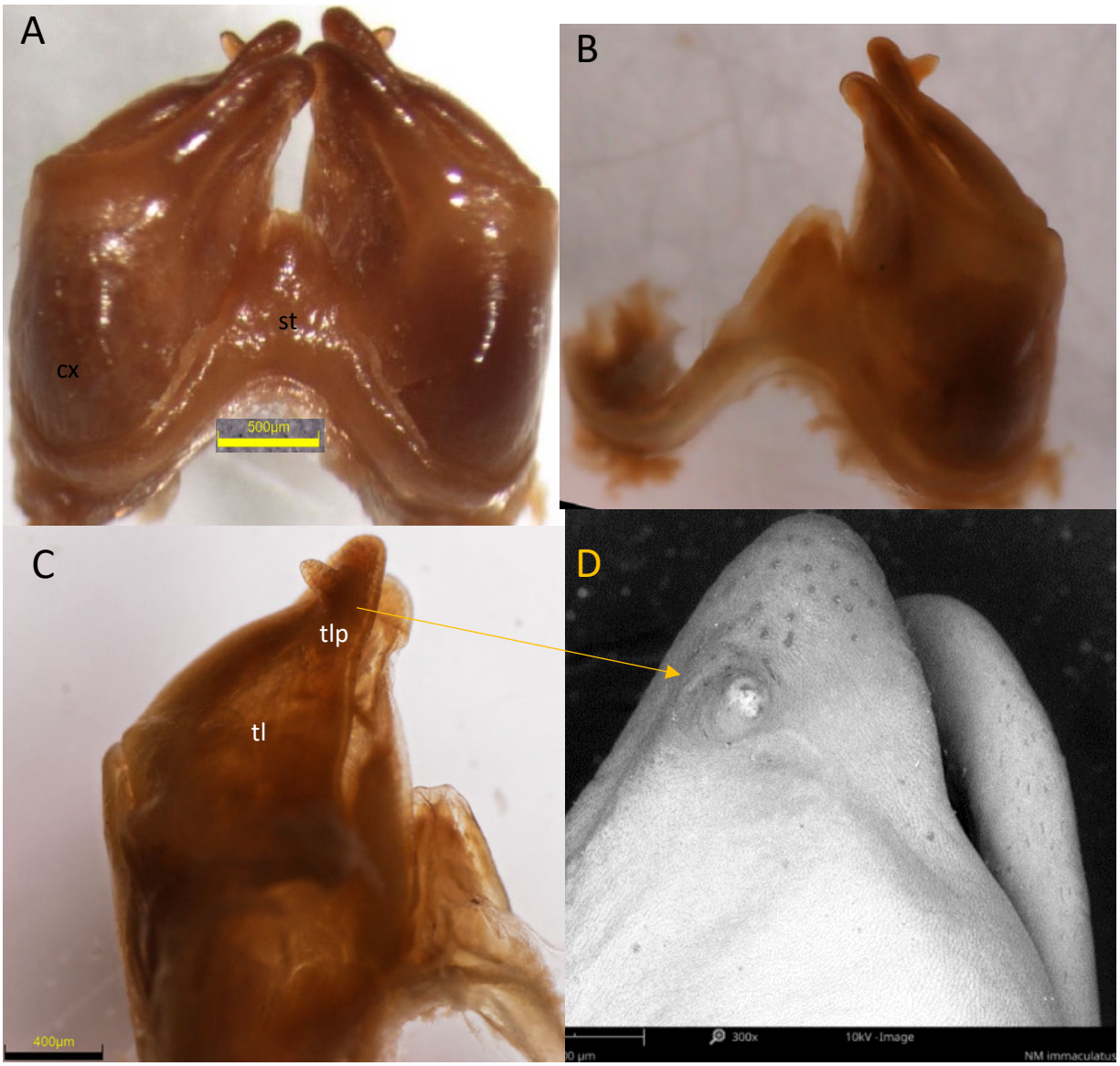

Figure 61: *Centrobolus immaculatus* ♂ (NMSA-6243). **A-E** anterior gonopods, A, D anterior view, B, C, E posterior view, **F** leg. Abbreviations: cx – coxa; st – sternum; tl – telopodite; tlp - telopodite process. Scale bars: 0.5 mm (**A**); 0.4 mm (**B-C**); 0.2 mm (**C**).

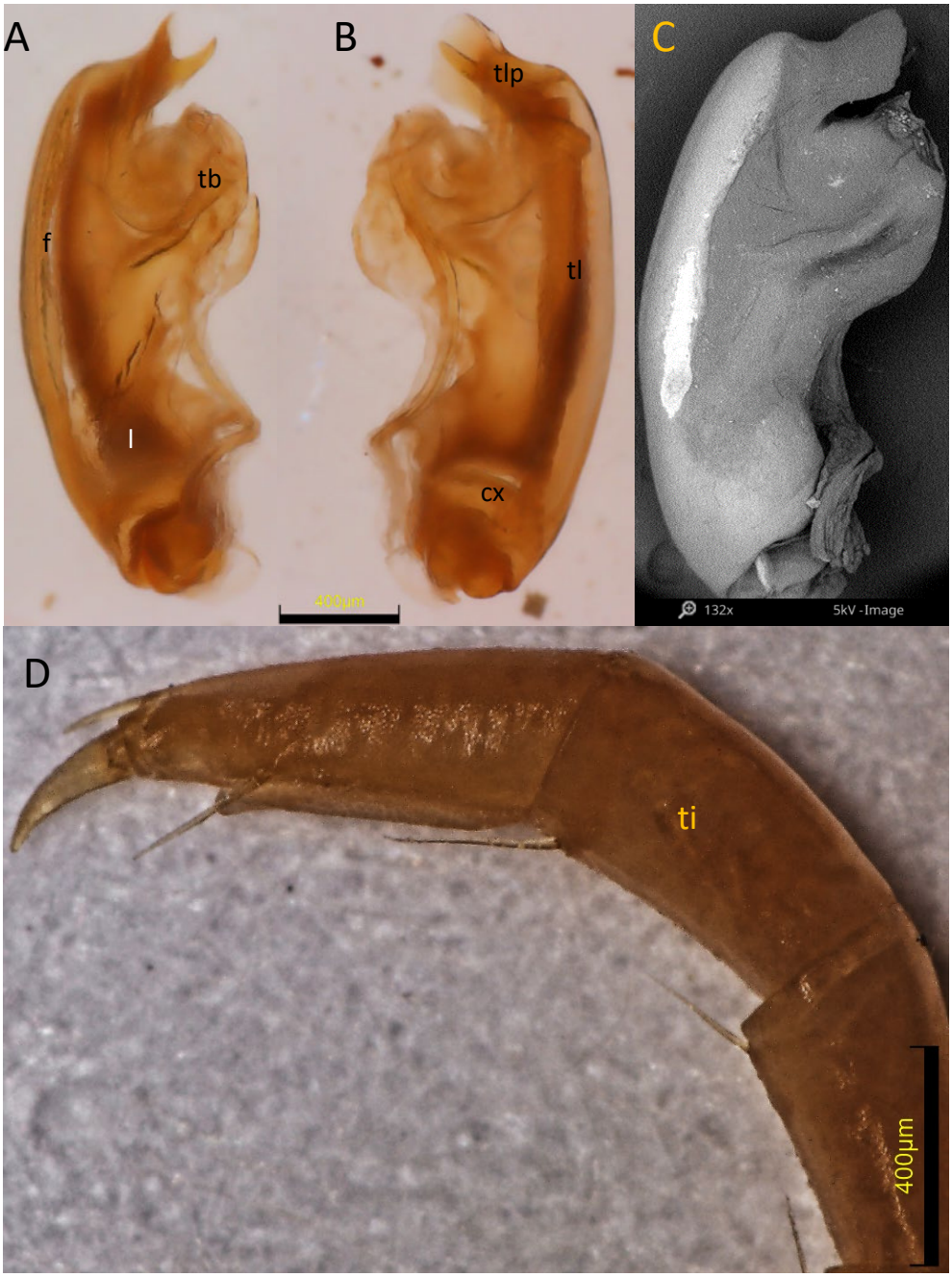

Figure 62: *Centrobolus immaculatus* ♂ (NMSA-6243). **A-C** posterior gonopods, **A** & **C** posterior view, **B** anterior view, **D** male leg. Abbreviations: cx – coxa; f - efferent groove; tb - tibial process; ti – tibia; tl – telopodite; tlp - telopodite process. Scale bars: 0.4 mm.

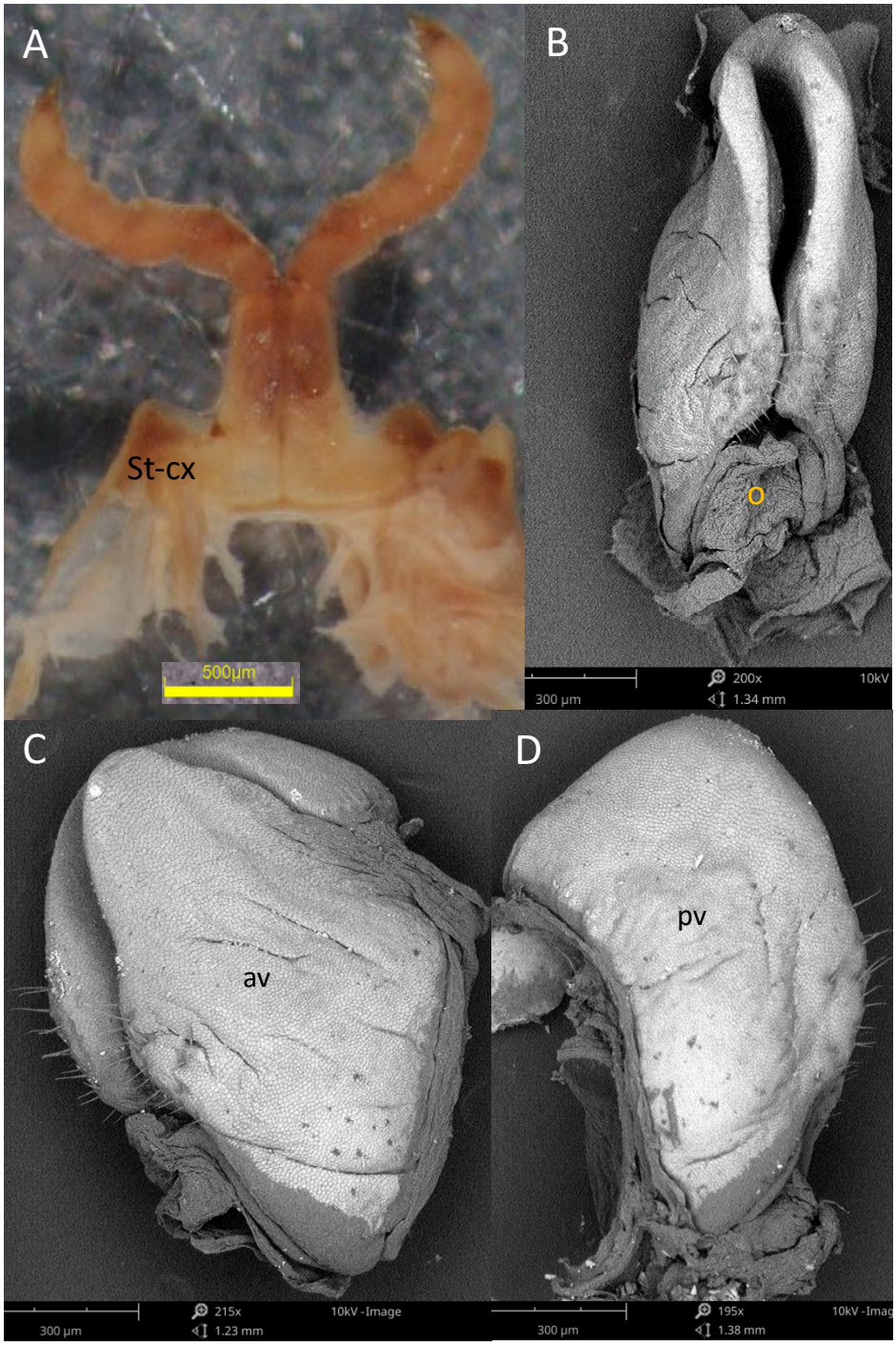

Figure 63: *Centrobolus immaculatus* ♀ (NMSA-6243). **A** female second pair legs, **B-D** vulva, **B** lateral view, **C** anterior view, **D** posterior view. Abbreviations: av - anterior valve; o – operculum; pv -posterior valve; st-cx – coxosternite. Scale bars: 0.5 mm (**A**); 0.3 mm (**B-D**).

***Centrobolus inscriptus* (Attems, 1928)**

Figs 64-68

Hamer 1998: 40.

Chersastus inscriptus Attems, 1928: 307-308; Attems 1934: 477; Schubart 1966: 48; Lawrence 1967: 634.

Diagnosis. Differs from congeners in the following combination of character states: distal process of telopodite of anterior gonopods with distal region inflated and rolled over, with second basal process somewhat flattened and with distal margin with two small teeth-like projections and one large terminal triangular tooth; sternum of anterior gonopods broad but strongly tapered and distal quarter very slender (Figs 66B-C).

Redescription. *Measurements*: ♂ Total length 43-49mm, greatest width 6mm, 42+0+T body rings, n=18. ♀ Total length 32-44mm, greatest width 7mm, 42+0+Tbody rings, n=4.

Body sculpturing: body rings smooth and shiny with few transverse striae and minute punctures; scobinae distinct horseshoe shaped pits (Figs 65E-F).

Legs: legs long (extending beyond the margins of body rings when extended); male with prominent tarsal pads; the first two and the last 14 pairs without tarsal pads; tibia condensed with two bristles (Fig. 68A).

Colour ♂ (after 60 years in ethanol): body in general olive brown with reddish tinge; head, antennae, legs reddish brown/orange (Figs 65A-B); collum reddish at anterior and dark brown from the middle to posterior margin (Fig. 65A); preanal ring and anal valves brownish (Fig. 65D); body rings with dark, olive brown metazonites, mesozonites somewhat light brown merging with dark brown colour and prozonites brown with margin olive brown (Fig. 65E).

Gonopods: *Anterior gonopods*: sternum of anterior gonopods very broad but last quarter narrow and sharply pointed at apex; lateral margin of coxa concave, with coxal process broad and not entirely covering telopodite; coxa with roundish protruding bulge basally (Fig. 66A). Distal process of telopodite with two parts, the distal one inflated, rolled over and with scattered small, short setae; basal one somewhat flattened, and with distal margin with two small teeth-like projections and one large terminal triangular tooth (Figs 66B-C).

Posterior gonopods: tibial process broad and projecting a little outwards, the tip broadly lobed and curved inwardly; longitudinal efferent groove well developed; inflated basal lobe absent; distal process of telopodite smooth and rounded; seminal duct opens at tip of tibial processes (Fig. 67).

Female sexual characters: Lateral extensions of the coxosternum of the second pair of legs with prominent rounded bulge. Vulva simple; small and roughly bean-shaped with margin opposite operculum broadly extended; anterior valve overlapping posterior one; both valves basally with two irregular rows of setae (Figs 68B-D).

Type locality: SOUTH AFRICA: *KwaZulu-Natal*: Scottburgh.

Type material (not examined): Holotype: ♂ SOUTH AFRICA: KwaZulu-Natal, Scottburgh, 1928, Attems C. (SAM A23350).

Material examined. SOUTH AFRICA: *KwaZulu-Natal*: 3♂ Durban, Bluff, 1935-10, Lawrence R.F. (NMSA-00282); 4♂ 4♀ Umgababa, South Coast, 1936-01, Rump W.G. (NMSA-00314); 9♂ Park Rynie, 1959-01, Rump W.G. (NMSA-02229); 1♂ Hluhluwe Game Reserve, Mbombe Forest, 2007-03, Armstrong A.J. (NMSA-22740); 1♂ Vernon Crookes Nature Forest, Armstrong A.J. & Gomez A. (NMSA-25996).

Distribution: This species is largely confined to the coastal forests of KwaZulu-Natal, from Dukuduku Forest near St Lucia in the north, to Port Edward in the south, with one distant record from the Eastern Cape coast at East London (NMSA-6227), which was listed by Lawrence (1967) but which was not confirmed in the current study. The species may occur south of the KwaZulu-Natal border but this region of the Eastern Cape has not been well sampled. There are several additional records from the KwaZulu-Natal interior forests including Kranskop, Valley of a Thousand Hills and Otto's Bluff near Pietermaritzburg as well as Mtunzini, Umhlanga Rocks, Kelso, Trafalgar, Port Shepstone on the coast (Lawrence 1967).

Remarks: Lawrence (1967) suggested that *C. inscriptus* is a common species with a fairly extensive distribution but there are not a large number of specimens that have been collected for this species over the last 30 years.

Conservation assessment

This is a South African species described from KwaZulu-Natal in 1928. *Centrobolus inscriptus* has been confirmed from two protected areas (Hluhluwe Game Reserve, Vernon Crookes Nature Reserve). The other localities are not protected. The species is known to occur mostly in coastal forest, with a few localities in scarp forest. The area in which this species has been recorded has undergone large scale transformation mainly through urbanisation, tourism and housing developments and agriculture, as well as degradation of remaining habitat fragments. These threats are certainly ongoing because of the high demand for land in the coastal areas, and the high human populations inhabiting the areas where this species occurs outside of the protected areas.

EOO = 180 000 km² if the East London locality is included, and 23 000 km² if it is excluded. The AOO is measured at about 80 km², and if other suitable habitats are also included, this would still be less than 200 km². Number of locations = 12, but these are mostly small areas, and highly fragmented.

Based on this assessment, *C. inscriptus* is categorised as Endangered (EN, B2a, bi, ii, iii, iv).

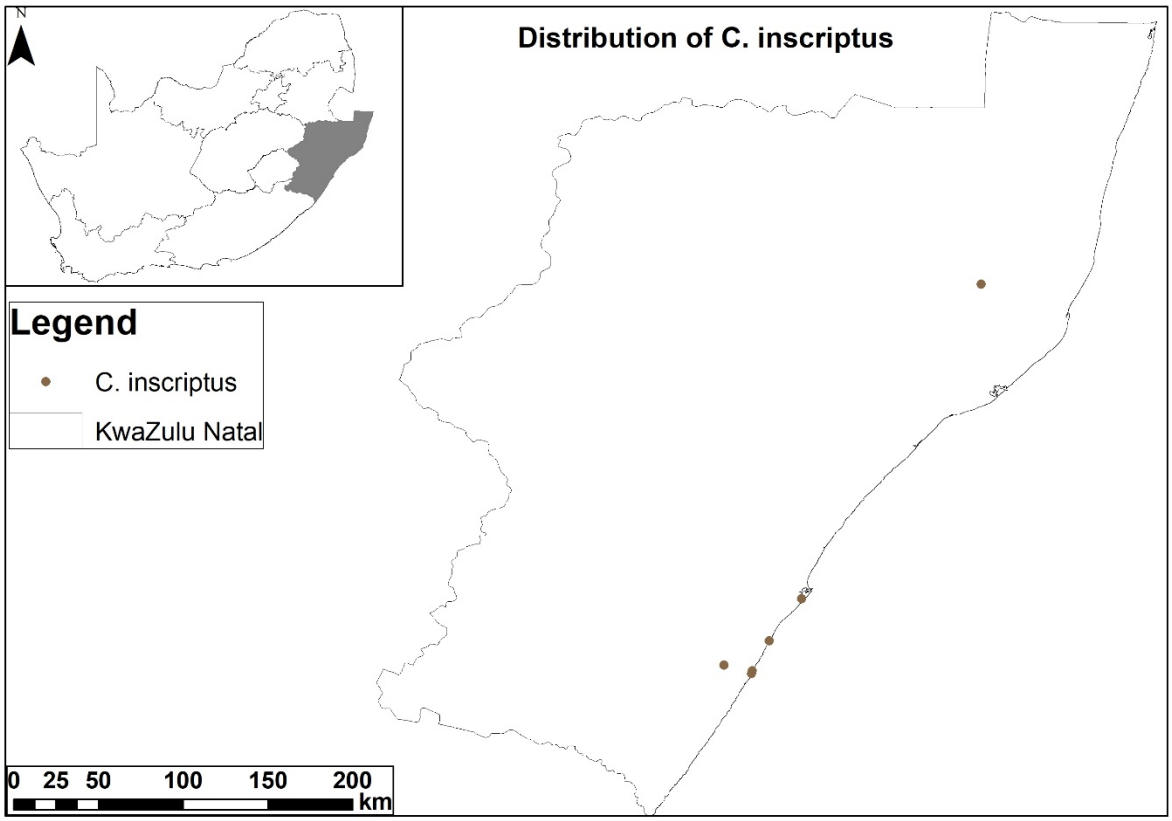

Figure 64: Distribution of *Centrobolus inscriptus* in South Africa, KwaZulu-Natal (unconfirmed Eastern Cape locality not shown).

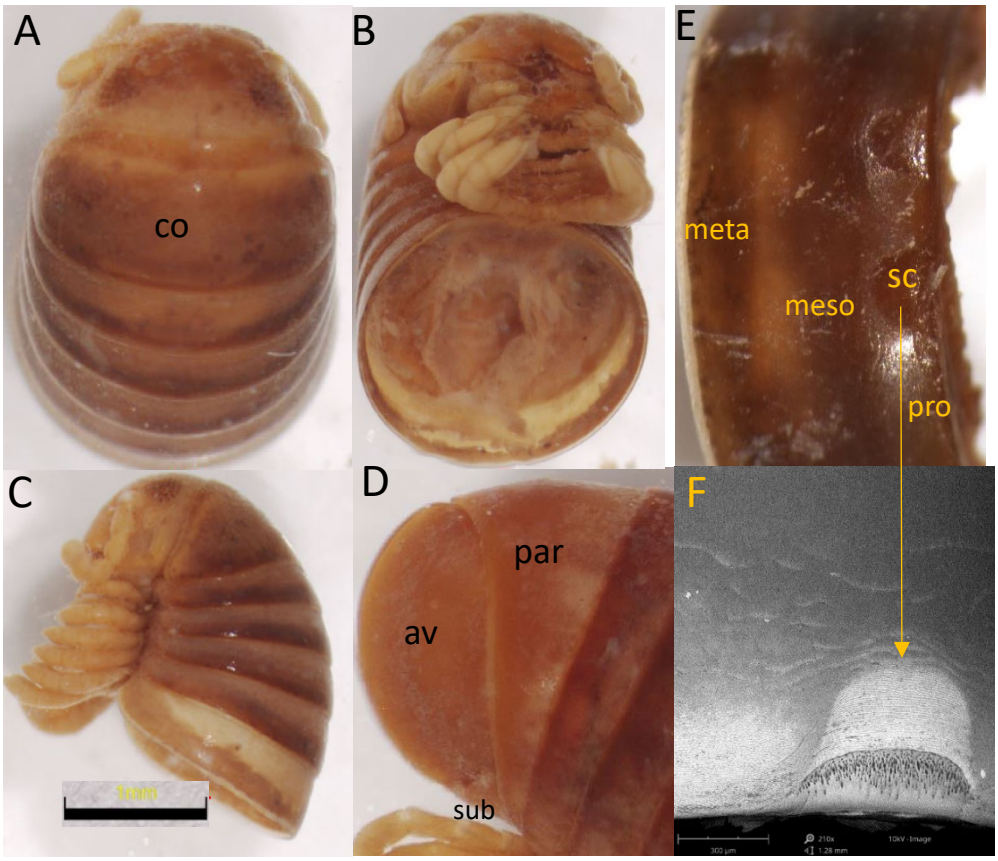

Figure 65: *Centrobolus inscriptus* (Umgababa, South Coast, KwaZulu-Natal) ♂ (NMSA-314). **A** anterior view of the head and collum, **B** lateral view, **C** ventral view, **D** terminal region of body, **E-F** terminal region of body. Abbreviations: av - anal valve; co – collum; meso – mesozonite; meta – metazonite; par - preanal ring; pro – prozonite; sc – scobina; sub - subanal scale. Scale bars:1. 0 mm (**A-E**); 0.3 mm (**F**).

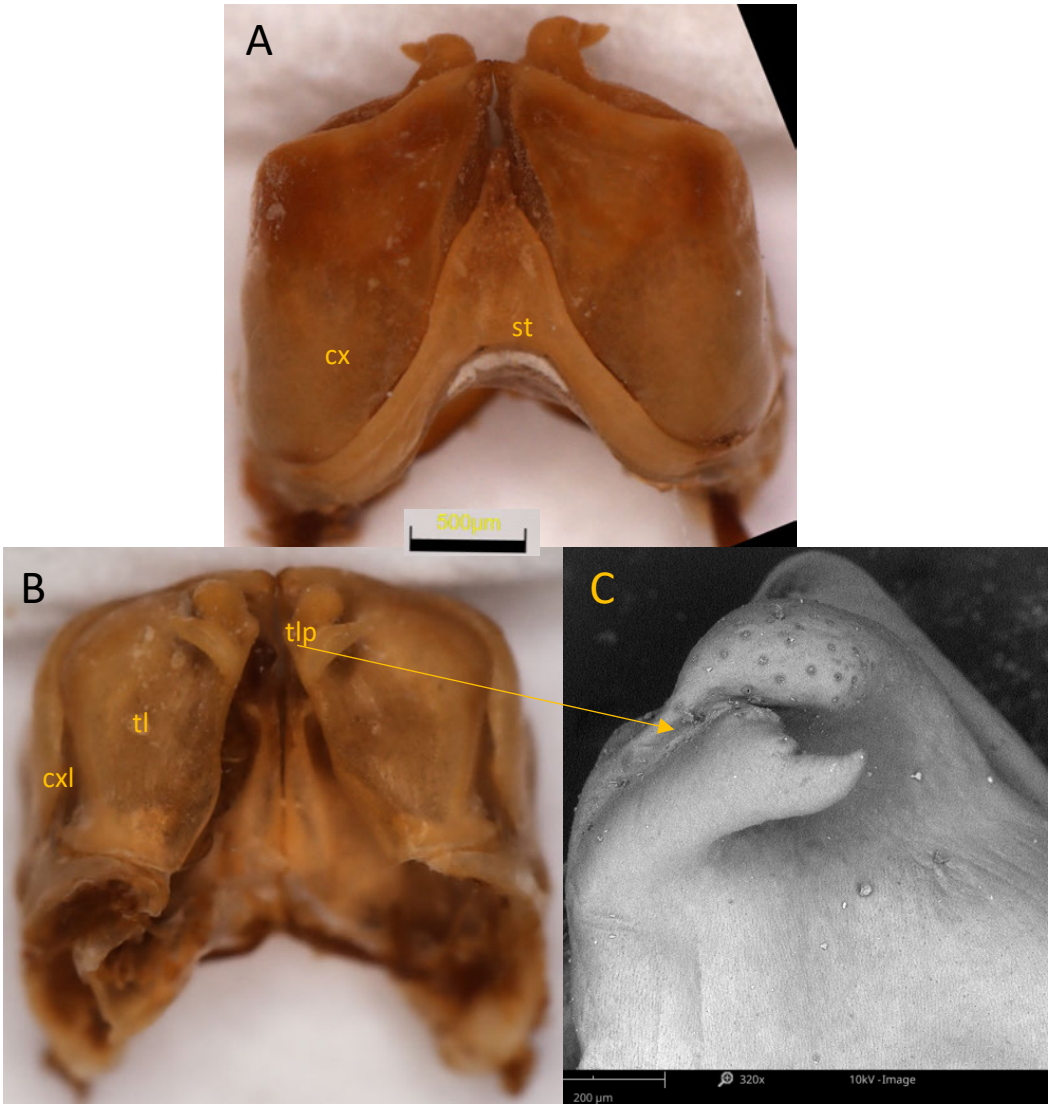

Figure 66: *Centrobolus inscriptus* ♂ (NMSA-314). **A-C** anterior gonopods; **A** anterior view, **B-C** posterior view. Abbreviations: cx – coxa; cxl -coxal endite lobe; st – sternum; tl – telopodite; tlp - telopodite process. Scale bars: 0.5 mm (**A-B**); 0.2 mm (**C**).

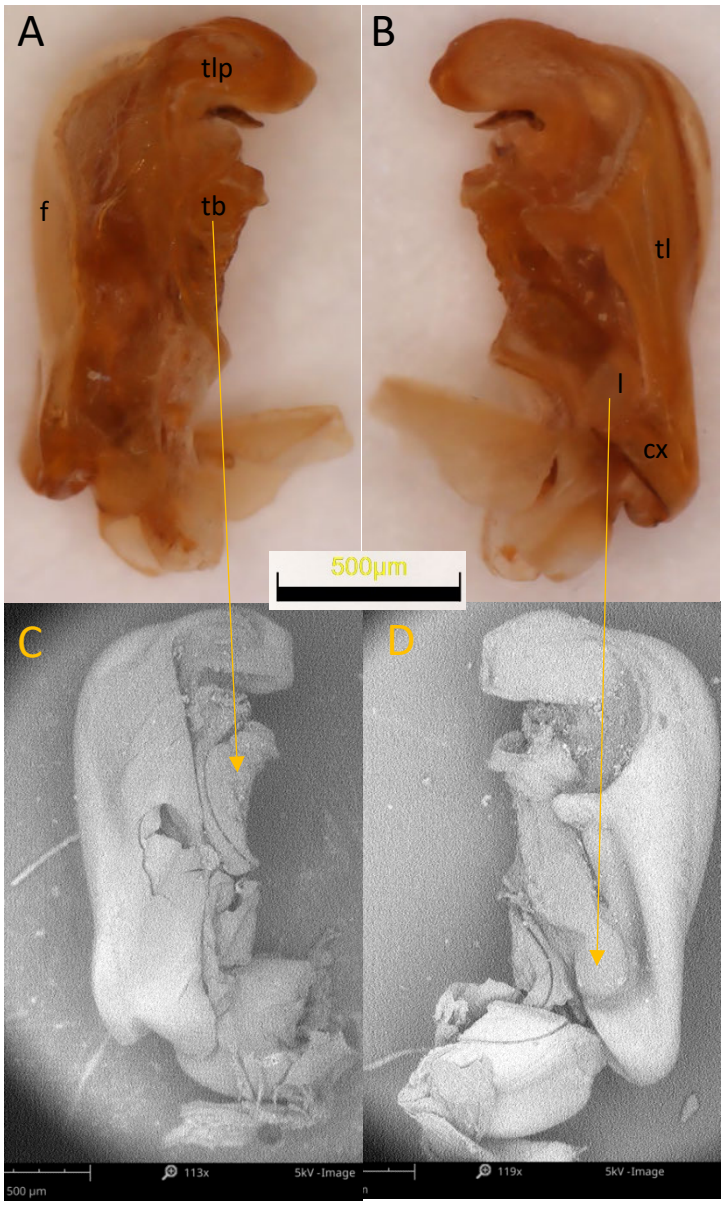

Figure 67: *Centrobolus inscriptus* ♂ (NMSA-314). **A-D** posterior gonopod; A & C posterior view, B & D anterior view. Abbreviations: cx – coxa; f - efferent groove; l – inflated basal lobe; tb - tibial process; tl – telopodite; tlp - telopodite process. Scale bars: 0.5 mm.

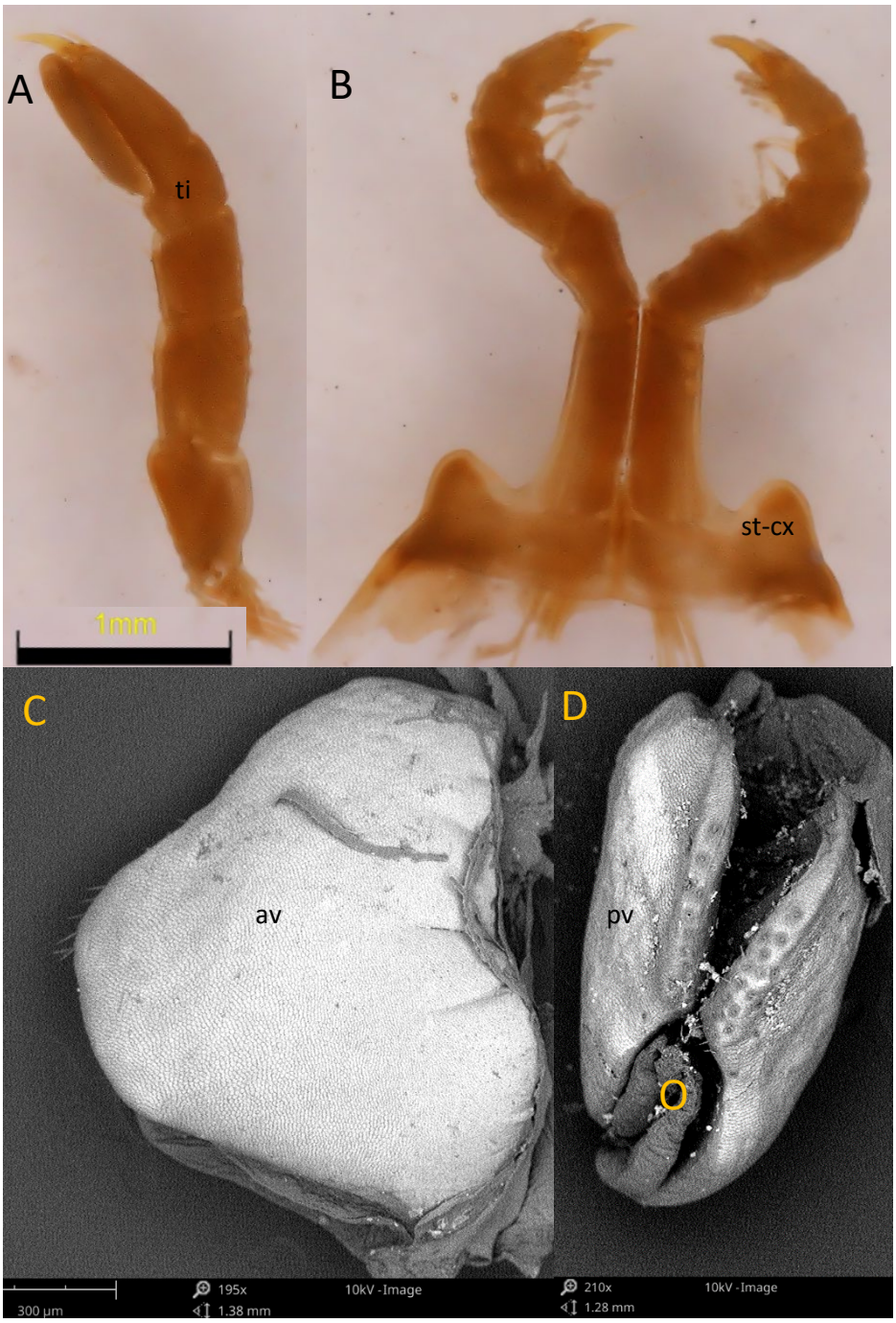

Figure 68: *Centrobolus inscriptus* ♀ (NMSA-314). **A** male leg; **B** female second pair leg, **C-D** vulva; **D** lateral view, **C** anterior view. Abbreviations: av - anterior valve; o – operculum; pv - posterior valve; st-cx – coxosternite; ti –tibia. Scale bars: 1.0 mm (**A-B**); 0.3 mm (**C-D**).

***Centrobolus inyanganus* (Lawrence, 1967)**

Figs 69-74

Hamer 1998: 40.

Chersastus inyanganus Lawrence, 1967: 614.

Diagnosis. Differs from congeners in the following combination of character states: sternum of anterior gonopods very large and robust, with lateral margins slightly convex; distal process of telopodite of anterior gonopods a simple thick and laterally directed triangular structure not extending beyond the distal margin of the telopodite (Figs 72B-C); posterior gonopods simple but with suture visible between coxa and telopodite, and apically extended, with three processes, one large and angular, one a hooked tooth and third a lamellae-like curved structure (Fig. 73).

Redescription. *Measurements*: ♂ Total length 24-32mm, greatest width 6mm, 30+0+T bodyrings, n=29. ♀ Total length 25-42mm, greatest width 6.9mm, 42+0+T or 43+o+T body rings, n=20.

Body sculpturing: Body smooth and shiny; scobinae absent. Anal valves with microscopic granulations (Figs 71D-E); eyes small with about 40 flat ommatidia.

Legs: Legs short, not extending beyond the margins of the body rings; all except the first two pairs of legs with distinct pads in the male; tibia condensed with two apical bristles (Fig. 74A).

Colour (after 17 years in ethanol): Body in general dark red with three longitudinal black stripes- one dorso-median and two dorso-lateral; head and collum reddish brown (Figs 70, 71A); antennae black-brown; body rings red with demarcated black dorso-median and two dorso-lateral black stripes occupying the meta- and mesozonites; metazonites brown, mesozonites red and yellow-brown at the margin, prozonites light brown/ yellow-brown (Fig. 71D); legs reddish (Fig. 70); preanal ring and anal valves reddish-brown (Fig. 71C).

Gonopods: *Anterior gonopods*: sternum of the anterior gonopods very wide and triangular, with distal region slightly tapered and apex bluntly rounded, almost reaching the tip of coxae; lateral margin of coxa slightly convex, with coxal process not strongly bent, slender and not entirely covering telopodite (Fig. 72A). Distal process of telopodite a large, simple triangular, laterally directed process, with very few scattered short setae; process not extending beyond the distal margin of telopodite (Figs 72B-C).

Posterior gonopods: distal process of telopodite with a fork-like shape at apex with three processes- one large and angular, one a hooked tooth and third a lamella-like curved structure;

suture line separating the telopodite and coxite visible; efferent groove and tibial processes absent; seminal duct opening at the base of the membrane/lamellae; apical disc of telopodite absent (Fig. 73).

Female sexual characters: Second pair of legs with coxasternal process with narrowly rounded bulge on distal margin (Fig. 74A). Vulva small and simple; roughly oval-shaped; anterior valve overlapping the posterior one; both valves with two to three irregular rows of long, well developed setae; operculum poorly sclerotized (Fig. 74).

Type locality: ZIMBABWE: Inyanga village.

Type material (examined). Syntypes: 1♂ 1♀ ZIMBABWE: Inyanga village, alt. 5,000 ft, 1961-11, Broadley D.G. (NMSA 8269).

Paratypes: ZIMBABWE: 8 ♂♂, 9 ♀ ♀ same data as for syntype.

Other material examined. SOUTH AFRICA: *Limpopo*: 12♂ 4♀ Soutpansberg, koppie behind Mt. View Hotel, 22°35'56.4"S, 29°33'32.4"E, 1997-11, Hamer M. (NMSA-15755); 2♂ 1♀ Lekgalameetse Nature Reserve, 24°05'45.6"S, 30°12'08.3"E, 1997-11, Hamer M. (NMSA-15753); 5♂ 5♀ 11 juveniles Roodewal Forest, Soutpansberg, 23°01'23.6"S, 30°02'22.4"E, Swaye J. (JS58, UKZN).

Additional records from Lawrence (1967): ZIMBABWE: Pungwe Gorge, Inyanga (5.000 ft. alt.)

Distribution. This species appears to be restricted to forest in the northern Drakensberg (Lekgalameetse) and the Soutpansberg mountains, with two localities much further north in the eastern highlands of Zimbabwe at Inyanga village and Pungwe Gorge.

Remarks. Lawrence (1967) designated a male and a female specimen as the "Holotype", but since there are two specimens, these are referred to here as syntypes. Lawrence (1967) also did not illustrate the posterior gonopods for this species.

The posterior gonopods resemble those of *Centrobolus* n.sp1, but in that species the distal process of the anterior gonopod telopodite has two parts. The simple distal telopodite process of the anterior gonopods of *C. inyanganus* is similar to that of *C. transvaalicus*, *C. albitarsis*, and *C. atrophus*, but the shape of the sternum of the anterior gonopods and the shape of the posterior gonopods distinguish *C. inyanganus* from these species.

Conservation assessment

This is a southern African species described from Zimbabwe in 1967 and collected in 1961 by D.G. Broadley. The species has a restricted distribution, only occurring in high altitude Afromontane forests in the north-east of South Africa, and in the west of Zimbabwe. In South Africa *C. inyanganus* has been recorded from Lekgalameetse, which is a provincial protected

area, and in forest in the Soutpansberg, which has some protection because this area is a biosphere reserve. There are, however, plantations in much of the Soutpansberg. Pungwe Gorge in Zimbabwe is protected, and because this area is largely inaccessible, it is unlikely to be threatened. The situation is probably similar in the Nyanga National Park.

The threats for this species include loss of habitat because of commercial timber, and possibly degradation of habitat as a result of extraction of forest products. These threats are not major, largely because the locations have some protection, and are not easily accessible for farming.

EOO = 27 055 km² and AOO = 25 km². Number of locations = 4.

While *C. inyanganus* meets the requirements for Endangered for AOO and number of locations, there is no real evidence that there has been any major reduction in EOO or AOO in the past or that the threats are ongoing. The requirements for Vulnerable D2 are met, but it is likely that this species occurs at additional locations, and it is not likely that there are any plausible threats that could drive the species to extinction in a very short time. Therefore, *C. inyanganus* qualifies as Least Concern (LC).

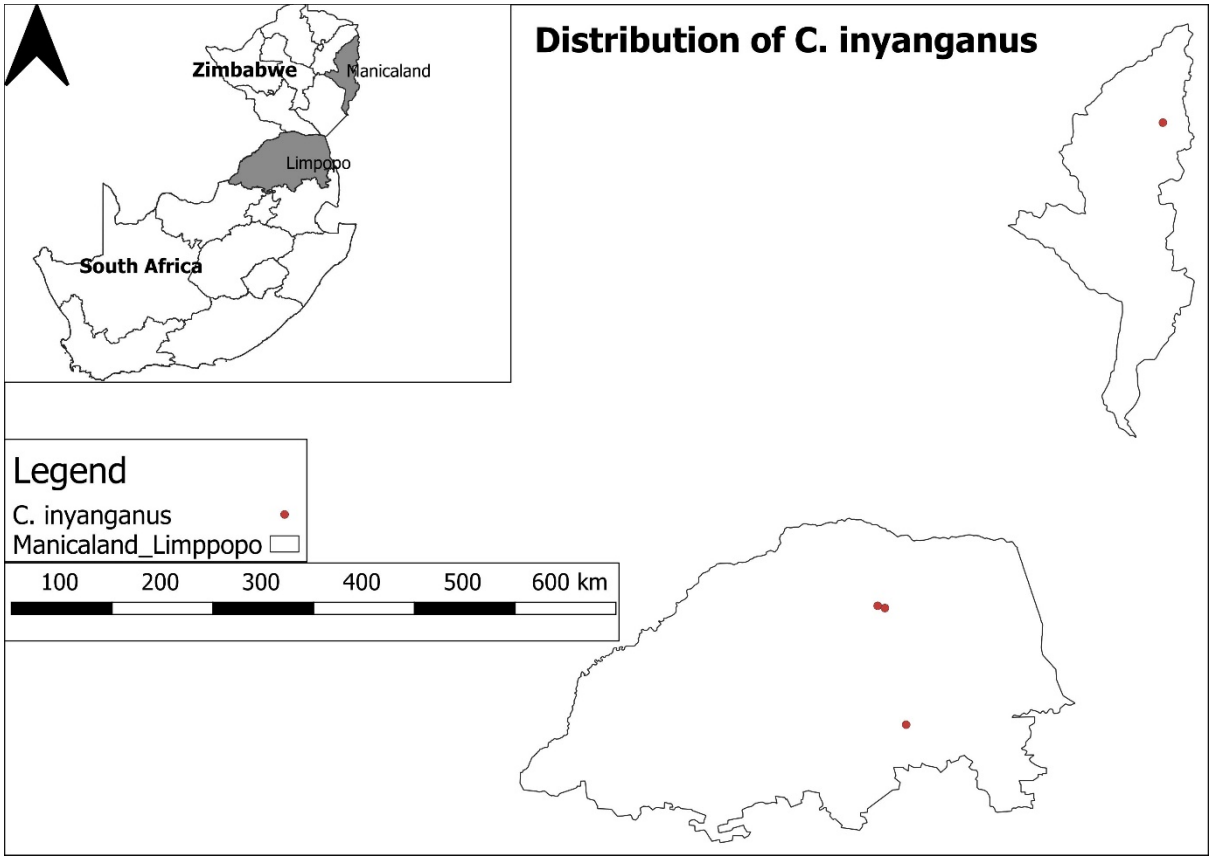

Figure 69: Distribution of *Centrobolus inyanganus* in southern Africa, Limpopo & Zimbabwe.

Figure 70: *Centrobolus inyanganus*. **A-B** Lekgalameetse. Photographer: Wynandd (CC-BY-NC) **C** Lajuma, Soutpansberg, Limpopo. Photographer: Gerhardd (CC-BY-NC). Source iNaturalist.

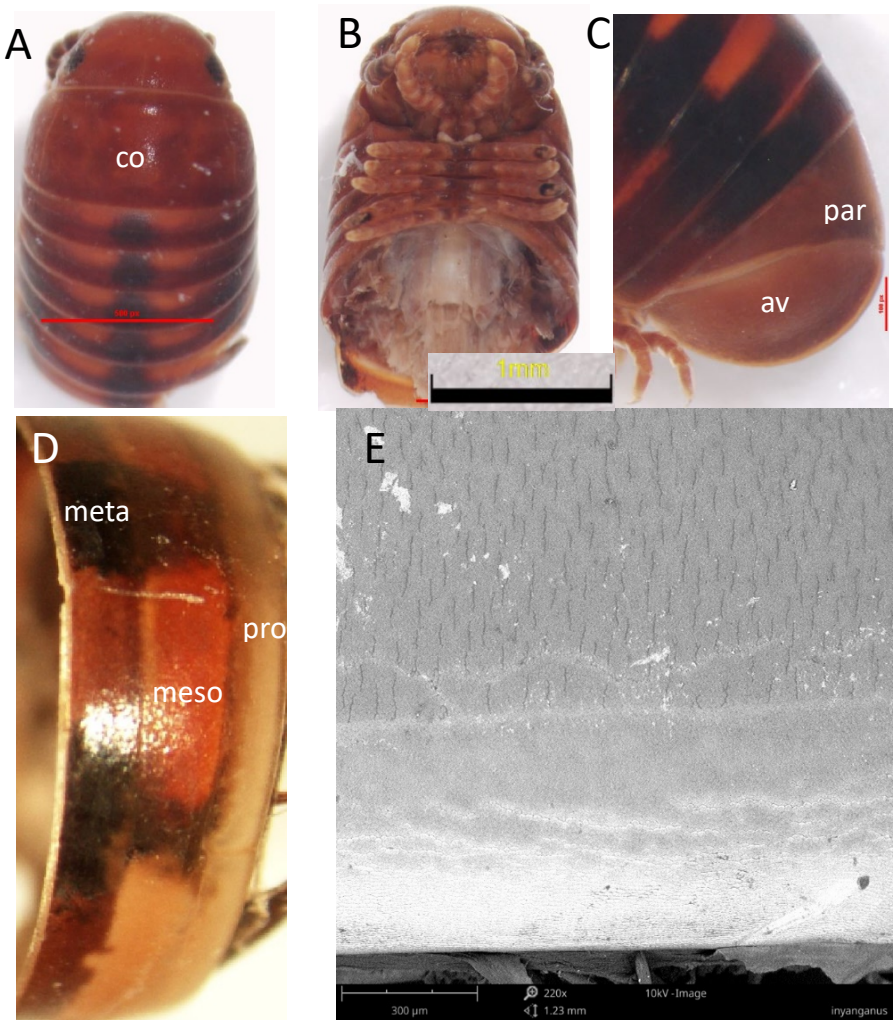

Figure 71: *Centrobolus inyanganus* (Roodewal forest, Limpopo) ♂ (JS58). **A** anterior view of the head and collum, **B** lateral view, **C** ventral view, **D** terminal region of body, **E-F** terminal region on body. Abbreviations: av - anal valve; co – collum; meso – mesozonite; meta – metazonite; par - preanal ring; pro – prozonite. Scale bars: 1.0 mm (**A-D**); 0.3 mm (**E**).

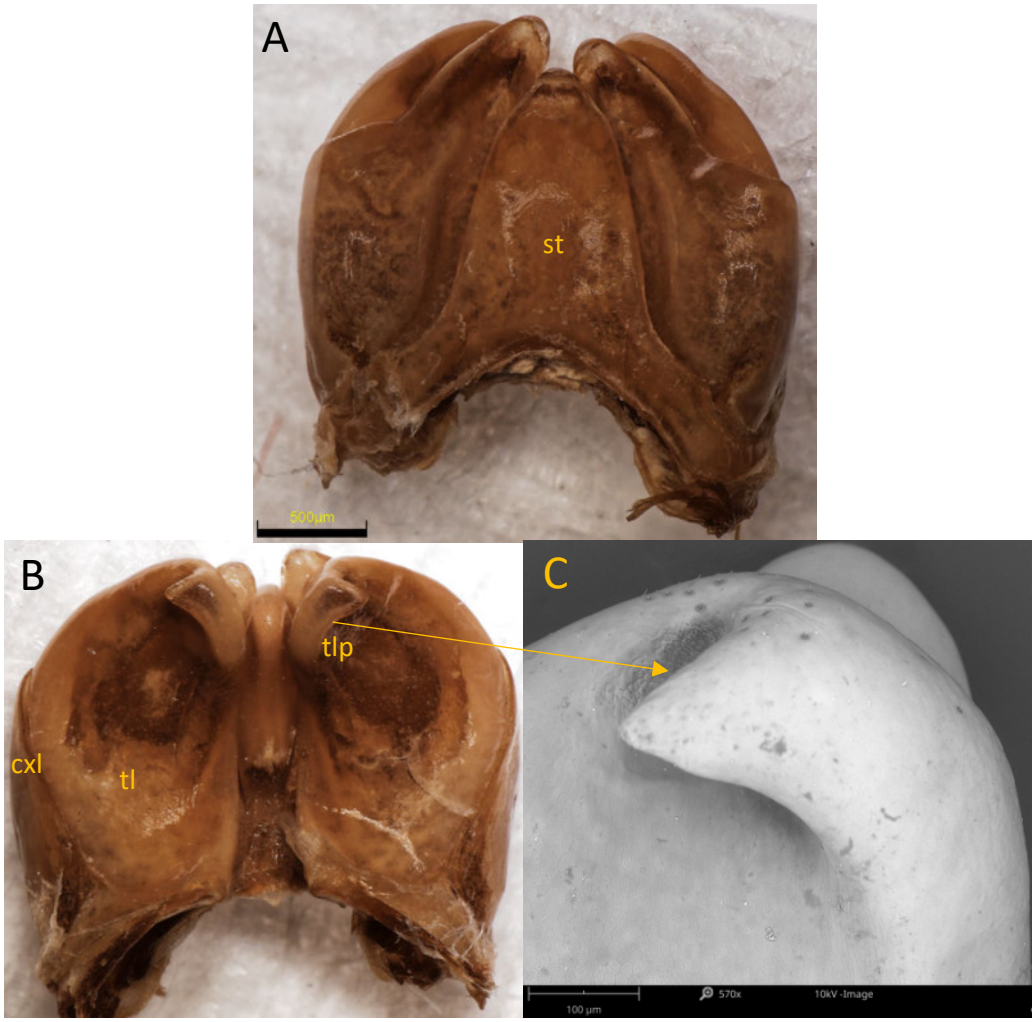

Figure 72: *Centrobolus inyanganus* ♂ (JS58). **A-C** anterior gonopods, **A** anterior view; **B-C** posterior view. Abbreviations: cx – coxa; cxl - coxal endite lobe; st – sternum; tl – telopodite; tlp - telopodite process. Scale bars: 0.5 mm (**A**, **B**, **D-F**); 0.1 mm (**C**).

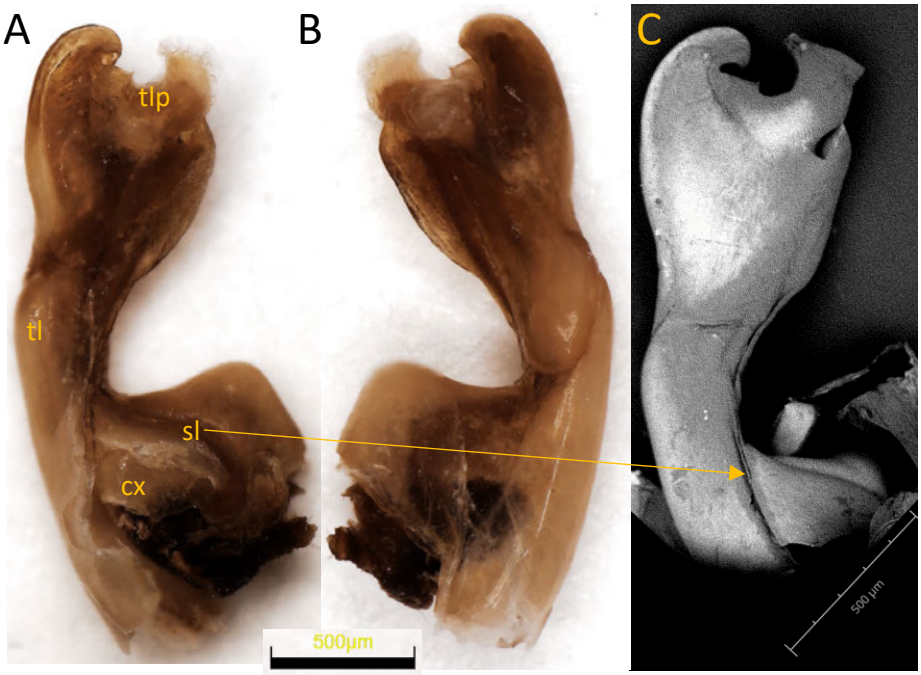

Figure 73: *Centrobolus inyanganus* ♂ (JS58). **A-C** posterior gonopod, **A** & **C** anterior view, **B** posterior view. Abbreviations: cx – coxa; sl - suture line; tl – telopodite; tlp - telopodite process. Scale bars: 0.5 mm.

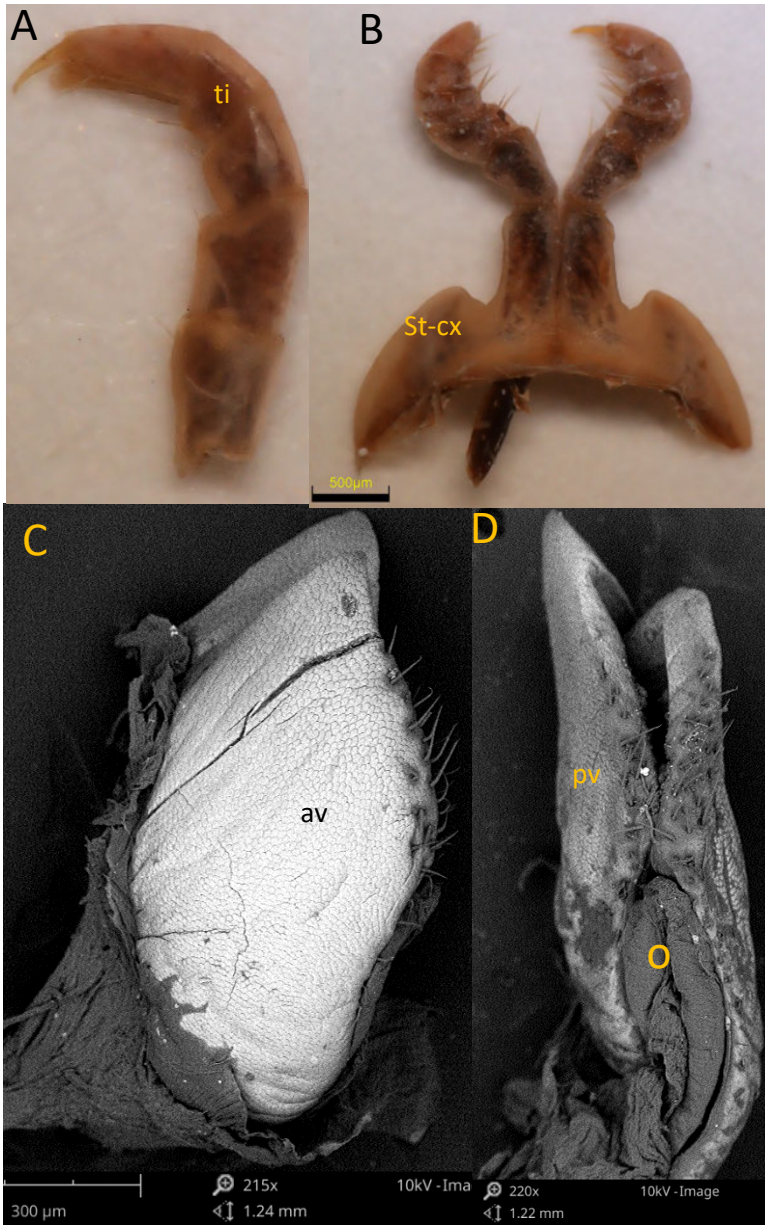

Figure 74: *Centrobolus inyanganus* ♀ (JS58). **A** male leg, **B** female second leg pair, **C-D** vulva, **D** lateral view, **C** anterior view. Abbreviations: av - anterior valve; o – operculum; pv - posterior valve; st-cx – coxosternite. Scale bars: 0.5 mm (**A-B**); 0.3 mm (**C-D**).

***Centrobolus lawrencei* (Schubart, 1966)**

Figs 75-79

Hamer 1998: 40.

Chersastus lawrencei Schubart, 1966: 50-53; Lawrence 1967: 631.

Diagnosis. Differs from congeners in having a combination of the following character states: distal process of the telopodite of anterior gonopods club-shaped, with the distal part long and slender and with inflated apical region, and the basal part slender, finger-shaped and slightly distally directed (Figs 77B-C); coxal process of anterior gonopods very broad, distal half tapered to a point, almost covering telopodite, last six pairs of legs lacking tarsal pads; head, antennae and metazonites blackish-brown; collum reddish with dark posterior third.

Redescription. *Measurements*: ♂ Total length 34-45mm, greatest width 5mm, 42+0+Tbody rings, n=29. ♀ Total length 35-37mm, greatest width 5mm, 42+0+Y body rings, n=20.

Body sculpturing: Body smooth and shiny; scobinae present and prominent, conical in shape (Figs 76E, F).

Legs: Legs long, extending beyond lateral margins of the body rings; all except the first two pairs and the last six pairs of legs with tarsal pads; tibia condensed with two apical bristles (Fig. 79A).

Colour (after 63 years in ethanol): The body in general brown and black banded; head brownish black (Fig. 76A); collum brownish red but with dark brown posterior third (Fig. 76A); antennae brown (Fig. 76B); body rings with dark brown metazonites and brown mesozonites and prozonites; (Fig. 76E); legs yellowish brown (Fig. 76C); preanal ring and anal valves brown (Fig. 76D).

Gonopods: *Anterior gonopods*; Sternum of the anterior gonopods triangular and apically pointed, with margins of distal region convex, reaching the middle of the gonopods; lateral margin of coxa slightly convex, with coxal process very broad, distally directed and apically pointed, almost entirely covering telopodite (Fig. 77A). Distal process of telopodite with two parts, apical part large and protruding and club-shaped, proximal part slender and finger-like, slightly distally directed (Figs 77B-C).

Posterior gonopods: Tibial processes broad and smooth; the seminal duct opens on the base of the tibial process; inflated basal lobe present and outwardly directed; longitudinal efferent groove strongly developed and runs diagonally with the telopodite; distal process of the telopodite curved with broad lamella attached (Fig. 78).

Female sexual characters: Distal margin of lateral extensions of coxosternum with low and broad bulge (Fig. 79B). Vulva simple and extremely small; half circle shaped; anterior valve overlaps the posterior valve; anterior valve with one row of setae; posterior valve with two rows of setae; surface of valves with patterning; operculum poorly sclerotized (Figs 79C-D).

Type locality: SOUTH AFRICA: *KwaZulu-Natal*: Town Bush, Pietermaritzburg.

Type material (not examined). Holotype: 1♂ SOUTH AFRICA: KwaZulu-Natal, Town Bush, Pietermaritzburg, 1948-10, Hanstrom B (MZLU).

Paratypes: South Africa: 7♂♂ 1♀ 2 Juv same data as for syntype.

Material examined. SOUTH AFRICA: *KwaZulu-Natal*: 1♂ 2♀ Pietermaritzburg, Town Bush, 1939-12, Lawrence R.F. (NMSA-2687); 1♂ same data as the preceding, 1944-10, (NMSA-4410), 2♂ 2♀ same data as the preceding, 1955-10, (NMSA-9381); 1♂ Nottingham Rd, 1955-07, Lawrence R.F. (NMSA-6290); 1♂ Richmond, 1958-10, Lawrence R.F. (NMSA-7829); 2♂ Impendle Nature Reserve, 29° 42' 59.07"S, 29° 53' 06.64"E, 2002-11, Armstrong A.J. (NMSA-22757); *Eastern Cape*: 1♂ 1♀ Mkhambathi Nature Reserve, 31.31806°S, 29.9672°E, 2008-01, Hamer M. (III-UKZN 5991); 1♂ 1♀ same collection data as the preceding, (III-UKZN 42491).

Distribution. This species has only been recorded from several localities in the KwaZulu-Natal midlands, where it was collected from Afromontane forest, and from one locality on the north Eastern Cape coast where it was collected in coastal dune forest.

Remarks. This species resembles *C. angelicus* (Jeekel, 1956) in colouring and slightly in gonopod form, but the shape of the main part of the distal process of the anterior gonopod telopodite is distinct in the two species, with that of *C. lawrencei* being longer than wide, while in *C. angelicus* it is wider than long, and the number of legs with tarsal pads and the shape of the vulva differ in the two species. Hoffman (1971) suggested that the gonopods of *C. richardi* and *C. lawrencei* are very similar, but that the two species differ in coloration and number of legs with tarsal pads, and their distribution is allopatric. Lawrence (1967) stated that *C. lawrencei*, *C. inscriptus* and *C. rubricollis* are closely related, but Hoffman (1971) noted that the gonopods for the two latter species had not been well illustrated. In the present study the gonopods of these three species are shown to be distinct, particularly the distal process of the anterior gonopod telopodite.

Conservation assessment

This is a South African species described from KwaZulu-Natal in 1966 and first collected in 1948 by B. Hanstrom. The species is relatively common in the KwaZulu-Natal midlands forest and was collected at one site at Mkambathi Nature Reserve on the Eastern Cape coast. *Centrobolus lawrencei* has been recorded from Town Bush forest in Pietermaritzburg, and this has undergone significant loss of habitat and degradation of forest over the last 20 years. This has largely been a result of alien invasive species, and the impact of adjoining timber plantations. The exact localities at Richmond and Nottingham Road are unknown but these areas have also undergone extensive transformation mainly through plantations. This species has been recorded from two protected areas, Impendle Nature Reserve in KwaZulu-Natal and Mkhambathi Nature Reserve in the Eastern Cape. The other localities are not protected and there are no conservation actions in place for this species. The species is known to occur in Afromontane and dune forest.

EOO = 5 534 km² and AOO = 20 km². Number of localities = 5.

Centrobolus lawrencei therefore qualifies as Vulnerable (VU B1, B2, a, bii).

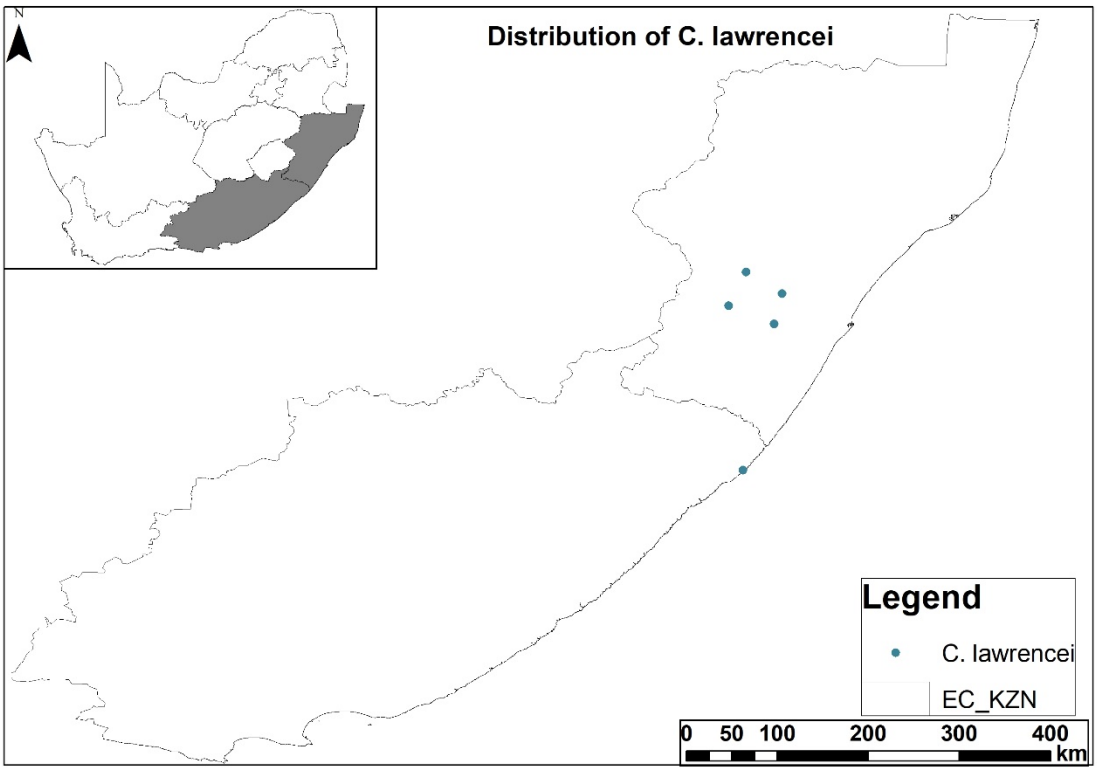

Figure 75: Distribution of *Centrobolus lawrencei* in South Africa. EC Eastern Cape, KZN-KwaZulu-Natal.

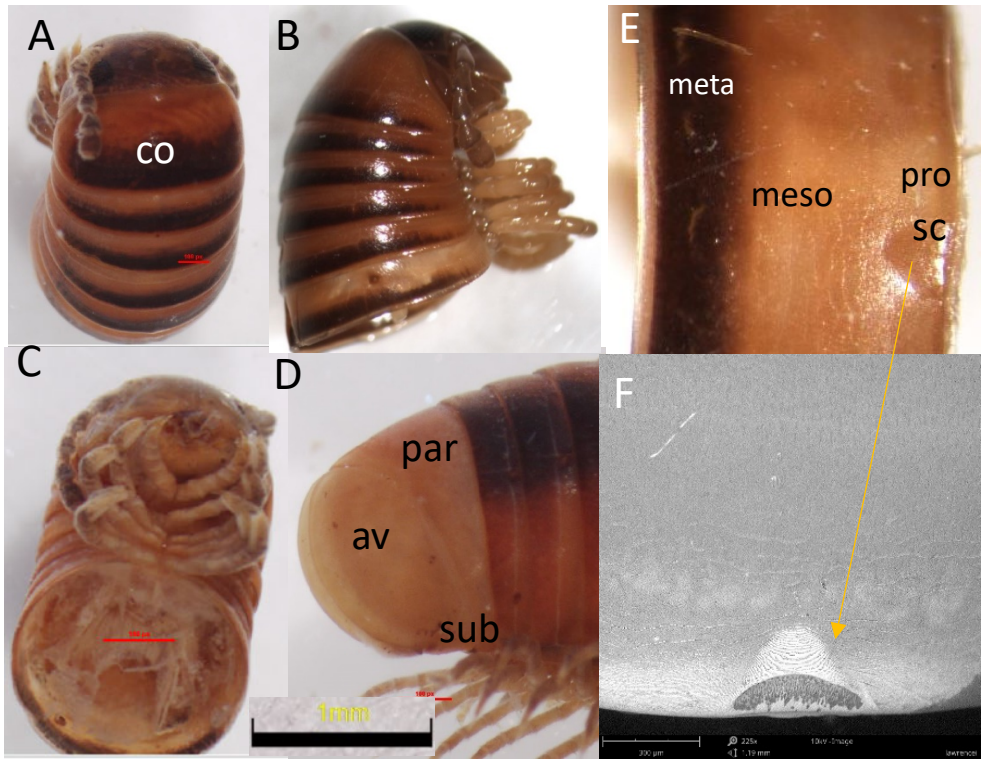

Figure 76: *Centrobolus lawrencei* (Town Bush, KwaZulu-Natal) ♂ (NMSA-9381). **A** anterior view of the head and collum, **B** lateral view, **C** ventral view, **D** terminal region of body, **E-F** terminal region on body. Abbreviations: av - anal valve; co – collum; meso – mesozonite; meta – metazonite; par - preanal ring; pro – prozonite; sc - scobina. Scale bars: 1.0 mm (**A-E**); 0.3 mm (**F**).

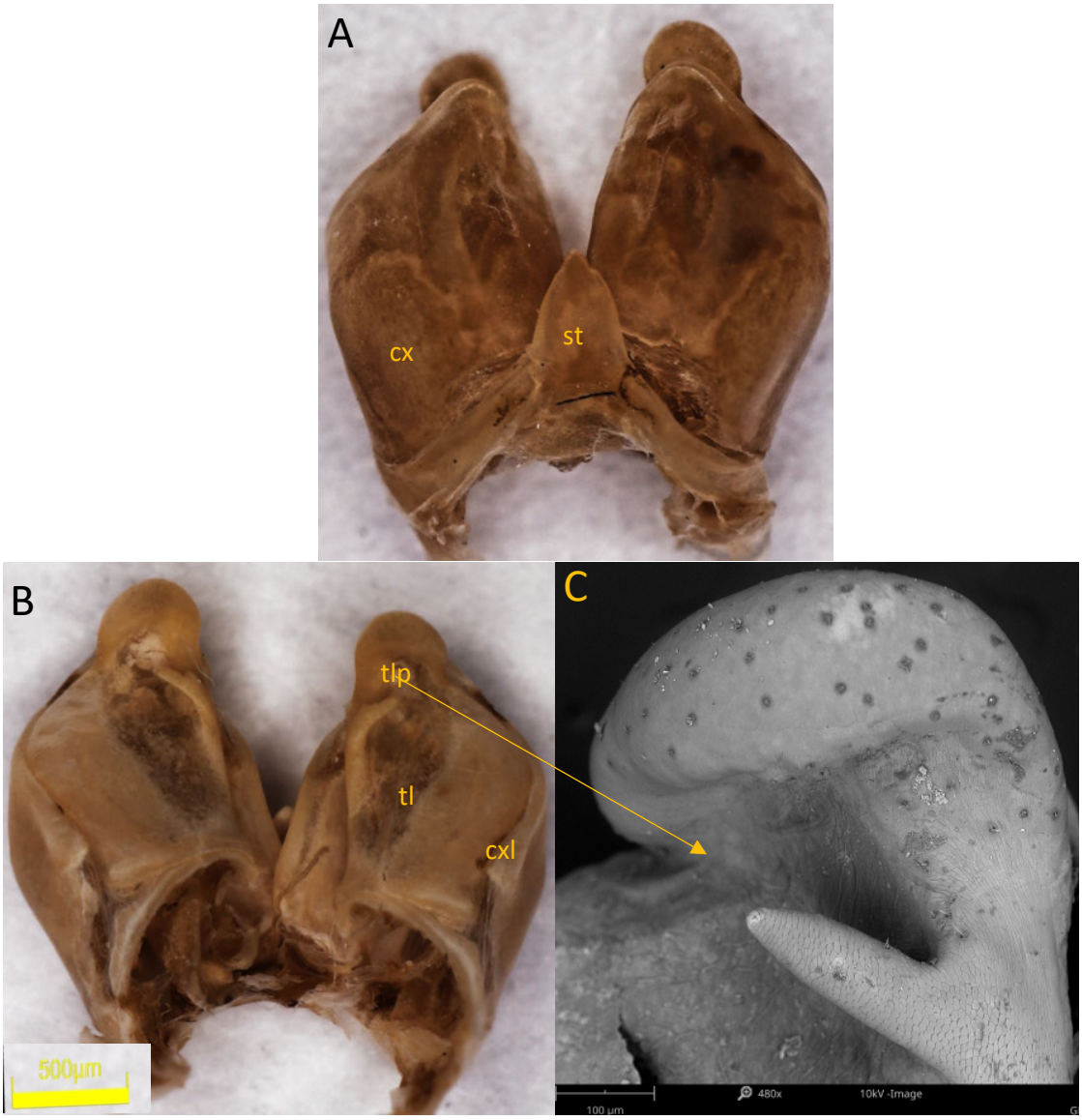

Figure 77: *Centrobolus lawrencei* ♂ (NMSA-9381). **A-C** anterior gonopods; **A** anterior view, **B-C** posterior view. Abbreviations: cx – coxa; cxl - coxal endite lobe; st – sternum; tl – telopodite; tlp - telopodite process. Scale bars: 0.5 mm (**A-B**); 0.1 mm (**C**).

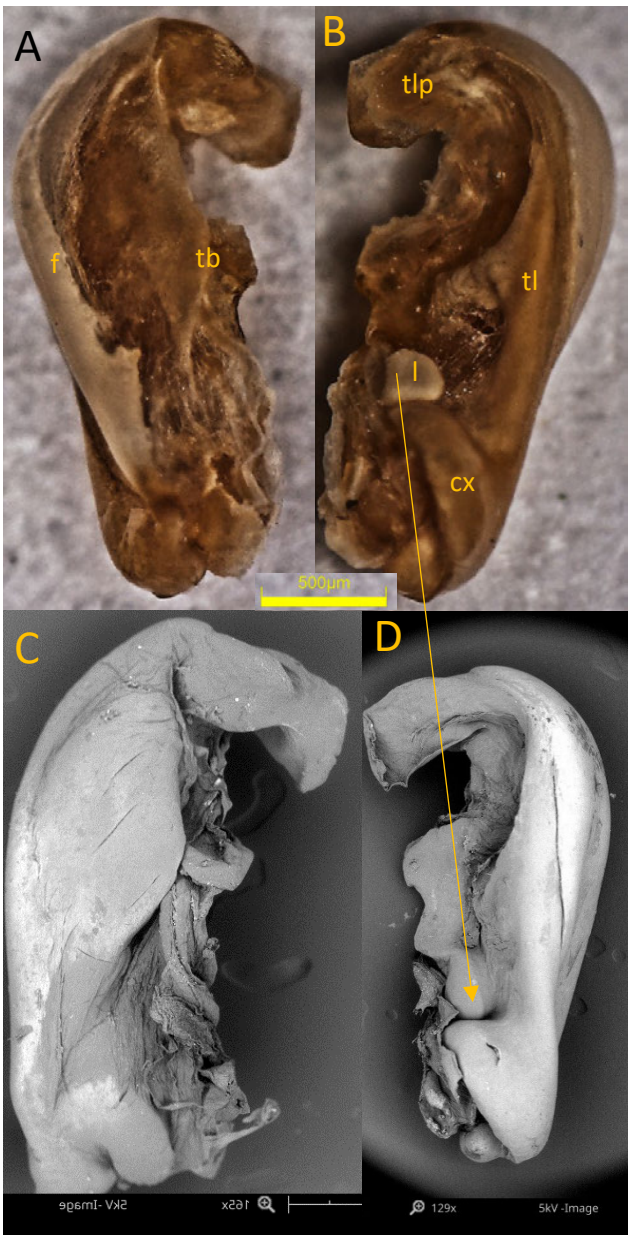

Figure 78: *Centrobolus lawrencei* ♂ (NMSA-9381). **A-D** posterior gonopod; **B** & **D** anterior view, **A** & **C** posterior view. Abbreviations: cx – coxa; f - efferent groove; l – inflated basal lobe; tb - tibial process; tl – telopodite; tlp - telopodite process. Scale bars:0.5 mm.

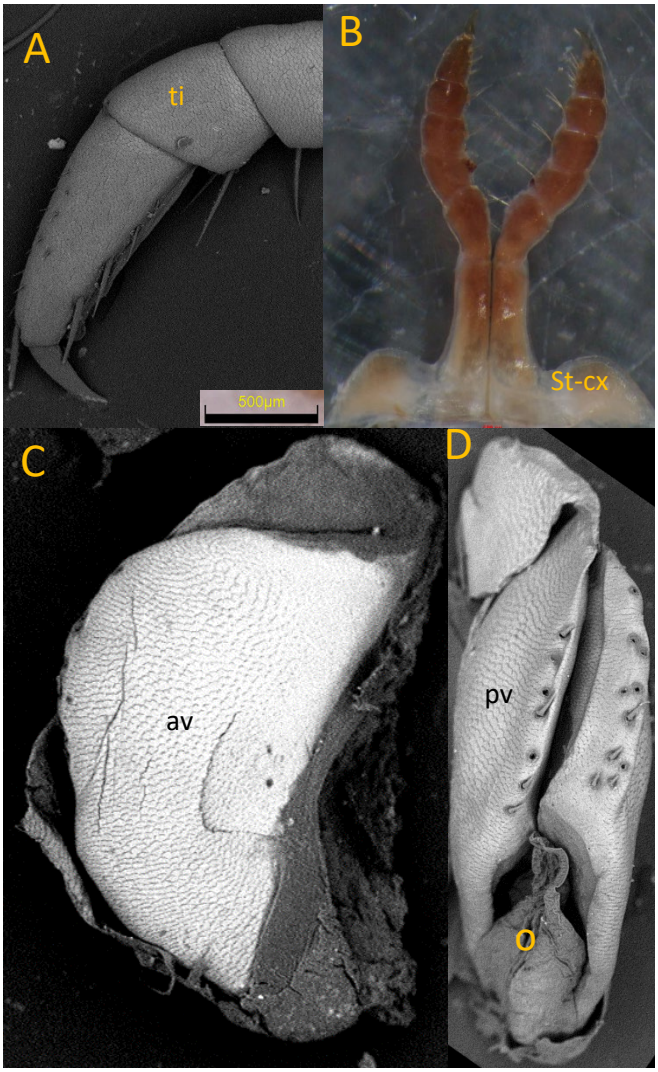

Figure 79: *Centrobolus lawrencei* ♀ (NMSA-9381). **A** male leg, **B** female second pair leg, **C-D** vulva, **D** lateral view, **C** anterior view. Abbreviations: av - anterior valve; o – operculum; pv - posterior valve; st-cx – coxosternite; ti-tibia. Scale bars: 0.5 mm (**A-B**); 0. 3 mm (**C-D**).

***Centrobolus litoralis* (Koch, 1865)**

Figs 80-84

Hoffman 1971: 158-162; Hamer 1998: 41.

Spirobolus litoralis Koch, 1865: 884; Attems 1928: 308; Jeekel 1956: 54.

Spirobolus tessellatus Porat, 1872: 21-22; Attems 1928: 309; Jeekel 1956: 95; Hoffman 1971: 160.

Chersastus erythroproctus Jeekel, 1956: 89-90; Schubart 1966: 68; Hoffman 1971: 160.

Chersastus elizabethae Schubart, 1966: 65-67; Hoffman 1971: 160.

Chersastus litoralis Schubart 1966: 69-70.

Diagnosis. Differs from congeners in the very short sternum of the anterior gonopods which reaches less than a quarter up the height of the coxae; the elongated, lamellae, slightly concave distal process of the anterior gonopod telopodite; the distinct coxal joint and the concave median margin of the coxae, and broad, straight apical margin of the coxal process (Figs 82B-D).

Redescription. *Measurements*: ♂ Total length 38mm, greatest width 3.5mm, 43+0+T body rings, n=2. ♀ Total length 32mm, greatest width 4.5mm, 43+0+T body rings , n=1.

Body sculpturing: Body shiny and smooth with minute punctuation; scobinae absent (Figs 81E-F).

Legs: Legs fairly long (female legs shorter); all legs with tarsal pads except the first two pairs in male; tibia condensed with two apical bristles (Fig. 84).

Colour (after 86 years in ethanol, colour faded, so the description is taken from Jeekel (1956): The body in general black with red paramedian spots; head red with black interocular band, antennae and legs reddish orange, collum black with red spots/band in the middle of the anterior margin, preanal ring grayish with red margins and anal valves reddish (Figs 81A-C); body rings with yellowish metazonites, mesozonites and prozonites (Fig. 81E).

Gonopods: *Anterior gonopods*: Sternum of the anterior gonopod short and reaching about a quarter of the height of the coxae; broadly triangular with narrow, pointed apex (Fig 82A). Distinct coxal joint, median margin of coxal process concave and apical margin broad and

straight (Fig. 82A). Distal process of telopodite elongated, lamellae, slightly concave and with scattered, short setae (Figs 82B-D).

Posterior gonopods: Tibial processes absent; efferent groove weakly developed; inflated lobe present and large; coxae completely fused with the telopodite; distal processes of the telopodite upwardly pointed (Fig. 83).

Female sexual characters: Female specimen examined lacks head region and so second pair of legs and vulvae not examined, and these were not described by other authors.

Type material (not examined). Syntypes: 1♀1 ♂ SOUTH AFRICA: Eastern Cape, Algoa Bay, Jeekel (1956) (ZMUH).

Material examined. SOUTH AFRICA: *Eastern Cape*: 2♂ Van Stadens, 20 miles east of Port Elizabeth, 1933-02, (SAM-ENW-B008000); 1♀ Port Elizabeth; Coll. H.A. Spencer, (SAM-ENW-X001517).

Distribution. This species has only been recorded from the Eastern Cape coastal region around Port Elizabeth.

Remarks. Hoffman (1971) provided a detailed history of the taxonomy of *C. litoralis* and confirmed earlier synonomies and synonomised *C. erythroproctus* described by Jeekel (1956) and *C. elizabethae* described by Schubart (1966) under *C. litoralis*. It appears that *C. litoralis* is variable in terms of colour, and so authors have based their determination of new species on this variation, which is mostly on the head and anal valves. However, Hoffman (1971) examined a series of specimens from Port Elizabeth and noted variation in colour even within specimens from the same locality.

Hoffman (1971) noted the unusual shape of the distal process of the anterior gonopod telopodite, which is shared with *C. lugubris* (Lawrence, 1967), a species from a locality close to Port Elizabeth but inland, and this similarity is confirmed in the present study. However, more material must be obtained for both species to confirm their status.

Conservation assessment

This is a South African species described from Eastern Cape by Koch in 1865. The species has a restricted distribution in the Eastern Cape and has only been recorded from two localities in the coastal area of Port Elizabeth, but this area is not very well surveyed. The habitat may be forest but this is uncertain. There is some uncertainty about the status of this species and *C. lugubris* may be a synonym. The locality is not a protected area and there are no conservation actions in place for this species.

There is insufficient information to make an assessment on this species as so it is categorised as Data Deficient (DD).

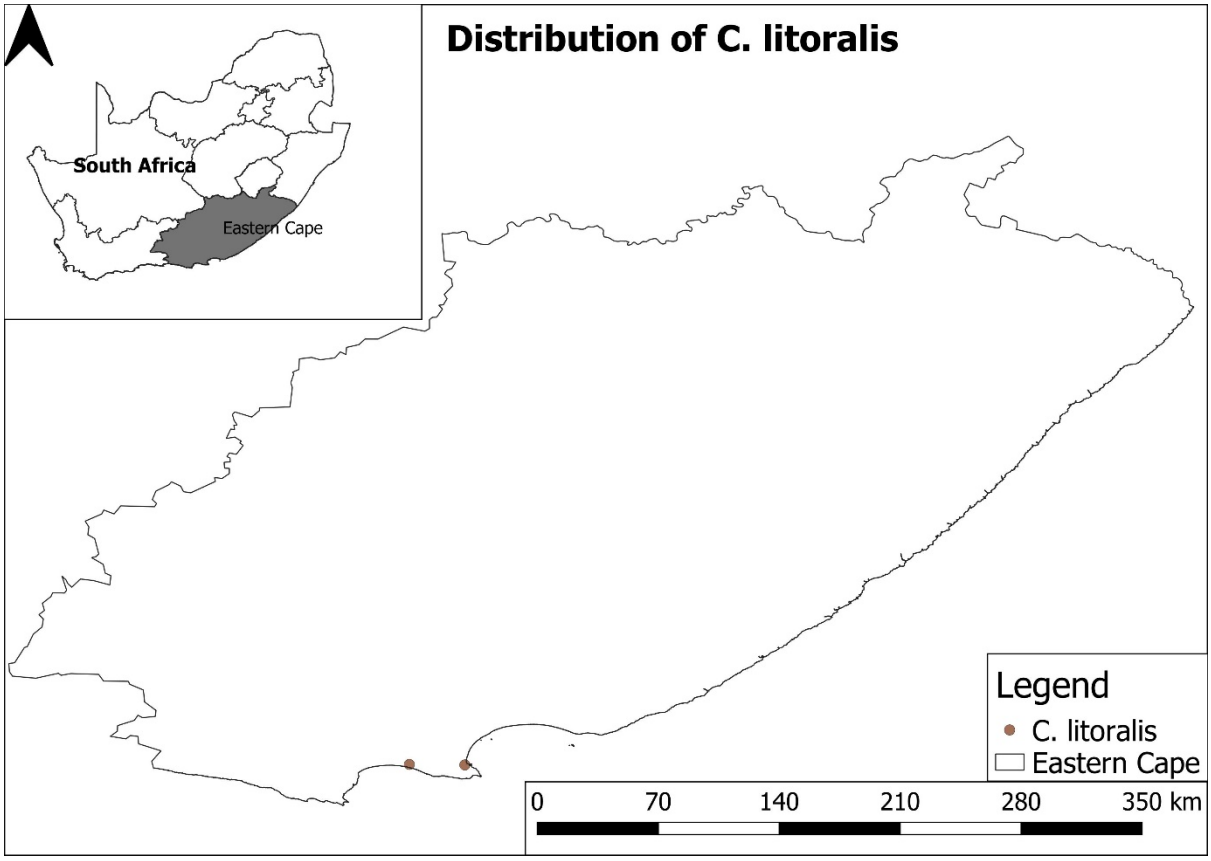

Figure 80: Distribution of *Centrobolus litoralis* in South Africa, Eastern Cape.

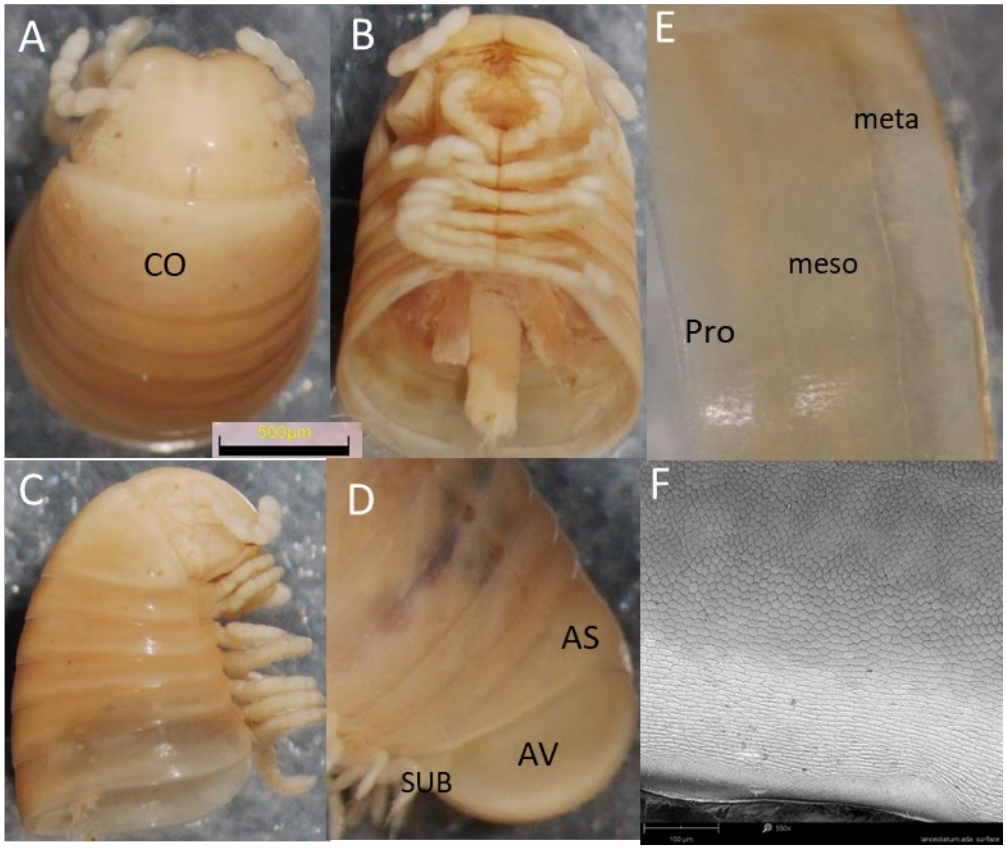

Figure 81: *Centrobolus litoralis* (Van Stadens, Eastern Cape) ♂ (SAM-ENW-B008000). **A** anterior view of the head and collum, **B** lateral view, **C** ventral view, **D** terminal region of body, **E-F** body ring. Abbreviations: av - anal valve; co – collum; meso – mesozonite; meta – metazonite; par - preanal ring; pro - prozonite. Scale bars: 0.5 mm (**A-E**); 0.1 mm (**F**).

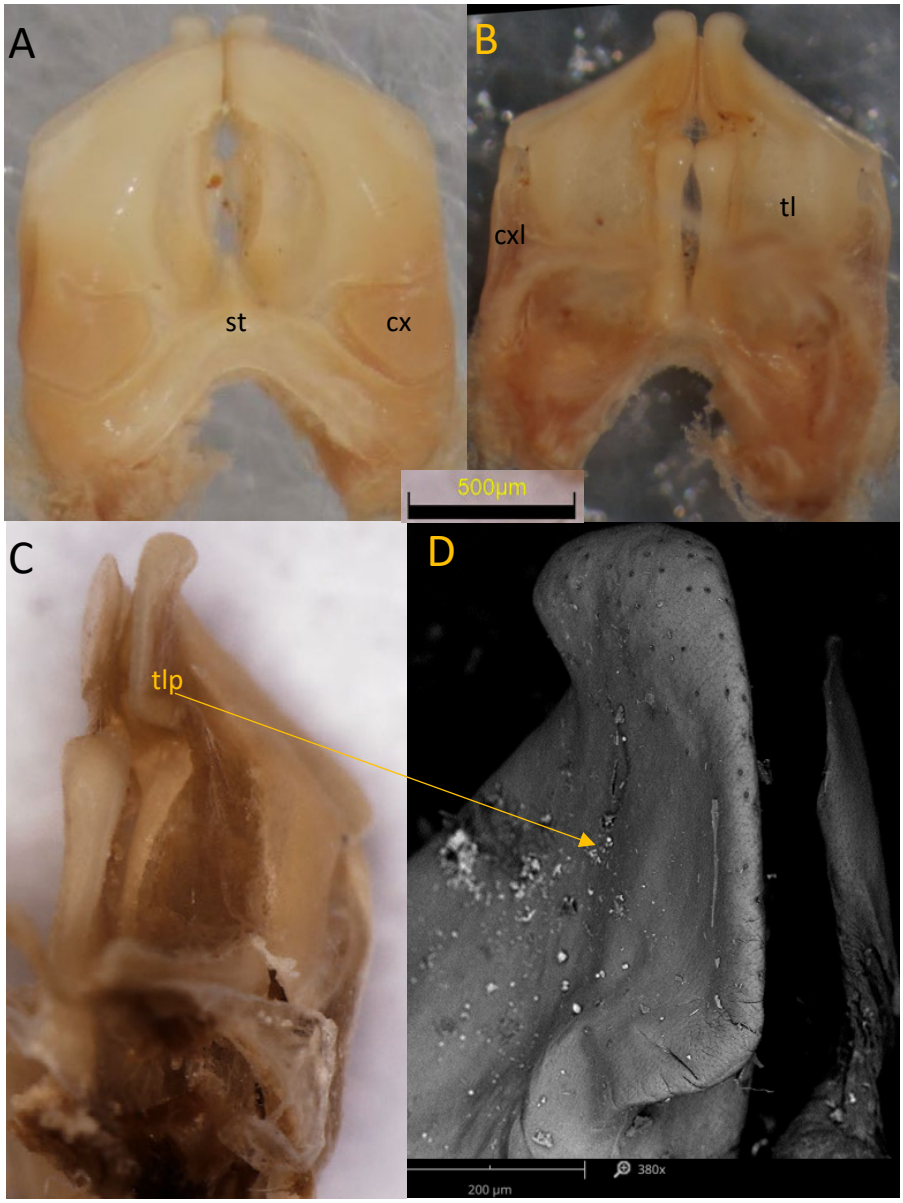

Figure 82: *Centrobolus litoralis* ♂ (SAM-ENW-B008000). **A-D** anterior gonopods; **A** anterior view, **B-D** posterior view. Abbreviations: cx – coxa; st – sternum; tl – telopodite; tlp - telopodite process. Scale bars: 0.5 mm (**A-C**); 0.2 mm (**D**).

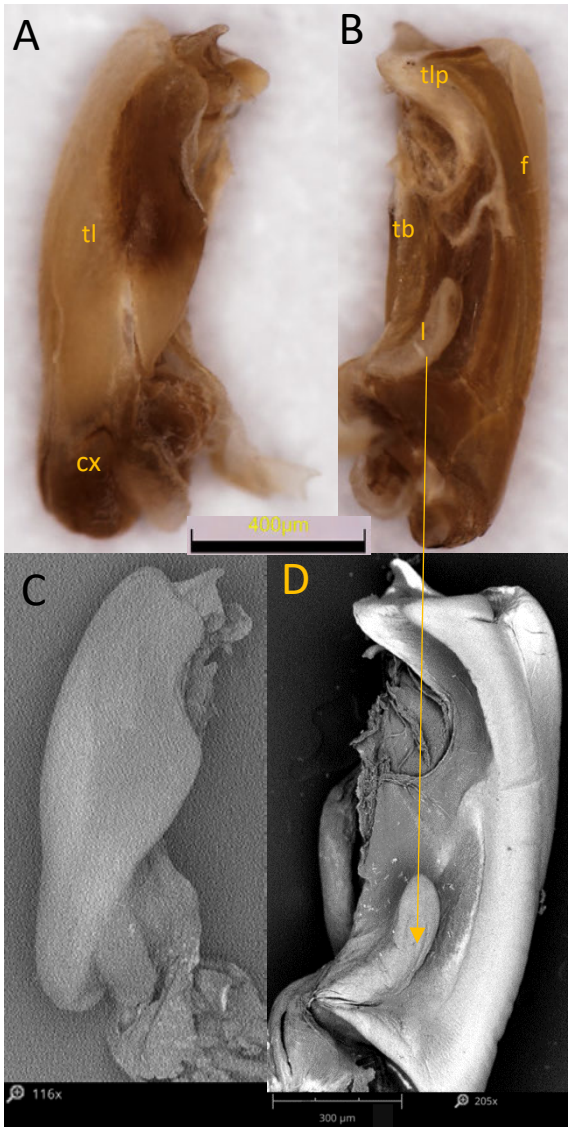

Figure 83: *Centrobolus litoralis* ♂ (SAM-ENW-B008000). **A-D** posterior gonopod; **B** & **D** posterior view, **A** & **C** anterior view. Abbreviations: cx – coxa; f - efferent groove; l - inflated basal lobe; tb - tibial process; tl – telopodite; tlp - telopodite process. Scale bars: 0.4 mm (**A-B**); 0.3 mm (**C-D**).

Figure 84: *Centrobolus litoralis* ♂ (SAM-ENW-B008000). Male leg. Abbreviations: ti-tibia; ts - tarsal pad. Scale bar: 0.2 mm.

***Centrobolus luctuosus* (Peters, 1855)**

Fig. 85.

Cook 1897: 74; Jeekel 1956: 85; Schubart 1966: 72-73; Lawrence 1967: 645; Hoffman 1971: 146-148 Hamer 1998: 41; Hoffman 2001: 49-51.

Spirobolus luctuosus Peters, 1855: 80-81.

Description. Original description by Peters (1855) translated using Google Translate: ♂

Total length 100mm, greatest width 6.0mm, 44 body rings.

Body sculpturing: eyes with 48 ommatidia.

Colour: "*…ater, cingulorum mediorum nigrofuscus; margo labialis rufofuscus, pedes apicibus rufoflavidis*".

Gonopods: from Cook (1897) description, "copulatory legs a whole longer than broad, the anterior lamellae close together, much exceeded by the produced apices of the posterior lamellae, which are armed on their posterior face with a distinct spine".

Type material (not examined): *Holotype*: MOZAMBIQUE: 1♂ Inhambane (ZMHB).

Remarks. There are no specimens of this species in any of the South African museums. The types were deposited in Museum für Naturkunde der Humboldt Universität, Berlin Germany. The gonopods are missing, but the illustrations of gonopods were discovered (Hoffman, 2001). The topotype of *Centrobolus luctuosus* needs to be collected from Inhambane to confirm the status of this species, which is considered as the type for *Centrobolus*.

Conservation assessment

The uncertain status of this species and the lack of information about the distribution mean that it is Data Deficient (DD).

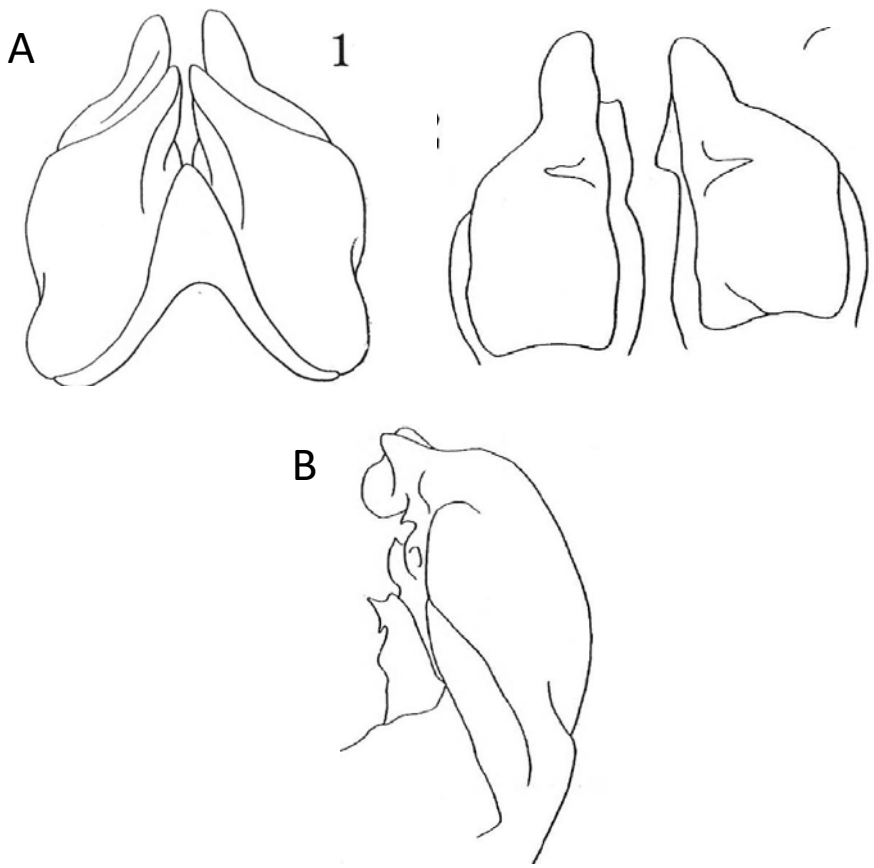

Figure 85: *Centrobolus luctuosus* ♂. **A** anterior and **B** posterior gonopods, taken from Hoffman (2001). Drawings produced by Cook (1897).

***Centrobolus lugubris* (Lawrence, 1967)**

Figs 86-90

Hamer 1998: 41.

Chersastus lugubris Lawrence, 1967: 626.

Diagnosis. Differs from congeners in very short sternum of the anterior gonopods which reaches less than a quarter up the height of the coxae and is apically indented; the elongated, lamellae, slightly concave distal process of the anterior gonopod telopodite and the distinct coxal joint and concave median margin of the coxal process (Figs 88B-C).

Redescription. *Measurements*: ♂ Total length 35mm, greatest width 4.9mm, 41+0+T body rings, n=1. ♀ Total length 35mm, greatest width 5mm, 43+0+T body rings, n=1.

Body sculpturing: Body smooth and shiny; scobinae present, indistinct, and mostly occurring in posterior segments; anal valves with microscopic granulations.

Legs: Legs fairly long; all except the first two pairs of legs with distinct tarsal pads; tibia extremely condensed with one apical bristle (Fig. 90A).

Colour (after 14 years in ethanol): The body in general black with a pair of paramedian red stripes; head red with black vague markings median to the eyes (Fig. 87B); collum black with red markings in the middle anterior margin forming a M-shape (Fig. 87A); antennae and legs reddish (Figs 87B-C); body rings with black metazonites, black mesozonites with a pair of paramedian red stripes and pale/light brown prozonites with pair of paramedian red markings and black emerging at posterior margins (Fig. 87F); preanal ring dark greyish with reddish posterior margin and anal valves reddish (Fig. 87E).

Gonopods: *Anterior gonopods*: Sternum of the anterior gonopod short and apically bluntly bifid (Figs 88A); coxae of anterior gonopods with lateral margin slightly convex but coxal process with distal margin almost straight and strong medially directed at about 45°; median margin of coxa concave, but distally with straight edge. Distal process of telopodite elongated, lamellate and concave, with very small, short and widely scattered setae (Figs 88B-C).

Posterior gonopods: Tibial process narrow with seminal duct opening on its base; inflated basal lobe present, elongated and situated laterally; longitudinal efferent groove strongly developed and runs diagonally across telopodite; distal processes of telopodite directed upward and indented (Fig. 89).

Female sexual characters: Distal margin of lateral extensions of coxosternum with distinct, bluntly triangular projection. Vulva simple and large; anterior valve overlapping the posterior valve; both valves with two irregular rows of setae basally; operculum poorly sclerotized. Inner basal region with undulating structure, with lobes loosely interlocking with the opposite valve margin (Fig. 90).

Type material (not examined). Syntypes: 1♂ 1♀ SOUTH AFRICA: Eastern Cape, Glenconnor, (about 100 miles NW of Port Elizabeth), collected under fallen and decaying *Euphorbia* stems, 1964-03. Lawrence R.F. (NMSA-9024).

Paratype*s*: SOUTH AFRICA: 1 ♂ same data as for syntype.

Material examined. SOUTH AFRICA: *Eastern Cape*: 1♂ 1♀ Rhodes University, Olive Schreiner Residence, 2005-04, Vermeulen B.M. (Ref no: 5, UKZN).

Distribution. This species has only been recorded from two localities in the Eastern Cape, inland from Port Elizabeth (Glenconnor and Grahamstown). It does not seem to be a forest species and was collected from an urban area and from valley bushveld habitat.

Remarks. Lawrence (1967) designated a male and a female specimen as the "Holotype", but since there are two specimens, these are referred to here as syntypes. Lawrence (1967) also did not illustrate the posterior gonopods for this species nor provide a description of gonopods. He described the scobinae as being absent yet these are present but small, and they do not occur on all segments. In the original description the head is given as black, but in the material examined it was red. Hoffman (1971) showed that there is colour variation in the closely related *C. litoralis*, and this may be the case with *C. lugubris* as well.

Centrobolus lugubris is very similar to *C. litoralis* in terms of gonopod structure, with both species sharing similar coxae and distal telopodite processes in the anterior gonopods, and the structure of the posterior gonopods. Unfortunately, no vulva was examined for *C. litoralis*, and so differences in this structure between the two species could not be studied. It is possible that *lugubris* is not distinct from *litoralis*, the only slight difference is on the apex of sternum where in *lugubris* is dented and in *litoralis* is smoothly pointed.

Conservation assessment

This is a South African species described from Eastern Cape in 1967. The species has a restricted distribution in the Eastern Cape and is only known from Rhodes University in Grahamstown and Glenconnor, which is inland of Port Elizabeth. The localities are not protected. The species is known from valley bushveld habitat and an urban environment. Given the uncertainty about the status of the species, and the fact that its distribution is not well known, *C. lugubris* is categorised here as Data Deficient (DD).

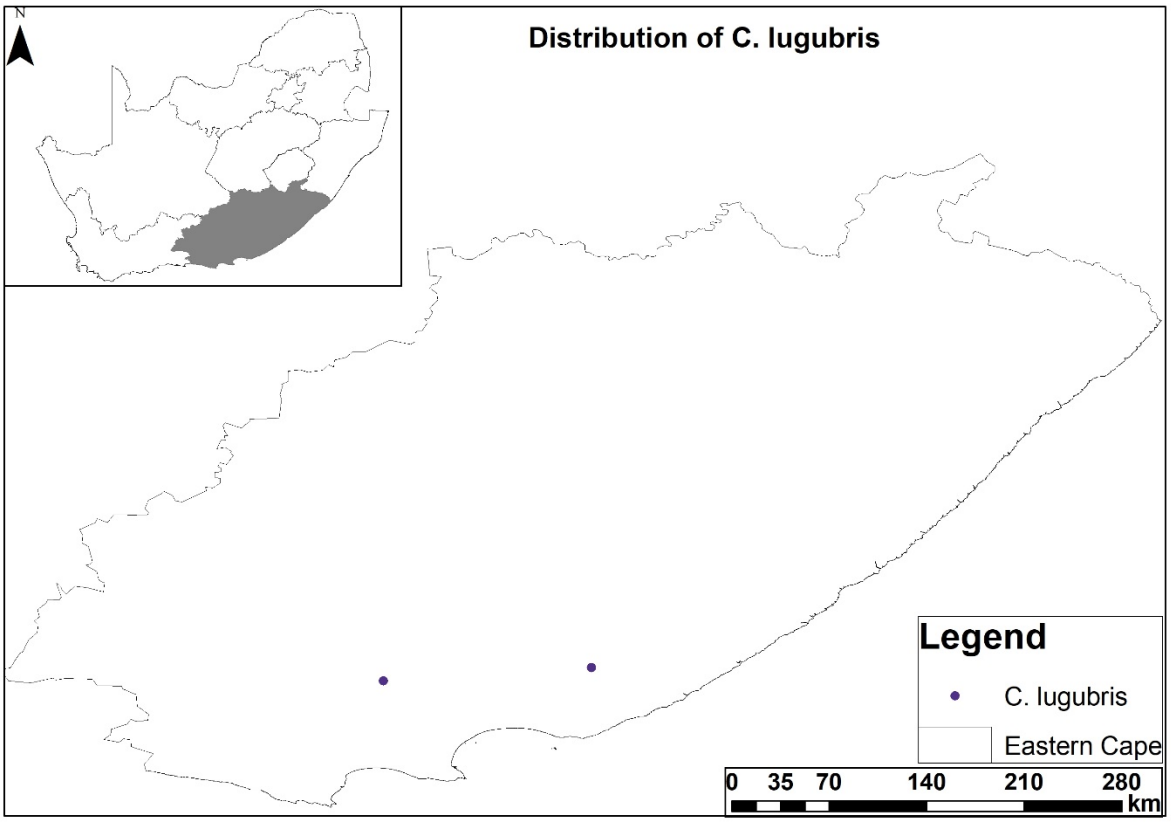

Figure 86: Distribution of *Centrobolus lugubris* in South Africa, Eastern Cape.

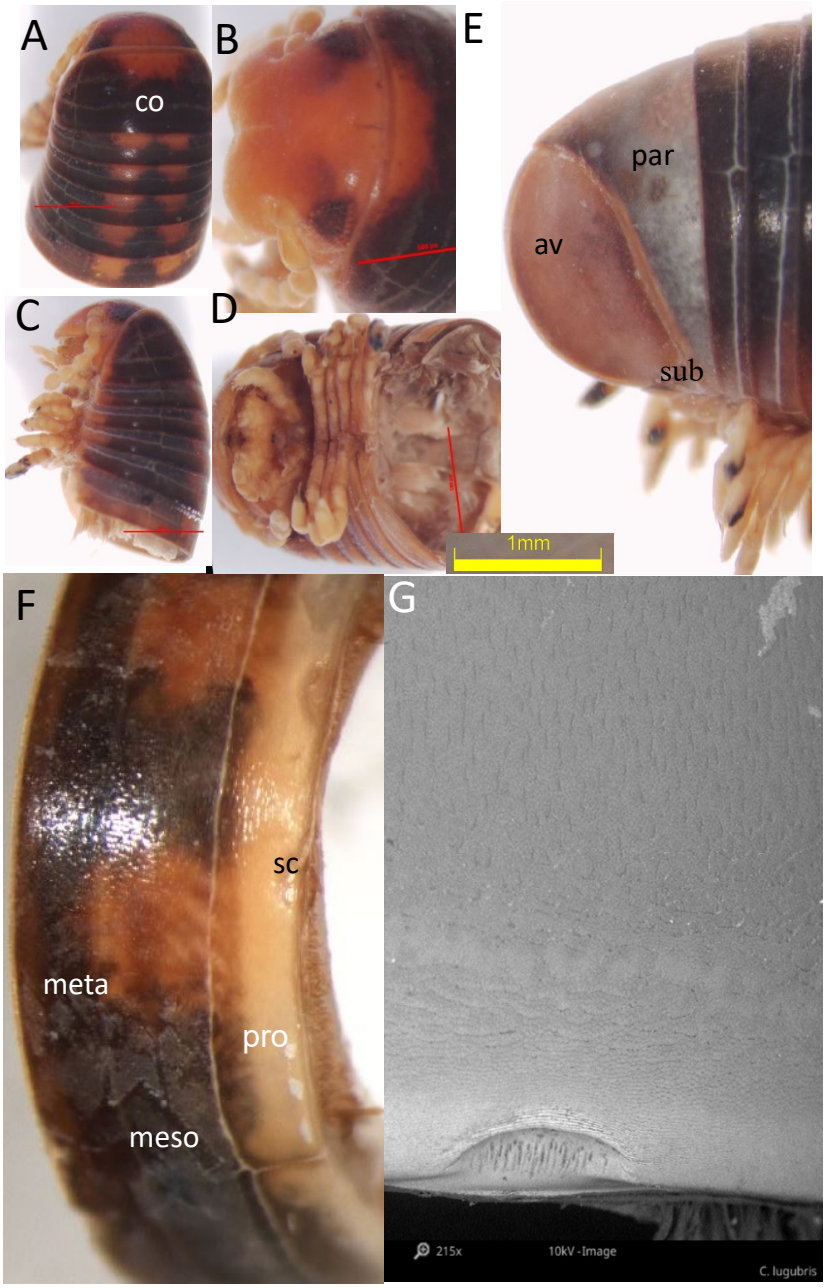

Figure 87: *Centrobolus lugubris* (Rhodes University, Eastern Cape) ♂ (Ref no: 5, UKZN). **A-B** dorsal view of the head and collum, **C** lateral view, **D** ventral view, **E** terminal region of body, **F-G** body ring. Abbreviations: av - anal valve; co – collum; meta – metazonite; meso – mesozonite; par - preanal ring; pro – prozonite; sc - scobina. Scale bars: 1.0 mm (**A-F**); 0.3 mm (**G**).

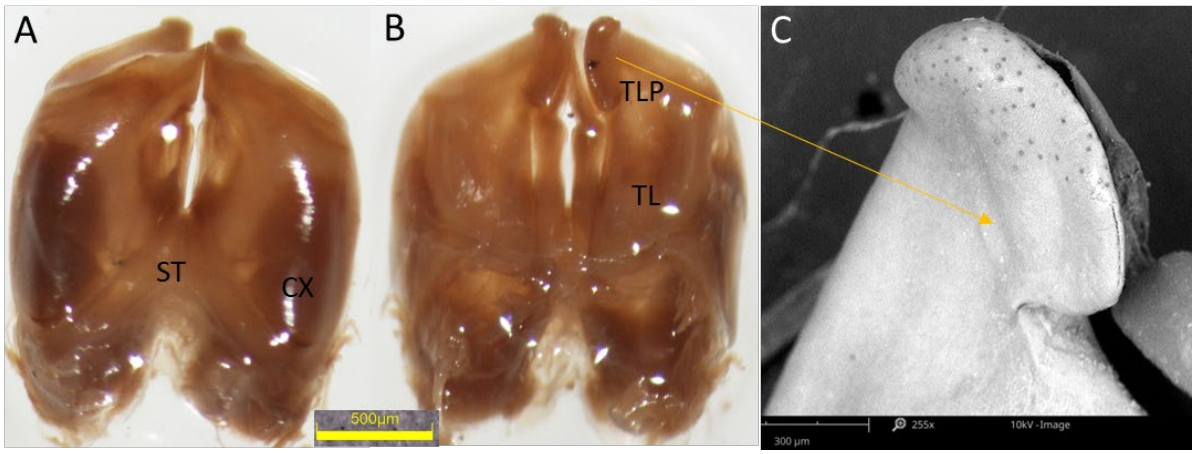

Figure 88: *Centrobolus lugubris* ♂ (Ref no: 5, UKZN). **A-C** anterior gonopod; **A** anterior view, **B-C** posterior view. Abbreviations: cx – coxa; st – sternum; tl – telopodite; tlp - telopodite process. Scale bars: 0.5 mm (**A-B**); 0.3 mm (**C**).

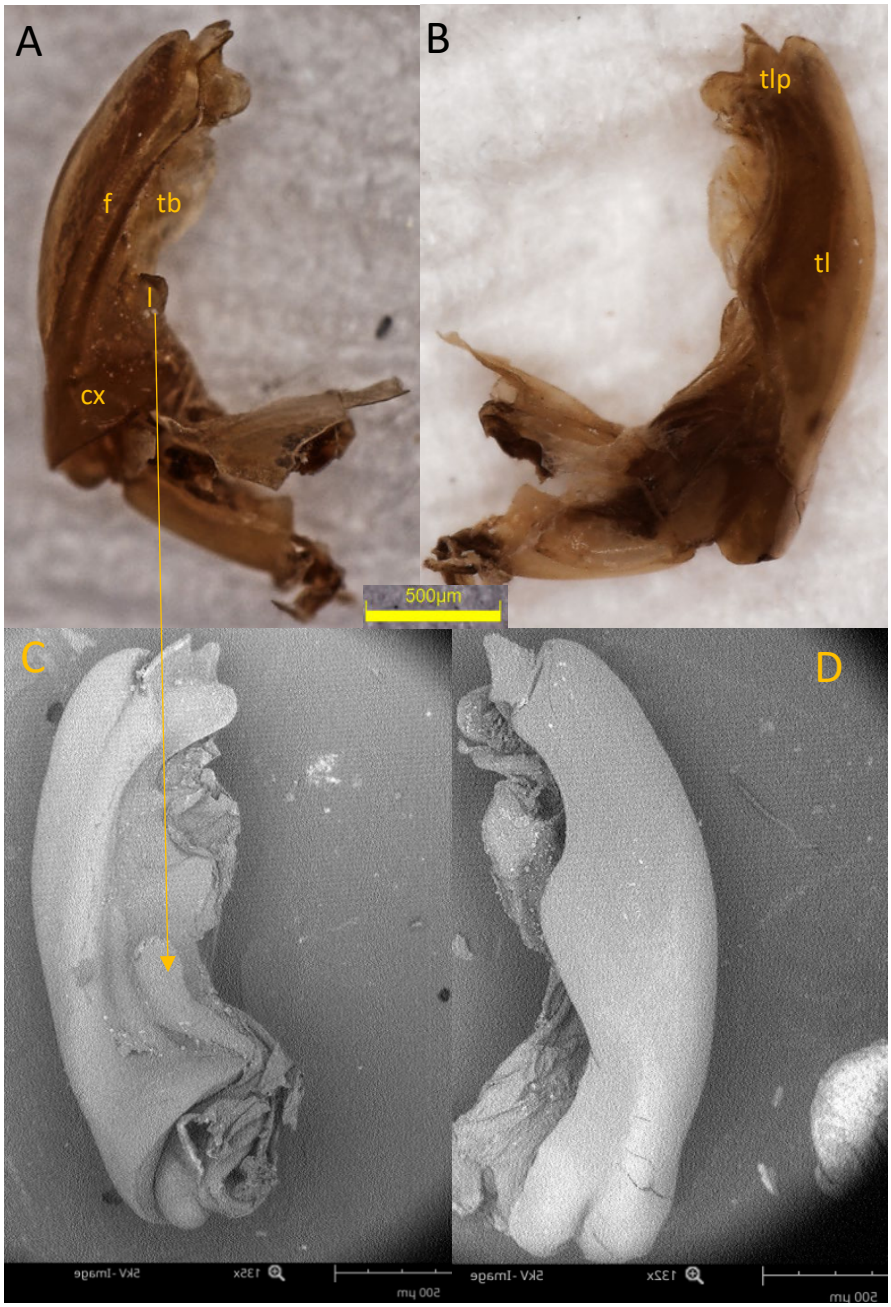

Figure 89: *Centrobolus lugubris* ♂ (Ref no: 5). **A-D** posterior gonopod, **A** & **C** anterior view, **B** & **D** posterior view. Abbreviations: cx – coxa; f - efferent groove; l - inflated basal lobe; tb - tibial process; tl – telopodite; tlp - telopodite process. Scale bars: 0.5 mm.

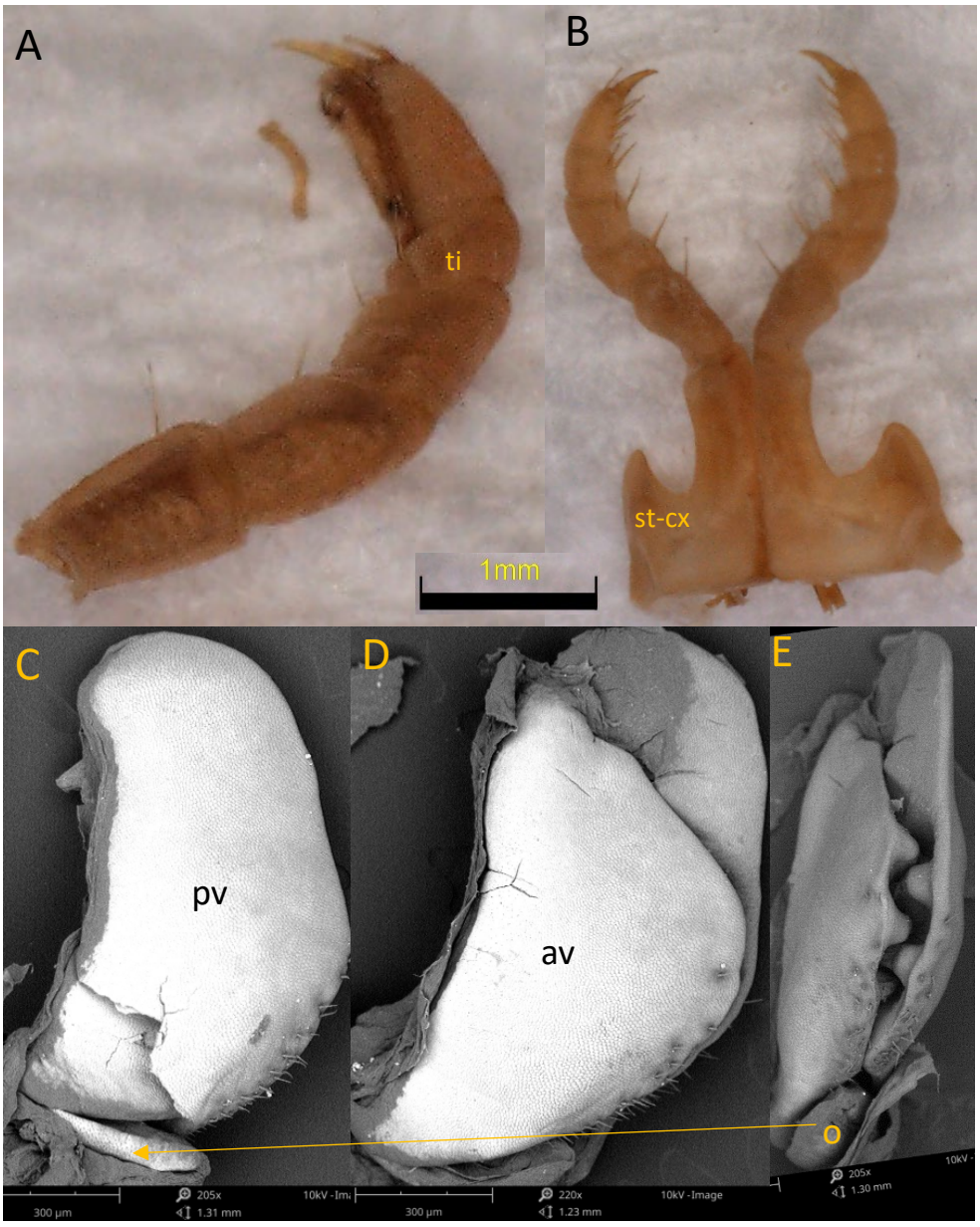

Figure 90: *Centrobolus lugubris* (Glenconnor, Eastern Cape) ♀ (NMSA-9024). **A** male leg, **B** female second pair leg, **C-E** vulva, **E** lateral view, **D** anterior view, **C** posterior view. Abbreviations: av - anterior valve; o – operculum; st-cx – coxosternite; pv - posterior valve; ti –tibia. Scale bars: 1.0 mm (**A**); 0.3 mm (**B-D**).

***Centrobolus miniatomaculatus* (Schubart, 1966)**

Fig. 91.

Hamer 1998: 41.

Chersastus miniatomaculatus Schubart, 1966: 68-69.

Description. Original description by Schubart (1966) translated using Google Translate: ♀ Total length 32-40mm, greatest width 4.5-5.1mm, 45+0+Tbody rings.

Body sculpturing: prozonites with transverse striation; mesozonites with minute punctuations with longitudinal striations to margins; metazonites with dense longitudinal striations and minute punctuation strongly developed; telson with bulging anal valves; scobinae absent.

Colour: the body in general black-brown with two paramedian bright vermillion spots; head and legs red-brown; collum black-brown with a narrow brown border; preanal ring light with two significant long narrow spots and anal valves black-brown with a wide red-brown margin; prozonites grey-yellow, mesozonites black-brown marbled on the ventral side, on the dorsal side one pair of paramedian vermillion spots (Fig. 91), which are interrupted by a triangular spot medianly, which continues narrowly on the posterior margin, metazonites black-brown with lower margin light brown.

Type material (not examined): *Allotype*: SOUTH AFRICA: *Eastern Cape*: 1♀ Tsitsikamma Forest, Storms River Mouth, under stones in meadow, 1951-01, (SSAE, loc. No. 136); 1♀ same data as the preceding, 1951-01, (MZLU).

Remarks. There are no specimens of this species in any of the South African museums. The types were deposited in Zoological Museums of Lundt. The sculpturing and colour of this species matches that of *Centrobolus silvanus* (Attems, 1928) and the type locality for *C. miniatomaculatus* is within the area where *C. silvanus* has been recorded. It is likely that *C. miniatomaculatus* is a synonym of *C. silvanus* but the collection of male specimens from the Tsitsikamma Forest is required to confirm this.

Conservation assessment

The uncertain status of this species and the lack of information about the distribution mean that it is Data Deficient (DD).

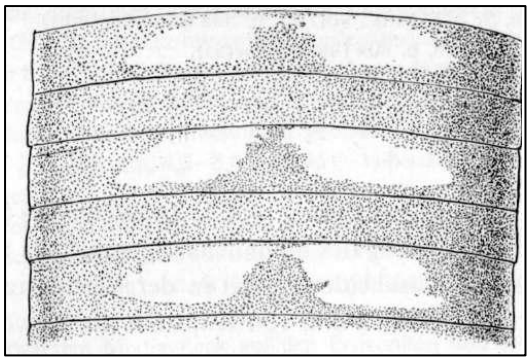

Figure 91: *Centrobolus miniatomaculatus*. Body rings. Illustration taken from (Schubart 1966).

***Centrobolus pococki* (Porat, 1893)**

Fig. 92.

Hoffman 1971: 150; Hamer 1998: 41.

Spirobolus pococki Porat, 1893: 22; Attems 1928: 309; Jeekel 1956: 94

Chersastus pococki Schubart 1966: 45.

Redescription (taken from Hoffman (1971)

Legs: Male with tarsal pads on all legs except first two pairs, but these small on the last six pairs. The tarsal pads on the other legs are large and extend past the edge of the tarsus to about midway along the tarsal claw.

Gonopods: Distal process of telopodite of anterior gonopods with one part, large, with rounded distal margin, and with lateral margin extended to form a pointed peak. Distal process lacking small denticles on surface.

Type locality: Stated by Porat (1893) as "Cape Colony, DeVylder".

Type material (not examined): 13 syntypes, labelled "Cape Colony, DeVylder" (NHRS). Hoffman (1971) designated one of the male as a lectotype.

Distribution: Known only from one locality in the Western Cape. The type locality could not be identified on Google Earth or in a gazeteer.

Remarks: Attems (1928) considered this species as *incertae sedis*. Jeekel (1956) suggested that *C. atrophus* is a synonym of this species, and Schubart (1966) supported this suggestion. Hoffman (1971) however examined the type material of *C. pococki*, and identified differences between the two species, including the number of legs lacking tarsal pads in the male, and the absence of small spines on the distal process of the telopodite of the anterior gonopods, which were present on the distal process. This seems to be the only character separating *pococki* and *atrophs*, and a single species, *C. pococki*, may actually be represented.

Conservation assessment

This species appears to be confined to the Western Cape, but its distribution is not known. As a result of the uncertainty about the status of this species it is considered here to be Data Deficient (DD).

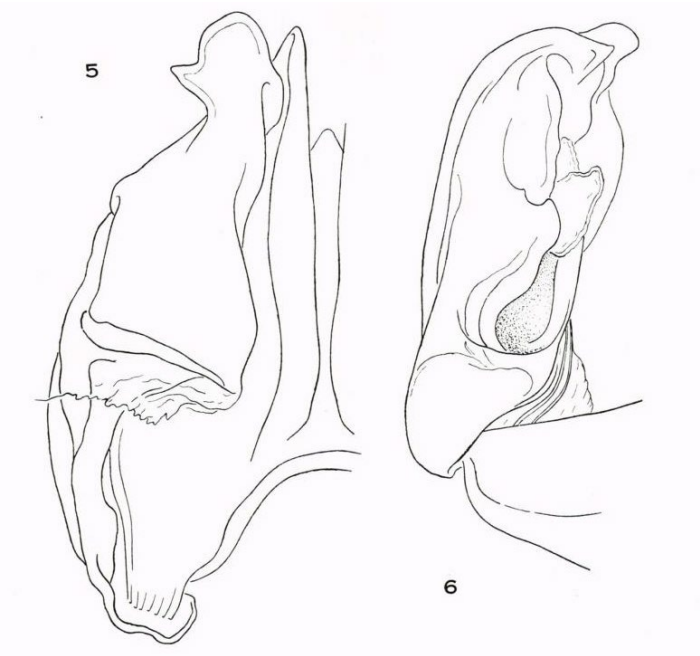

Figure 92. *Centrobolus pococki.* Lectotype. Anterior and posterior gonopod, taken from Hoffman (1971).

***Centrobolus promontorius* (Schubart, 1966)**

Figs 93-95

Hamer 1998: 41.

Chersastus promontorius Schubart, 1966: 45-47.

Redescription. Modified from Schubart (1966) using Google Translate: *Measurements*: ♂ Total length 32mm, greatest width 4.8mm, 44+0+T body rings. ♀ Total length 27-33mm, greatest width 4.2-5mm, 44+0+T body rings.

Body sculpturing: Body shiny with microscopic punctures and minute striae; scobinae present and small, crescent shaped with area of strong striations.

Legs: Legs fairly long reaching the margins of body rings when extended; all legs in male with prominent tarsal pads except the first two pairs; tibia condensed with one apical bristle.

Colour (after 10 years in ethanol): The body in general blackish-grey with two dorso-median rows of large red spots arranged longitudinally; anterior part of head yellowish and posterior half black; antennae reddish brown; collum black with reddish markings at the anterior and posterior margins forming an M-shape; legs yellowish; preanal ring and anal valves reddish brown; body rings with black metazonites with red spots and gradually becoming reddish orange towards the suture, mesozonites greyish with two large red spots; yellow/light brown prozonites.

Gonopods: *Anterior gonopods*: sternum of the anterior gonopod long, reaching the third quarter of the anterior gonopods, apically blunt and slightly bifid. Coxae of anterior gonopods large and roughly rectangular, with lateral margins straight, coxal projections only slightly angled, narrow and extended to acute point. Telopodite process with two parts, distal one extended, apically rounded and slightly bulbous with scattered short setae, proximal part moderate length, broadly triangular and laterally directed.

Posterior gonopods: Telopodite bent inwards; tibial process short, broad and smooth with seminal duct opening on its distal end; longitudinal efferent groove runs parallel to the length of the telopodite, transparent; inflated basal lobe absent; distal process of telopodite with finger-like projections at the apex.

Type material (not examined). *Holotype*: 1♂ SOUTH AFRICA: Western Cape, Hout Bay, Little Lions Head, (MZLU).

Distribution. This species has only been recorded from the Cape Peninsula in the Western Cape.

Remarks. The colour of this species is very similar to *C. digrammus* (Pocock, 1893) and the type locality is within the area from which *digrammus* has been recorded. It is very likely that *promontorius* is a synonym of *digrammus* but the type material needs to be examined to confirm this.

Conservation assessment

Since *C. promontorius* is most likely a synonym of *C. digrammus*, it is categorised as Data Deficient (DD). The type material needs to be checked before the status can be confirmed.

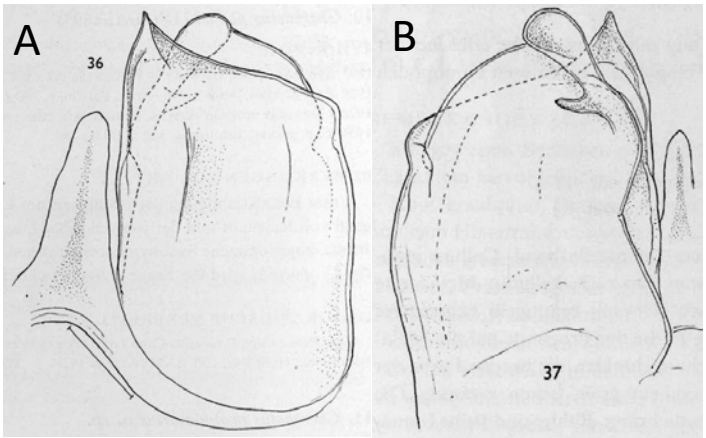

Figure 93. *Centrobolus promontorius.* Anterior gonopods, taken from Schubart (1966).

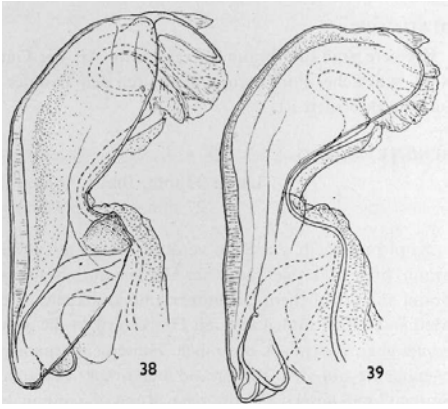

Figure 94. *Centrobolus promontorius.* Posterior gonopods, taken from Schubart (1966).

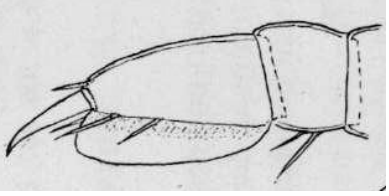

Figure 95. *Centrobolus promontorius.* Male leg, taken from Schubart (1966).

***Centrobolus pusillus* (Lawrence, 1967)**

Figs 96-100

Hamer 1998: 41.

Chersastus pusillus Lawrence, 1967: 629.

Diagnosis. Differs from congeners in distal process of telopodite of anterior gonopods with oval-shaped bulbous distal part and finger-like, thick and triangular proximal part; very long median extension of the sternum which reaches about two-thirds height of coxae; tarsal pads absent on last 10 pairs of legs (Figs 98B-C).

Redescription. *Measurements*: ♂ Total length 55mm, greatest width 6mm, 43+0+T body rings, n=1.

Body sculpturing: Body smooth and shiny; scobinae present, distinct and horseshoe shaped (Figs 97D-E).

Legs: Legs fairly long, exceeding lateral margins of body rings when extended; the first two and the last 10 pairs of legs without pads; tibia standard, with one apical bristle (Fig. 100).

Colour ♂ (after 21 years in ethanol): The body in general with red and brown/black transverse stripes; head, antennae and legs dark brown/black (Figs 97A-B); collum, preanal ring and anal valves red (Figs 97A, C); body rings with red metazonites, black mesozonites and brown prozonites (Fig. 97D).

Gonopods: *Anterior gonopods*: Sternum of the anterior gonopods with median process long, reaching two-thirds height of the coxae, narrow and triangular (Fig. 98A). Lateral margin of coxae gently sloping, distinct suture between basal and apical part of coxa, apical region distally directed with apex acute (Fig. 98A). Distal process of telopodite with two parts, distal one bulbous, oval-shaped and with minute scattered setae, proximal one smaller and bluntly triangular (Figs 98B-C).

Posterior gonopods: Tibial process narrow; seminal duct opens at the base of the tibial process; longitudinal efferent groove weak and runs diagonally in the middle of the telopodite; telopodite broad; distal process of telopodite broad and smoothly rounded with tapering lamella/membrane (Fig. 99).

Female sexual characters: Unknown.

Type locality: SOUTH AFRICA: *Eastern Cape*: Qolora River mouth.

Type material (not examined). Syntypes: 1♂ 1♀ SOUTH AFRICA: Eastern Cape, Qolora river mouth, 1962-01, Lawrence R.F. (NMSA-8243).

Paratypes: SOUTH AFRICA: 3♂♂ 1♀ same data as for syntypes.

Material examined. SOUTH AFRICA: *Eastern Cape*: 1♂ Fynbos rocky, 33°43.477, 24°14.298, Herbert D. (NMSA-Myr. 27510).

Distribution. This species has only been recorded from two localities in the Eastern Cape. No locality was provided for the specimen examined (NMSA 27510), but the coordinates place the locality in the Baviaanskloof Nature Reserve, which is about 400km south-west of the type locality. It is very likely that *C. pusillus* occurs at localities between the two known points but this area is poorly surveyed. The habitat for the Baviaanskloof specimen is described as rocky fynbos, but on Google Earth there does seem to be some woodland/forest close to the collection point. Qolora Mouth has open grassland with coastal forest patches.

Remarks. Lawrence (1967) designated a male and a female specimen as the "Holotype", but since there are two specimens, these are referred to here as syntypes. Lawrence (1967) did not illustrate the posterior gonopods for this species, and his illustrations of anterior gonopods are not very detailed. He also did not provide a description of the gonopods.

Conservation assessment

This is a South African species described from Eastern Cape in 1967 but collected in 1962. There is insufficient information to make an assessment on this species because it has been recorded from two localities, widely separated, and in a poorly surveyed part of South Africa. There are no major threats at the two localities, but until more information on the distribution is available, it is considered to be Data Deficient (DD).

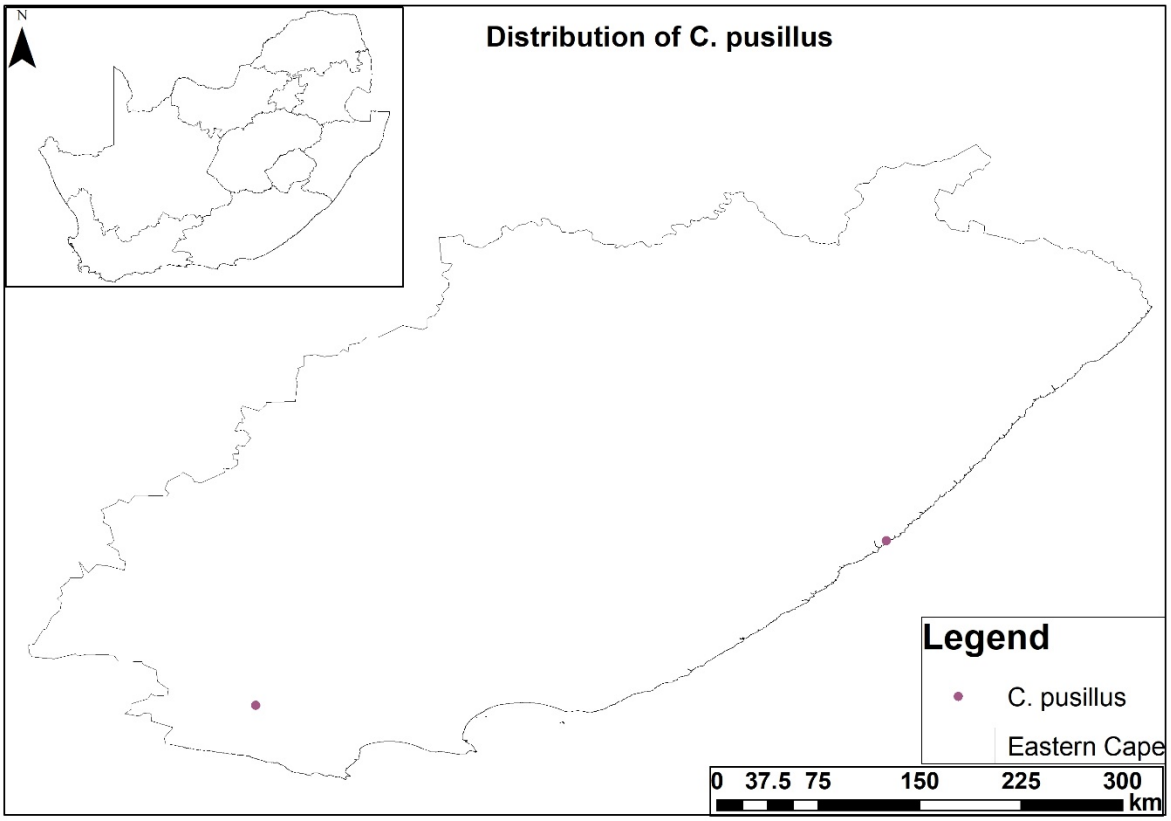

Figure 96: Distribution of *Centrobolus pusillus* in South Africa, Western Cape.

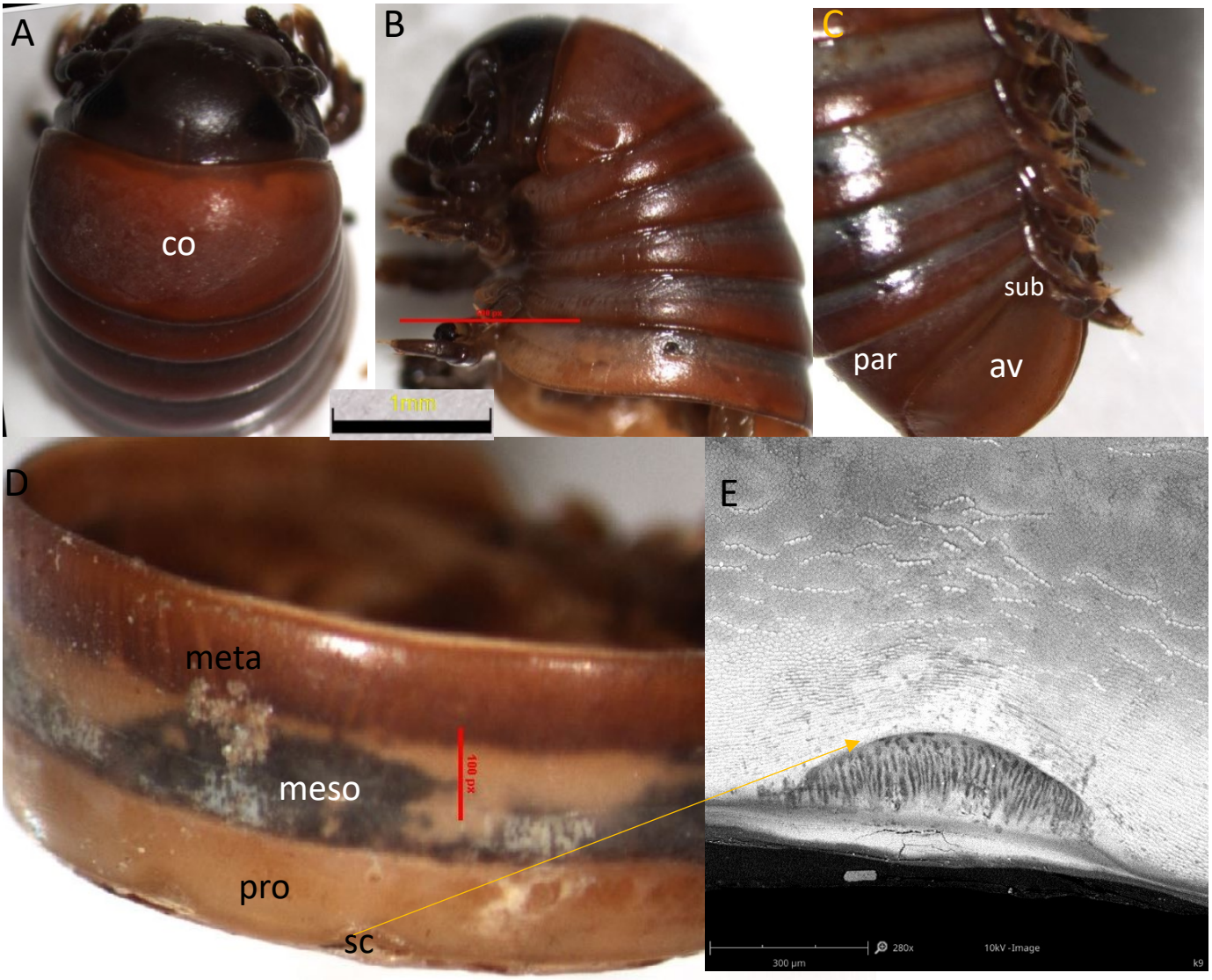

Figure 97: *Centrobolus pusillus* (Fynbos, Eastern Cape) ♂ (NMSA-Myr. 27510). **A** anterior view of the head and collum, **B** lateral view, **C** ventral view, **D** terminal region of body, E-**F** terminal region on body. Abbreviations: av - anal valve; co – collum; meso – mesozonite; meta – metazonite; par - preanal ring; pro – prozonite; sc - scobina. Scale bars: 1.0 mm (**A-D**); 0.3 mm (**E**)

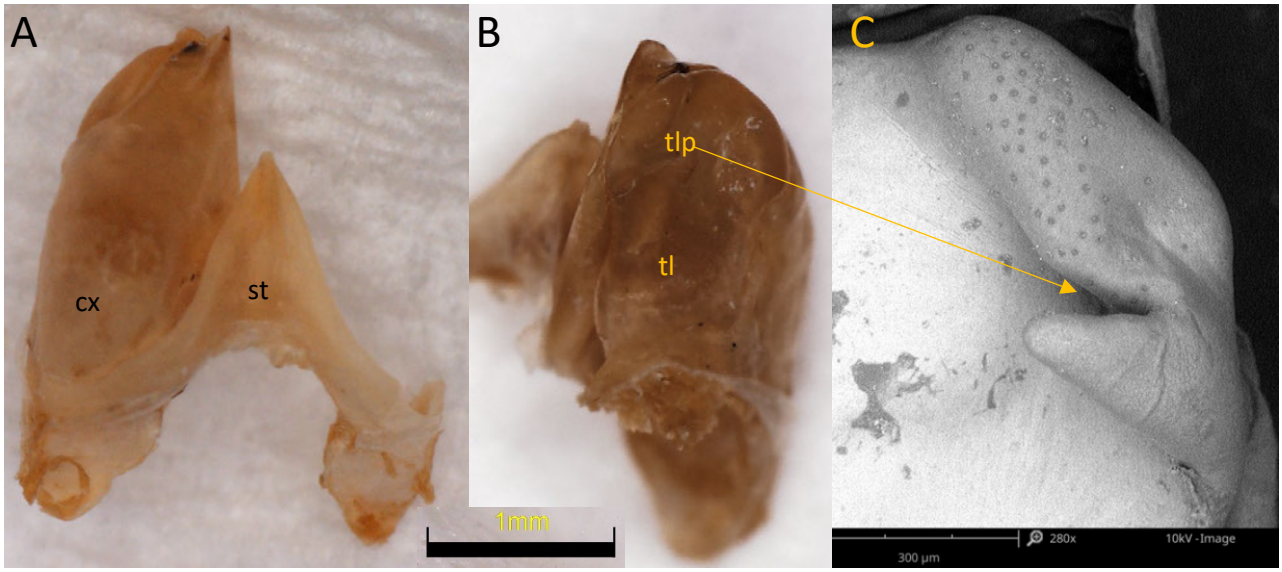

Figure 98: *Centrobolus pusillus* ♂ (NMSA-Myr. 27510). **A-C** anterior gonopod; A anterior view, B-C posterior view. Abbreviations: cx – coxa; st – sternum; tl – telopodite; tlp - telopodite process. Scale bars: 1.0 mm (**A**-**B**); 0.3 mm (**C**).

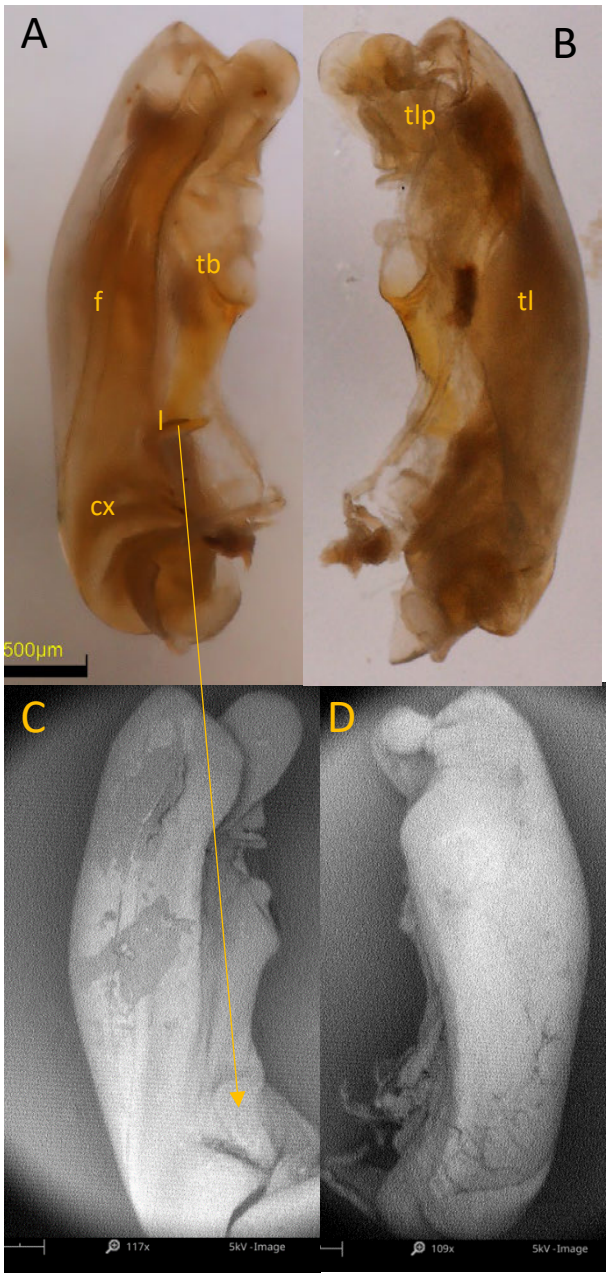

Figure 99: *Centrobolus pusillus* ♂ (NMSA-Myr. 27510). **A-D** posterior gonopod; **A** & **C** anterior view, **B** & **D** posterior view. Abbreviations: cx – coxa; f - efferent groove; l – inflated basal lobe; tb - tibial process; tl – telopodite; tlp - telopodite process. Scale bars: 0.5 mm.

Figure 100: *Centrobolus pusillus* ♂ (NMSA-Myr. 27510). Male leg. Scale bar: 1.0 mm.

***Centrobolus richardi* (Lawrence, 1967)**

Figs 101-106

Hamer 1998: 41.

Chersastus richardi Lawrence, 1967: 621.

Diagnosis. Differs from congeners in the distal process of the anterior gonopod telopodite which comprise a rounded, bulbous ridge with ventro-lateral corner pointed, and slender, finger-shaped and laterally pointed proximal part (Figs 105B-C). Last 19-22 pairs of legs without tarsal pads in male; blood red body with black bands distinct laterally but less so dorsally, head, antennae, collum, legs, preanal ring and anal valves blood red.

Redescription. *Measurements*: ♂ Total length 32-55mm, greatest width 5-7.3mm, 42+0+T body rings, n=50. ♀ Total length 38-55mm, greatest width 5-8.0mm, 42+0+Tor 43+0+T body rings, n=34.

Body sculpturing: Body smooth and shiny; scobinae present, small, and half-circle shaped (Figs 103E, G).

Legs: Legs long, exceeding lateral margin of body rings when extended; the first two and the last 19-22 pairs without tarsal pads in male; tibia standard with one apical bristle (Fig. 106A).

Colour (after 17 years in ethanol): The body in general blood red with black bands along length of body, distinct laterally but more faint dorsally; head, antennae, collum, legs, preanal ring and anal valves blood red (Figs 102, 103A-D); body rings with blood red metazonites, black mesozonites and light brown to yellow prozonites (Fig. 103E).

Gonopods: *Anterior gonopods*: Proximal part of coxae with lateral margins almost straight, distal part with straight distal margin and medianly directed at about 45° angle, apex bluntly pointed. Sternum of anterior gonopods robust, moderately extended medianly and triangular (Fig. 104A). Distal process of telopodite with two parts, distal one a rounded, bulbous ridge with ventro-lateral corner forming a small point; proximal part moderate sized finger-shaped and laterally directed; both parts with small and scatted setae (Figs 104B-C).

Posterior gonopods: Stout; tibial process projected medanly; seminal duct opens at the base of the tibial process; inflated basal lobe present; longitudinal efferent groove very well developed and runs diagonally across telopodite; distal process of telopodite broad, smoothly rounded and curved downwards (Fig. 105).

Female sexual characters: Second pair of legs with lateral extensions of the coxosternum with distal margin with low, rounded bulge (Fig. 106B); vulva simple, roughly bean-shaped, with

three lobed appearance; anterior valve overlaps posterior one; both valves basally with one to three irregular rows of short, strong setae; operculum poorly sclerotized (Fig 106C-D).

Type locality: SOUTH AFRICA: *KwaZulu-Natal*: Richards Bay.

Type material (examined). Holotype: ♂ SOUTH AFRICA: KwaZulu-Natal, Richards Bay, 1960-12, Lawrence R.F. (NMSA-8129).

Paratype*s*: SOUTH AFRICA: 2 ♂♂ same data as for holotype.

Other material examined. SOUTH AFRICA: *KwaZulu-Natal:* 2♂ 1♀ Nkandla Forest, 1937-01, Lawrence R.F. (NMSA-01428); 1♂ St Lucia, Lake View cabanas, 1995-11, Reavell P. (NMSA-15518); 8♂ 2 ♀ Mapelane dune forest, mouth of Umfolozi River, 1995-12, Hamer M. (NMSA-15524); 1♂ 3♀ same locality data as the preceding, 1985-09, Fokkens B. (NMSA-16522); 4♂ 1♀ Cape Vidal, Mvubu trail, 1996-12, Hamer M. (NMSA-15529); 1♂ 1♀ Lake St Lucia Park Reserve, 1988-11, Londt J. (NMSA-15531); 1♂ same locality and collector data as the preceding, 1998-02, (NMSA-15534); 1♂ Dukuduku Forest, 1995-12, Hamer M. (NMSA-15533); 1♂ Enseleni Nature Reserve 1997-12, Reavell P. (NMSA-15535); 1♂ 1♀ Empangeni, 1997-11, Reavell P. (NMSA-15539); 1♂ 4♀ same data locality and collector as the preceding, 1998-04, (NMSA-15575); 1♂ 1♀ Dukuduku Forest, trail from NPB picnic site, Hamer M. & Herbert D. (NMSA-5557); 2♂ 2♀ Lake Sibayi, Crocodile Bay, south area, 1968-01, Lamoral B. (NMSA-15590); 2♂ 3♀ St Lucia, Charters Creek, 1985-11, Griswold C.E., Doyen J.T. & Griswold M.T. (NMSA-15675); 1♂ 1♀ Richards Bay, Crocodile Farm in Nkonkinga Valley, 1995-12, Reavell P. (NMSA-15700); 3♂ 2♀ Mapelane area of Richards Bay mining area, 1996-12, Cooper M. (NMSA-15720); 1♂ Mtunzini area, Umlazi Nature Reserve, 1997-10, Londt J. (NMSA-15756); 1♂ 1♀ Mbibi River, Barringtonia swamp forest, 1996-09, Reavell P. (NMSA-16124); 1♂ Mtunzini, 1995-11, Reavell P. (NMSA-16455); 1♀ Empangeni, N of Lake Msingazi, Mbibi River, 1996-09, Reavell P. (NMSA-16464); 1♂ Mabibi, Maputaland, 2000-11, Yogani, UniZulu (NMSA-19051); 1♂ Lake Sibayi Fresh Water Reserve, 2003-05, Armstrong A.J. (NMSA-22708); 1♂ same data as the preceding (NMSA-22784); 1♂ Coastal Forest Reserve, Amanzamnyama - Kosi Bay, 2009-05, Armstrong A.J. (NMSA-22736); 1♀ Cape Vidal State Forest, Coastal Forest, 2010-01, Armstrong A.J. (NMSA-22752); 1♂ Umlalazi Nature Reserve near picnic site, 28°57'06.2"S, 31°46'13.6"E, 2000-11, Armstrong A.J. (Ref: 1369, UKZN); 1♂ Cape Vidal, 1998-11, Hamer M. (MH3, UKZN); 1♂ Charter's Nature Reserve, 28°12'29.315"S, 32° 24'53.943"E, 2001-03, Armstrong A., Ngwenya P. & Kasseepursad B. (Ref no:1392); 1♂ same data as the preceding (Ref: 1390, UKZN); 1♂ same data as the preceding (Ref: 1389, UKZN); 1♂ Sodwana Bay area, Mgobolozeni, 2001-04,

Coddington J. (JC13, UKZN); 1♂ Cape Vidal, up tree next to plot on tree bank, 1998-11, Hamer M. (MH5, UKZN); 1♂ Sodwana Bay, Trail, 2001-04, Hamer M. (MH11, UKZN).

Distribution: This species has only been recorded from the north-eastern part of KwaZulu-Natal province, mainly along the coast, from Mtunzini in the south to Kosi Bay in the north and with one locality more inland at Nkandla. *Centrobolus richardi* appears to be mostly a coastal forest species.

Remarks: Lawrence (1967) did not illustrate the posterior gonopods for this species, his illustrations of the anterior gonopods are not very detailed and he did not provide a description of the gonopods.

Conservation assessment

This is a South African species described from KwaZulu-Natal in 1967. The species is relatively widespread along the coast of north-eastern KwaZulu-Natal, and it has been recorded from several protected areas including Nkandla, Dukuduku and Cape Vidal State Forests, and Enseleni, Umlalazi and Charter's Creek Nature Reserves. The species is known to occur in coastal and scarp forests.

The major threats include loss of habitat due to urbanization and industrialisation, mostly in the Richards Bay area, plantations, and clearing of habitat for settlements and subsistence farming as well as tourism developments. There may be habitat degradation through alien invasive plants and human activities in the forests. It is likely that habitat has already been lost, especially in the more southern part of the distribution, and that loss is likely to continue, especially outside of protected areas.

EOO approximately 7500 km² and AOO approximately 200 km² with number of known locations = 10, and these are highly fragmented. *Centrobolus richardi* therefore qualifies as Vulnerable (VU) B1, B2, a,b,i,ii,iii.

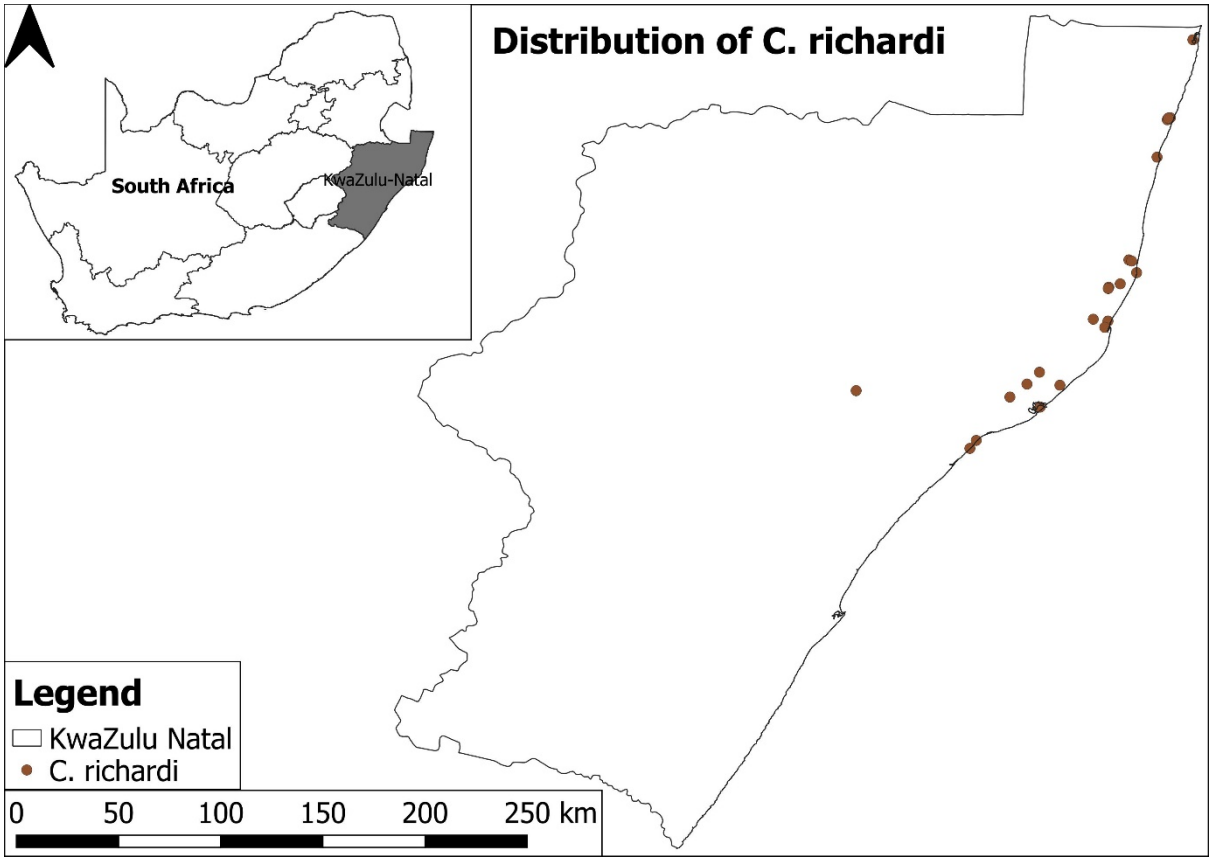

Figure 101: Distribution of *Centrobolus richardi* in South Africa, KwaZulu-Natal.

Figure 102: *Centrobolus richardi*. **A** iSimangaliso. Photographer: Magdastlucia (CC-BY-NC), **B** Uthungulu DC, KwaZulu-Natal, South Africa. Photographer: Tjeerd (CC-BY-NC). Source iNaturalist.

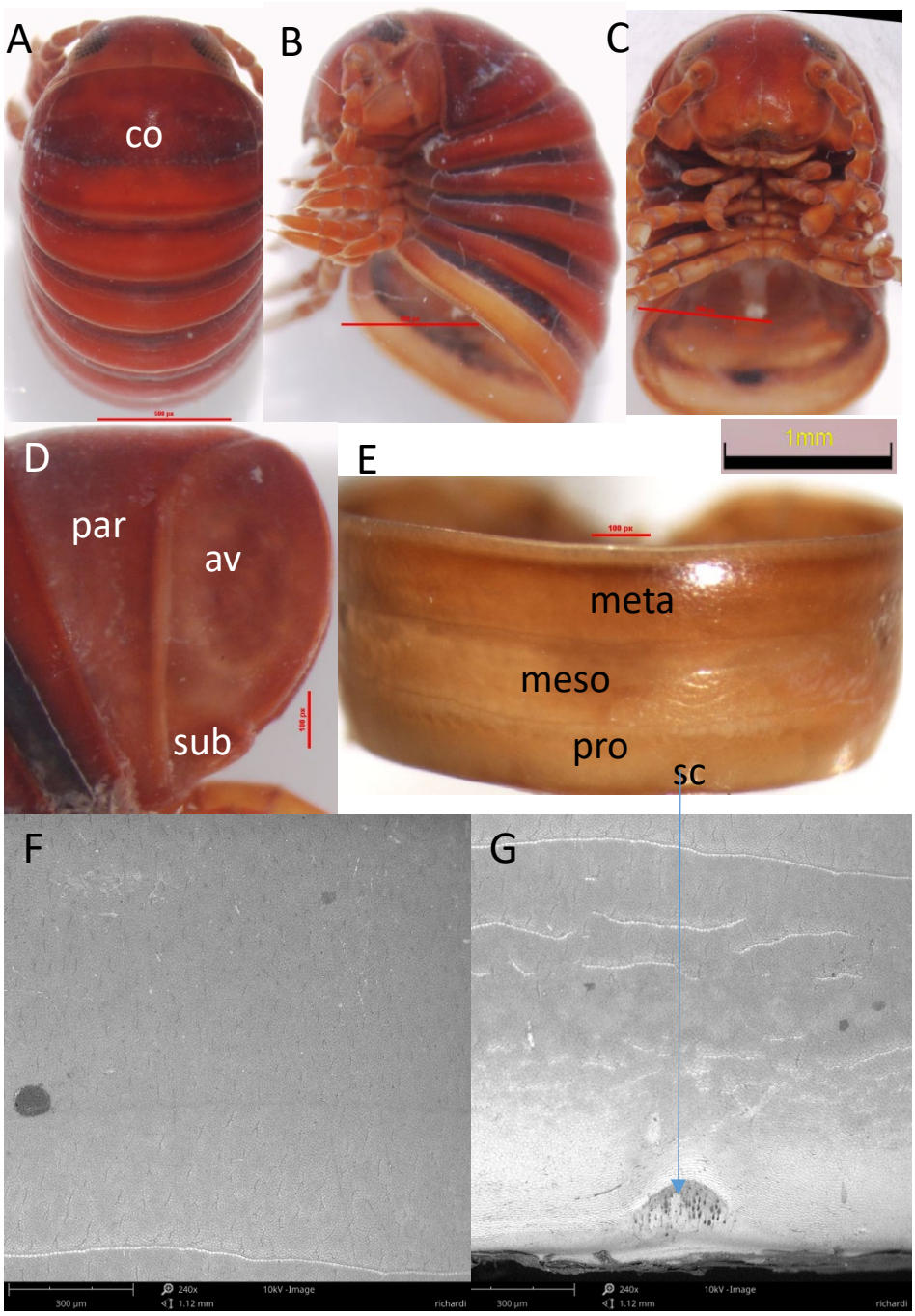

Figure 103: *Centrobolus richardi* (Cape Vidal, KwaZulu-Natal) (MH5). **A** anterior view of the head and collum, **B** lateral view, **C** ventral view, **D** terminal region of body, **E-F** body ring. Abbreviations: av - anal valve; co – collum; meso – mesozonite; meta – metazonite; par - preanal ring; pro – prozonite; sc - scobina. Scale bars: 1.0 mm (**A-E**), 0.3 mm (**F-G**).

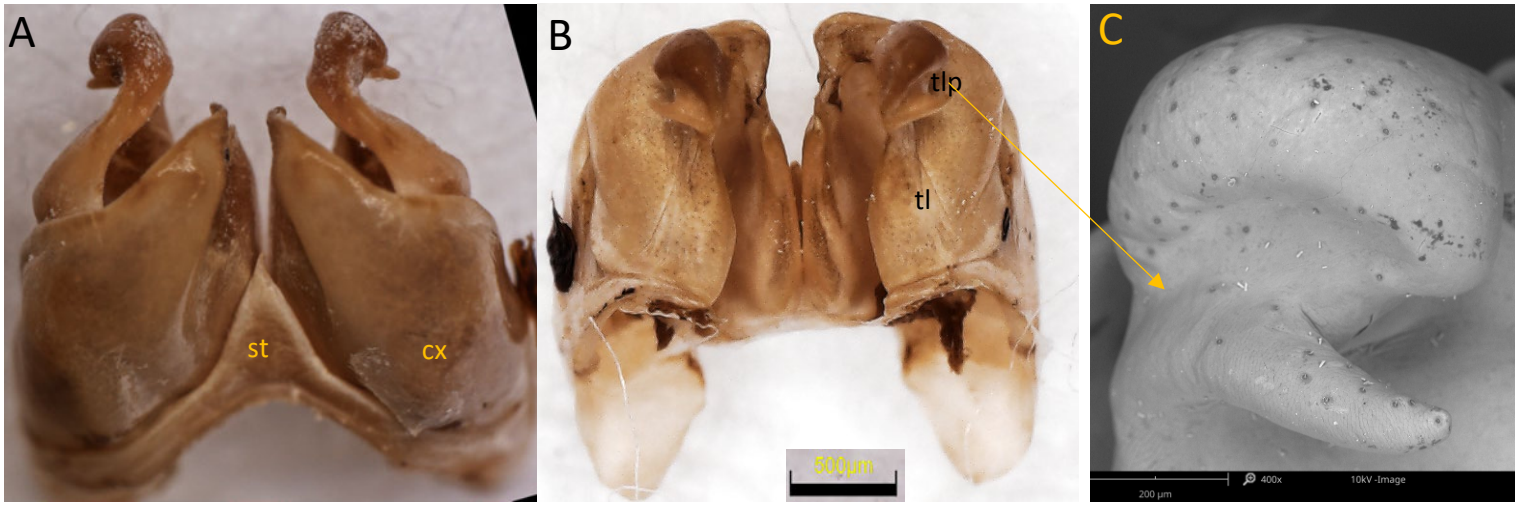

Figure 104: *Centrobolus richardi* ♂ (MH5). **A-C** anterior gonopods; **A** anterior view, **B-C** posterior view. Abbreviations: cx – coxa; st – sternum; tl – telopodite; tlp - telopodite process. Scale bars: 0.5 mm (**A-B**); 0.2 mm (**C**).

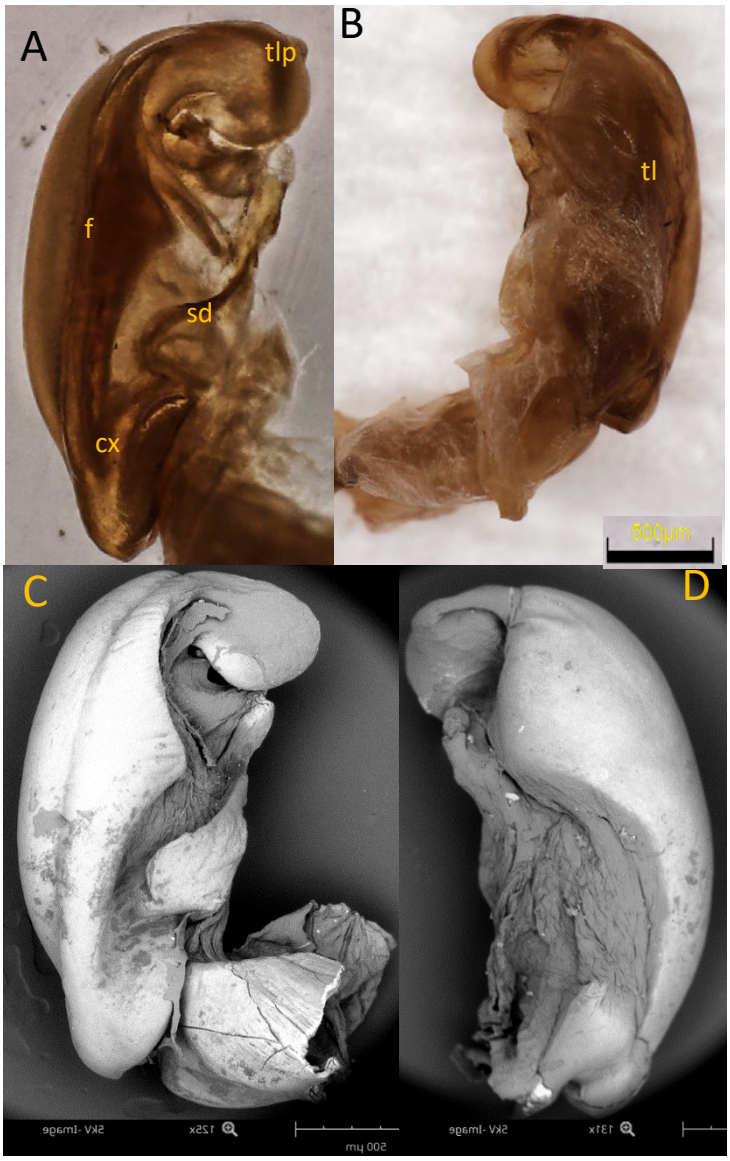

Figure 105: *Centrobolus richardi* ♂ (MH5). **A-D** posterior gonopod; **A** & **C** anterior view, **B** & **D** posterior view. Abbreviations: cx – coxa; f - efferent groove; sd – seminal duct; tb - tibial process; tl – telopodite; tlp - telopodite process. Scale bars: 0.5 mm.

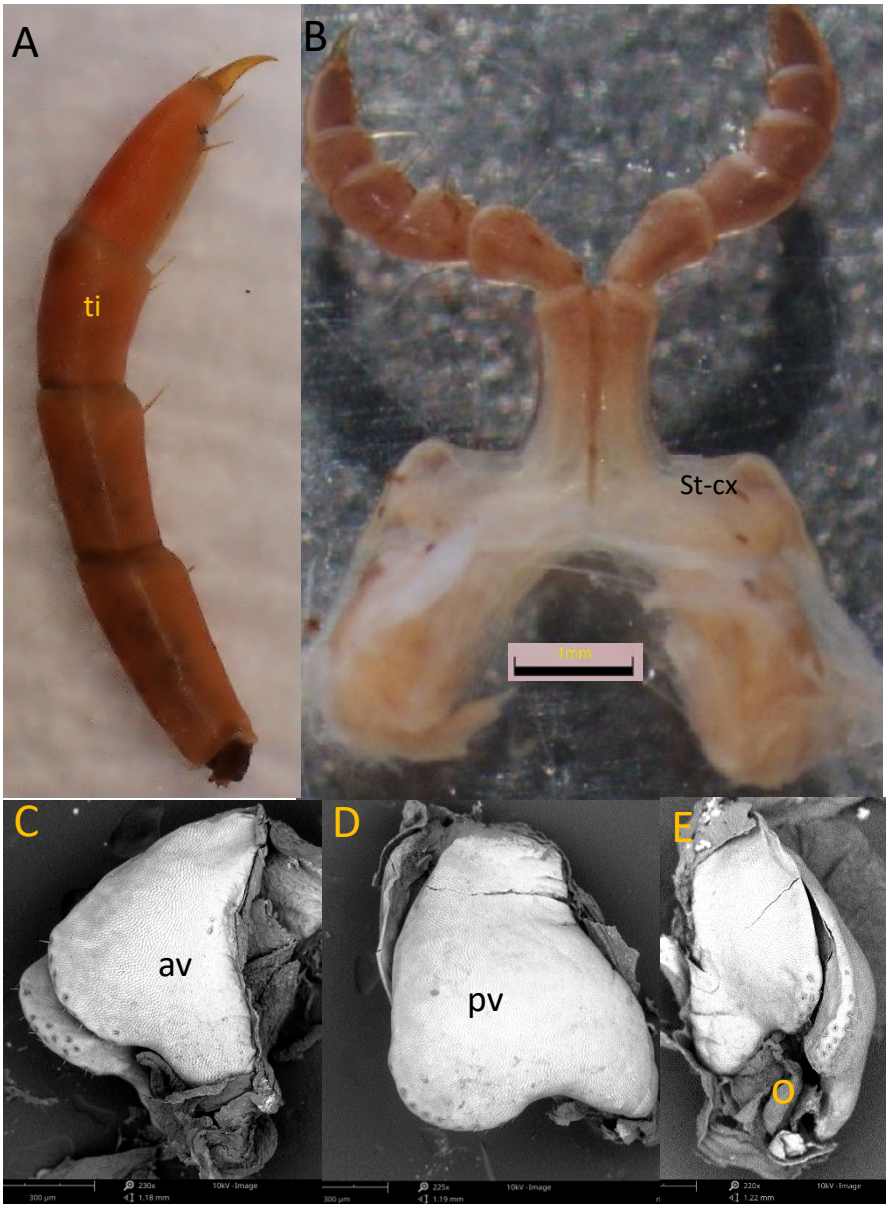

Figure 106: *Centrobolus richardi* (Mapelane dune forest, KwaZulu-Natal) ♀ (NMSA-16522). **A** male leg, B female second pair leg, **C-E** vulva, **E** lateral view, **C** anterior view, **D** posterior view. Abbreviations: av - anterior valve; o – operculum; st-cx – coxosternite; pv - posterior valve; ti –tibia. Scale bars: 1.0 mm (**A-B**); 0.3 mm (**C-E**).

***Centrobolus ruber* (Attems, 1928)**

Figs 107-112

Hamer 1998: 41.

Chersastus ruber Attems, 1928: 304-305; Attems 1934: 476, 478-479; Warren 1934: 369-377; Jeekel 1966: 95; Schubart 1966: 35; Lawrence 1967: 633.

Diagnosis. Differs from congeners with distal process of telopodite of anterior gonopod large, oval and bulbous; finger-like process positioned proximally and partially hidden under bulbous knob (Figs 110B-D). Scobinae small and weak. Last 14 pairs of legs without tarsal pads. Body with uniformly deep red colour with black head, antennae, legs black with whitish glow.

Redescription. *Measurements*: ♂ Total length 43-60mm, greatest width 4.4-6.0, 43+0+T body rings, n=38. ♀ Total length 46mm, greatest width 5.5-9mm, 44+0+T body rings, n=5.

Body sculpturing: Scobinae present, broadly triangular, and weak (Figs 109E-F).

Legs: Legs fairly long, exceeding lateral margins of body rings when extended; the first two and the last 14 pairs of legs without tarsal pads; tibia standard length with one apical bristle (Fig. 112A).

Colour (after 7 years in ethanol): The body in general deep red; head, antennae and legs black, the latter with whitish glow (Figs 108, 109A-C); body rings with deep red metazonites, reddish mesozonites and brown prozonites (Fig. 109E); preanal ring and anal valves red (Fig. 109D).

Gonopods: *Anterior gonopods*: Sternum of the anterior gonopods reaching about half height of coxae; distal part strongly tapered and apical part narrow (Fig. 110A). Coxa robust, proximal region with lateral margin slightly convex, distal half medianly directed at an angle of about 45° and tapered to a blunt apex (Fig. 110A); suture between two parts of coxa visible. Telopodite with distal process bulbous and oval-shaped, a short, finger-like and partly obscured structure under the bulbous knob; both processes with small, scattered setae (Figs 110B-D).

Posterior gonopods: Tibial process broad and projecting a little with smooth margin; seminal duct opens at the distal end of the tibial process; longitudinal efferent groove very well developed and running straight along length of telopodite; inflated basal lobe absent; distal process of telopodite rounded (Fig. 111).

Female sexual characters: Distal margin of lateral extensions of coxosternum with low and broad bulge. Vulva simple, and sub-oval shaped; both valves with a row of two to three irregularly arranged setae; operculum poorly sclerotized (Figs 112B-C).

Type locality: SOUTH AFRICA*: KwaZulu-Natal*: Umzimkulu.

Type material (not examined). Syntypes: 1♂ 1♀ SOUTH AFRICA: KwaZulu-Natal, Marble Quarry, mouth of Umzimkulu River (SAMC).

Material examined. SOUTH AFRICA: *KwaZulu-Natal*: 1♀ Port Shepstone, 1936-12, French G. (NMSA-01634); 3♂ Ifafa, Umzinto, Akerman C. (NMSA-1447); 2♂ Umtamvuna Gorge, 1995-11, Hamer M. (NMSA-16149); 3♂ Umtamvuna Nature Reserve, near old pont, King Fisher trail, 1997-12, James S. (NMSA-16184); 1♂ Mpenjati Nature Reserve, Yengele trail, 1997-12, James S. (NMSA-16188); 1♂ same data as the preceding (NMSA-16189); 1♂ Port Shepstone, Marble Delta, Umzimkulu River, 2001-10, Herbert D. (NMSA-19119); 1♂ Umzumbe Fairview Farm, Feb. 2007-02, Armstrong A.J. & Craigie J.D. (NMSA-21898); 1♀, Skyline Nature Reserve, 2002-10, Armstrong A.J. (NMSA-22709); 1♂ same data as the preceding (NMSA-22730); 2♂ Mvutshini Valley, Ramsgate, 2003-11, Armstrong A.J. (NMSA-22732); 1♂ Armadale Farm, Melville, 2002-10, Armstrong A.J. (NMSA-22776); 2♂ Port Shepstone, Anerly, 1996-01, Cooper M. (NMSA-23006); 1♂ Port Shepstone, Lawrence R.F. & Holliday R.A. (NMSA-4022); 1♂ Ngoye Forest, 1953-02, Lawrence R.F. (NMSA-5041); 2♂ 1♀ Beach terminus, Port Shepstone, 1966-10, Lawrence R.F. (NMSA-9628); 1♂ Armadale Farm, Port Shepstone, 2001-11, Armstrong A. & Murray H. (Ref.No: 1761, UKZN); 2♂ Mable Delta, 2011-11 (GO6a.2, UKZN); 3♂ same as the preceding (MO6.2, UKZN); 2♂ same as the preceding (MO7.1, UKZN), 1♂ same as the preceding (MO5.1, UKZN); *Eastern Cape*: 2♂ 1♀ Port St. Johns, Development camp & nearby forest, 1989-01, Reavell P. (NMSA-15536); 1♂ Kentani district, 1928, (13771. UKZN): *Western Cape*: 1♂ Knysna, Storms River Mouth, 1939-01, Rump W.G. (NMSA-02467).

Distribution. This species has been recorded predominantly from the lower south coast region of KwaZulu-Natal, extending southwards with two localities on the coast of the Eastern Cape (Port St Johns and Kentani district), and one on the coast of the Western Cape. It is possible that *C. ruber* also occurs at other localities along the Eastern Cape coast since this region is not well sampled. A photograph posted on iNaturalist from Amatole, presumably the large forests in this area, matches the colour of *C. ruber* (Fig. 106A) and this suppots the possibility of a wider distribution. Lawrence (1967) noted that the specimens from Ngoye may not be *C. ruber*, and this locality is considerably out of the range (200km north) and habitat type of the species (see below).

Remarks. While Attems (1928) gave the type locality as Umzimkulu, Lawrence (1967) obtained details from the South African Museum that clarified it as Marble Quarry, Umzimkulu River, which is the same locality as Marble Delta near Port Shepstone. Lawrence (1967) stated that the colour of the Ngoye specimens differs slightly from that of the coastal specimens, and

that more material needed to be studied to confirm the identification. Unfortunately, no additional material has been collected from Ngoye since 1953, but the gonopods of the material examined do match those of the description of *C. ruber*.

Conservation assessment

This is a South African species described from KwaZulu-Natal in 1928. The species is relatively widespread along the KwaZulu-Natal lower south coast and probably occurs along much of the Eastern Cape coast, although it has only been recorded from Port St. Johns and Kentani. There is one known locality on the coast of the Western Cape. The species is known to occur in coastal forests, with one locality in scarp forest (Ngoye).

Centrobolus ruber does occur in protected areas at Umtamvuma, Mpenjati and Skyline Nature Reserves, and at Storms River Mouth, as well as at Ngoye, but outside of these areas, particularly in KwaZulu-Natal, there has been extensive loss of habitat through housing, tourism and industrial development. Marble Delta, the type locality, is being mined for cement. The loss of habitat is likely to continue in KwaZulu-Natal.

The EOO is estimated as 32 000 km² and AOO = 56 km², and while this is likely to be higher considering suitable habitat that has not been sampled, it is unlikely that the AOO will exceed 2000 km² and it may even be less than 500 km². The number of known locations = 10, but this is probably higher. The locations are highly fragmented because the forest habitat may be naturally patchy, and coastal development has further fragmented it. If the higher estimate of AOO is accepted, then *C. ruber* qualifies as Vulnerable (VU) B2 a, b, ii, iii, iv.

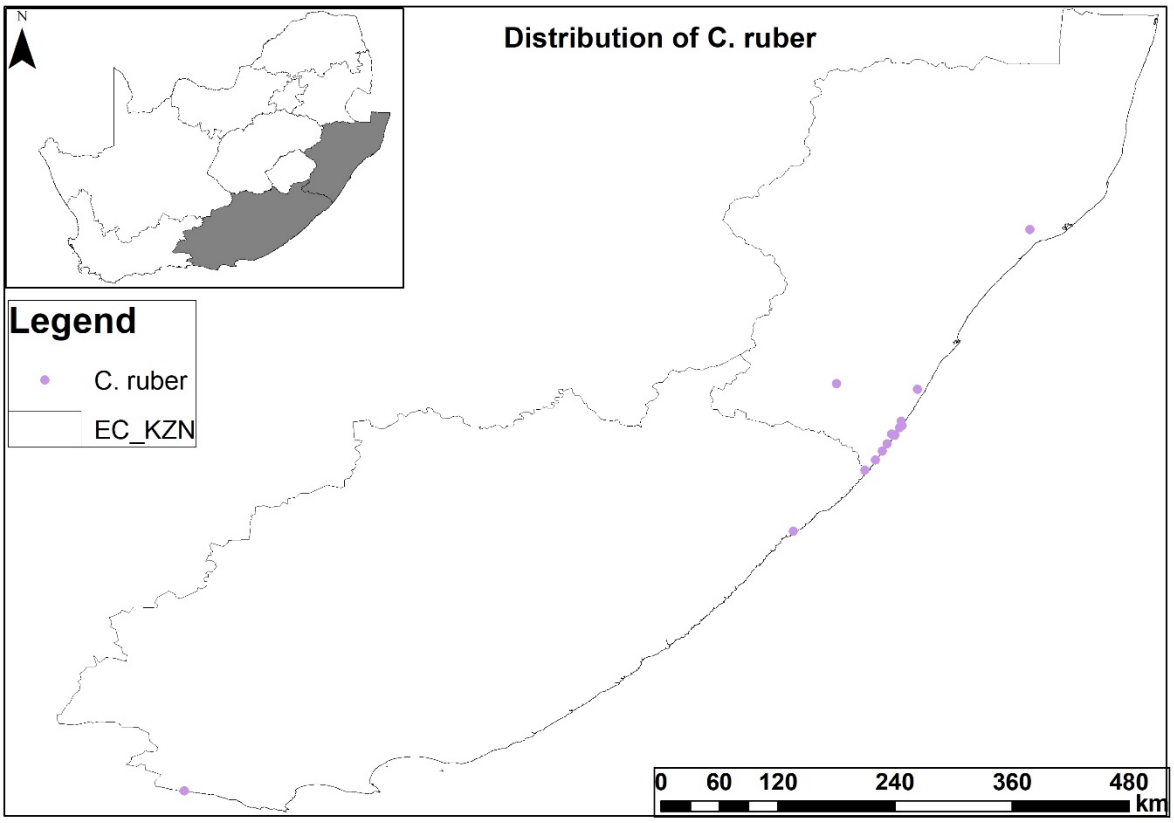

Figure 107: Distribution of *Centrobolus ruber* in South Africa, Eastern Cape.

Figure 108: *Centrobolus ruber* **A** Amatole. Photographer: Gareth Yearsley (CC-BY-NC), **B** Ramsgate. Photographer: Igmar Grewar (CC-BY-NC), **C** Ivungu, St Michael, KwaZulu-Natal. Photographer: Garth Aiston (CC-BY-NC). Source iNaturalist.

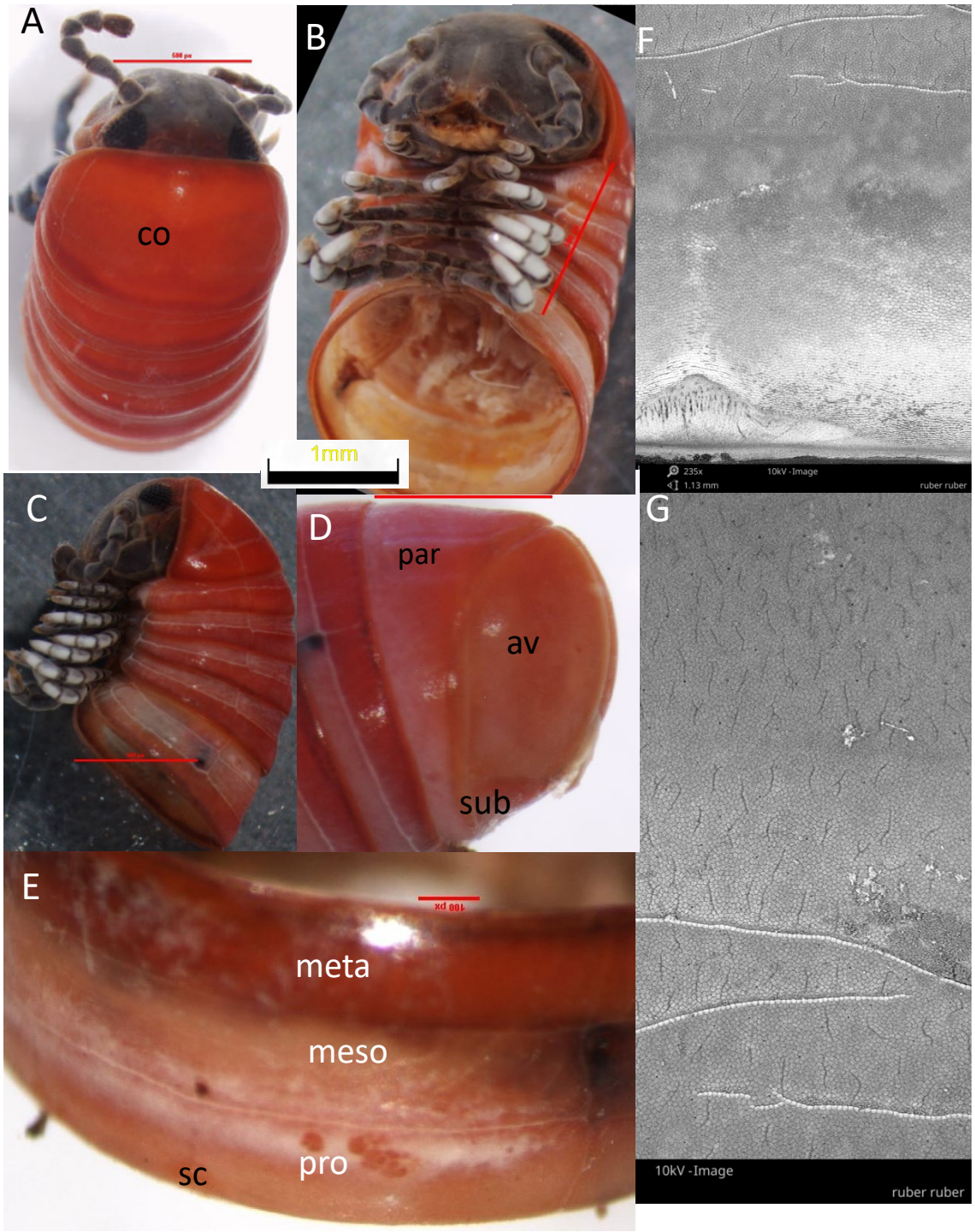

Figure 109: *Centrobolus ruber* (Mable Delta, KwaZulu-Natal) ♂ (MO62). **A** anterior view of the head and collum, **B** lateral view, **C** ventral view, **D** terminal region of body, **E-F** terminal region of body. Abbreviations: av - anal valve; co – collum; meso – mesozonite; meta – metazonite; par - preanal ring; pro – prozonite; sc - scobina. Scale bars: 1.0 mm (**A-E**); 0.3 mm (**F-G**).

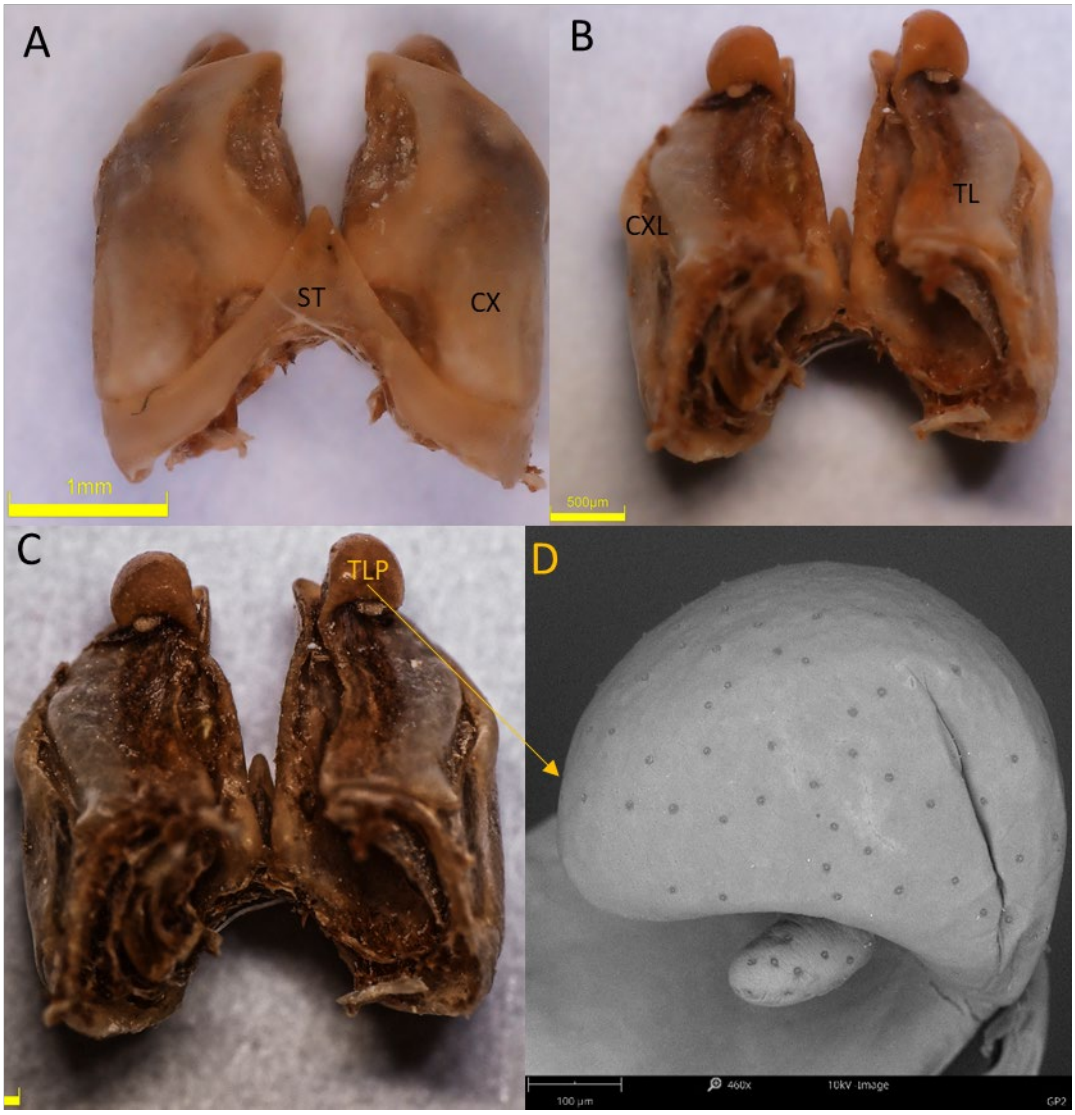

Figure 110: *Centrobolus ruber* ♂ (MO62). **A-D** anterior gonopods; **A** anterior view **B-D** ventral view. Abbreviations: cx – coxa; cxl - coxal endite lobe; st – sternum; tl – telopodite; tlp – telopodite process. Scale bars: 1.0 mm (**A**); 0.5 mm (**B-C**) 0.1 mm (**D**).

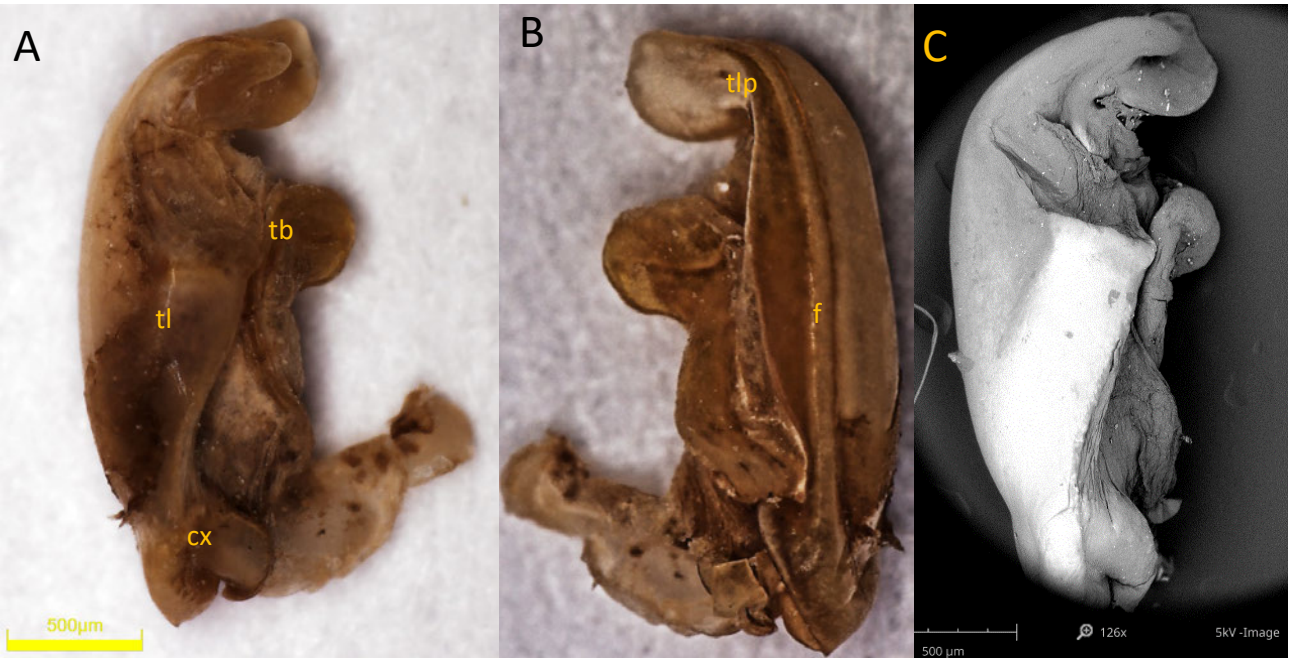

Figure 111: *Centrobolus ruber* ♂ (MO62). **A-C** posterior gonopod; **B** anterior view, **A** & **C** posterior view. Abbreviations: cx – coxa; f - efferent groove; tb - tibial process; tl– telopodite; tlp - telopodite process. Scale bars: 0.5 mm.

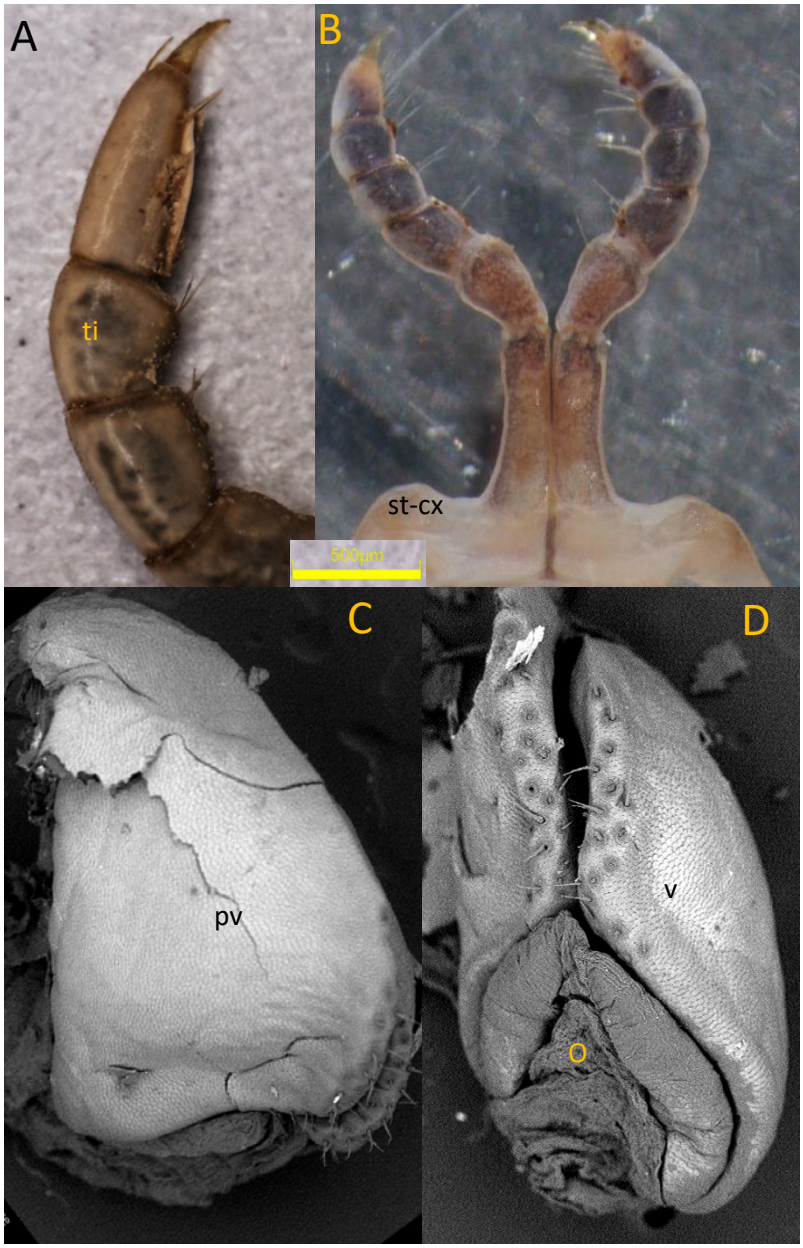

Figure 112: *Centrobolus ruber* (Mable Delta, KwaZulu-Natal) ♀ (MO7.1). **A** male leg, **B** female second pair leg, **C-D** vulva, **D** lateral view, **C** anterior view. Abbreviations: av - anterior valve; o – operculum; pv - posterior valve; st-cx – coxosternite; ti-tibia. Scale bars: 0.5 mm (**A-B**); 0.3 mm (**C-D**).

***Centrobolus rubricollis* (Schubart, 1966)**

Figs 113-117

Hamer 1998: 42.

Chersastus rubricollis Schubart, 1966: 43-44; Lawrence 1967: 631-632.

Diagnosis. Differs from congeners in having the distal process of telopodite with two parts, the distal one oval, with two indented regions on surface, covered by scattered short setae; the proximal part almost same size as distal part, but triangular (Figs 115B-D). Last 15 pairs of legs without tarsal pads. Body in general with dark brown and reddish bands; head, antennae and legs dark brown; collum, preanal ring and anal valves reddish brown.

Redescription. *Measurements*: ♂ Total length 40-45mm, greatest width 5mm, 42+0+T body rings, n=15. ♀ Total length 20-64mm, greatest width 4-7mm, 42+0+T body rings, n=11.

Body sculpturing: Scobinae present, distinct and half-circle shaped (Figs 114D-E).

Legs: Legs moderately long, with the first two and the last 15 pairs without tarsal pads in male; tibia condensed with one apical bristle (Fig. 117A).

Colour (after 31 years in ethanol): The body in general with dark brown and reddish bands; head, antennae and legs dark brown (Figs 114A-B); collum, preanal ring and anal valves reddish brown (Figs 114A, C); body rings with dark brown metazonites, brown mesozonites and light brown/pale prozonites (Fig. 114D).

Gonopods: *Anterior gonopods*: Sternum of the anterior gonopods very long and narrow reaching far beyond the middle of the gonopods (Fig. 115A). Coxa with lateral margin of proximal half almost straight and distal half angled at about 45°, tapering to an acute apex (Fig. 115A), and with distinct suture between two parts of coxa. Distal process of telopodite with two parts, the distal one oval, with two indented regions on surface, covered by sparsely scattered short setae; the proximal process almost same size as distal process, but triangular (Figs 115B-D).

Posterior gonopods: Tibial process broad and seminal duct opening on its distal end; inflated basal lobe present; longitudinal efferent groove well developed and running along lateral margin; distal process of telopodite pointed at the distal margin laterally and curved smoothly downwards; coxite is separated from telopodite (Fig. 116).

Female sexual characters: Second pair of legs with distal margin of the lateral extension of the coxosterna with prominent, broadly rounded bulge (Fig. 116B). Vulva simple and roughly

bean-shaped; anterior valve overlaps the posterior one; both valves basally with one row of weakly developed setae; operculum poorly sclerotized (Figs 117C-D).

Type locality: SOUTH AFRICA: *KwaZulu-Natal*: Karkloof.

Type material (not examined). Holotype: 1♀ 1juv SOUTH AFRICA: KwaZulu-Natal, Karkloof, Waterfall, 25 miles NE of Pietermaritzburg, 1948-10, Hanstrom B, (MZLU).

Material examined. SOUTH AFRICA: *KwaZulu-Natal*: 1♂ 1♀, Karkloof Nature Reserve, Rockwood Farm, 29°18'10"S, 30°13'40"E, 1987-12, Starega W. & Croeser P. (NMSA-15593); 3♂ 2♀ 1 juvenile same data as the preceding (NMSA-15627); 2♂ 1♀ Karkloof Nature Reserve, 1995-02, Hamer M. (NMSA-15635); 1♂ Karkloof Forest, 25 miles NNW of Pietermaritzburg, 29° 26'S, 30° 19'E, 1984-01, Griswold C.E. & Griswold T.M. (NMSA-15659); 1♂ 3♀ 1 juvenile; Blinkwater, indigenous forest, 1997-01, Herbert D. (NMSA-16158); 3♂ 3♀ Blinkwater Nature Reserve, 2013, Armstrong A.J. (NMSA-25986); 1♀ Karkloof, Farm Coulbourne, 1964-10, Bourquin O. (NMSA-9645); 1♂ Karkloof area, Demagtenberg forest 29°17,470'S, 30°09,688'E, Hamer M. (DEM3 17, UKZN); 1♂ Karkloof, Leopards' Bush Nature Reserve, 2000-02, Hamer M. (MH65, UKZN); 2♂ Karkloof, 1944-03, Lawrence R.F. & Rump W.G. (NMSA-4055).

Distribution. This species has only been recorded from forest in the Karkloof area and the nearby Blinkwater area in the midlands of KwaZulu-Natal.

Remarks. Schubart (1966) described this species based on a female specimen. The male was described by Lawrence (1967) from the same locality as the type female.

Conservation assessment

This is a South African species described from KwaZulu-Natal in 1966.. The species occurs in *Centrobolus rubricollis* occurs in the Karkloof Nature Reserve and Blinkwater Nature Reserve, which are both protected areas with Afrotemperate, mistbelt forest. The forests in the area were heavily logged in the 1800's, but this largely stopped in the 1940s. The areas between the forests are heavily transformed by timber plantations and there are alien invasive plants mostly at the forest margins.

The species is not widespread with EOO estimated to be 150 – 250 km² and AOO between 20 - 30 km² and with number of locations between three and five. While *C. rubricollis* meets the criteria for Endangered in terms of AOO and EOO, there is little evidence that these are declining or that the habitat is deteriorating. The AOO is close to the cut off for Vulnerable D2 (20 km²), and on the basis of the small number of locations, it meets the requirements for Vulnerable (VU) D2.

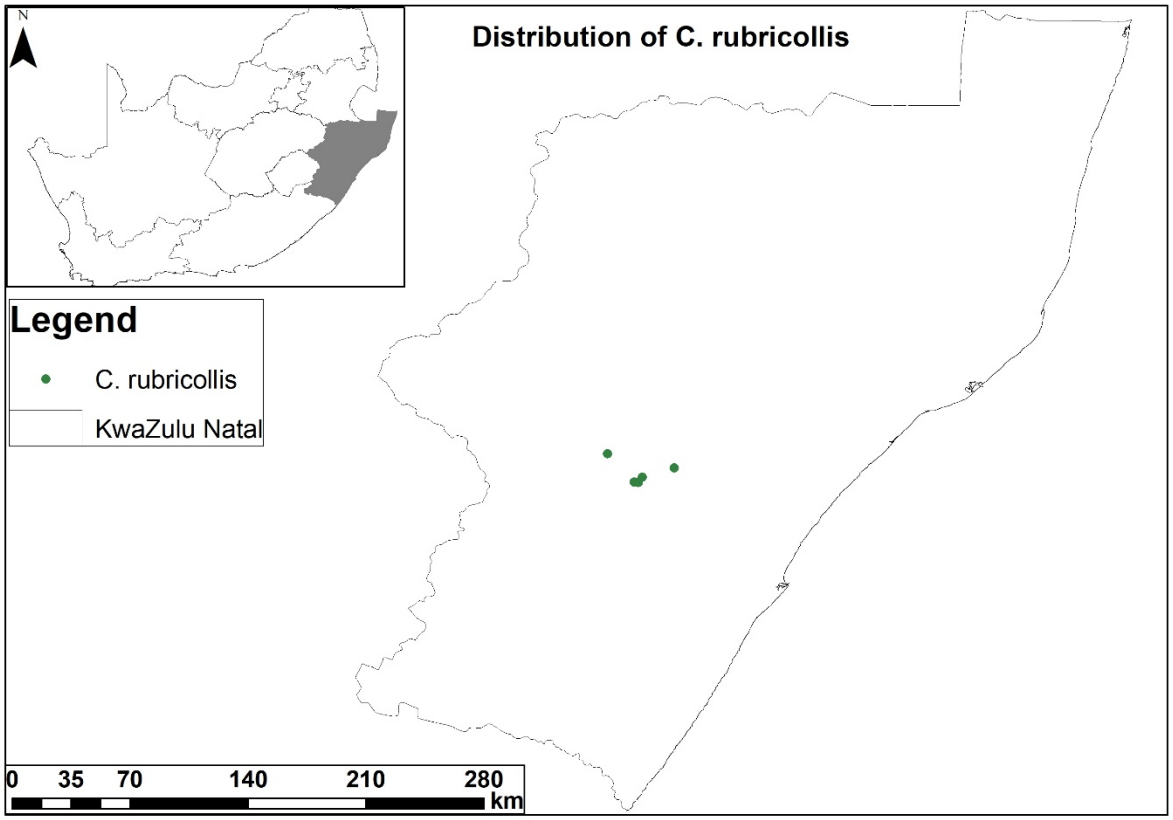

Figure 113: Distribution of *Centrobolus rubricollis* in South Africa, KwaZulu-Natal.

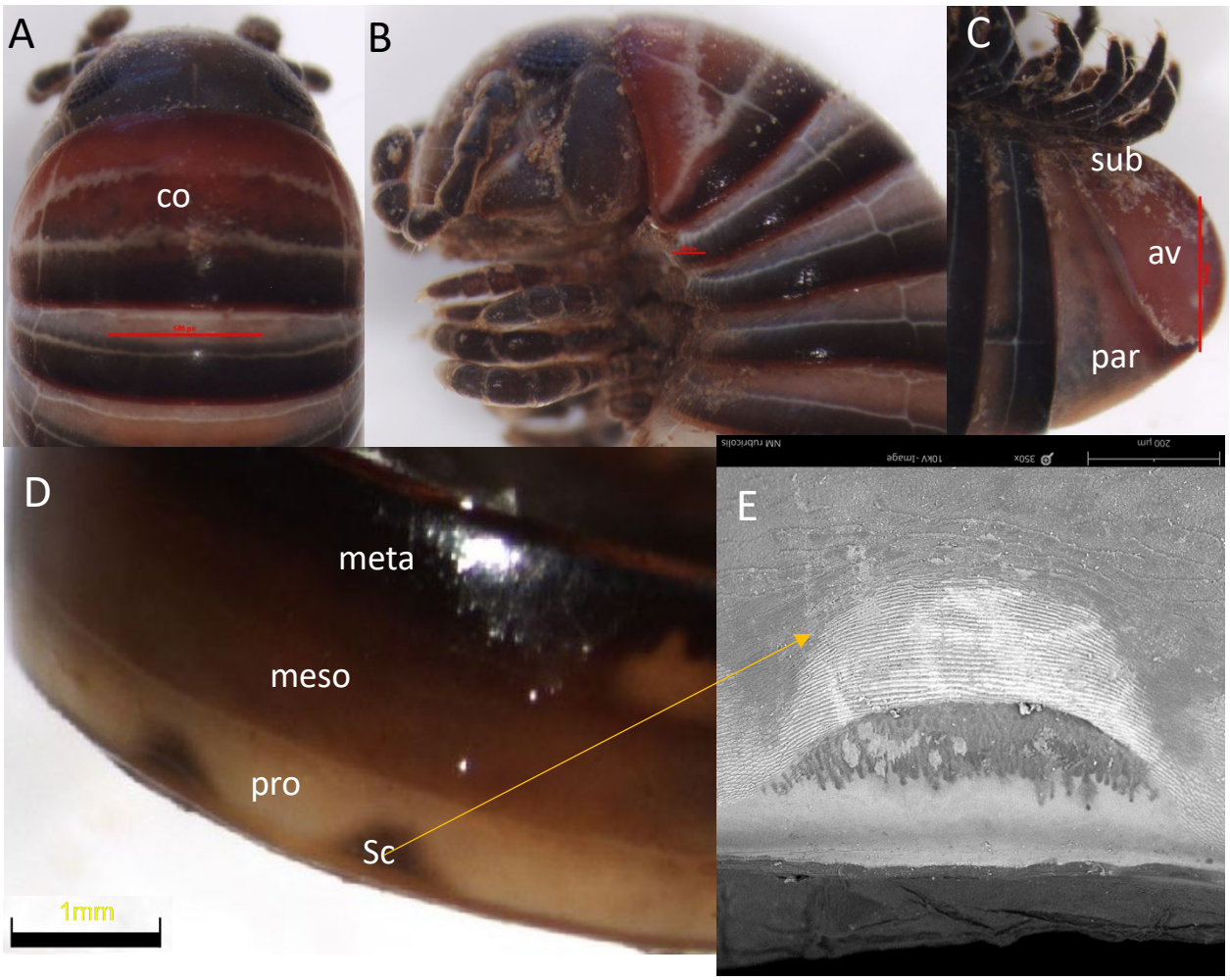

Figure 114: *Centrobolus rubricollis* (Karkloof Nature Reserve, Rockwood Farm, KwaZulu-Natal) ♂ (NMSA-15627). **A** anterior view of the head and collum, **B** lateral view, **C** ventral view, **D** terminal region of body **E-F** body ring. Abbreviations: av - anal valve; co – collum; meso – mesozonite; meta – metazonite; par - preanal ring; pro – prozonite; sc - scobina. Scale bars: 1.0 mm (**A-D**); 0.2 mm (**E**).

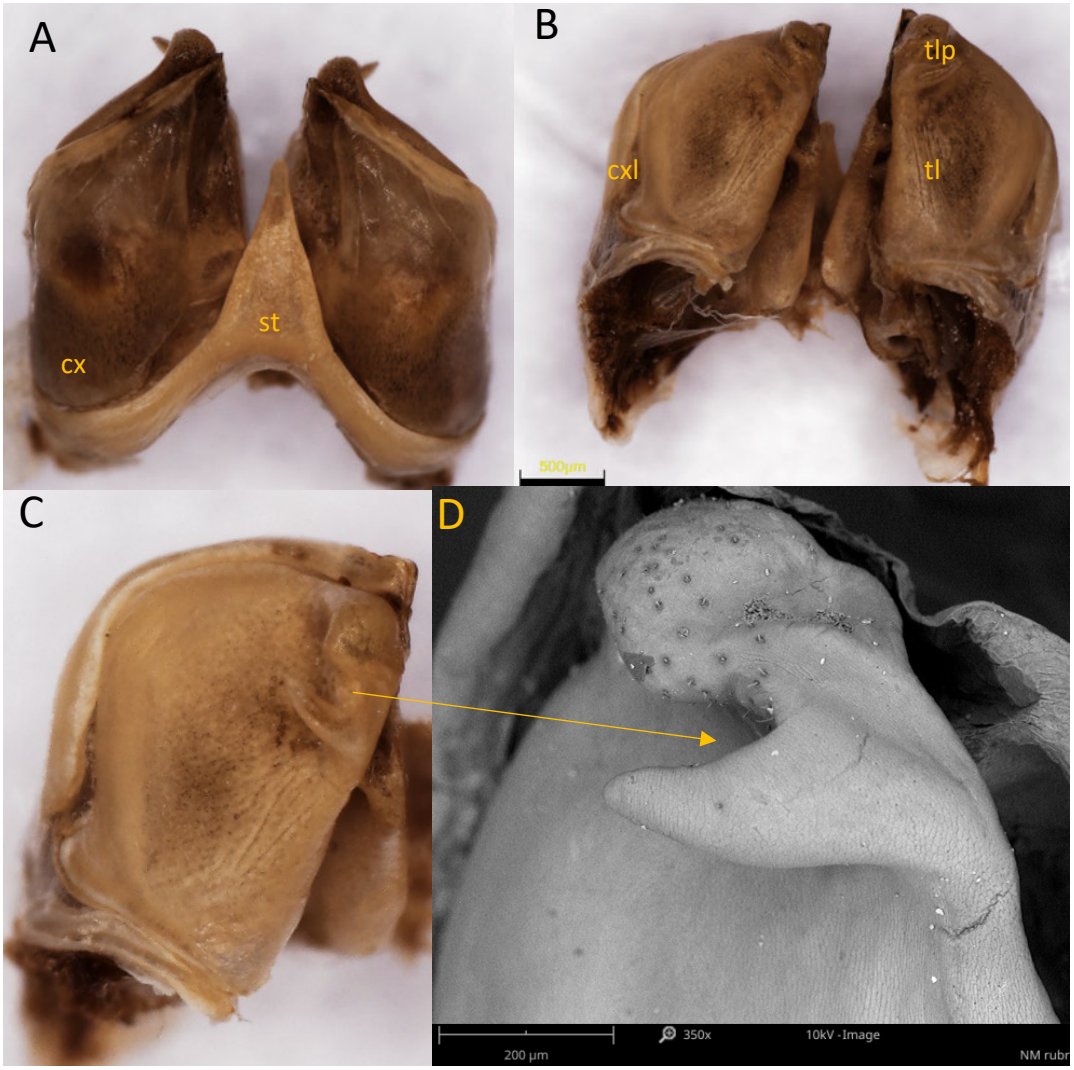

Figure 115: *Centrobolus rubricollis* ♂ (NMSA-15627). **A-D** anterior gonopods; **A** anterior view, **B-C** posterior view. Abbreviations: cx – coxa; cxl - coxal endite lobe; st – sternum; tl – telopodite; tlp - telopodite process. Scale bars: 0.5 mm (**A-C**); 0.2 mm (**D**).

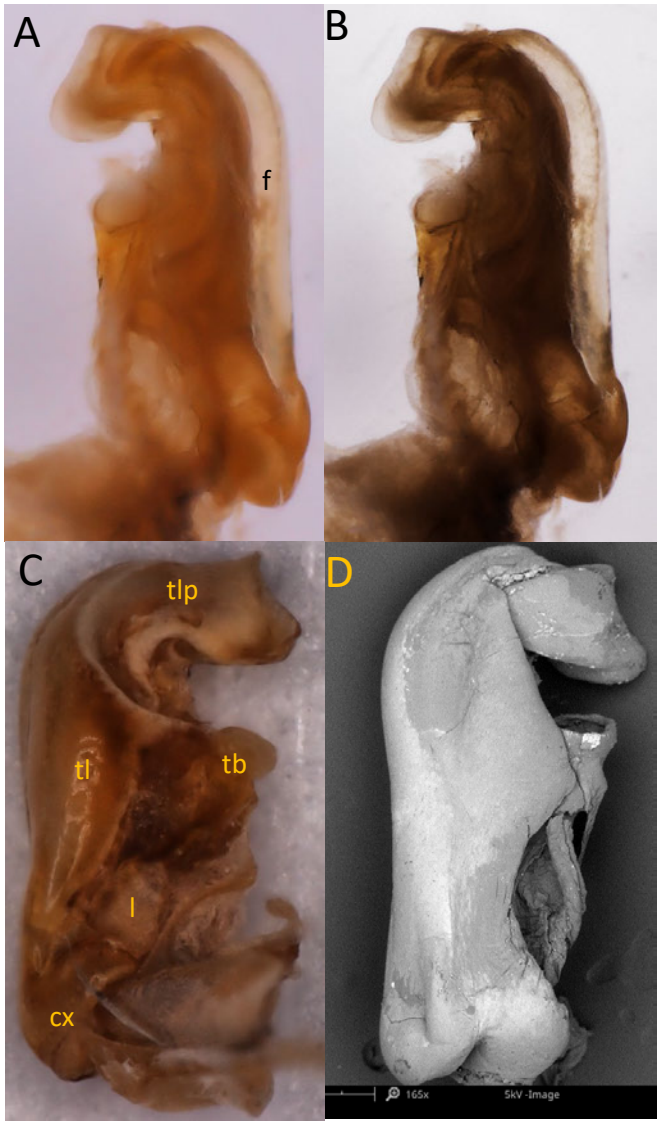

Figure 116: *Centrobolus rubricollis* ♂ (NMSA-15627). **A-D** posterior gonopod; **A** anterior view, **B**, **C**, **D** posterior view. Abbreviations: cx – coxa; f - efferent groove; l – inflated basal lobe; tb - tibial process; tl – telopodite; tlp - telopodite process. Scale bars: 0.5 mm.

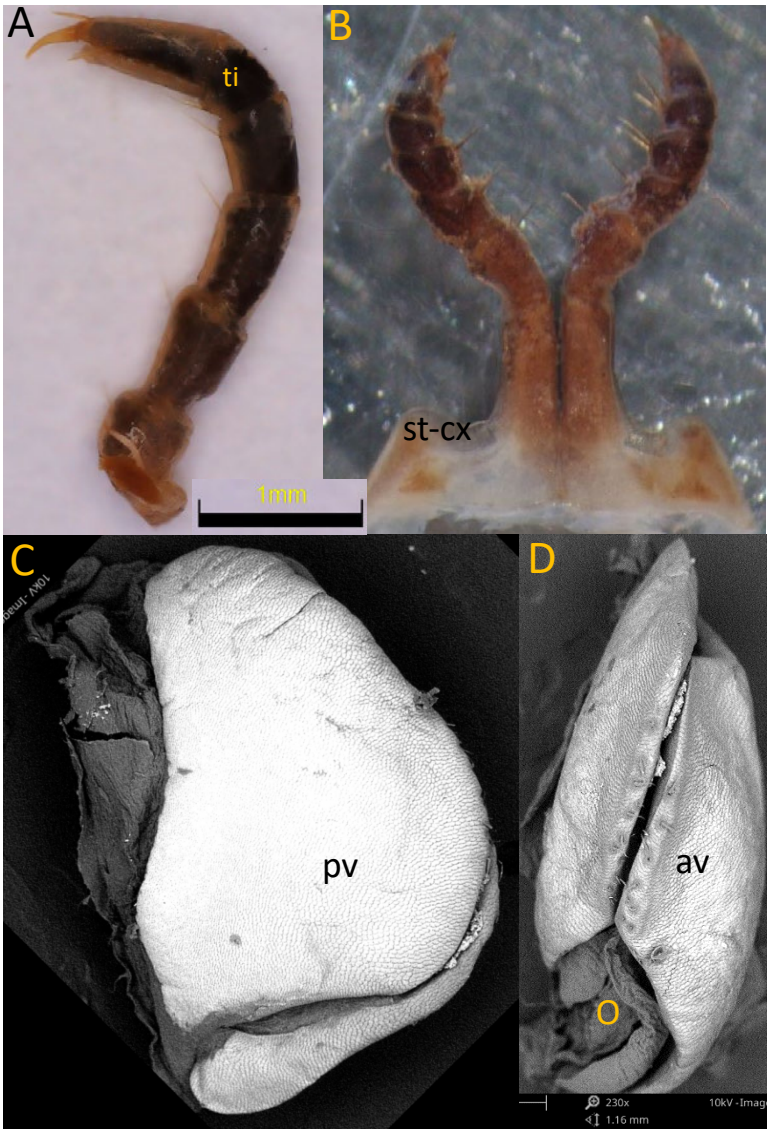

Figure 117: *Centrobolus rubricollis* ♀ (NMSA-15627). **A** male leg, **B** female second pair leg, **C-D** vulva, **D** lateral view, **C** anterior view. Abbreviations: av - anterior valve; o – operculum; pv - posterior valve; st-cx – coxosternite; ti –tibia. Scale bars: 1.0 mm (**A-B**); 0.3 mm (**C-D**).

***Centrobolus rugulosus* (Lawrence, 1967)**

Figs 118-122

Hamer 1998: 42.

Chersastus rugulosus Lawrence, 1967: 618-620.

Diagnosis. Differs from congeners in having a long, broad, lobed distal process of telopodite of anterior gonopod with a thick, pointed, finger-shaped proximal part (Figs 120B-D). Sternum of anterior gonopods short and stout. Scobinae prominent and crescent shaped. Body with distinct short, longitudinal striations giving a wrinkled texture. Legs fairly long and all except first two pairs with tarsal pads.

Redescription *Measurements*: ♂ Total length 30-62mm, greatest width 4-6.2mm, 41+0+T body rings, n=91. ♀ Total length 28-48mm, greatest width 4.9-8.4mm, 42+0+Tor 43+0+T body rings, n=59.

Body sculpturing: Body with distinct short, longitudinal striations giving a wrinkled texture. Scobinae present and crescent-shaped (Figs 119E-F).

Legs: Legs short, not exceeding the lateral margin of body rings when extended; all legs padded except the first two pairs in male; tarsal pads prominent; tibia extremely condensed, with two apical bristles (Fig. 122A).

Colour **(**after 20 years in ethanol): The body in general brown with orange tinge; head and collum, antennae and legs reddish brown/orange (Figs 119A-C); body rings reddish brown with metazonites, mesozonites and prozonites light brown/pale; (Fig. 119E); legs yellow with an orange tinge (Fig. 119B); preanal ring and anal valves pale, the latter brown on the edges (Fig. 119D).

Gonopods: *Anterior gonopods*: Sternum of the anterior gonopod short, stout and triangular (Fig. 120A). Coxa with lateral margin slightly concave proximally, distal half bent at about 45°, and with distal margin slightly concave, apex a narrow point (Fig. 120A). Distal process of telopodite with two parts, distal one an angular lobe with scattered small setae across surface, proximal part prominent and finger-shaped with acute apex (Figs 120B-D).

Posterior gonopods: Tibial process narrow and the seminal duct opens on its distal end; inflated basal lobe present; longitudinal efferent groove very well developed and runs along length of telopodite; distal process of telopodite short with attached indented lamella basally (Fig. 121).

Female sexual characters: Distal margin of lateral extensions of coxosternum with distinct, blunt triangular bulge. Vulva large; anterior valve overlaps the posterior one and a different

shape; both valves with a row of two to three setae basally; operculum poorly sclerotized, inner lips of valves with a row of large rounded, almost interlocking pegs (Figs 122B-E).

Type locality: SOUTH AFRICA*: KwaZulu-Natal*: Hluhluwe Game Reserve.

Type material (examined). Syntypes: 7♂ 9♀ SOUTH AFRICA: KwaZulu-Natal, Hluhluwe Game Reserve, 1935-10, Lawrence R.F. (NMSA-00264).

Other material examined. SOUTH AFRICA: *KwaZulu-Natal*: 2♂ 6♀ St Lucia Bay, 1935-11, Rump W.G. (NMSA-00293); 5♂ 3♀ Dukuduku Forest, 1957-12, Lawrence R.F. (NMSA-06817); 1♂ Ngoye Forest, 1953-02, Lawrence R.F. (NMSA-9617); 5♂ 4♀ Mapelane, Umfolozi River, 1995-12, Hamer M. (NMSA-15527); 2♂ same locality and collector data as the preceding (NMSA-16460); 4♂ 5♀ Ngome, Mist belt Forest, 1995-12, Hamer M. (NMSA-15544); 6♂ 6♀ 1 juvenile, Ithala Game Reserve, trail behind main camp, 1996-03, Hamer M. (NMSA-15553); 2♂ 1♀ Dukuduku Forest, trail from NPB picnic site, 1996-03, Hamer M. & Herbert D. (NMSA-15558); 12♂ Ithala Game Reserve, Ntshondwe woodland, 1997-12, Reavell P.E. (NMSA-15712); 2♀ Cape Vidal, 1997-10, Herbert D. (NMSA-15782); 1♂ Nkandla Forest, 1997-08, Herbert D. (NMSA-15796); 1♂ Richard's Bay near Lake Nhlabane, Nelurhalani M.J. (NMSA-15846); 5♂ 5♀ Vryheid Nature Reserve, forest behind camp, 27° 45' 00"S, 30° 46' 30"E, 1997-02, Hamer M. (NMSA-16405); 2♂ 3♀ same data as the preceding (NMSA-16406); 3♂ 2♀ Cape Vidal, Mvubu Trail, 1996-01, Hamer M. (NMSA-16490); 2♀ Hlatikulu Forest, 27° 19'22.793"S, 31° 59'32.473"E, 2002-08, Armstrong A.J. (NMSA-20120); 1♀ Gwaliweni, 1957-12, Lawrence R.F. (NMSA-16490); 2♂ 5♀ 6 juveniles, Vryheid Nature Reserve, in a forest on a wooded slope, 27,749°S, 30,798°E, 1333masl, 1999-12, Hamer M., King H. & Bullock W.; 4♂ 2♀ Hluhluwe Game Reserve, 1995-01, Hamer M. (NMSA-15520); 1♂ same locality and collector data as the preceding (NMSA-15543); 2♂ 2♀ same locality and collector data as the preceding (NMSA-16481); 1♂ Hluhluwe Game Reserve, Imfolozi Park, 28°03'51.44"S, 32°02'38.76E, 2013-10, Armstrong A.J. (NMSA-25966); 1♂ same locality and collector data as the preceding (NMSA-25963); 1♂ same locality and collector data as the preceding (NMSA-25967); 1♂ same data as the preceding (NMSA-25962); 1♂ same data as the preceding (NMSA-25964); 6♂ 1♀ Hluhluwe, 1998-11, Hamer M. (MH. 14, UKZN); 2♂ same locality and collector data as the preceding (MH. 46, UKZN); 1♂ 2♀ Hluhluwe Game Reserve, 28° 3' 10.02"S, 32° 3' 11.58"E, 568 m; Sep. 2002, Armstrong A.J. (NMSA-22770); 2♀ Hluhluwe Game Reserve, Mbambe Forest, 28° 04' 12.07"S, 32° 02' 13.01"E, 494 m, 2002-08, Armstrong A.J. (NMSA-22729); 1♂ 1juvenile Hluhluwe, Mbambe Forest, 28°19'22.793"S/31°59'23.473"E, 2002-08, Armstrong A.J. & Mtshali P. (NMSA-19988).

Distribution. This species has been recorded from a number of localities with various types of forest and woodland habitat in the northern part of KwaZulu-Natal province.

Remarks. Lawrence (1967) designated a male and female specimen as the "Holotype", and so these are referred to here as syntypes. Lawrence (1967) also did not illustrate the posterior gonopods for this species nor did he provide a description of the gonopods. There are some variations of colour of *C. rugulosus*. Lawrence (1967) described the colour as reddish yellow but did note that is faded in alcohol.

Conservation assessment

This is a South African species described from KwaZulu-Natal in 1967. The species is relatively widespread in the northern part of KwaZulu-Natal, and has been recorded from several protected areas including Hluhluwe and Ithala Game Reserves, iSimangaliso Wetland Park, Vryheid Nature Reserve, and Ngoye, Ngome, Nkandla, Dukuduku and Hlatikulu (Gwaliweni) Forests. The species is known to occur in coastal, scarp and Afromontane forests. The major threats include loss of habitat along the coast through dune mining and industrialisation in the Richards Bay area, timber plantations, tourism and housing development in forests such as Dukuduku, wood harvesting for curios. This species is relatively abundant in forest habitat (Hamer, pers. comm).

EOO = 18 000 – 20 000 km² and AOO = 60 - 180 km² with number of locations = 13, and these are fragmented. There has been some loss of habitat, and this may continue at some locations where these are outside of protected areas, but the scale of this is small relative to the overall EOO and AOO. *Centrobolus rugulosus* is therefore considered as Least Concern (LC).

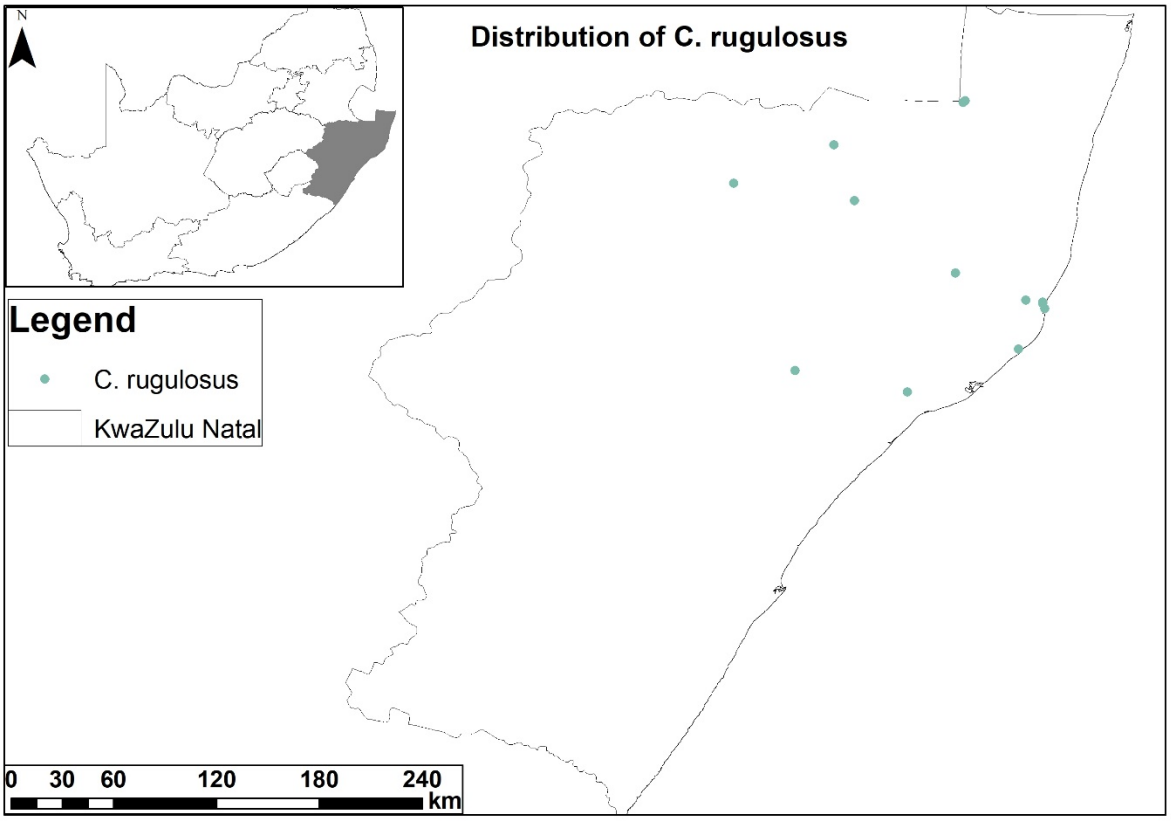

Figure 118: Distribution of *Centrobolus rugulosus* in South Africa, KwaZulu-Natal.

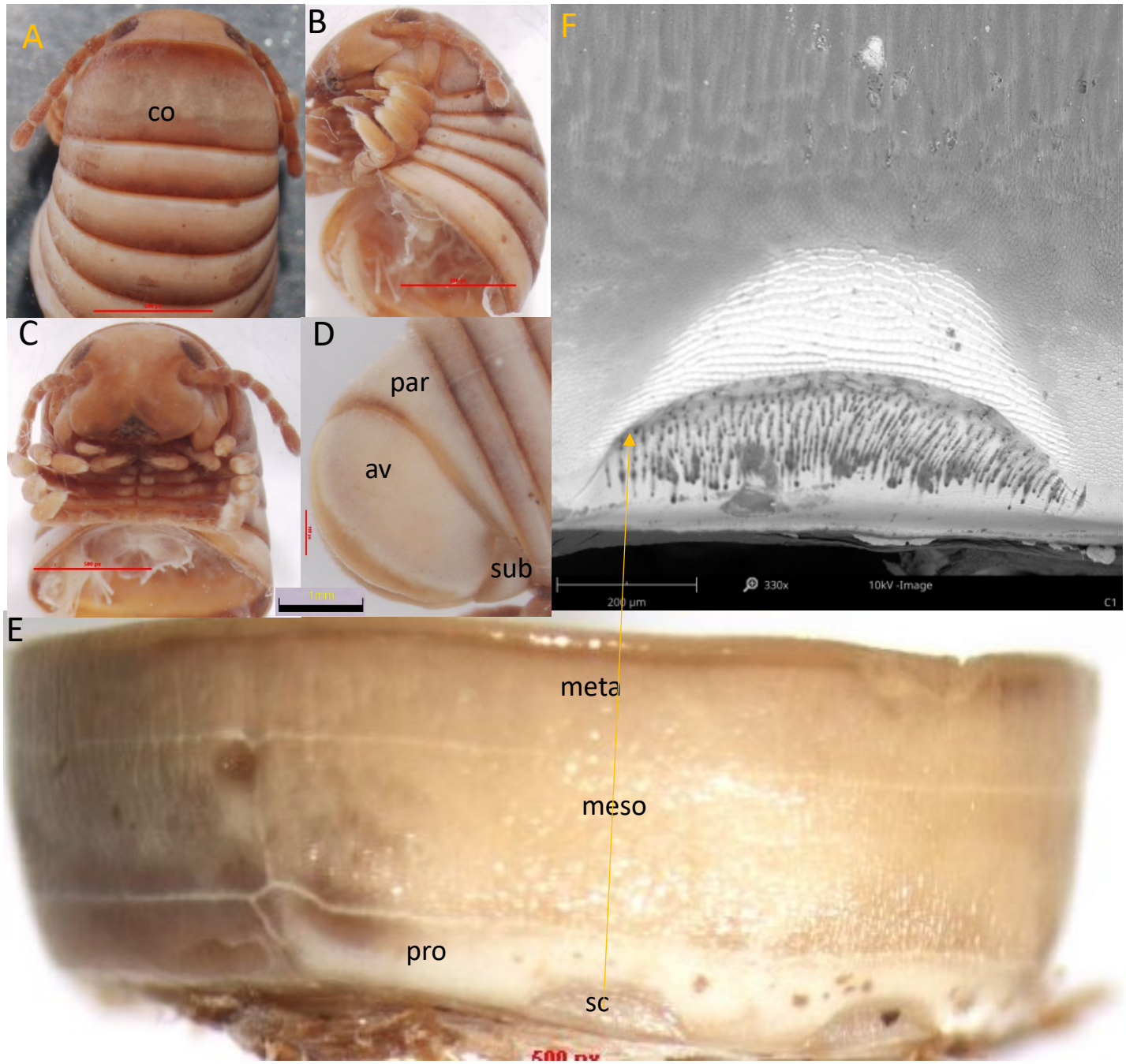

Figure 119: *Centrobolus rugulosus* (Hluhluwe Game Reserve, KwaZulu-Natal) ♂ (MH14). **A** anterior view of the head and collum, **B** lateral view, **C** ventral view, **D** terminal region of body, **E-F** body ring. Abbreviations: av - anal valve; co – collum; meso – mesozonite; meta – metazonite; par - preanal ring; pro – prozonite; sc - scobina. Scale bars: 1. 0 mm (**A-E**); 0.2 mm (**F**).

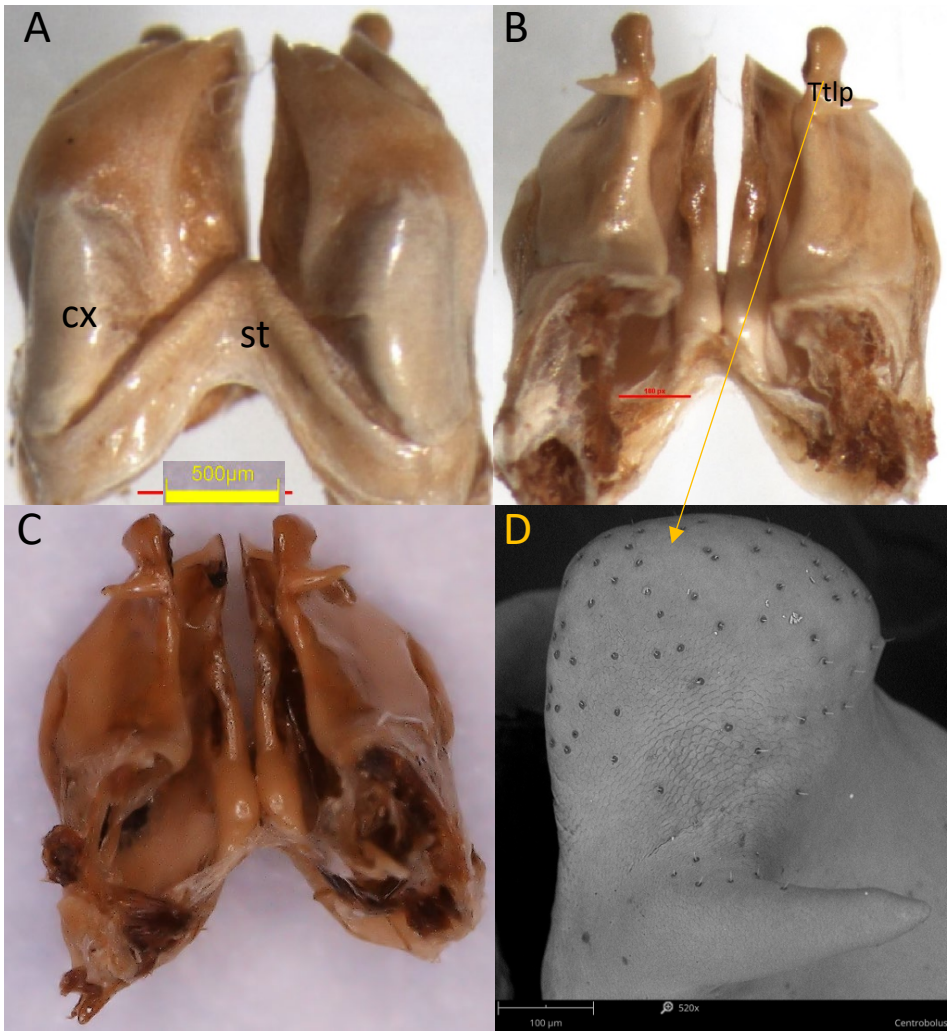

Figure 120: *Centrobolus rugulosus* ♂ (MH14). **A-D** anterior gonopods; **A** anterior view, **B-D** posterior view. Abbreviations: cx – coxa; cxl - coxal endite lobe; st – sternum; tl – telopodite; tlp - telopodite process. Scale bars: 0.5 mm (**A-C**); 0.1 mm (**D**).

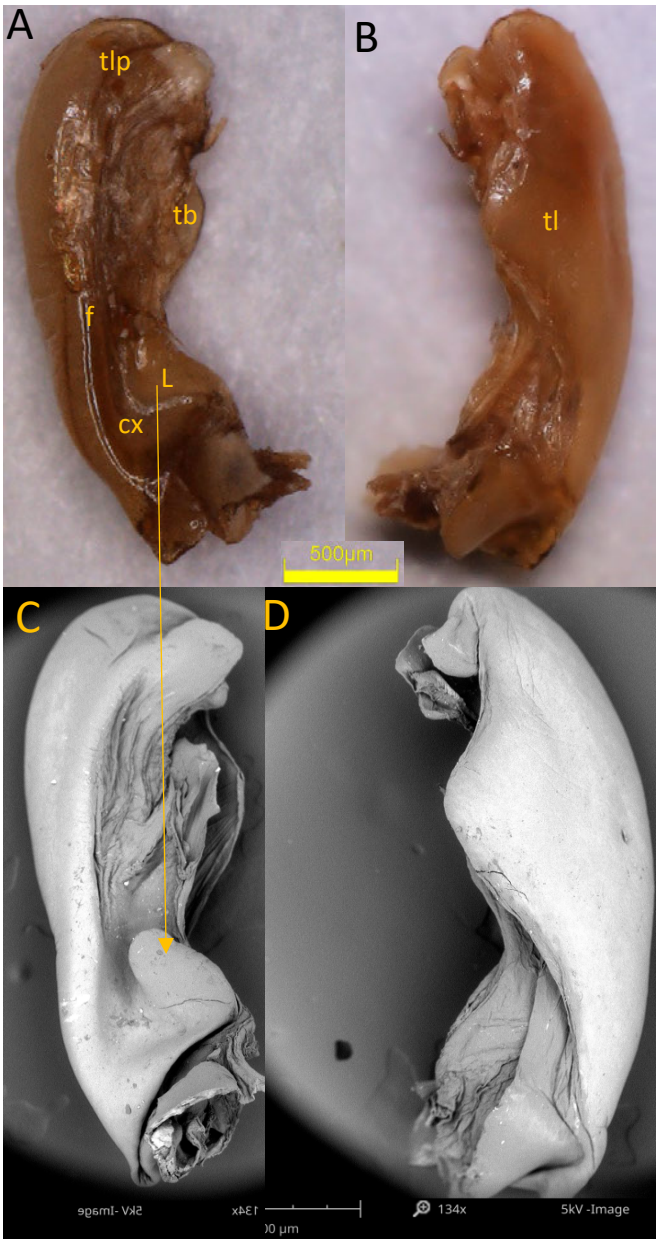

Figure 121: *Centrobolus rugulosus* ♂ (MH14). **A-D** posterior gonopod; **A** & **C** posterior view, **B** & **D** anterior view. Abbreviations: cx – coxa; f - efferent groove; l - inflated basal lobe; tb - tibial process; tl – telopodite; ; tlp - telopodite process ,;. Scale bars: 0.5 mm.

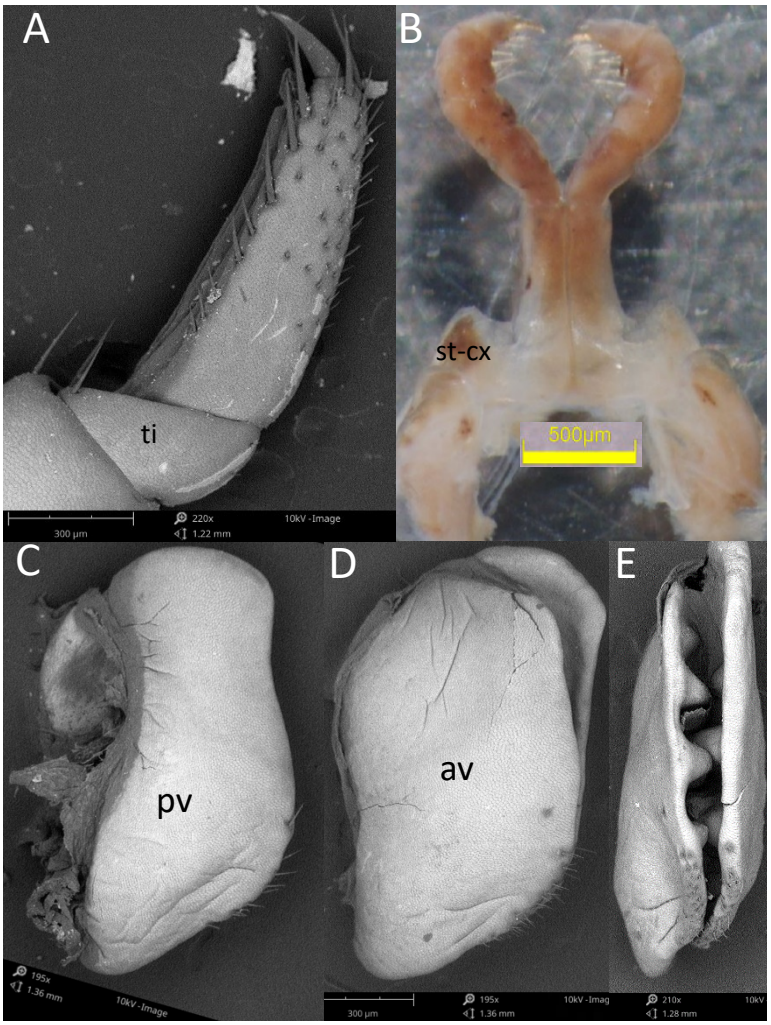

Figure 122: *Centrobolus rugulosus* ♀ (MH14). **A** male leg, **B** female second pair leg, **C-E** vulva, **E** lateral view, **C** posterior view, **D** anterior view. Abbreviations: av - anterior valve; o – operculum; pv - posterior valve; st-cx – coxosternite; ti –tibia. Scale bars: 0.5 mm (**B**); 0.3 mm (**A**, **C-E**).

***Centrobolus sagatinus* (Schubart, 1966)**

Figs 123-127

Hamer 1998: 42.

Chersastus sagatinus Schubart, 1966: 35-38.

Diagnosis. Differs from congeners by having the following combination of character states: distal process of telopodite with two parts, apical one distinctly rectangular and proximal one small and angular; scobinae absent (Figs 125B-D). The operculum of the vulva well sclerotized (Fig. 127A).

Redescription. *Measurements*: ♂ Total length 25-32mm, greatest width 4.3-5.0mm, 44+0+T body rings, n=15. ♀ Total length 28-45mm, greatest width 7mm, 44+0+T body rings, n=12.

Body sculpturing: Body smooth and shiny; scobinae absent; preanal ring slightly protruding beyond the curved anal valves (Fig. 124D).

Legs: short, not exceeding the external margin of body rings when extended; with the first and last two pairs without tarsal pads; tibia condensed with two apical bristles (Fig. 127A).

Colour (after 33 years in ethanol): The body in general black/reddish; head, antennae and legs reddish; collum reddish with vague darker areas/markings (Figs 124A-C); body rings with reddish metazonites and mesozonites (slightly lighter) with a black dorso-median spot and a large spot on each side, and prozonites light brown (Fig. 124G); preanal ring and valves light brown (Figs 124D-E).

Gonopods: *Anterior gonopods*: Sternum of the anterior gonopods short, reaching less than a quarter the height of the gonopods, broad and medianly truncate, with extension not reaching higher than a third the height of gonopods (Fig. 125A); proximal half of coxa with somewhat straight lateral margins, distal half bent at about 45° angle and with distal margin straight; median margin concave; apically pointed (Fig. 125A). Distal process of telopodite with two parts; the larger and more distal one longitudinally oriented and rectangular with surface covered in widely scattered small setae, and second part an angular lappet some distance from main part of process (Figs 125B-D).

Posterior gonopods: Tibial process broad with seminal duct opening on distal end; longitudinal efferent groove very well developed and runs along length of telopodite; telopodite broad with distal processes slightly convex and slightly spiked; thin basal lobe present and very distinct (Fig. 126).

Female sexual characters: Second pair of legs with distal margin of the lateral extensions of the coxosterna with prominent, narrowly triangular bulge; vulva with anterior valve much larger than and overlapping posterior valve; both valves basally with a short row of two to three setae; operculum well sclerotized (Figs 127B-E).

Type locality: SOUTH AFRICA: *Eastern Cape*: between Uitenhage and Addo, N of Port Elizabeth.

Type material (not examined). Syntypes: 4♂ 6♀ SOUTH AFRICA: Eastern Cape, between Uitenhage and Addo, N of Port Elizabeth, 1951-01, Schubart O. (MZLU).

Material examined. SOUTH AFRICA: *Western Cape*: 8♂ 6♀ 3 juveniles Karoo National Park, 10km N of Beaufort West, 32°18'S/22°33'E. el. 3500ft, 1985-10, Griswold C., Doyen J. & Melkie-Griswold T. (NMSA-15546). *Eastern Cape*: 1♀ Cookhouse, 1905-10, Purcell W.A. (SAM-ENW-B000805); 3♂ Willowmore 1929-02, Lawrence R.F. (SAM-ENW-B007465).

Distribution. This species has been recorded from the relatively dry, inlands parts of the Western and Eastern Cape Provinces.

Remarks. A female specimen from Merebank in Durban, KwaZulu-Natal in the South African Museum was identified as *C. sagatinus*, but this identification cannot be confirmed without examining male specimens. It is unlikely that it is this species because of the difference in habitat and the distance from other localities. The specimen from Willomore were originally labelled as *C. digrammus*.

Conservation assessment

This is a South African species described from Eastern Cape in 1966. The species occurs over a relatively large area in the more arid Karoo region and is protected in the Karoo National Park. No information is provided about the habitat of this species, but it is likely to be Karoo shrubland. The major threat is probably commercial agriculture in some areas.

The EOO is estimated to be about 30 000 – 40 000 km² and because the habitat is not known, the AOO cannot be estimated. The number of known locations = seven, but there are likely to be more than this and they may be fragmented. Based on the relatively large EOO, the number of locations, and the relatively low level of threat, *C. sagatinus* is considered as Least Concern (LC).

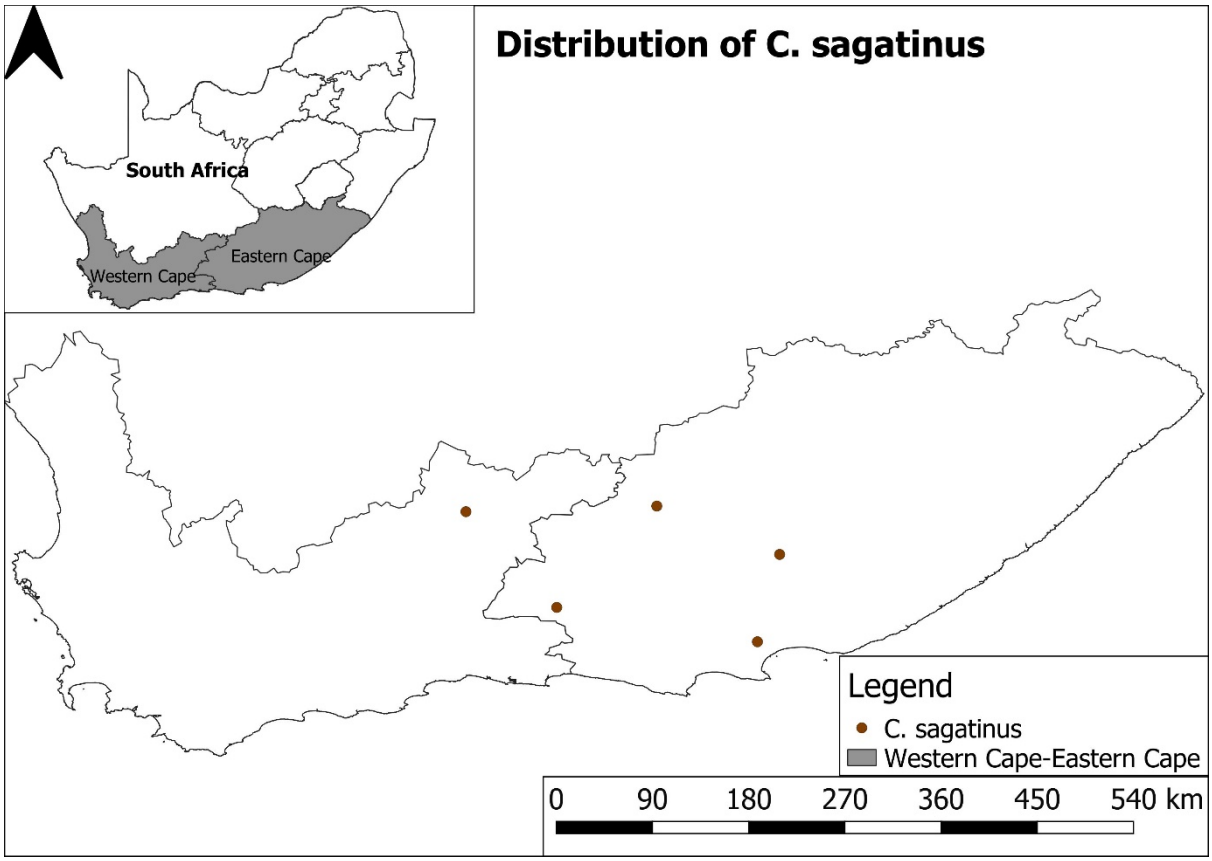

Figure 123: Distribution of *Centrobolus sagatinus* in South Africa. EC= Eastern Cape, WC= Western Cape.

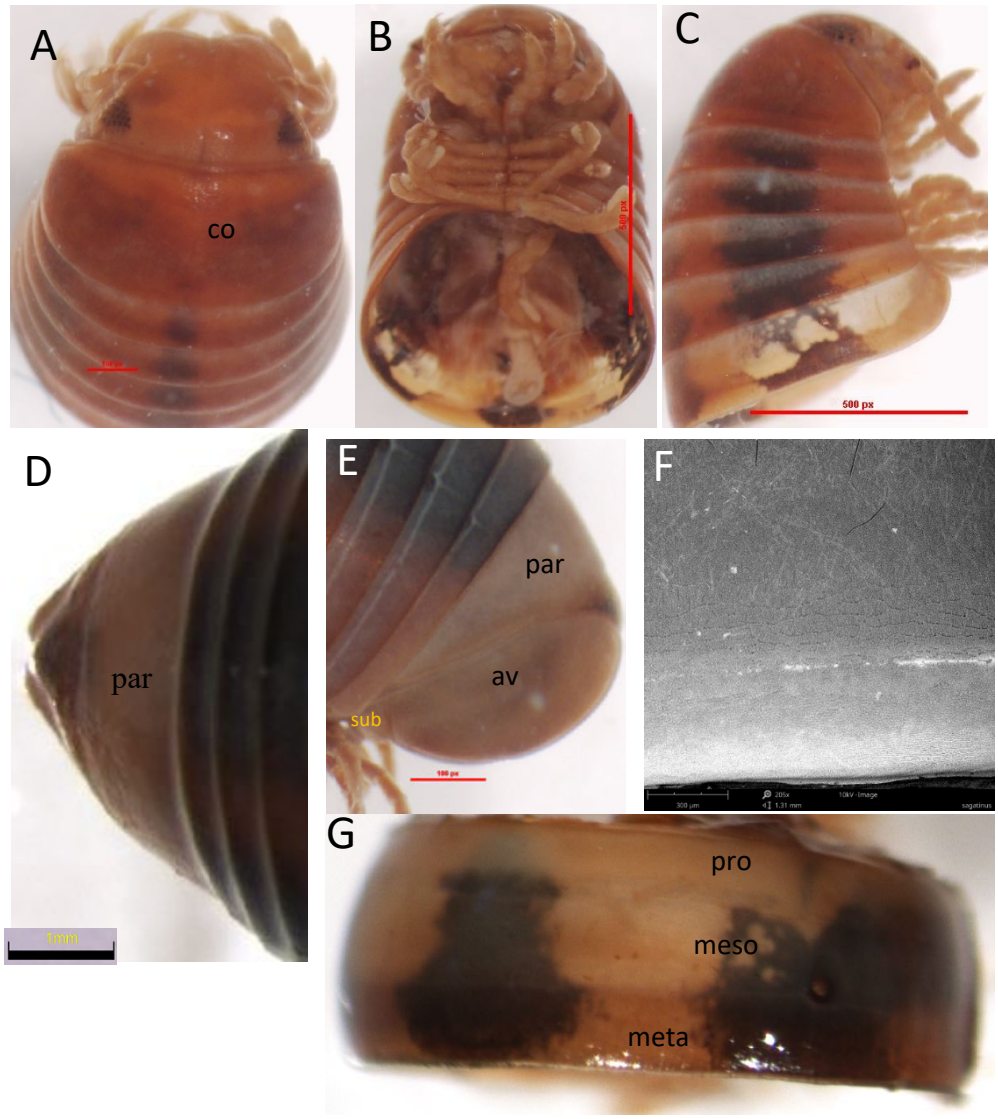

Figure 124: *Centrobolus sagatinus* (Karoo National Park, Western Cape) ♂ (NMSA-15546). **A** anterior view of the head and collum, **B** ventral view, **C** lateral view, **D-E** terminal region of body, **F-G** body ring. Abbreviations: av - anal valve; co – collum; meso – mesozonite; meta – metazonite; par - preanal ring; pro – prozonite. Scale bars: 1.0 mm (**A-E**, **G**); 0.3 mm (**F**).

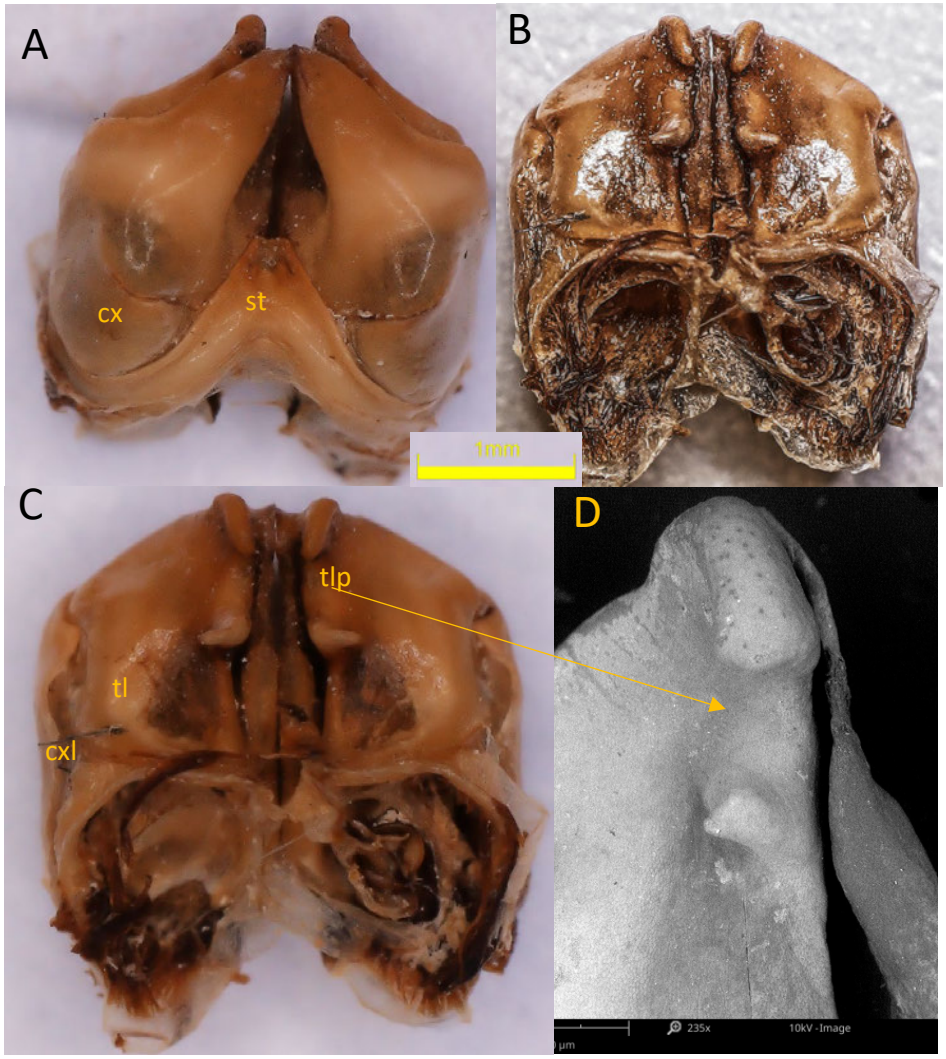

Figure 125: *Centrobolus sagatinus* ♂ (NMSA-15546). **A-D** anterior gonopods; **A** anterior view, **B-D** posterior view. Abbreviations: cx – coxa; cxl - coxal endite lobe; st – sternum; tl – telopodite; tlp - telopodite process. Scale bars: 1.0 mm (**A-C**); 0.3 mm (**D**).

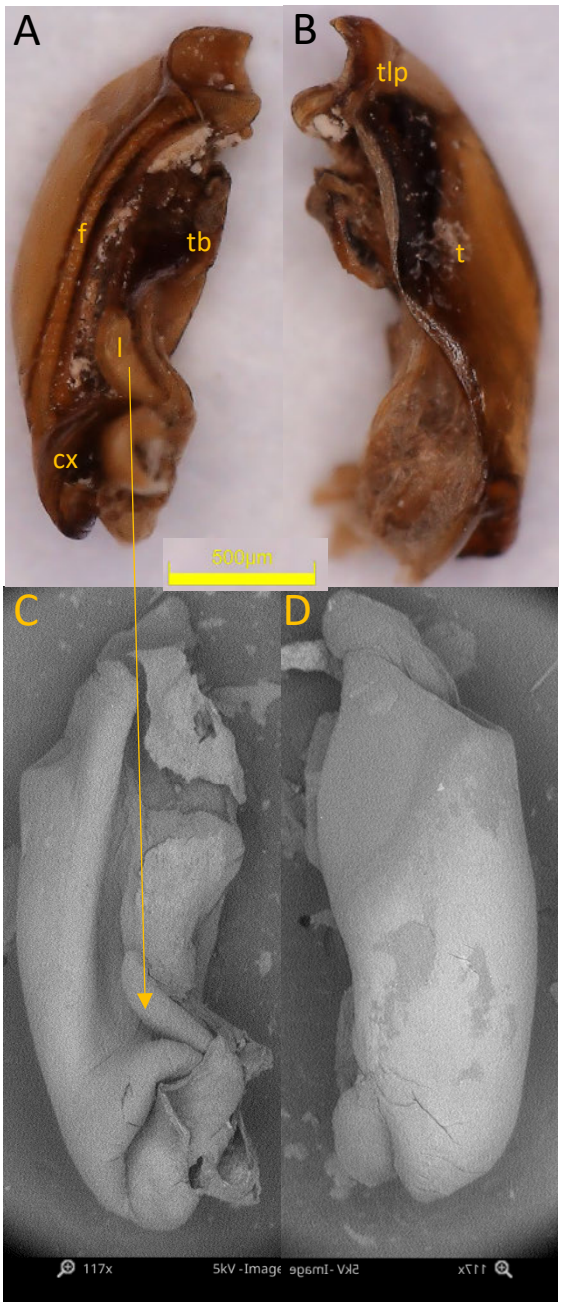

Figure 126: *Centrobolus sagatinus* ♂ (NMSA-15546). **A-D** posterior gonopod; **A &C** anterior view, **B** & **D** posterior view. Abbreviations: cx – coxa; f - efferent groove; l - inflated basal lobe; tb - tibial process; tl – telopodite; tlp - telopodite process. Scale bars: 0.5 mm.

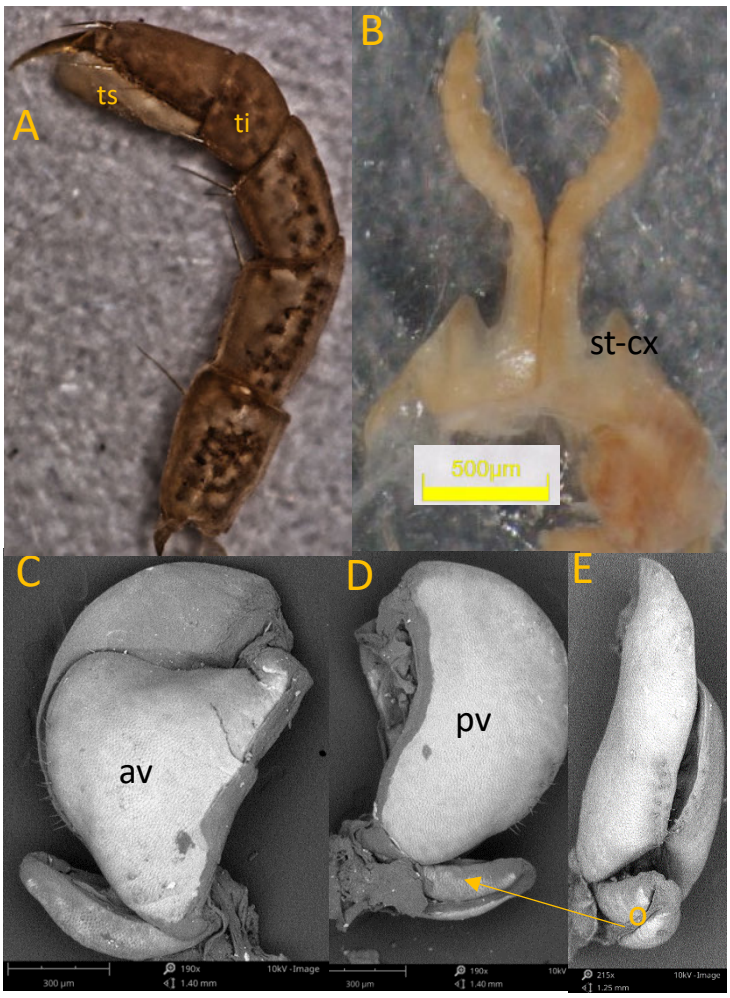

Figure 127: *Centrobolus sagatinus* ♀ (NMSA-15546). **A** male leg, **B** female second pair leg, **C-E** vulva, **E** lateral view, **C**, anterior view, **D** posterior view. Abbreviations: av - anterior valve; o – operculum; pv - posterior valve; st-cx – coxosternite; ti –tibia; ts – tarsal pad. Scale bars: 0.5 mm (**A-B**); 0.3 mm (**C-E**).

***Centrobolus sanguineomarginatus* (Schubart, 1966)**

Figs 128-132

Hamer 1998: 42.

Chersastus sanguineomarginatus Schubart, 1966: 35-38.

Diagnosis. Differs from congeners in distal process of the telopodite of anterior gonopods which is comprised of two parts, the distal one an elongated, inflated lobe that extends beyond the distal margin of the coxa, and a proximal part that is small, slender, finger-shape process (Figs 130C-D); the large sternum with median process apically indistinctly indented, and the apical part of the coxa which is strongly tapered to an acute point (Figs 130A-B); all legs except first two pairs with tarsal pads. Body in general with black and reddish-brown bands; head black and reddish at the labrum; collum red with thick black band in the middle, antennae and legs reddish brown/orange, preanal ring black and anal valves reddish.

Redescription. *Measurements*: ♂ Total length 58mm, greatest width 4.7mm, 45+0+T body rings, n=7. ♀ Total length 65mm, greatest width 6.0mm, 45+0+T body rings, n=2.

Body sculpturing: Body smooth and shiny; scobinae present and small (Figs 129E-F).

Legs: Legs long, extending beyond lateral margin of body rings; all legs with prominent pad except the first two pairs; tibia standard length with one apical bristle (Fig. 132A).

Colour (after 33 years in ethanol): The body in general with black and reddish-brown bands; head black and reddish at the labrum (Fig. 129A); collum red with thick black band in the middle, antennae and legs reddish brown/orange (Fig. 129A); body rings with reddish brown metazonites, black mesozonites and prozonites light brown/pale (Fig. 129E); preanal ring black and anal valves reddish (Fig. 129D).

Gonopods: *Anterior gonopods*: Sternum of the anterior gonopods with median extension reaching about two thirds length of gonopods, barely tapered and slightly indented at the apex (Figs 130A-B). Proximal two thirds of coxa with median margin almost straight, distal third bent at about 40 ° angle and with distal margin straight, and with apical region strongly tapered forming a pointed extension (Fig. 130A). Distal process of telopodite with two parts the distal one elongated and inflated, and proximal one a small finger-like process (Figs 130B-C).

Posterior gonopods: Telopodite slightly curved downwards, and with broad angular apical region; longitudinal efferent groove well developed and runs along posterior surface of

telopodite; inflated basal lobe absent; distal process of telopodite broad and somewhat serrated at the margins (Fig. 131).

Female sexual characters: Second pair of legs with lateral extensions of the coxosterna without a distinct bulge on the distal margin (Fig. 132B). Vulva large and with indentations on two main margins, anterior valve slightly shorter than posterior valve; both valves with a row of two to three setae; operculum poorly sclerotized (Figs 132C-D).

Type locality: SOUTH AFRICA: *Western Cape*: Bains Kloof.

Type material (not examined). Holotype: 1♂ SOUTH AFRICA: Western Cape, Bains Kloof, 1951-07, Schubart O. (MZLU).

Material examined. SOUTH AFRICA: *Western Cape*: 5♂ 1♀ Heidelberg, Grootvadersbosch, 1985-05, Prins A.J. (NMSA-15633); 1♂ Swellendam area Grootvadersbosch, 1997-03, Cooper M. (NMSA-15731); 1♀ same data as the preceding (NMSA-15732).

Distribution. This species has only been recorded from two localities, 160 km apart, in the mountainous part of the Western Cape province.

Remarks. The gonopods of this species are similar to those of *C. digrammus* and *C. promontorius* but *C. sanguineomarginatus* differs in the colour of the body rings which lack paramedian spots, and the colour pattern of the collum of *sanguineomarginatus* which has a broad black band in the middle compared to the M-shaped broad band in *digrammus*. The other differences are the shape of the vulva of the female and the bulge of the distal margin of the extensions of the coxosterna, which is rounded in *C. sanguineomarginatus* but slightly angled in *C. digrammus*.

Conservation assessment

This is a South African species described from the Western Cape in 1966. There is insufficient information to make an assessment on this species, and it is likely that it occurs at additional locations along the Langeberg or other mountain ranges. The habitat is unknown, and it may be fynbos or forest. No major threats are likely in the mountains which are not suitable for agriculture, and which have a number of protected areas, including Grootvadersbosch. *Centrobolus sanguineomarginatus* is categorised as Data Deficient (DD) because of the lack of distribution data.

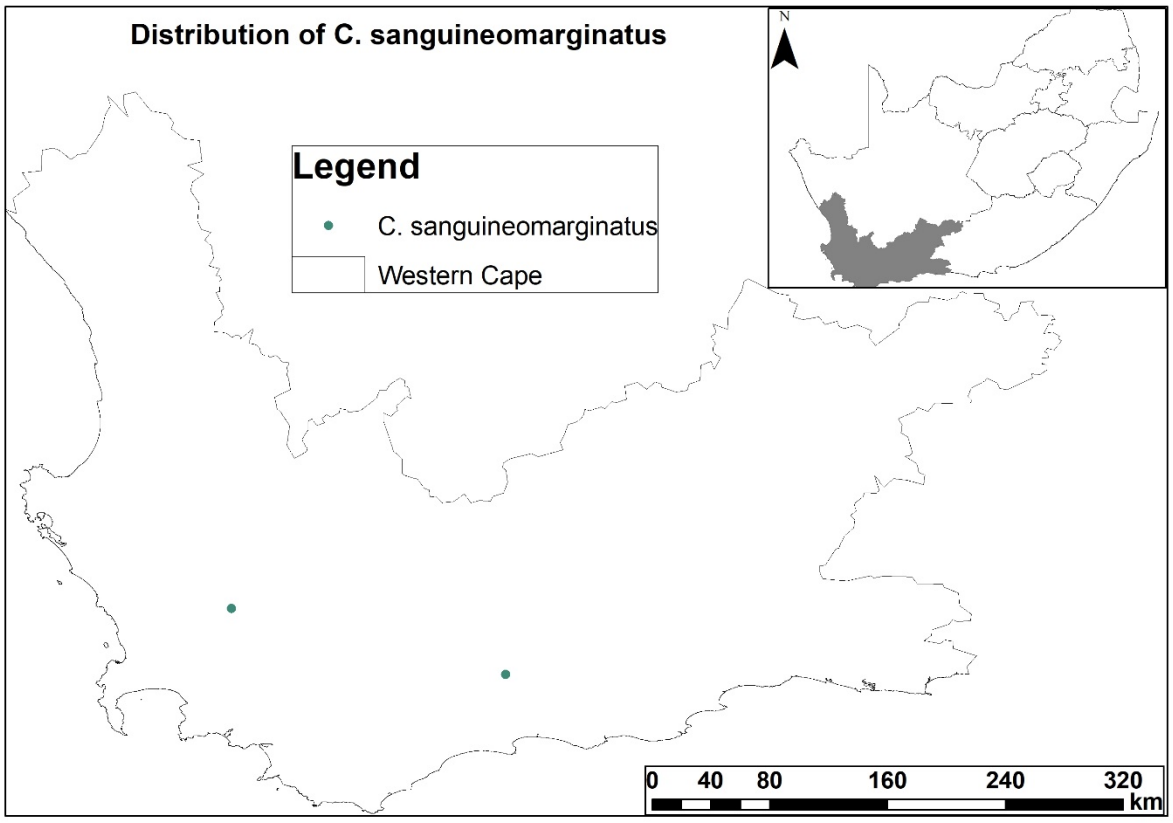

Figure 128: Distribution of *Centrobolus sanguineomarginatus* in South Africa, Western Cape.

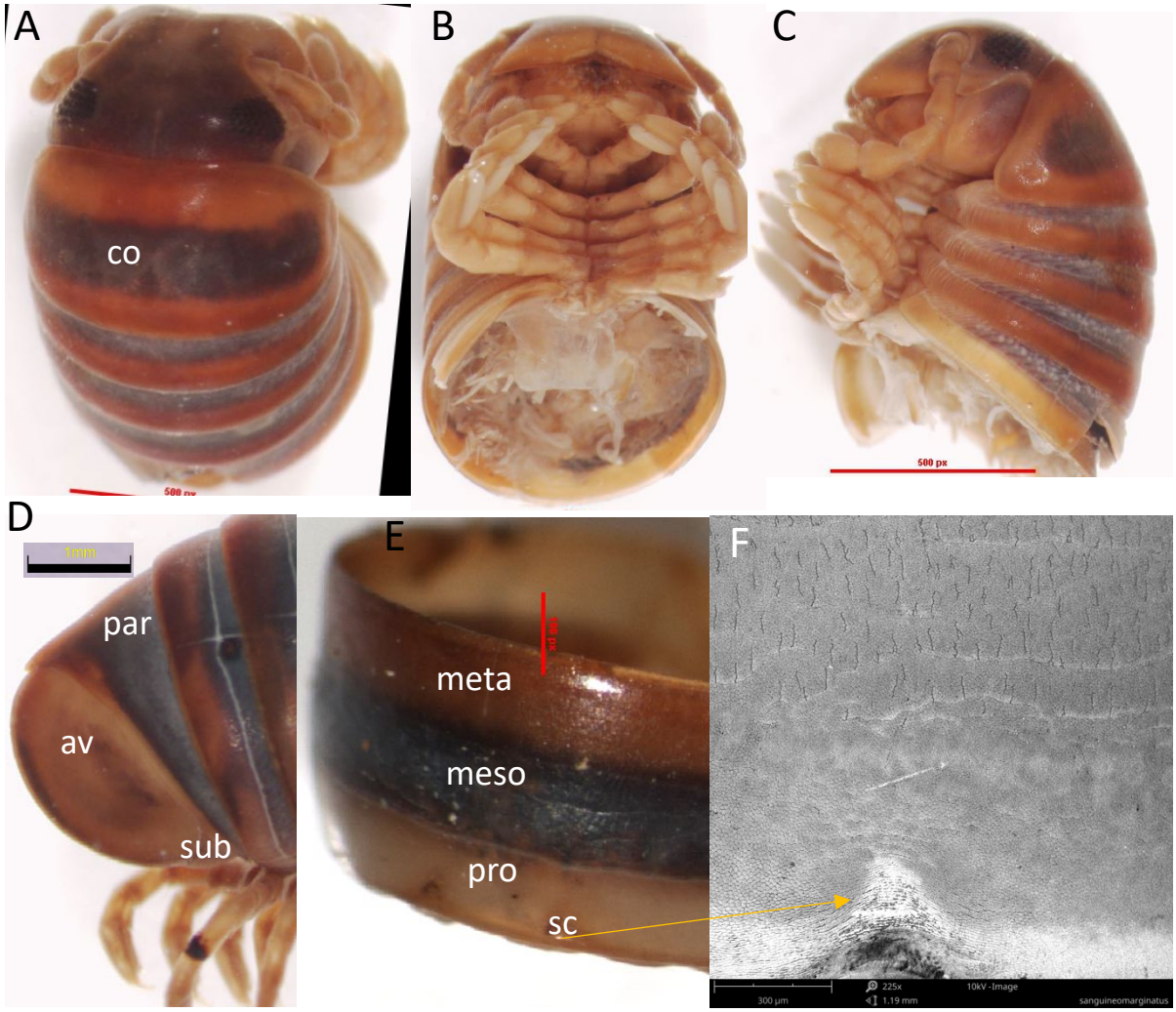

Figure 129: *Centrobolus sanguineomarginatus* (Heidelberg, Grootvadersbosch, Western Cape) ♂ (NMSA-15633). **A** anterior view of the head and collum, **B** ventral view, **C** lateral view, **D** terminal region of body, **E-F** body ring. Abbreviations: av - anal valve; co – collum; meso – mesozonite; meta – metazonite; par - preanal ring; pro – prozonite; sc - scobina. Scale bars: 1.0 mm (**A-E**); 0.3 mm (**F**).

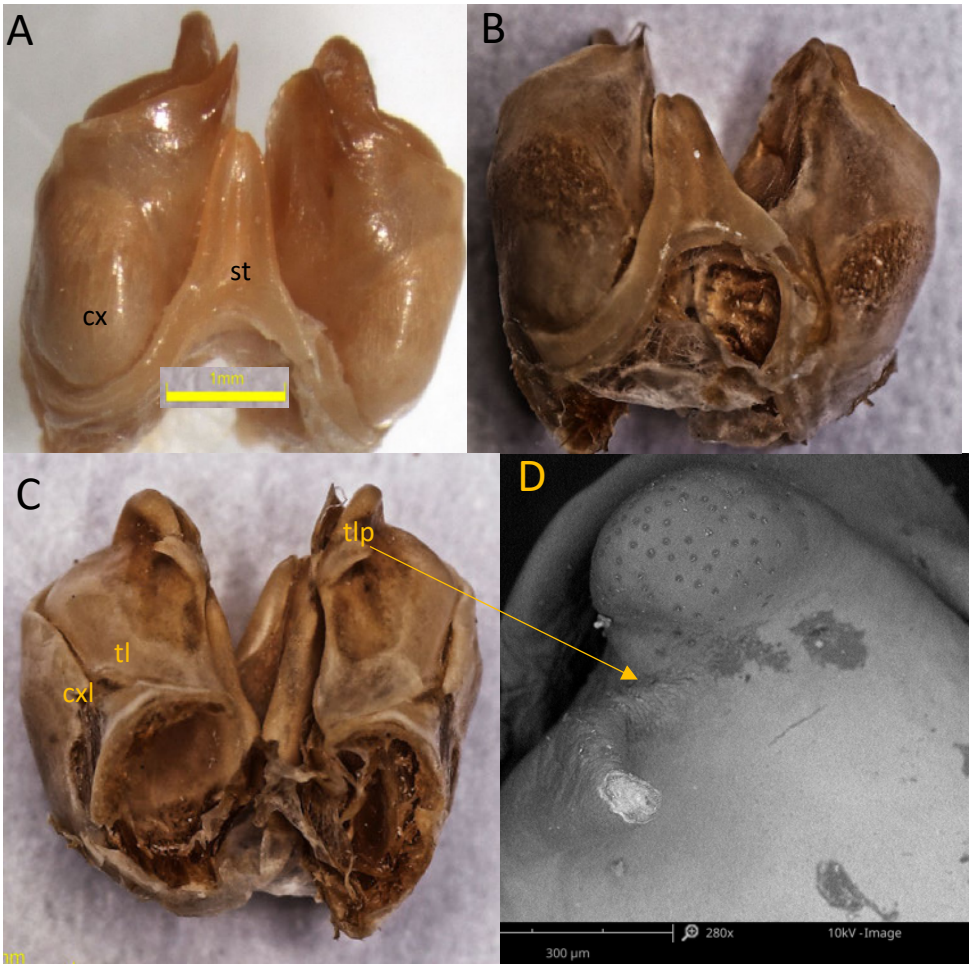

Figure 130: *Centrobolus sanguineomarginatus* ♂ (NM. 15633). **A-D** anterior gonopods; **A-B** anterior view, **C-D** posterior view. Abbreviations: cx – coxa; cxl - coxal endite lobe; st – sternum; tl – telopodite; tlp - telopodite process. Scale bars: 1.0 mm (**A-C**); 0.3 mm (**D**).

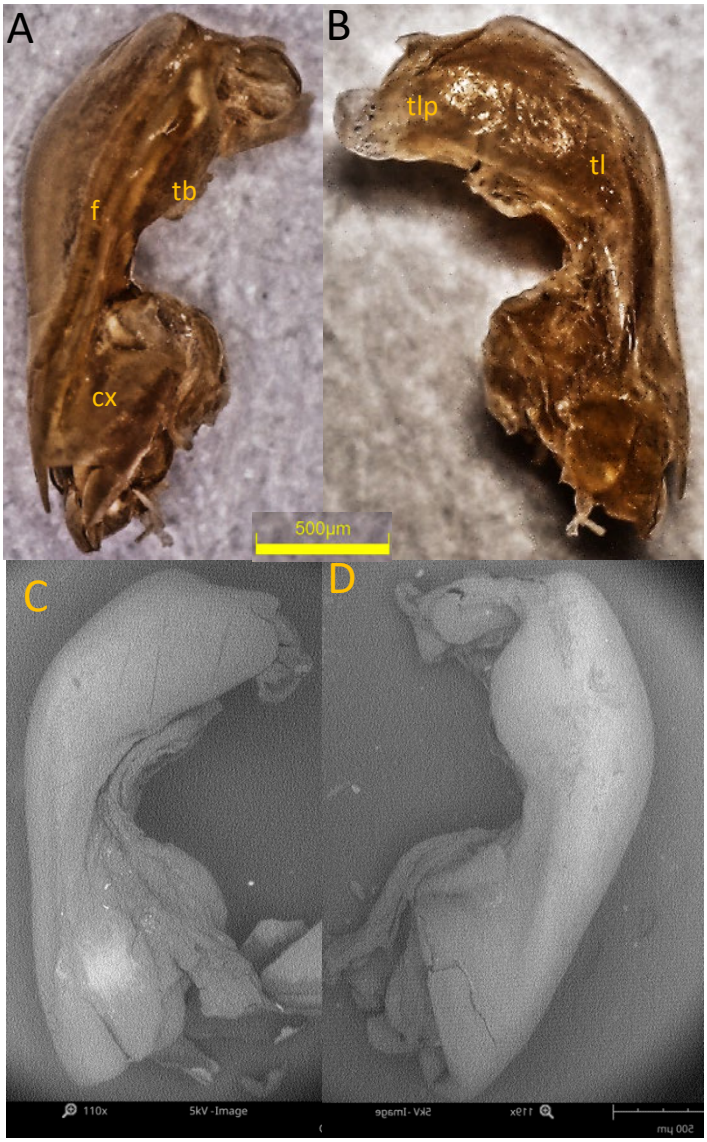

Figure 131: *Centrobolus sanguineomarginatus* ♂ (NMSA-15633). **A-D** posterior gonopod; **A** & **C** anterior view, **B** & **D** posterior view. Abbreviations: cx – coxa; f - efferent groove; tb - tibial process; tl – telopodite; tlp - telopodite process. Scale bars: 0.5 mm.

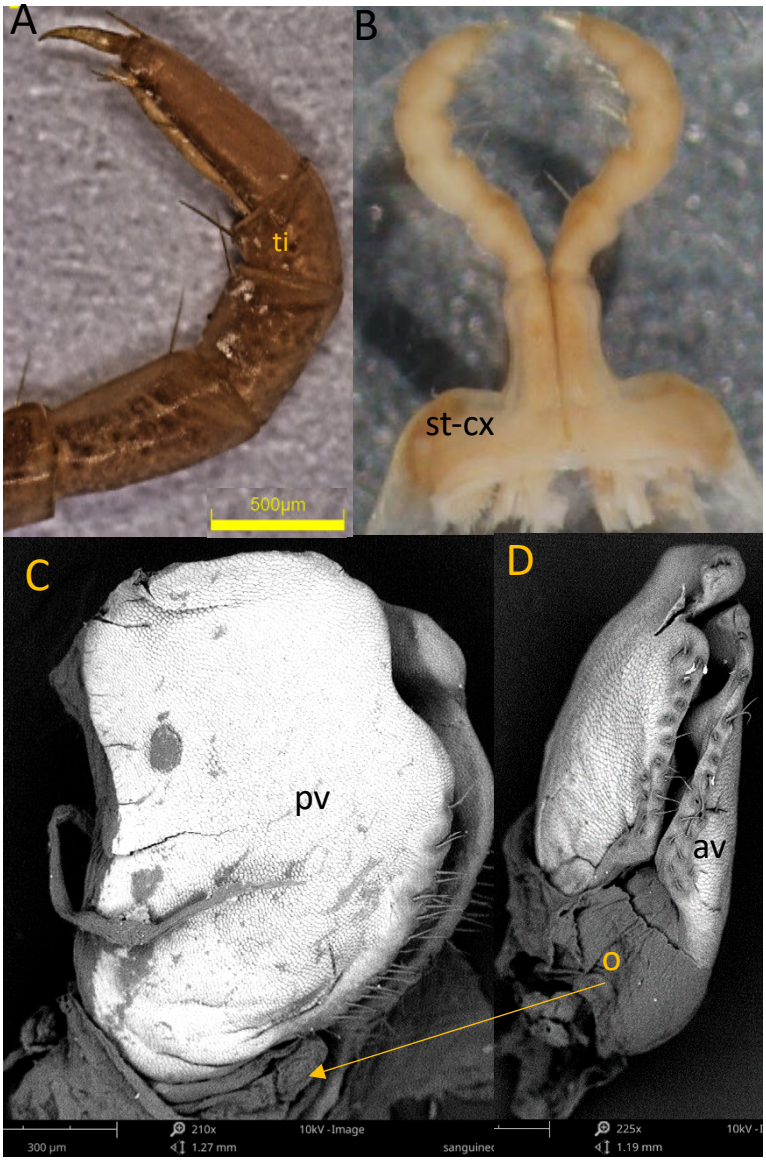

Figure 132: *Centrobolus sanguineomarginatus* ♀ (NMSA-15633). **A** male leg, **B** female second pair leg, **C-D** vulva, **D** lateral view, **C** posterior view. Abbreviations: av - anterior valve; o – operculum; pv - posterior valve; st-cx – coxosternite; ti - tibia. Scale bars: 0.5 mm (**A-B**); 0.3 mm (**C-D**).

***Centrobolus sanguinipes* (Lawrence, 1967)**

Figs 133-137

Hamer 1998: 42.

Chersastus sanguinipes Lawrence, 1967: 625.

Diagnosis. Differs from congeners in distal process of telopodite of anterior gonopods with a flattish lobe with uneven surface and scattered short setae and a hooked, tooth-shaped proximal part (Figs 135B-D); short, stout sternum, last 14 pairs of legs without tarsal pads, deep purple-black body, with reddish-orange head and antennae, and scarlet legs.

Redescription. *Measurements*: ♂ Total length 56mm, greatest width 5mm, 42+2 or 41+2 body segments n=6. ♀ Total length 60mm, greatest width 6.0mm, 42+2 body segments n=4.

Body sculpturing: Body smooth and shiny; scobinae present, large, distinct, and half-circle shaped (Figs 134E-F).

Legs: Legs fairly long, exceeding lateral margins of body rings when extended, with the first two and the last 14 pairs without tarsal pads in male; tibia condensed with two apical bristles (Fig. 137A).

Colour (after 24 years in ethanol): colour faded, description from Lawrence (1967). The body in general deep purple-black; head and antennae reddish orange (Figs 134A-C), legs bright scarlet (Fig. 134C), collum purple-black (Fig. 134A); body rings with deep purple-black metazonites, mesozonites purple black laterally and brownish medianly and prozonites brown (Fig. 134E); preanal ring and anal valves red with whitish coverage (Fig. 134D).

Gonopods: *Anterior gonopods*: sternum about a third the height of the coxae, and with blunt apex (Fig. 135A). Coxa with lateral margin slightly convex, distal part bent medianly at about 40° angle; apex bluntly rounded (Fig. 135A). Distal process of telopodite with two parts, the distal one a broad, laterally directed lobe with uneven surface, with scattered small setae; proximal part a slightly hooked, large tooth (Figs 135B-C).

Posterior gonopods: Tibial process broad and projecting outwards with seminal duct opening on its basal end; longitudinal efferent groove very well developed and runs along the lateral margin of telopodite; inflated basal lobe present; distal process of telopodite very broad and smoothly rounded (Fig. 136).

Female sexual characters: The second pair of legs with distal margin of lateral extensions of the coxosterna with prominent and bluntly triangular bulge. Vulva with anterior valve

overlapping the posterior one; both valves basally with two irregular rows of setae; operculum poorly sclerotized (Figs 137B-D).

Type locality: SOUTH AFRICA: *Eastern Cape*: Qolora River Mouth.

Type material (examined). Holotype: ♂ SOUTH AFRICA: Eastern Cape, Qolora River Mouth, 1962-01, Lawrence R.F. (NMSA-8247).

Material examined. SOUTH AFRICA: *KwaZulu-Natal*: 5♂ 4♀ Oribi Gorge Nature Reserve, 1995-11, Lucas D. (NMSA-15572).

Distribution. This species has only been recorded from one locality on the coast of the Eastern Cape and one on the southern KwaZulu-Natal coast.

Remarks. The sternum of the anterior gonopods of the holotype is missing hence Lawrence (1967) did not include this in his illustration.

Conservation assessment

This is a South African species described from the Eastern Cape in 1966. The two known localities are about 280 km apart, and it is likely that this species occurs in other river gorges along the east coast of South Africa, particularly between the two known localities, which is a poorly sampled area. Based on the limited number of records and the lack of collecting in the area, *C. sanguinipes* is considered as Data Deficient (DD).

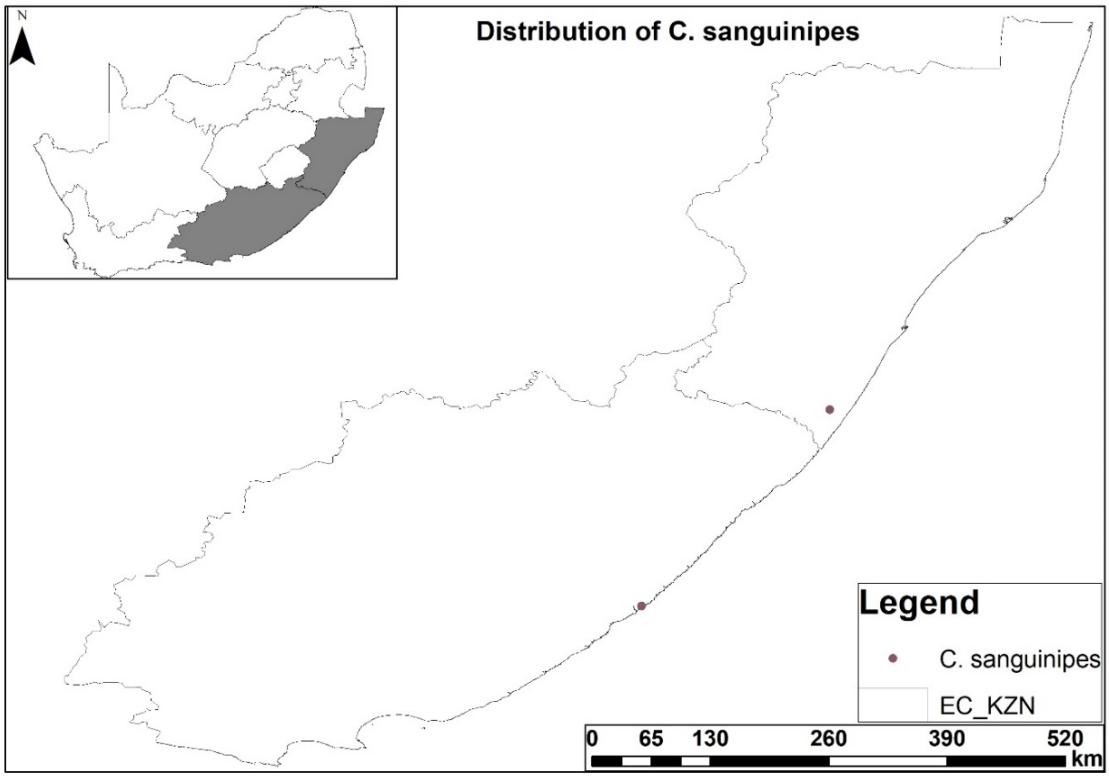

Figure 133: Distribution of *Centrobolus sanguinipes* in South Africa. EC= Eastern Cape, KZN= KwaZulu-Natal.

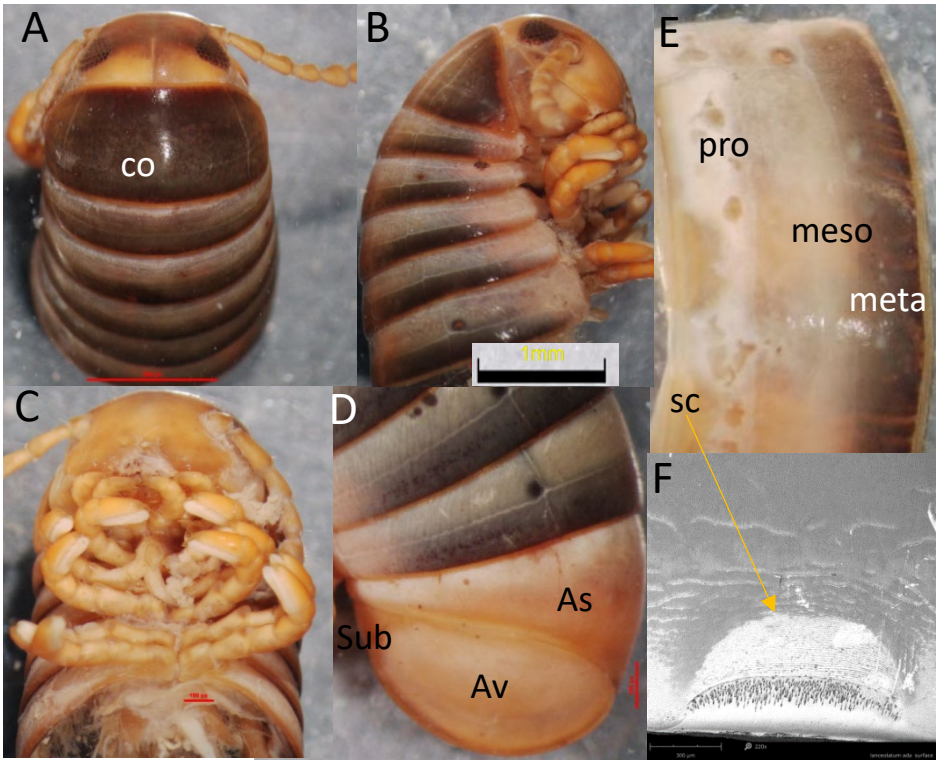

Figure 134: *Centrobolus sanguinipes* (Oribi Gorge Nature Reserve, KwaZulu-Natal) ♂ (NMSA-15572). **A** anterior view of the head and collum, **B** lateral view, **C** ventral view, **D** terminal region of body; **E-F** body ring. Abbreviations: av - anal valve; co – collum; meso – mesozonite; meta – metazonite; par – preanal ring; pro – prozonite; sc - scobina. Scale bars: 1.0 mm (**A-E**); 0.3 mm (**F**).

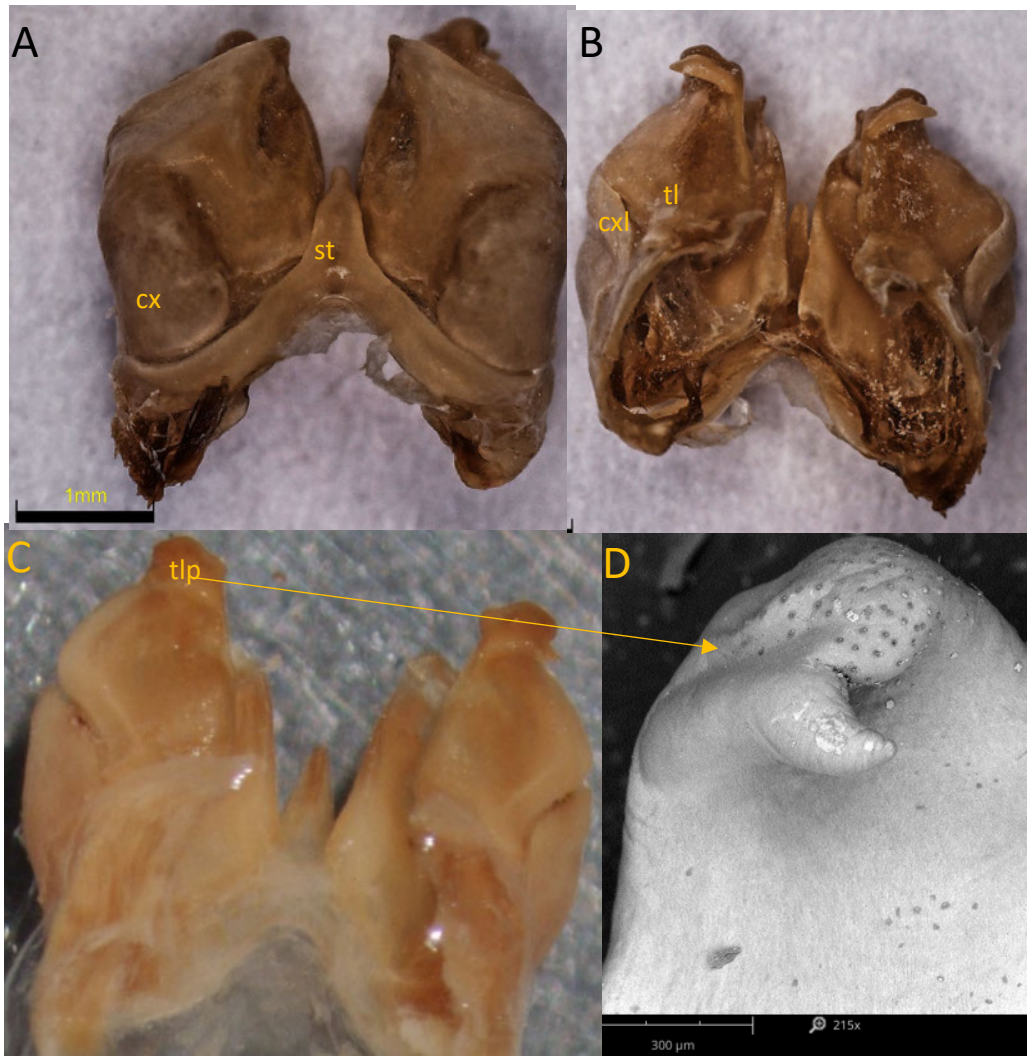

Figure 135: *Centrobolus sanguinipes* ♂ (NMSA-15572). **A-D** anterior gonopod; **A** anterior view, **B-D** posterior view. Abbreviations: cx – coxa; cxl- coxite endite lobes; st – sternum; tl – telopodite; tlp - telopodite process. Scale bars: 1.0 mm (**A-C**); 0.3 mm (**D**).

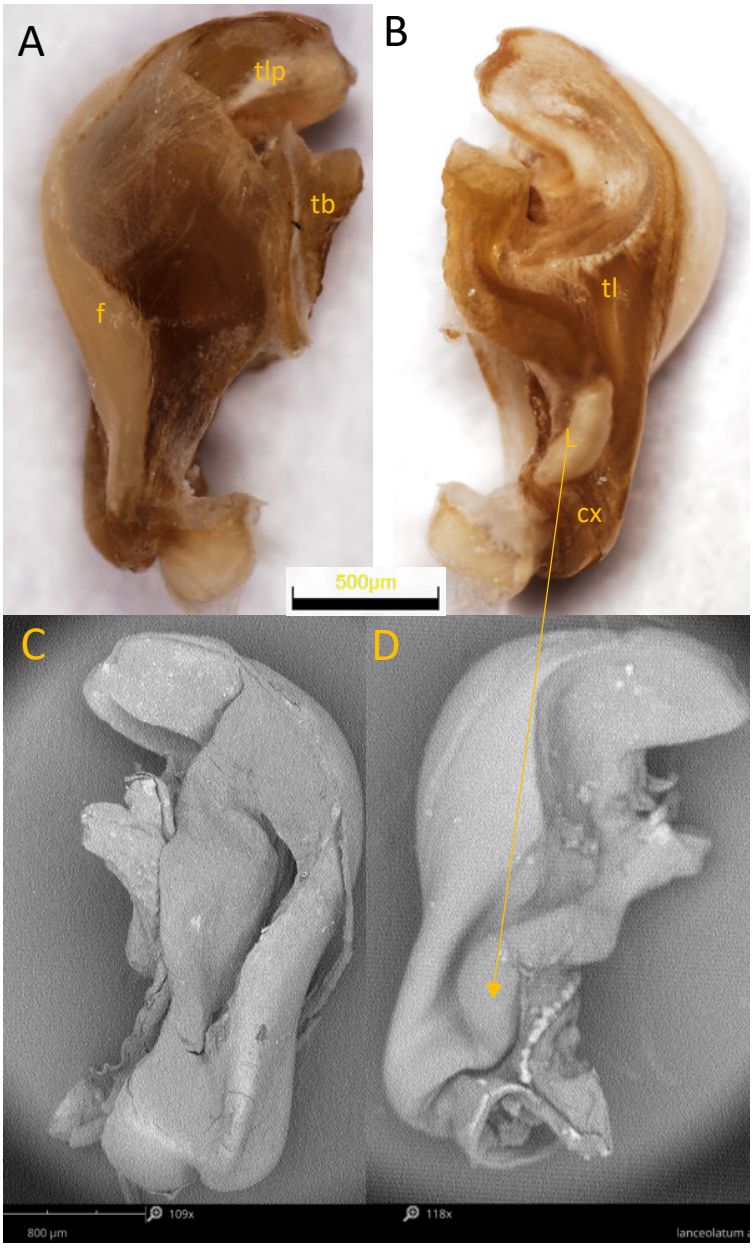

Figure 136: *Centrobolus sanguinipes* ♂ (NMSA-15572). **A-D** posterior gonopod; **A** & **C** posterior view, **B** & **D** anterior view. Abbreviations: cx – coxa; f - efferent groove; l – inflated basal lobe; tb - tibial process; tl – telopodite; tlp - telopodite process. Scale bars: 0.5 mm.

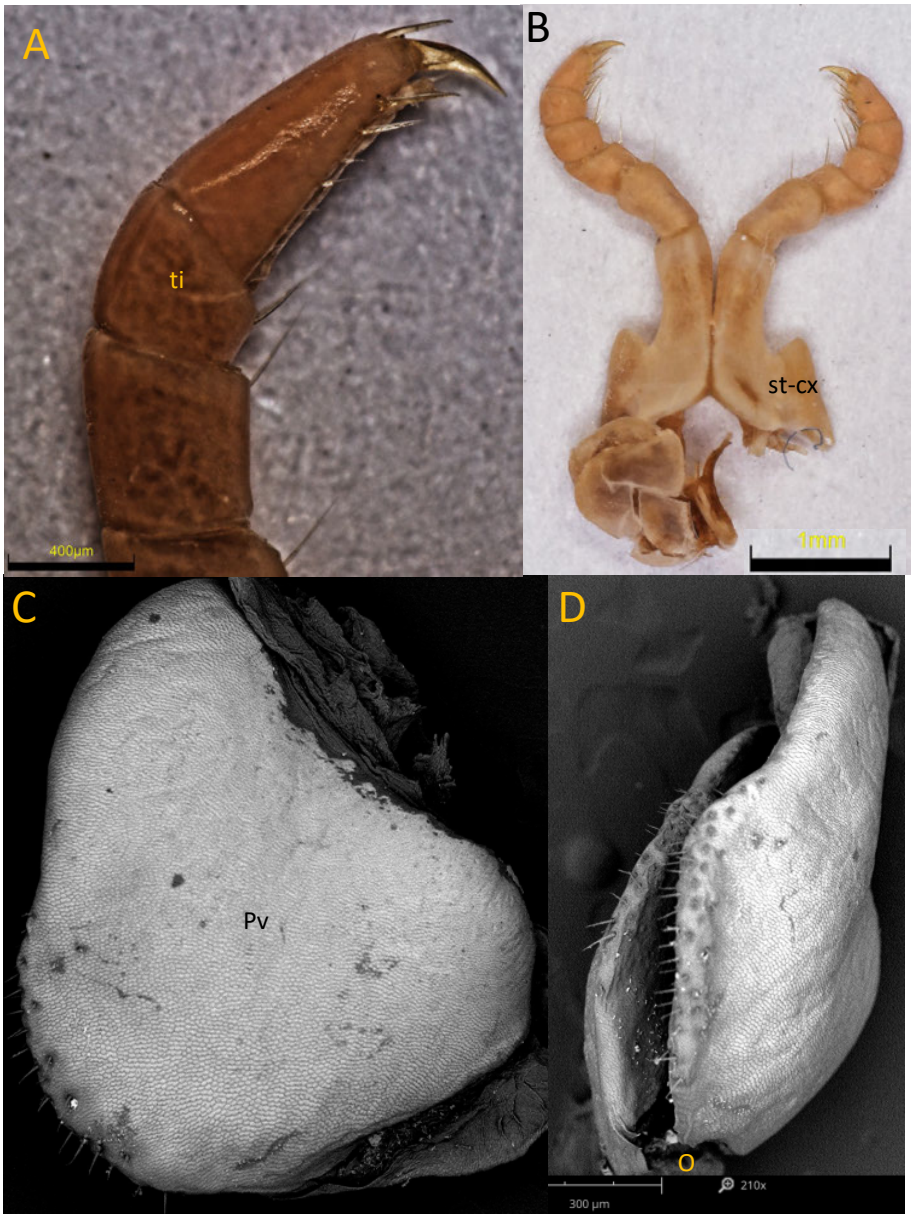

Figure 137: *Centrobolus sanguinipes* ♀ (NMSA-15572). **A** male leg, **B** female second pair leg, **C-D** vulva, **D** lateral view, **C** anterior view. Abbreviations: av - anterior valve; o – operculum; st-cx – coxosternite; ti –tibia. Scale bars: 0.4mm (**A**); 1.0 mm (**B**); 0.3 mm (**C-D**).

***Centrobolus saussarii* (Porat, 1872)**

Fig. 138

Hamer 1998: 40; Hoffman 1971: 162.

Spirobolus falcatus Voges, 1871; Hoffman 1971: 162.

Spirobolus saussarii Porat, 1872: 20; Attems 1928: 309; Jeekel 1956: 95.

Chersastus saussarii Schubart 1966: 50.

Description. Original description by Porat (1872) translated using Google Translate with additional description of gonopods, legs, scobinae from Hoffman (1971): ♂ Total length 62mm, greatest width 6.0mm, 43+0+Tbody rings.

Body sculpturing: Eyes with 45 ommatidia; scobinae absent.

Legs: All legs of male except the first two pairs with large tarsal pads.

Colour: Head olive-green; anal valve reddish.

Gonopods: Distal process of anterior gonopods a longitudinal, almost rectangular structure. Distal process of posterior gonopod telopodite pointed.

Type material (not examined): 12 syntypes, 1 ♂ lectotype, "Caffraria", 1840-45, J.A. Wahlberg (NRMS).

Remarks. Hoffman (1971) stated that there were 12 syntypes in the Naturhistorisches Museum, Stockholm, and he designated a male as lectotype for the species. He also synonymised *Spirobolus falcatus* with this species. The distribution was given as "Caffraria" which means that is not possible to know the precise locality of this species, which would allow collection of additional material. The exact type locality is in the Eastern Cape. Hoffman (1971) highlighted the similarity of the anterior gonopods of this species and those of *C. litoralis*, but the posterior gonopods of the two species do distinguish them. The anterior gonopods of *C. saussarii* are also similar to those of *C. lugubris*, but it appears that the posterior gonopods are different, but this would need to be checked by examining material.

Conservation assessment.

This species is Data Deficient (DD) because of the lack of certainty about its taxonomic status and distribution.

Figure 138: Anterior, posterior and male leg of *Centrobolus saussarii* drawn by Hoffman (1971) from lectotype specimen.

***Centrobolus silvanus* (Attems, 1928)**

Figs 139-143

Hamer 1998: 42.

Chersastus silvanus Attems, 1928: 305; Jeekel 1956: 90-92; Schubart 1966: 54-56.

Diagnosis. Differs from congeners in distal process of telopodite with two parts, distal part small and wedge-shaped, proximal part large, thick, finger-shaped and projecting laterally (Figs 141C-D). Last 10-12 pairs of legs without tarsal pads. Vulva with anterior valve distal margin extended to form narrow extension.

Redescription. *Measurements*: ♂ Total length 47mm, greatest width 4.5mm, 43+0+T body rings, n=5. ♀ Total length 53mm, greatest width 5.5mm, 43+0+T body rings, n=9.

Body sculpturing: Body shiny and smooth with minute punctuation and longitudinal parallel striae; scobinae present but small; anal valve with minute punctuation (Figs 140E-F).

Legs: Legs very long (male legs longer than female); all legs with tarsal pads except the first two and the last 10-12 pairs in male; tibia standard length and width with one apical bristle (Fig. 143A).

Colour (after 117 years in ethanol) actual colour taken from Attems (1928): The body in general black or brown with red paramedian spots; head reddish with black band in the middle, with a red spot under each eye; antennae, legs and anal valves reddish or yellowish (Figs 140A-D); preanal ring black with red spots or bands (Fig. 140D); collum black with paramedian red longitudinal stripes (Fig. 140A); body rings with metazonites, mesozonites and prozonites black with red paramedian spots, forming paramedian red stripes along the body (Fig. 140E).

Gonopods: *Anterior gonopods*: Sternum of the anterior gonopods robust, with median extension broadly triangular, long, reaching more than half the height of coxae, blunt apex (Figs 141A-B). Distal process of telopodite with two parts, distal one relatively small, triangular and inflated; proximal part prominent, finger-shaped and laterally directed (Figs 141C-D).

Posterior gonopods: Tibial processes short and broad with seminal duct opening at the proximal base; efferent groove running along lateral margin and weakly developed; inflated lobe absent; coxa completely fused with the telopodite; distal processes of the telopodite smoothly rounded with broad attached lamellae (Fig. 142).

Female sexual characters: Vulva with anterior valve with distal margin with long, narrow extension and overlapping posterior valve; both valves basally with two short and irregular rows of setae; operculum poorly sclerotized (Figs 143B-C).

Type locality: SOUTH AFRICA: *Western Cape*: Knysna Forest.

Type material (examined). Syntypes: 1♂ 2♀ 6 juveniles SOUTH AFRICA: Western Cape, Knysna Forest, 1896-03, Purcell F. (SAM-ENW-X001547).

Other material examined. SOUTH AFRICA: *Eastern Cape*: 1♀ East London, 1905-09, Purcell F.W. (SAM-ENW-A002390). *Western Cape*: 1♂ Pacaltsdorp, George, 1902, Leipoldt L. (SAM-ENW-X007396); 1♂ Keurboom River near Knysna, 1931-01, Barnard K.H. (SAM-ENW-B007709); 1♂ Wilderness, George, 1931-08, Haughton T. (SAM-ENW-B007956); 1♂ 2♀ Groot Brak (River) Valley Cape, 1986-03, Macpherson M. & Roux A. (SAM-ENW-C002947); 4♀ 1 juvenile Knysna, 1929-02, Hesse A.J. (SAM-ENW-B007464).

Distribution. This species has been recorded from a restricted part of the coastal region of the south Western Cape province. The one Eastern Cape locality cannot be confirmed until a male specimen is available, and it does seem unlikely that *C. silvanus* occurs as far as north as East London.

Conservation Assessment

This is a South African species described from Western Cape in 1928. The species has been recorded from restricted part of the Western Cape coast, where there are large forests, but it was last collected 90 years ago, and because the localities are not very specific it is not possible to be certain about the habitat. The area has not been surveyed for millipedes recently, and so it is possible that *C. silvanus* is still present in the southern Cape coastal region. Unfortunately the locality data for all the specimens recorded are not very detailed and so it is difficult to know the habitat or assess the threats accurately.

The possible threats include loss of habitat due to housing and small scale agricultural developments, commercial agriculture including timber, alien invasive plant species, and large, uncontrolled fires. There are protected areas that include forest in the region and is it is possible that *C. silvanus* is protected in these.

The EOO is estimated as 2 500 km² but it is not possible to estimate the AOO without information about habitat. The number of locations is four, but there may be more. *Centrobolus silvanus* is therefore considered as Data Deficient (DD) on the basis of distribution and habitat data, and the lack of recent records.

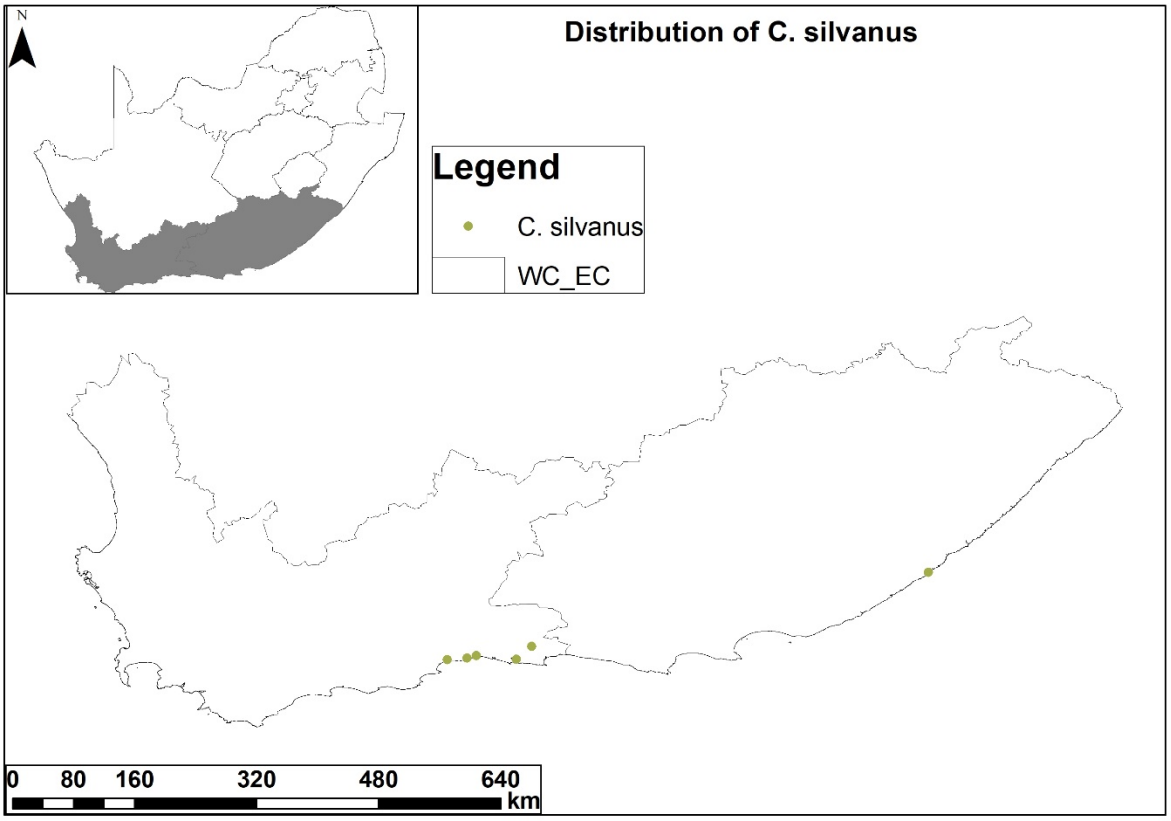

Figure 139: Distribution of *Centrobolus silvanus* in South Africa. WC= Western Cape, EC= Eastern Cape.

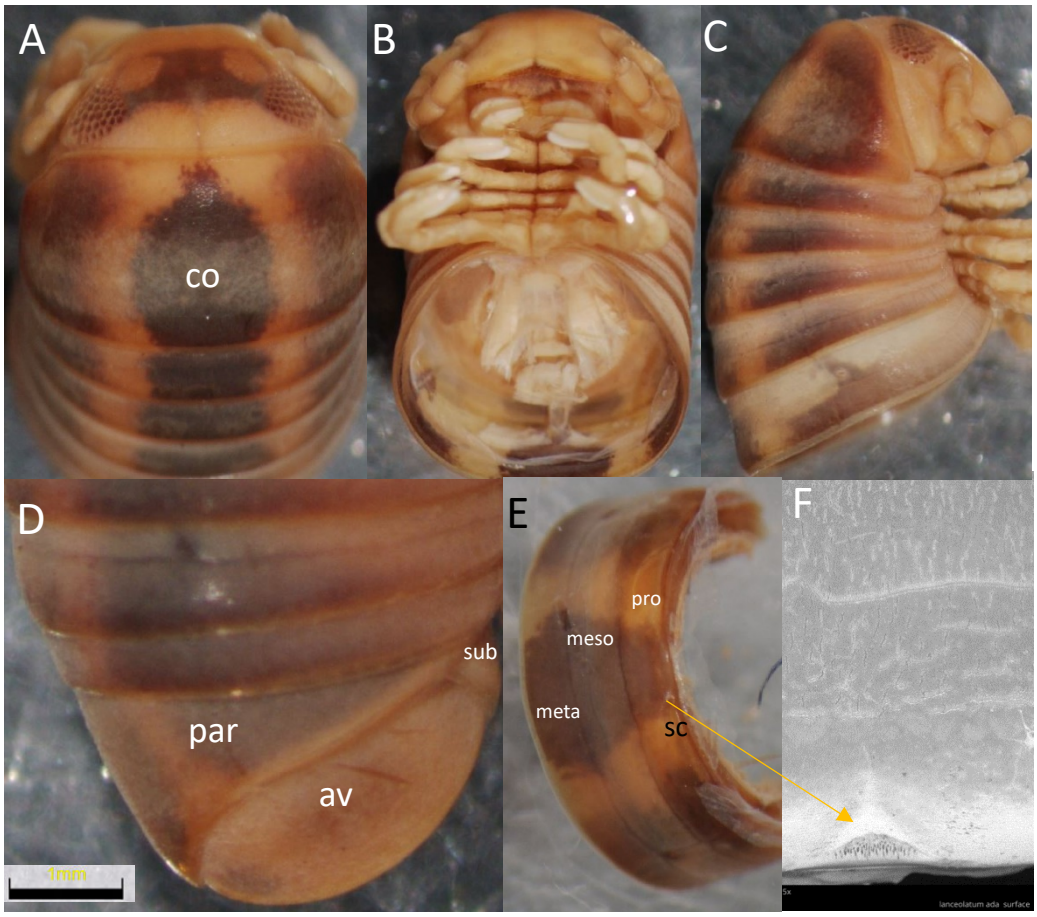

Figure 140: *Centrobolus silvanus* (Pacaltsdorp, George, Western Cape) ♂ (SAM-ENW-X007396). **A** anterior view of the head and collum, **B** ventral view, **C** lateral, **D** terminal region of body, **E-F** body ring. Abbreviations: av - anal valve; co – collum; meso – mesozonite; meta – metazonite; par - preanal ring; pro – prozonite; sc - scobina. Scale bars: 1.0 mm (**A-E**); 0.3 mm (**F**).

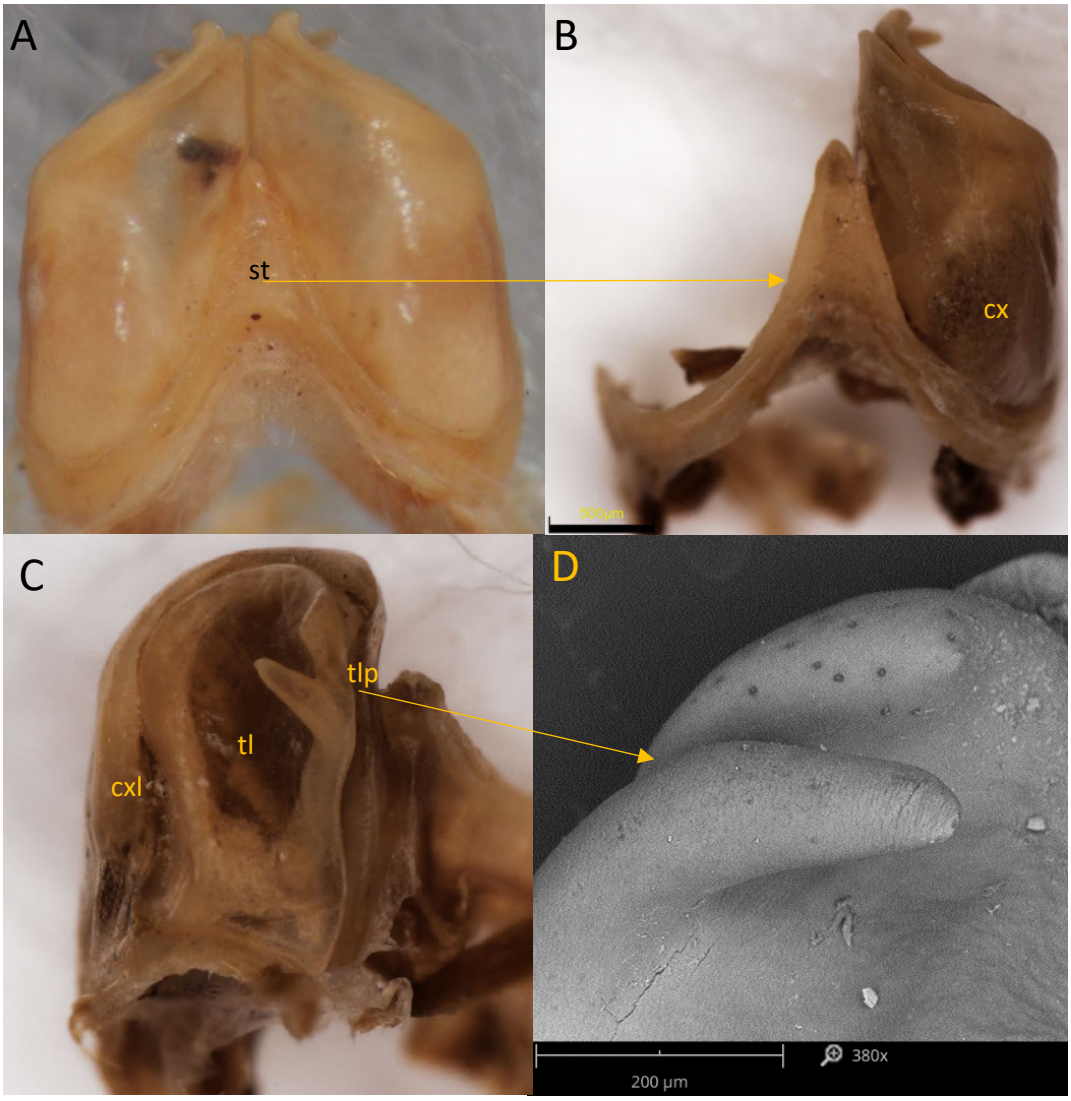

Figure 141: *Centrobolus silvanus* ♂ (SAM-ENW-X007396). **A-D** anterior gonopods; **A-B** anterior view, **C-D** posterior view. Abbreviations: cx – coxa; st – sternum; tl – telopodite; tlp - telopodite process. Scale bars: 0.5 mm (**A-C**); 0.2 mm (**D**).

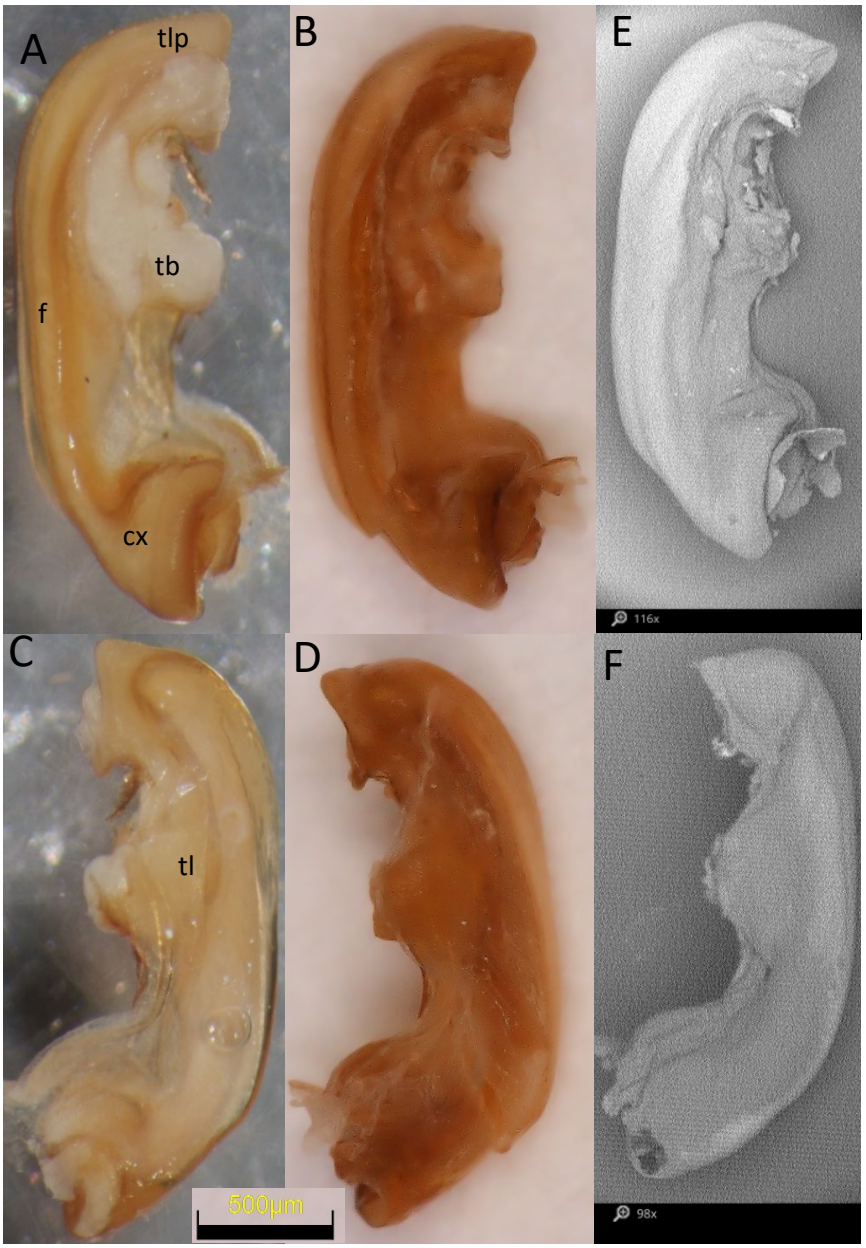

Figure 142: *Centrobolus silvanus* ♂ (SAM-ENW-X007396). **A-F** posterior gonopod; **A**, **B** & **E** anterior view, **C, D** & **F** anterior view. Abbreviations: cx – coxa; f - efferent groove; tb - tibial process; tl – telopodite; tlp - telopodite process. Scale bars: 0.5 mm.

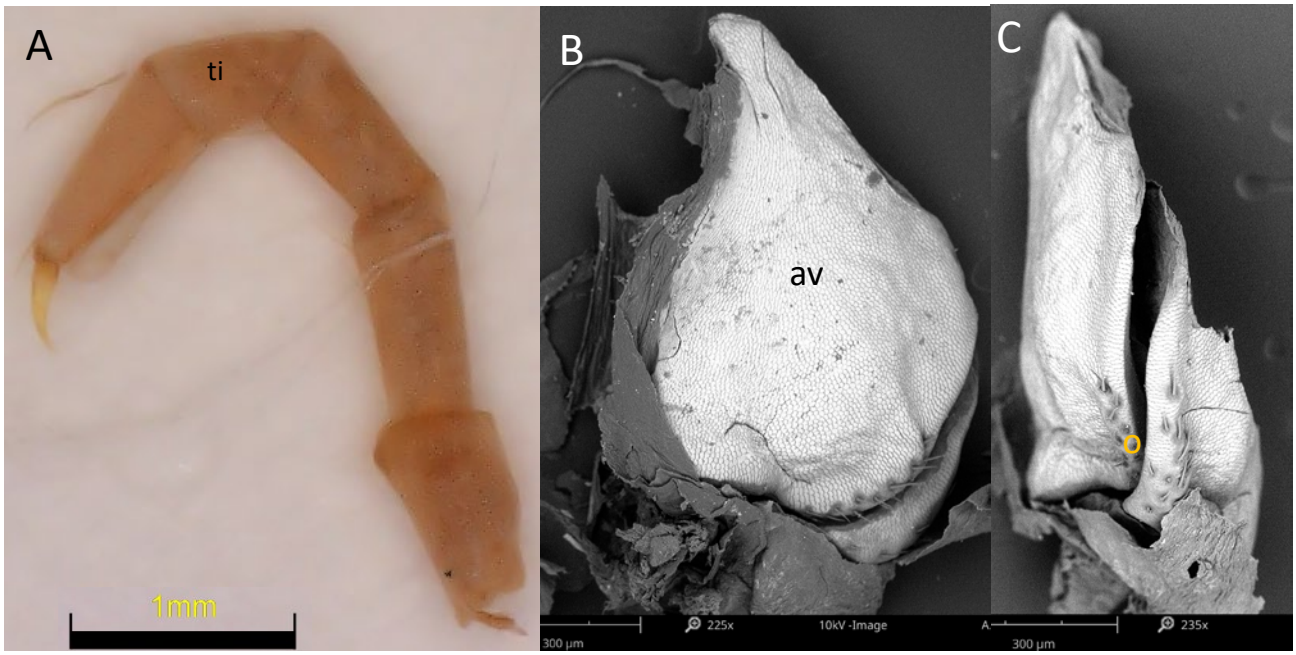

Figure 143: *Centrobolus silvanus* ♀ (SAM-ENW-X007396). **A** male leg, **B-C** vulva, **B** anterior view, **C** lateral view. Abbreviations: av - anterior valve; o – operculum; ti –tibia. Scale bars: 0.3 mm.

***Centrobolus splendidus* (Attems, 1928)**

Figs 144-146

Hamer 1998: 42.

Chersastus splendidus Attems, 1928: 303-304; Schubart 1966: 47-48.

Description. Original description by Attems (1928): *Body sculpturing*: scobinae absent; the metazonites and the free part of the prozonites very finely wrinkled, leather-like; the sulci of the prozonites and metazonites, the position of the pore, and the transverse sulcus like that of *C. vulpinus*; behind the pore a sharp furrow not touching the posterior margin; the medial margin of the anal valves not thickened; the anal scale nearly truncate; the dorsal angle blunt. The sternites with some sharp cross furrows in the anterior part.

Legs: All legs with tarsal pads.

Colour: Head and collum dark red; the dorsum of the prozonites light red with a median black spot; the dorsum of the metazonites blackish up to the line of the pores; in the last third of the body the darkening spreads beyond the pores; the sides and the underside of the prozonites and metazonites dark red; antennae and legs reddish-brown; the tip of the tarsus and the pad yellow.

Gonopods: *Anterior gonopods*: Sternum of the anterior gonopods broadly rounded and relatively long, reaching nearly to the tip of the anterior gonopods; the basal joint of the gonopod has a distinct shoulder, and becomes a blunt cone distally from the shoulder; the distal joint is broadly rounded and bears near the tip a triangular lappet directed laterally; the tip is somewhat swollen and perforated by small pores; no hairs (Fig. 144).

Posterior gonopods: The sternite of the posterior gonopods is a broad V with blunt angle; the base of the gonopod surpasses the sternite with a thickly chitinised blunt lappet. The telopodite is well defined; the base is narrowed; the prostate canal runs to a broad, short lappet; the tip is broadly rounded (Fig. 145).

Type locality: MOZAMBIQUE: Masiene, Chai Chai, (6034).

Type material (examined): Holotype: 1♂ MOZAMBIQUE: Masiene, Chai Chai, (SAM-ENW-B06034, SAMC).

Remarks. The gonopods of the type specimen on loan from Iziko Museum are missing and there is no additional material of this species. The colour is completely lost from the material examined. The gonopods were redrawn from the original illustration by Attems (1928), but these are not very detailed.

Conservation assessment

Centrobolus splendidus is known only from one specimen, and there is no information about the habitat or exact locality. Xai Xai (=Chai Chai) is a coastal city in southern Mozambique that has been hit by repeated tropical storms in 2000, 2013, 2015 and in 2021, resulting in severe floods. Soil dwelling organisms such as millipedes would have been impacted by flood waters which take weeks to drain. Habitat may also have been lost or altered as a result of flooding, and the area of Xai Xai is very densely populated, with housing and subsistence farming have transformed most of the surrounding habitat. However, without more data on this species, it can only be categorised as Data Deficient (DD).

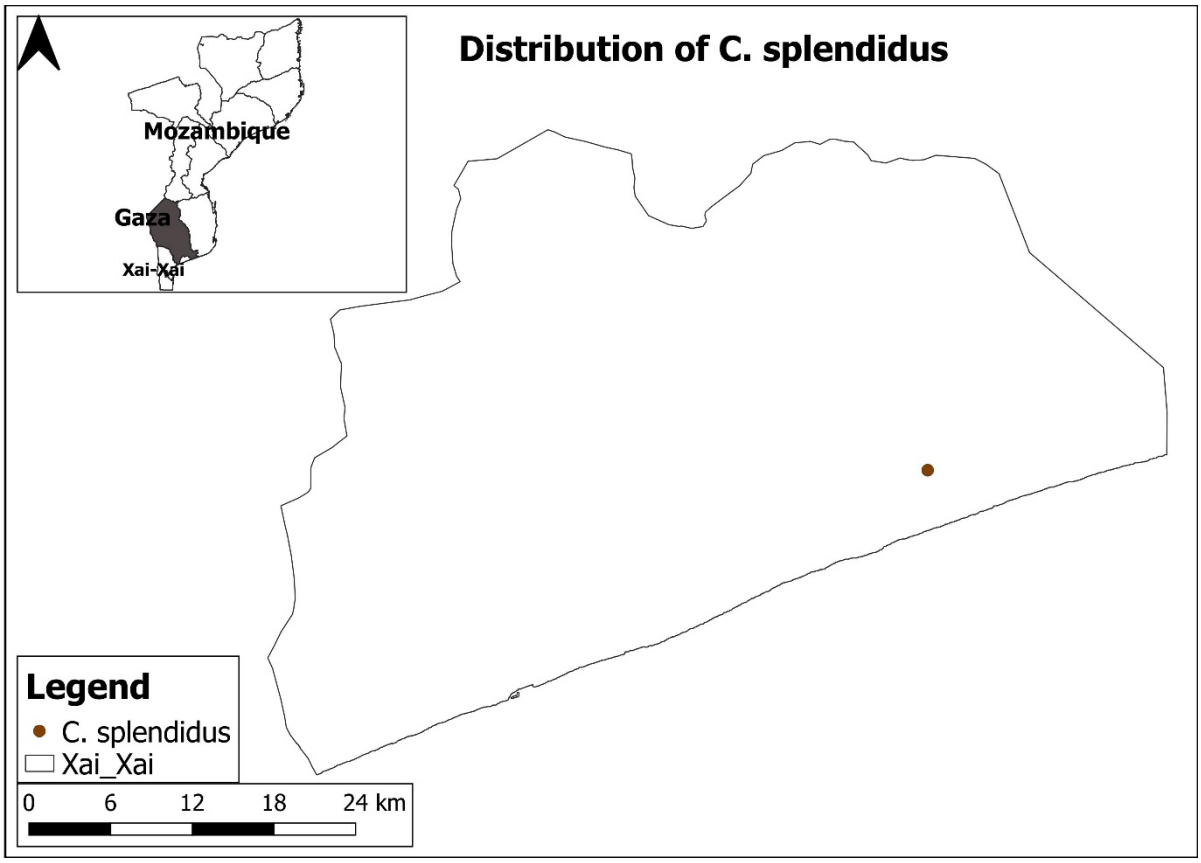

Figure 144: Distribution of *Centrobolus splendidus* in Mozambique.

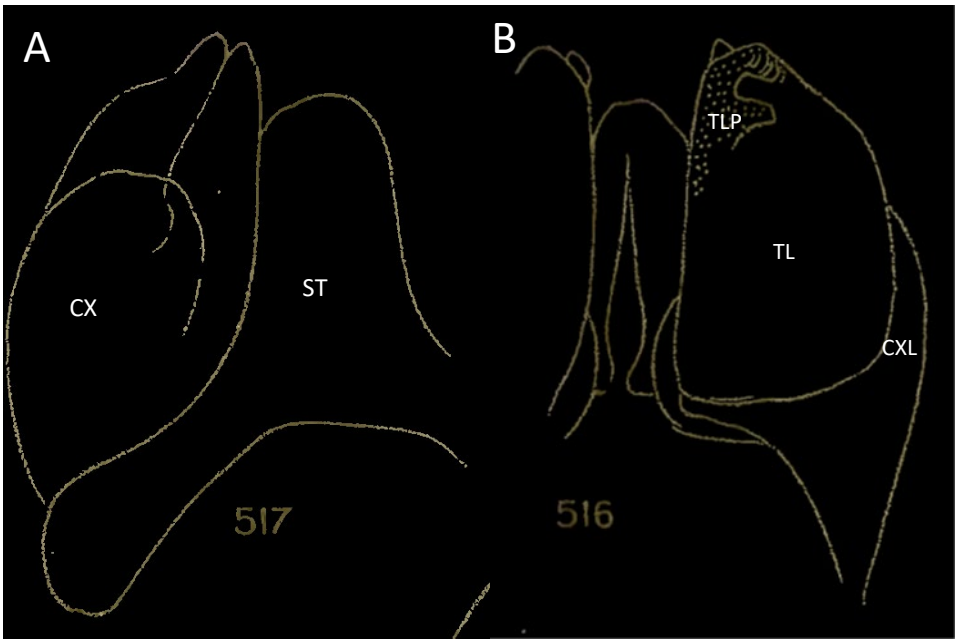

Figure 145: Anterior gonopods of *C. splendidus*. **A** anterior view, **B** posterior view. Abbreviations: cx – coxa; cxl - coxal lobe; st – sternum; tlp – telopodite process; tl – telopodite. Illustrations are from the original description by Attems (1928).

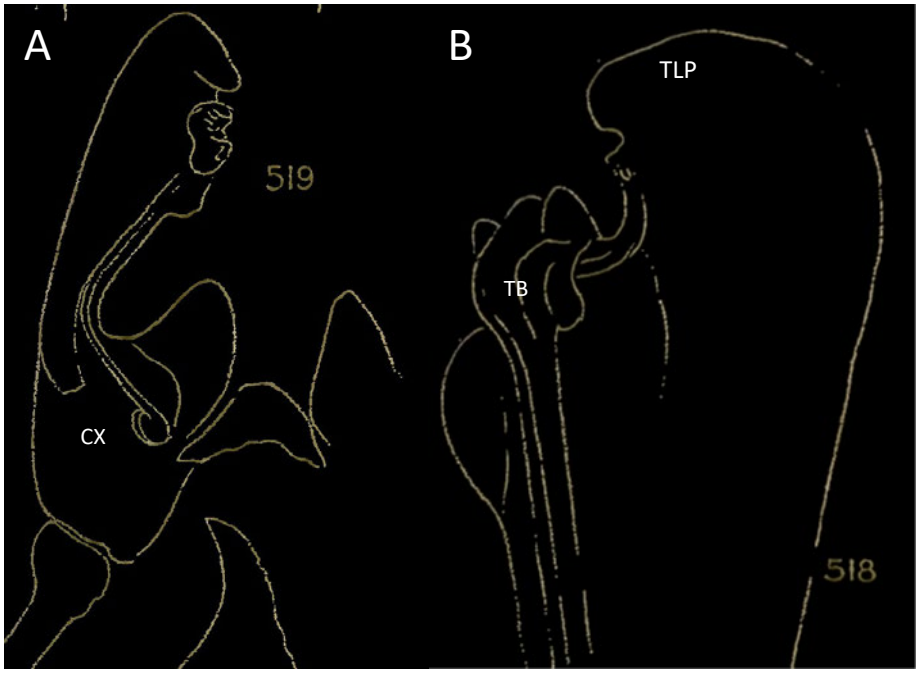

Figure 146: Posterior gonopods of *C. splendidus*. **A** anterior view, **B** posterior view. Abbreviations: cx – coxa; tb – tibial process; tlp – telopodite process; sd - seminal duct. Illustrations are from the original description by Attems (1928).

***Centrobolus strigosus* (Porat, 1872)**

Hamer 1998: 42.

Spirobolus strigosus Porat, 1872: 17-18; Attems 1928: 309; Jeekel 1956: 95.

Chersastus strigosus Schubart 1966: 65.

Description. Description translated from Porat (1872) using Google Translate: ♀ Total length 52mm, greatest width 6.5mm, 43 body segments.

Body sculpturing: eyes with 45 ommatidia; striations concentric and longer.

Colour: head black with the edge of clypeus yellow; body rings with reddish mesozonites and pale prozonites and metazonites black dorsally with two longitudinal rows of small reddish spots. Antennae and legs ferruginous.

Types: Porat (1872) did not designate a type specimen but provided some information about the locality (Caffraria) and collector (Wahlberg).

Remarks. The description of this species was based on a female specimen and no illustration was provided. The locality for the material described was stated only as "Caffraria". For these reasons, this species is considered *incertae sedis* (Attems 1928; Hoffman 1971).

Conservation assessment

This species is Data Deficient (DD) on the basis of the uncertain status.

***Centrobolus striolatus* (Attems, 1934)**

Hamer 1998: 42.

Chersastus striolatus Attems, 1934: 479-480; Schubart 1966: 44; Lawrence 1967: 634.

Description. Description from Attems (1934): ♀ Total length 68mm, greatest width 6.8mm, 43 body rings.

Body sculpturing: striations concentric and longer.

Colour: description from Lawrence (1967): "antennae blackish; legs dark brown, the tarsi yellow; body rings with very sharply defined transverse banding, metazonites dorsally uniformly deep black". Description from Schubart (1966): collum yellow; head grey-brown.

Type material (not examined): SOUTH AFRICA: *Eastern Cape*: 1♀ Needs Camp, 20 miles W East London, Port St Johns, (SAMC).

Remarks. With extensive field work conducted in the past in the type locality of species, no further female or male of this has ever been obtained. For these reasons, this species is considered *incertae sedis*.

Conservation assessment

This species is Data Deficient (DD) on the basis of the uncertain status.

***Centrobolus titanophilus* (Schubart, 1966)**

Figs 147-148

Hamer 1998: 42.

Chersastus titanophilus Schubart, 1966: 62-65.

Diagnosis. Diagnosis and description modified and translated from Schubart (1966) using Google Translate, with additional details added from illustrations of gonopods in the original description: Banded grey-brown species of the genus *Chersastus*, with two paramedian, not very clear patches, slight puncturing on the metazonites and more developed long striations on the lower margins.

Description. *Measurement*: ♂ Total length 27-28mm, greatest width 4.0-4.1mm, 45+0+T, 44+0+T body rings, n=3. ♀ Total length 25-33mm, greatest width 3.9-4.6mm, 45+0+T, 44+0+T body rings, n=5. Juv total length 8-22mm, greatest width 1.5-3.8mm, 45+0+T, and 27+5+T body rings.

Body sculpturing: scobinae absent (Fig. 146); prozonites with fine transverse striations, mesozonites with fine minute punctuation and with oblique striations on the margins, metazonites with long striations on the lower margins and with short, fine minute punctuation; preanal ring with irregular transverse striation, anal valves with a wide, slightly budged edge.

Legs: all legs with tarsal pads.

Colour: the body in general grey-brown with two paramedian red-yellow spots, head brown and brownish-yellow to the clypeus and labrum; antennae and legs brownish-yellow, collum dark brown with lightened brown sides and narrow brown edged front, body rings with pale yellowish prozonites, mesozonites grey-brownish and metazonites dark brown and light brown on the lower margins; preanal ring dark brown and anal valves lighter with a brown-yellow border.

Gonopods: *Anterior gonopods*: sternum short, narrow and protruding medianly with smoothly rounded apex. Coxa not prominent and apically broad bending at approximately 45° angle. Distal process of telopodite with two parts, apical part small and narrow, and proximal part very small finger-like process directed downwards (Fig. 148A).

Posterior gonopods: Tibial process long, truncated and only slightly protruding, not very prominent; seminal duct opens on its distal end. Efferent groove broad and runs parallel to the

outer edges of the telopodite. Inflated basal lobe present and roundish to oval shaped. Telopodite distally with membranous sheet narrow and slightly bulged in the middle (Fig. 148B).

Material (not examined). Holotype: SOUTH AFRICA: *Western Cape*: 1♂ De Hoop Vlei, 20 miles ENE Bredasdorp, on steep slope of limestone hill, 1951-01, (MZLU).

Paratypes: 3♂ 10 juveniles same data as holotype; 1♀ Maanschijnkop, seven miles east of Hermanus, under stones and rotten logs in shaded ravine, 1950-12, (SSAE, loc. No. 93).

Distribution: This species has only been recorded from two localities separated by about 85km in the southern part of the Western Cape. Confirmation of the Maanschijnkop specimen's identity is not possible because it is a female.

Remarks. There are no specimens of this species in South African museums and the type material is deposited at the Zoological Museum of Lund in Schubart's collection.

The sternum of the anterior gonopods of this species is similar to that of *C. litoralis* however the two species differ slightly in the posterior gonopods and the distal process of telopodite.

Conservation assessment

Centrobolus titanophilus is known only from two localities, one of which cannot be confirmed because only one female specimen has been collected there. Habitat data are not available. Most of the Western Cape has not been well surveyed for millipedes. For these reasons, this species is categorised as Data Deficient (DD).

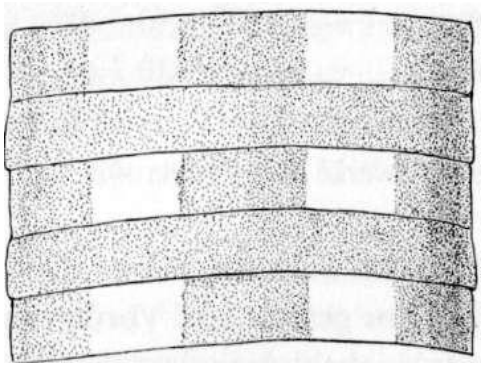

Figure 147: *Centrobolus silvanus* ♂. Body ring, from Schubart (1966).

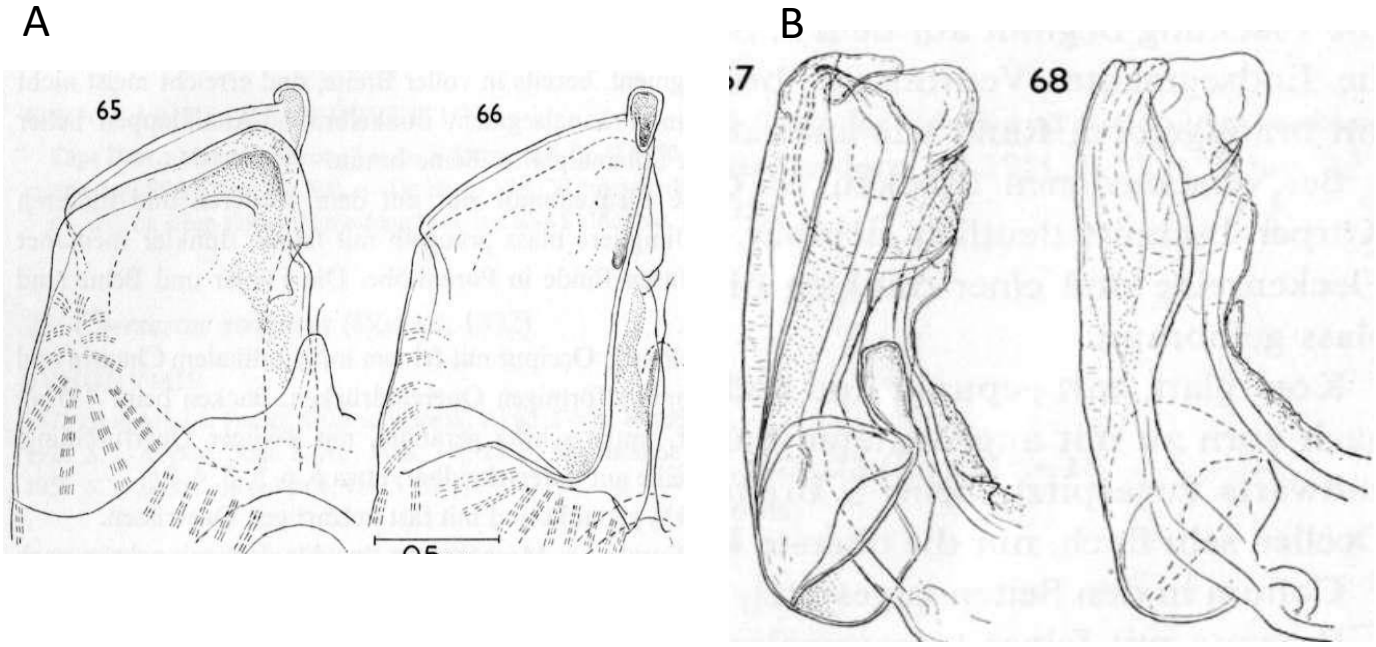

Figure 148: *Centrobolus silvanus* ♂. A anterior gonopods, B posterior gonopods, from Schubart (1966).

***Centrobolus transvaalicus* (Lawrence, 1967)**

Figs 149-153

Hamer 1998: 43.

Chersastus transvaalicus Lawrence, 1967: 618.

Diagnosis. Differs from congeners in distal process of the telopodite of anterior gonopods, which has one simple, triangular part (Figs 151C-E); sternum with median extension very short and broad; scobinae triangular; male legs with tarsal pads on all except the first two pairs.

Redescription. Modified from Lawrence (1967): *Measurements*: ♂ Total length 35-45mm, greatest width 4.2-5.0, 41+0+T body rings, n=12. ♀ Total length 26-32mm, greatest width 3.9-4.4mm, 42+0+T body rings, n=8.

Body sculpturing: Body smooth and shiny; scobinae present, moderate sized but strongly impressed, and roughly triangular in shape (Figs 150E-F).

Legs: Legs long; all legs with prominent tarsal pads excluding the first two pairs; tibia strongly condensed with two apical bristles (Fig. 153A).

Colour (after 12 years in ethanol): Body in general red; head, preanal ring and anal valves red (Figs 150A-D); labrum pale; collum red with broad brown band medianly (Fig. 150A); legs yellow (Figs 150B-C); body rings with red metazonites, brown mesozonites and prozonites light brown (Fig. 150F).

Gonopods: *Anterior gonopods*: Sternum of the anterior gonopods very short, with stout, apically blunt median extension, reaching less than a quarter height of gonopods (Figs 151A-B). Coxa with distal part bent medianly at about 45° angle, even width and apically bluntly rounded (Fig. 151B). Distal process of telopodite with only one part, short, laterally directed and bluntly triangular (Figs 151C-E).

Posterior gonopods: Tibial process very broad, angular and projecting outwards; seminal duct opens on distal end of tibial process; longitudinal efferent groove well developed and runs along length of telopodite; telopodite straight; distal process of telopodite smoothly curved with pointed tip distally (Fig. 152).

Female sexual characters: Second pair of legs with distal margin of lateral extension of the coxosterna with moderate size and slightly narrowed bulge (Fig. 153B). Vulva large, almost

rectangular, with basal part slightly extended; anterior valve slightly overlapping posterior one; both valves basally with irregular row of setae; operculum poorly sclerotized (Figs 153C-D).

Type locality: SOUTH AFRICA: *Mpumalanga*: Mariepskop.

Type material (examined). Holotype: 1♂ SOUTH AFRICA: Mpumalanga, Mariepskop, 1960-03, Lawrence R.F. (NMSA-7746).

Paratypes: SOUTH AFRICA: 3♂♂ same data as holotype.

Material examined. SOUTH AFRICA: *Mpumalanga*: 1♂ Mariepskop, 1961, Lawrence R.F. (NMSA-07746); 1♂ Mariepskop Forest, indigenous riverine forest at picnic site in leaf litter on forest floor, Horn J.L. (JLHM33, UKZN); 2♂ 1♀ Mariepskop Forest, from fynbos vegetation on top of Mariepskop, under rocks, S 24° 32. 968', E 30° 52.283', 1900m asl, 2006-11, Horn J.L. (JLHM66, UKZN). *Limpopo*: 4♀ Entabeni Forest, Louis Trichardt 1961-11, Vari L. (NMSA-07734); 1♂ Soutpansberg, Entabeni State Forest 25°00'36.0"S, 30°09'00.0"E, 1995-12, Plisko J.D. (NMSA-15532); 1♂ 1♀ Tzaneen area, Debegeni Rd, Woodbush, 1995-12, Plisko J.D. & Liversage T. (NMSA-16142); 1♂ Louis Trichardt, 1961-11, Vari L. (NMSA-23076); 1♀ Entabeni Forest, Louis Trichardt, 1965-02, van Bruggen A.C. (NMSA-9344); 1♂ 2♀, Goedehoop Forest, Soutpansberg, 23°04'06.5"S, 30°06'55.6"E, 1996-10, Swaye J. (JSM12, UKZN); 1♂ Entabeni Forest, Soutpansberg, 22°59'32.4"S 30°17'09.6"E, 2001-10, Swaye J. (JSM15, UKZN).

Distribution. This species has been recorded from high altitude forest in Limpopo and from one locality with similar habitat, and from fynbos in Mpumalanga province.

Remarks. Lawrence (1967) did not provide a description of the gonopods and he did not illustrate the posterior gonopods for this species. The shape of the gonopods is very similar to that of *C. albitarsis*, but the two species can be distinguished by the colour of legs; black with white tarsi in *C. albitarsis* and yellow in *C. transvaalicus*.

Conservation assessment

This is a South African species described from Limpopo in 1967. The species has been recorded from two mist belt, Afromontane forests in the Soutpansberg, one in the Magoebaskloof area and from the top of Mariepskop and in forest on the slopes of this mountain. All of these forests have some level of protection. The forests in the Magoebaskloof and Soutpansberg areas and other forests in Mpumalanga province were well surveyed by J. Horn (nee Swaye), and so there can be some certainty about the distribution. The threats to the species include ecotourism activities and possibly some alien invasive plants, minor roads that cut through forest which

fragments the forest, and erosion of habitat along forest margins because of timber plantations. In the past there was harvesting of timber within the forests but these are now protected by legislation.

The estimated EOO for *C. transvaalicus* is 9 500 km², and the AOO is approximately 80 – 100 km². There are four known locations. Based on these measures, this species meets some of the requirements for Endangered or Vulnerable, but there is limited evidence that the habitat is declining in quality, or that the EOO or AOO will decrease in future through the threats identified. *Centrobolus transvaalicus* does have few enough locations to meet the criteria for Vulnerable D2 (<5 locations), but not in terms of becoming extinct or critically Endangered in a very short time. This species is therefore considered as Least Concern (LC).

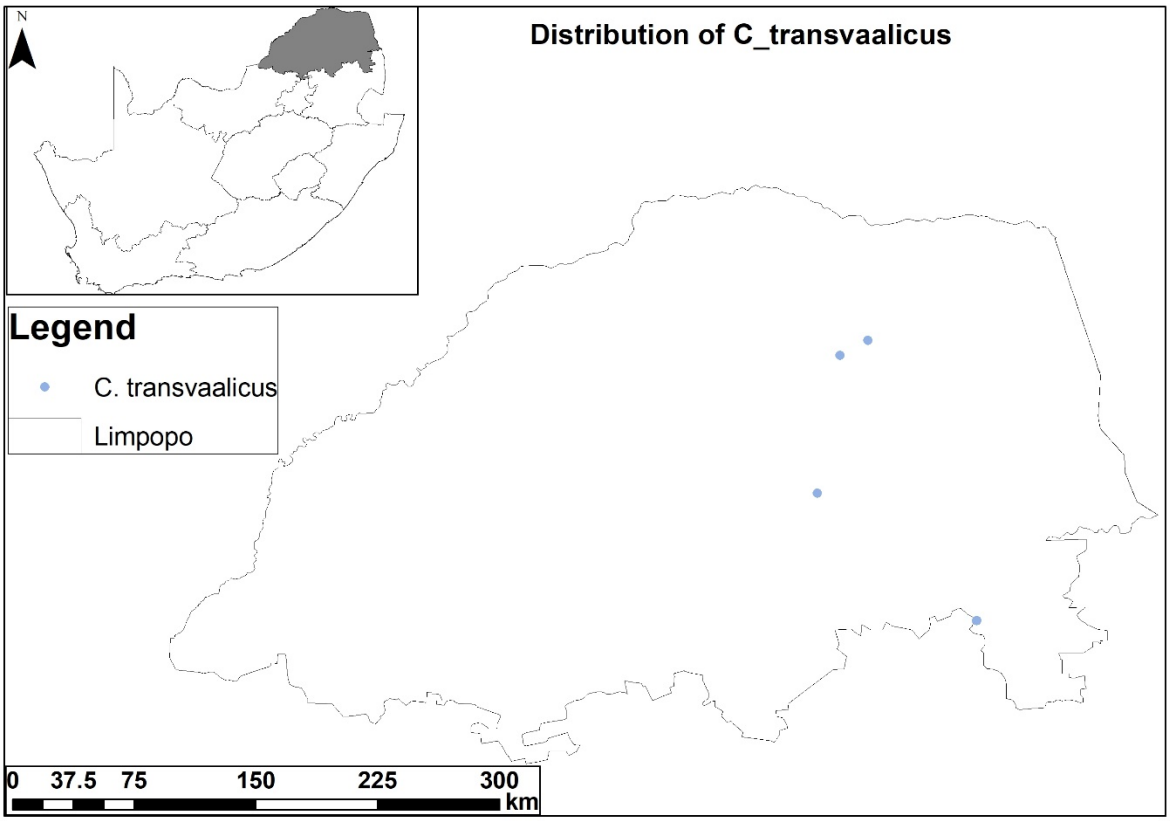

Figure 149: Distribution of *Centrobolus transvaalicus* in South Africa, Limpopo and Mpumalanga.

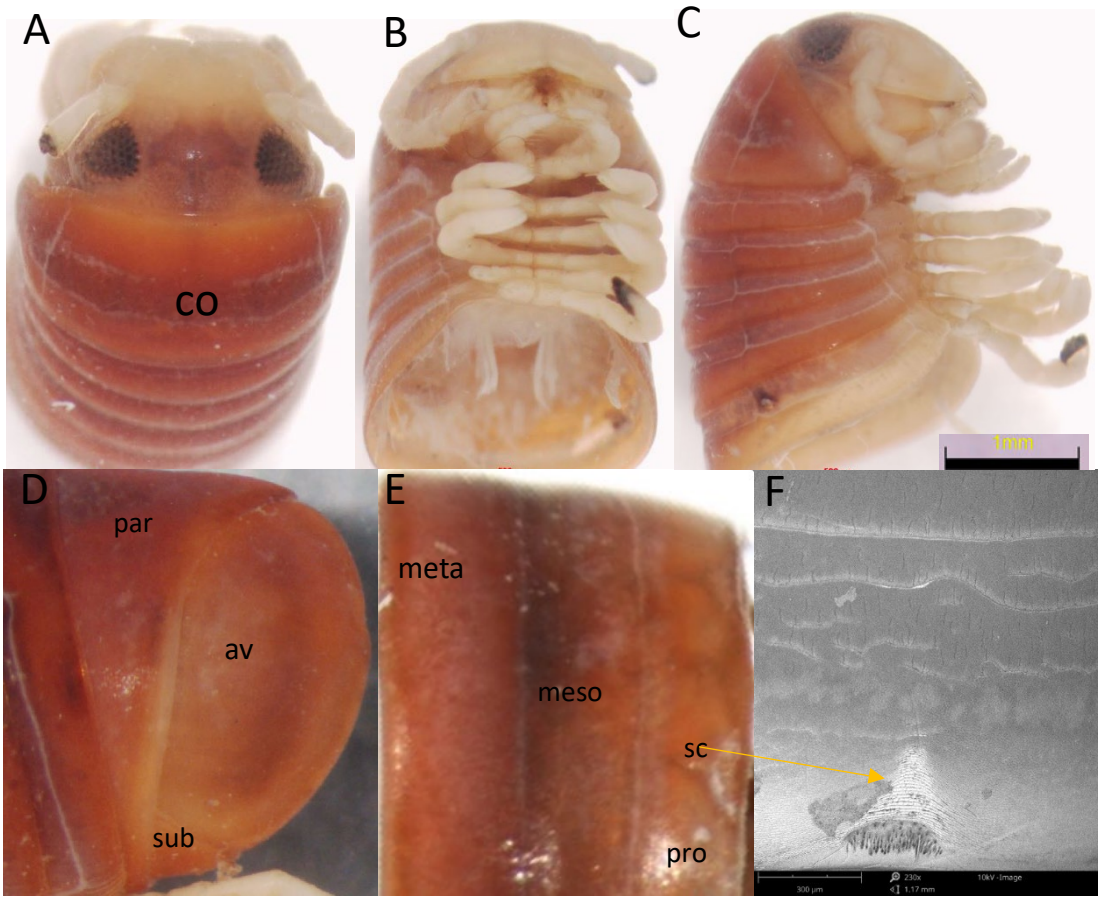

Figure 150: *Centrobolus transvaalicus* (Marieskop forest from fynbos vegetation, Mpumalanga) ♂ (JLHM66). **A** anterior view of the head and collum, **B** ventral view, **C** lateral view, **D** terminal region of body, **E-F** body ring. Abbreviations: av - anal valve; co – collum; meso – mesozonite; meta – metazonite; par - preanal ring; pro – prozonite; sc - scobina. Scale bars: 1.0 mm (**A-E**); 0.3 mm (**F**).

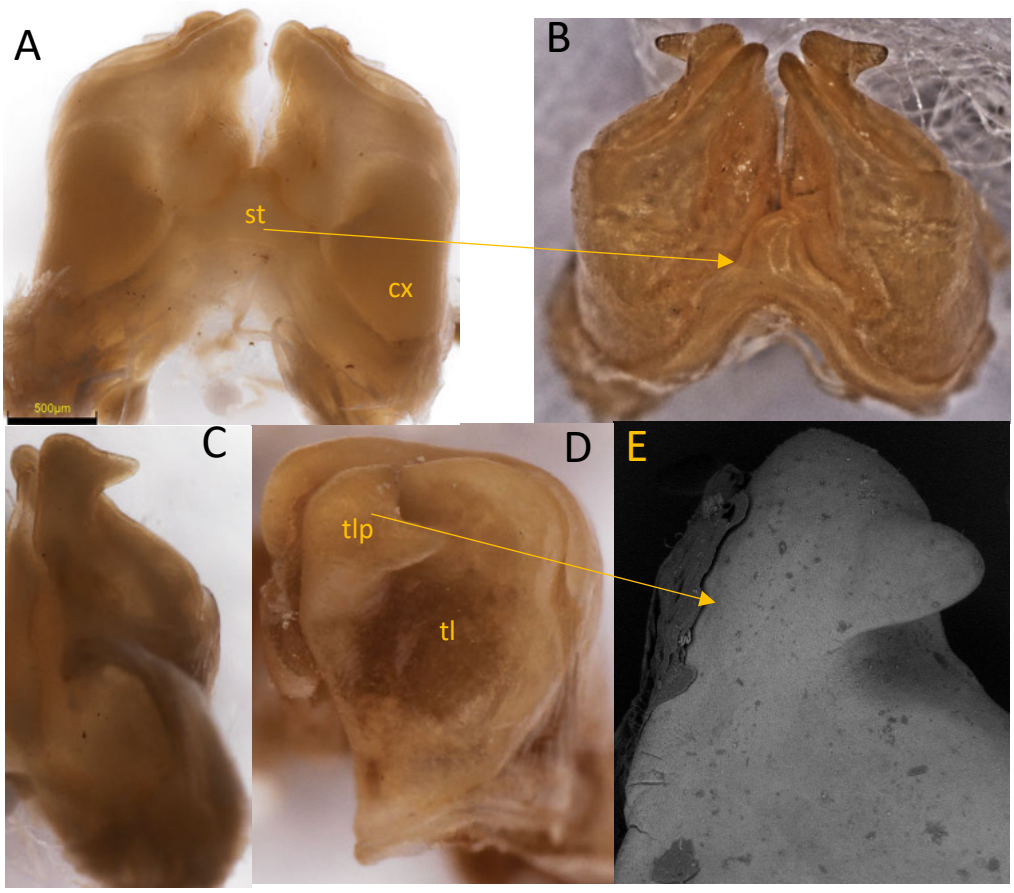

Figure 151: *Centrobolus transvaalicus* ♂ (JLHM66). **A-E** anterior gonopods; **A-B** anterior view, **C-E** posterior view. Abbreviations: cx – coxa; st – sternum; tl – telopodite; tlp - telopodite process. Scale bars: 0.5 mm (**A-D**); 0.2 mm (**E**).

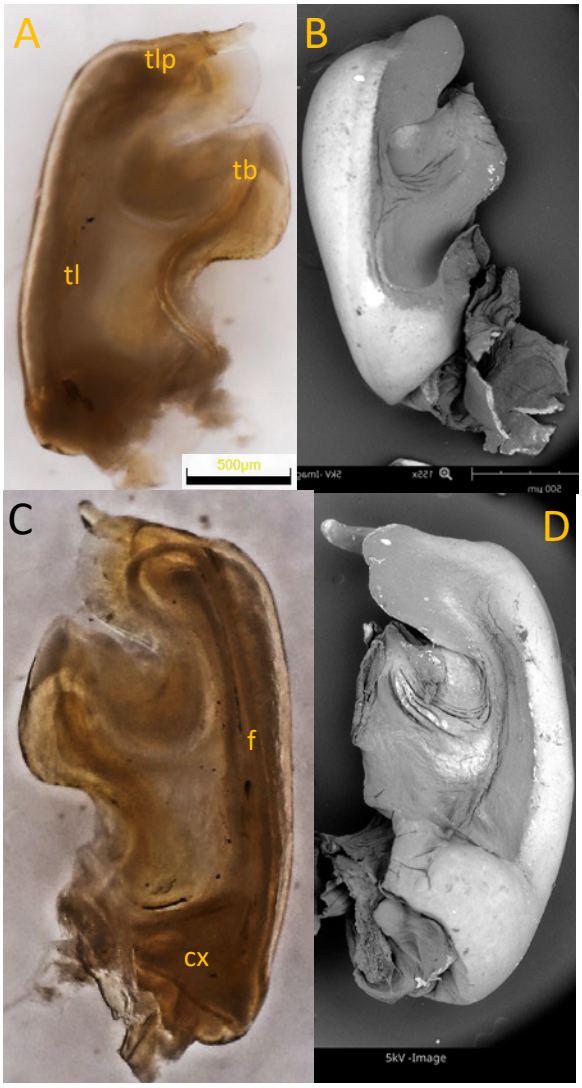

Figure 152: *Centrobolus transvaalicus* ♂ (JLHM66). **A-D** posterior gonopod; **A-B** posterior view, **C-D** anterior view. Abbreviations: cx – coxa; f - efferent groove; tb - tibial process; tl – telopodite; tlp - telopodite process,. Scale bars: 0.5 mm.

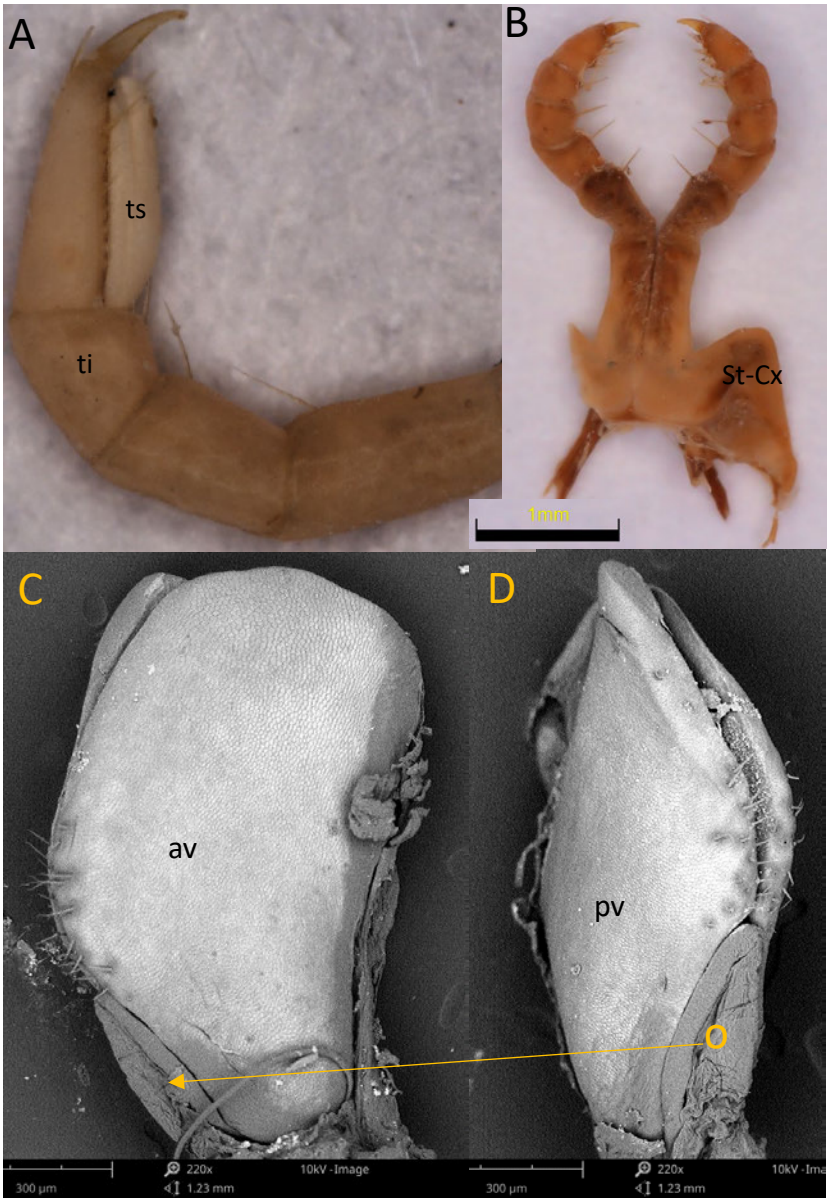

Figure 153: *Centrobolus transvaalicus* ♀ (JLHM66). **A** male leg, **B** female second pair leg, **C-D** vulva, **D** lateral view, **C** anterior view. Abbreviations: av - anterior valve; o – operculum; pv - posterior valve; st-cx – coxosternite; ti –tibia; ts – tarsal pad. Scale bars: 1.0 mm (**A-B**); 0.3 mm (**C-D**).

***Centrobolus tricolor* (Lawrence, 1967)**

Figs 154-158

Hamer 1998: 43.

Chersastus tricolor Lawrence, 1967: 615-616.

Diagnosis. Differs from congeners in having distal process of telopodite with two parts, the distal one with a slightly inflated appearance, with indentation and scattered setae on surface, and proximal one prominent, laterally directed, finger-shaped, and apically acute (Figs 156B-E); male with last six pairs of legs without tarsal pads; body with red, black and light brown bands, head, antennae and legs black.

Redescription. *Measurements*: ♂ Total length 34-49mm, greatest width 5mm, 42+0+T body rings, n=18. ♀ Total length 35-39mm, greatest width 5.2mm, 42+0+T body rings, n=3.

Body sculpturing: Body smooth and shiny without sculpture; scobinae present but relatively small and weak (Figs 155E-F).

Legs: Legs long, exceeding the lateral margin of body rings when extended, the first two and the last six pairs of legs without tarsal pads in male; tibia strongly condensed with two apical bristles (Fig. 158A).

Colour (after 75 years in ethanol): Colour faded, the description is from Lawrence (1967): The body in general transversely banded in three colours (red, black, light brown); head and antennae black brown (Figs 155A-B); collum red with wide black band in the middle (Fig. 155A), legs, preanal ring and anal valves reddish black (Fig. 155D); body rings with red metazonites, black mesozonites and dirty white/light brown prozonites (Fig. 155E).

Gonopods: *Anterior gonopods*: Sternum of the anterior gonopods with long and broad median extension with concave surface, barely tapered and with rounded apex (Fig. 156A). Proximal part of coxa with lateral margin very slightly convex, distal part broad but apically pointed, bent at about 40° (Fig. 156A). Distal process of telopodite with two parts, distal one with a slightly inflated appearance, with long indentation and scattered setae on surface, and proximal one prominent, laterally directed, finger-shaped, and apically acute (Figs 156B-E).

Posterior gonopods: Tibial process narrow; telopodite straight; inflated basal lobe present but indistinct; longitudinal efferent groove well developed, situated laterally and curved to run at a slight angle along length of telopodite; distal process of telopodite narrow and covered with membrane (Fig. 157).

Female sexual characters: Second pair of legs with prominent bulge on distal margin of lateral extensions of the coxosternum (Fig. 158B). Vulva somewhat bean-shaped, but with proximal region extended; anterior valve overlaps posterior one; both valves with single row of long setae; operculum poorly sclerotized (Figs 158C-D).

Type locality: SOUTH AFRICA: *KwaZulu-Natal*: Champagne Castle.

Type material (examined). Syntypes: 1♂ 1♀ SOUTH AFRICA: KwaZulu-Natal, Champagne Castle, Drakensberg Mts, alt. 7,00 ft, 1943-03, Lawrence R.F. (NMSA-3992).

Paratypes: SOUTH AFRICA: 2♂♂ same data as holotype.

Other material examined. SOUTH AFRICA: *KwaZulu-Natal*: 1♂ Cathkin Peak, 1938-01, Lawrence R.F. (NMSA-1680); 1♂ 1♀ Little Tugela Valley, 1938-01, Lawrence R.F. (NMSA-2224); 2♂ same locality and collector data as the preceding, 1941-02, (NMSA-3451); 3♂ 1 ♀ same locality and collector data as the preceding, 1943-09 (NMSA-4008); 2♂ same locality and collector data as the preceding, 1942-01, (NMSA-3486); 1♂ same locality and collector data as the preceding, 1943-09, (NMSA-3992); 2♂ Bulwer, 1937-02, Lawrence R.F. (NMSA-1448); 1♂ Champagne Castle, 1944-10, Lawrence R.F. (NMSA-4400); 2♂ same locality and collector data as the preceding, 1945-02, (NMSA-4476).

Distribution. This species has been recorded from the central Drakensberg and from two localities (Bulwer and Mount Currie Nature Reserve) east of the southern Drakensberg in KwaZulu-Natal Province. Material from two localities in Highmoor Nature Reserve in the central Drakensberg and from two localities in Mount Currie Nature Reserve was collected and identified by A. Armstrong (Ezemvelo KZN Wildfire), and while this material was not examined, the identifications are probably accurate.

Remarks. Lawrence (1967) designated a male and a female specimen as the "Holotype", but since there are two specimens, these are referred to here as syntypes. He did not provide a description of the gonopods, but he did illustrate the anterior gonopods.

Conservation assessment

The species occurs in the central Drakensberg, and southern part of KwaZulu-Natal. It has been collected in both grassland and in forest patches. There has been some tourism development in the Cathkin Peak and Champagne Castle area, and some habitat loss as a result of semi-rural

housing development and agriculture in the Bulwer, Mount Currie and central Drakensberg areas. However, this is not a major threat because most of the recorded localities are on steep slopes or in protected areas.

Centrobolus tricolor has estimated EOO = 3500 km². The AOO is difficult to calculate because the exact habitat is uncertain. There are six known locations, but probably more will be identified with additional sampling. This species does not meet any of the criteria for threatened and is therefore considered as Least Concern (LC).

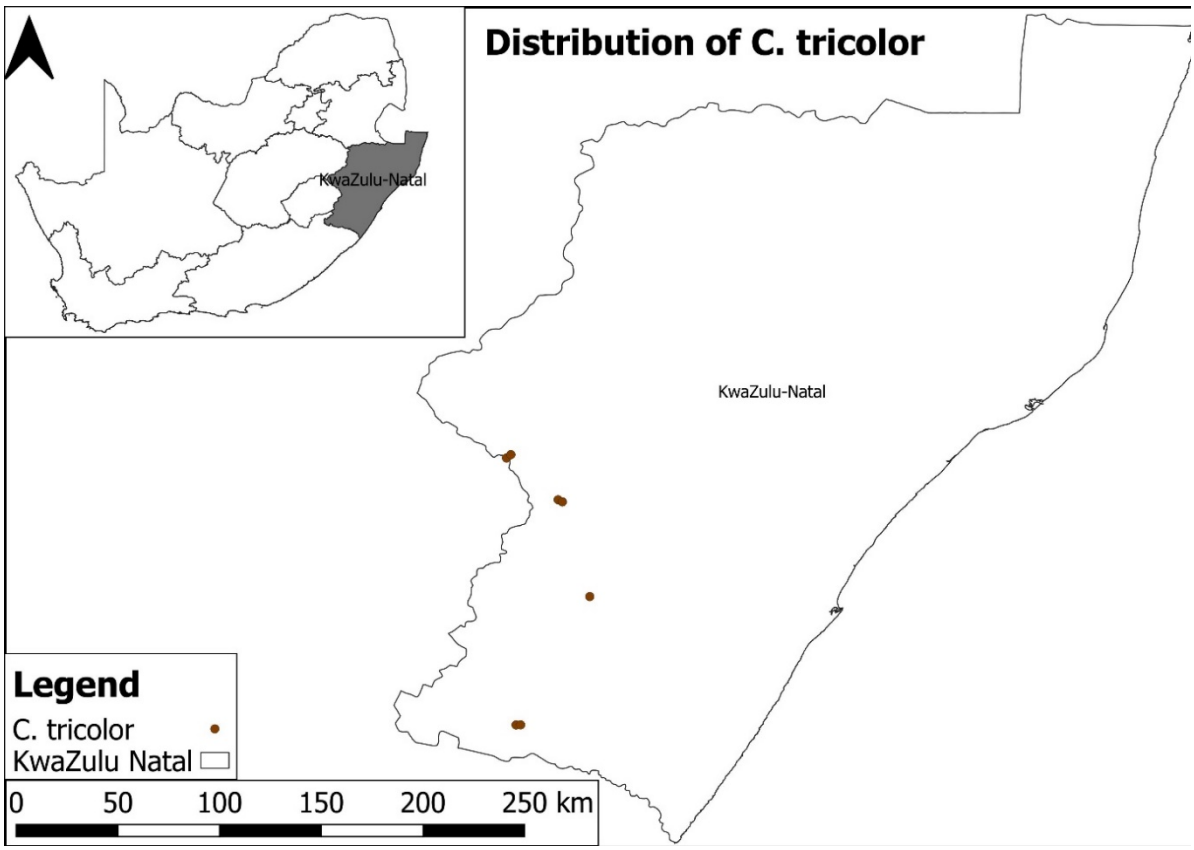

Figure 154: Distribution of *Centrobolus tricolor* in South Africa, KwaZulu-Natal.

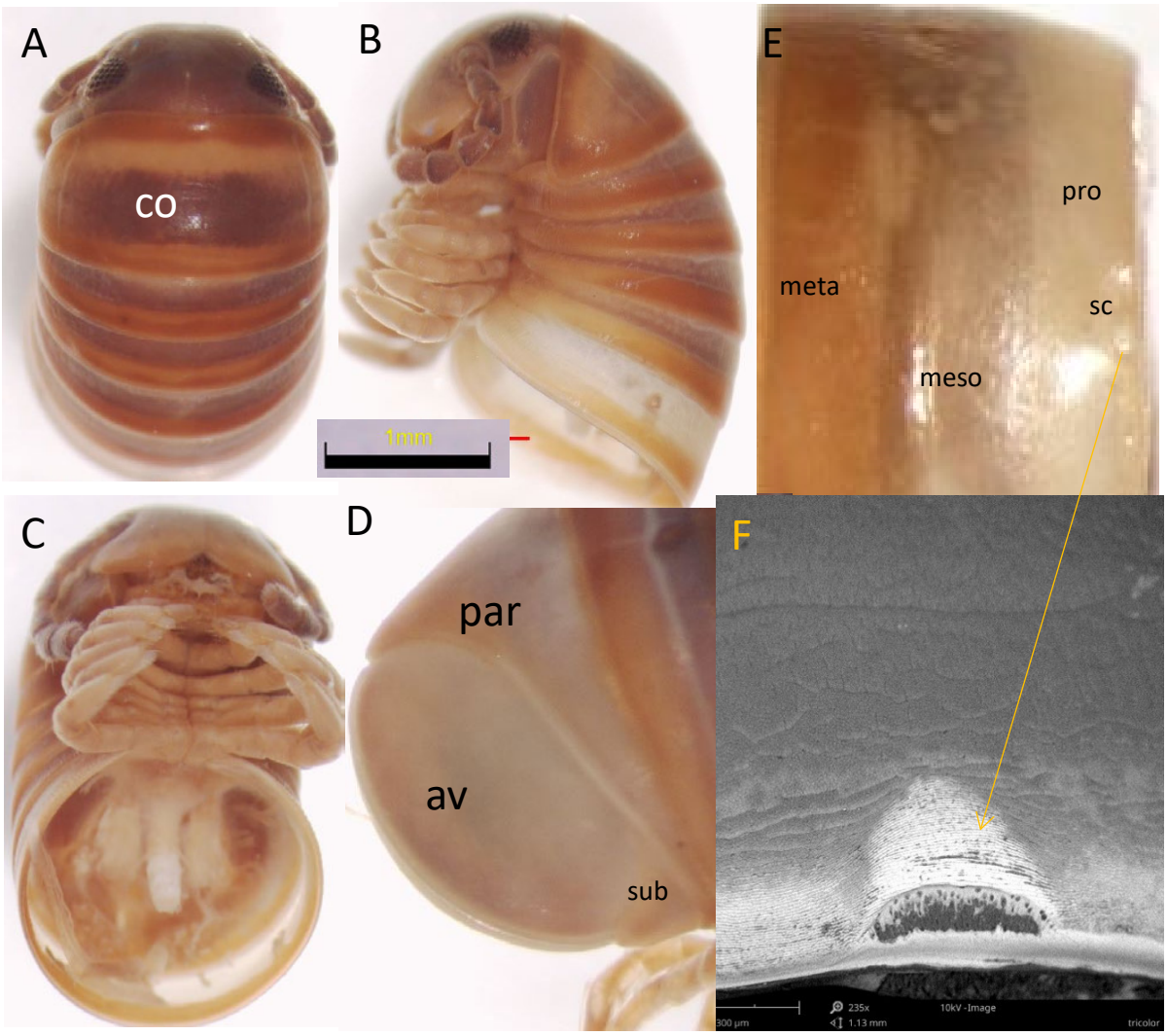

Figure 155: *Centrobolus tricolor* (Cathkin Peak, KwaZulu-Natal) ♂ (NMSA-04008). **A** anterior view of the head and collum, **B** lateral view, **C** ventral view, **D** terminal region of body, **E-F** body ring. Abbreviations: av - anal valve; co – collum; meso – mesozonite; meta – metazonite; par - preanal ring; pro – prozonite; sc - scobina. Scale bars: 1.0 mm (**A-E**); 0.3 mm (**F**).

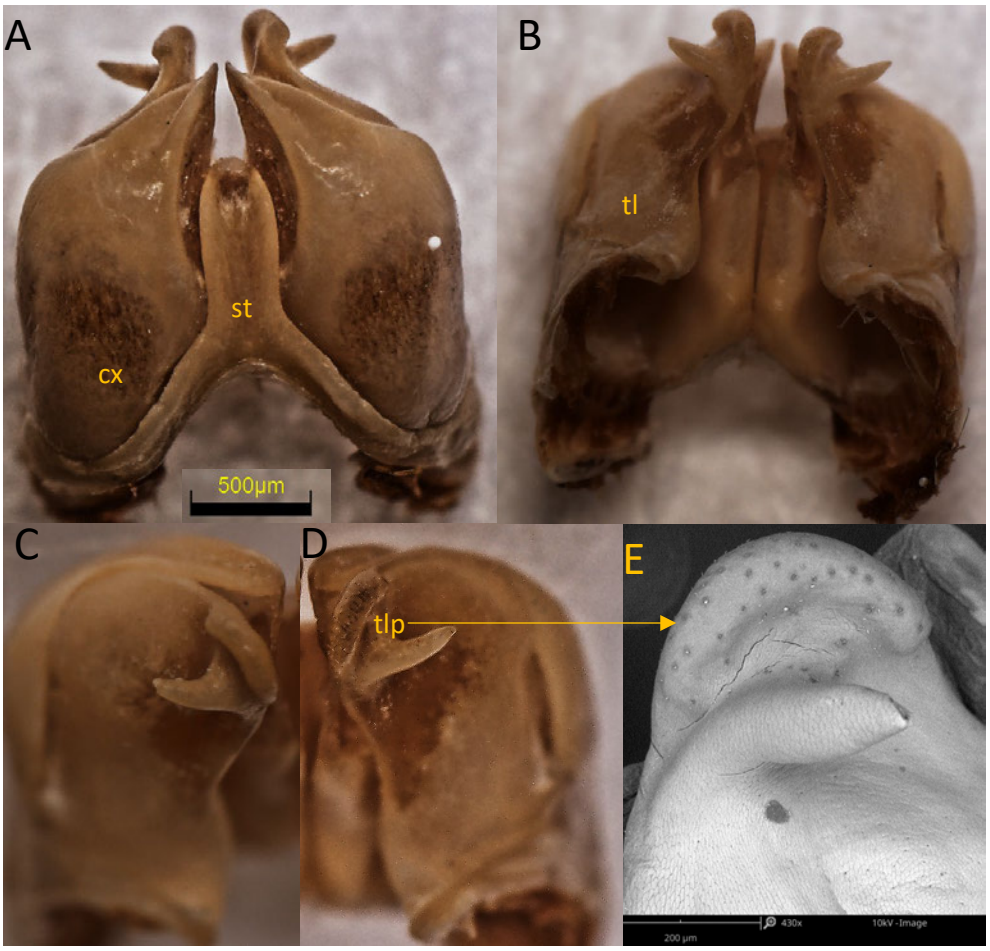

Figure 156 *Centrobolus tricolor* ♂ (NMSA-04008). **A-E** anterior gonopods; **A** anterior view, **B-E** posterior view. Abbreviations: cx – coxa; st – sternum; tl – telopodite; tlp - telopodite process. Scale bars: 0.5 mm (**A-D**); 0.2 mm (**E**).

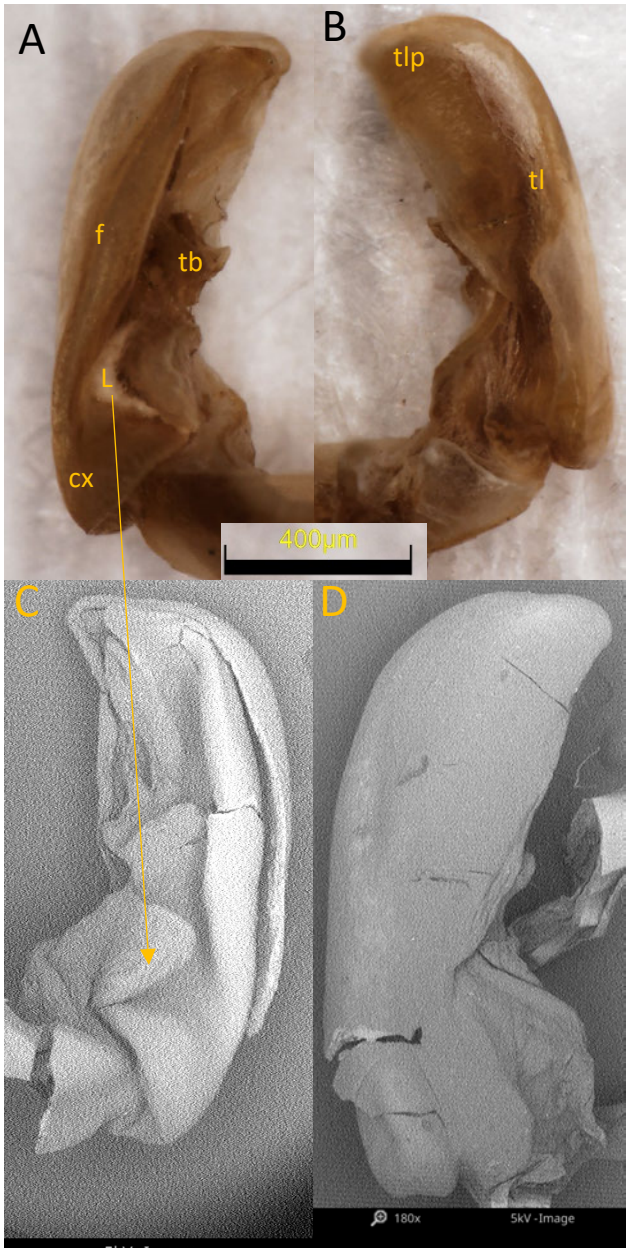

Figure 157: *Centrobolus tricolor* ♂ (NMSA-04008). **A-D** posterior gonopod; **A** & **C** anterior view, **B** & **D** posterior view. Abbreviations: cx – coxa; f - efferent groove; l – inflated basal lobe; tb - tibial process; tl – telopodite; tlp - telopodite process . Scale bars: 0.4 mm.

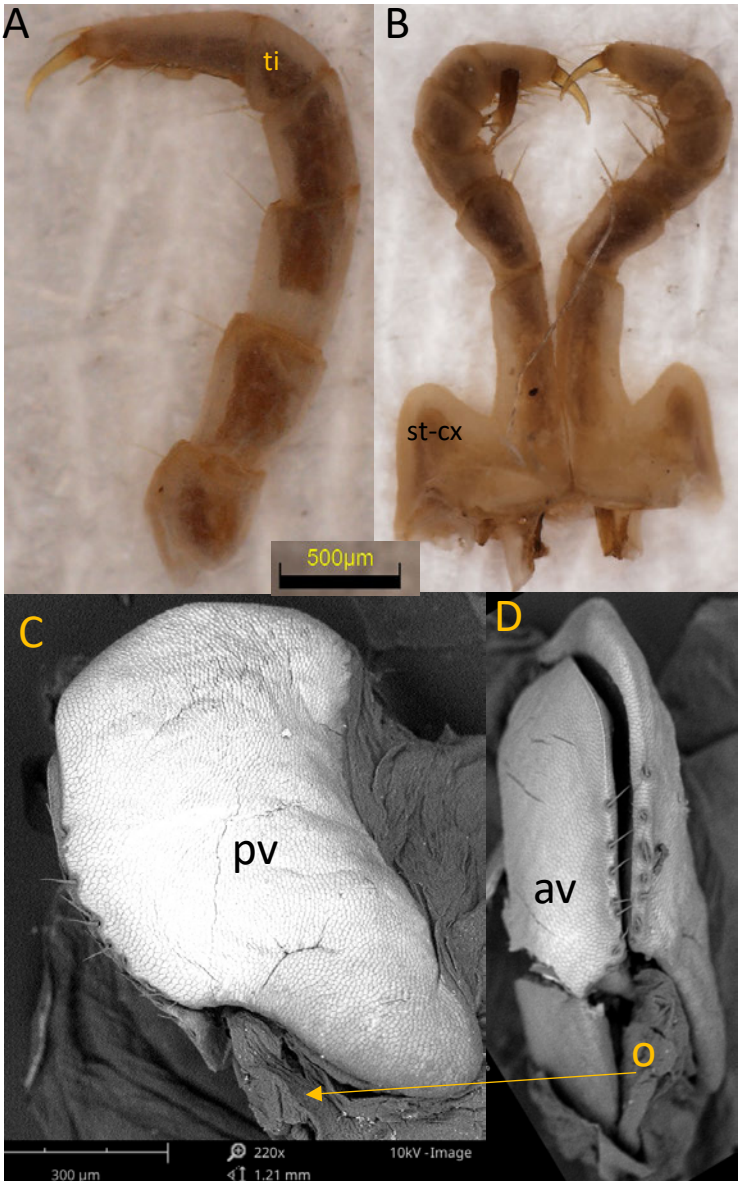

Figure 158: *Centrobolus tricolor* ♀ (NMSA-04008). **A** male leg, **B** female second pair leg, **C-D** vulva, **D** lateral view, **C** anterior view. Abbreviations: av - anterior valve; o – operculum; pv - posterior valve; st-cx – coxosternite; ti –tibia. Scale bars: 1.0 mm (**A**); 0.3 mm (**B-C**).

***Centrobolus validus* (Lawrence, 1967)**

Hamer 1998: 43.

Chersastus validus Lawrence, 1967: 624-625.

Description. Original description by Lawrence (1967): ♀ Total length 70mm, greatest width 8mm, 39 body rings.

Body sculpturing: Collum shiny and smooth; metazonites and mesozonites with large coarse furrow-like groove transversely; eyes with about 50 ommatidia; scobinae small, not strongly impressed.

Colour: Trunk blackish-brown, the head and anterior collum segments with reddish tinge, antennae orange, legs yellow.

Legs: long and slender, surpassing the sides of the body ring when extended laterally. Tibia much longer than wide, with one apical bristle.

Type examined: Holotype: ZIMBABWE: 1♀ Haroni River, climbing on trees in *Podocarpus* forest at 1,300 ft. altitude, 1965-12, Graham. M. (NMSA-9397).

Remarks. According to Lawrence (1967) this species may belong to the genus *Metiche* Attems, 1909 because of its large and robust size. *Metiche* was synonymised with *Epibolus* (Engoff, 1977) which is represented in Mozambique by *E. mossabicensis* but this species was synonymised with the widespread *E. pulchripes* (Gerstäcker, 1873) by Enghoff (2011).

Only one female specimen of *C. validus* has been collected and Lawrence (1967) did not provide illustrations. While the male of this species must be collected to confirm or validate the status of this species and it is almost certain that it is not a *Centrobolus* species. It is considered as *incertae sedis*.

***Centrobolus vastus* (Attems, 1934)**

Figs 159-164

Hamer 1998: 43.

Chersastus vastus Attems, 1934: 477-478; Jeekel 1956: 85; Schubart 1966: 56-57 Lawrence 1967: 630-631.

Diagnosis. Distal telopodite process with two parts, the distal one folded medianly, broad and with lateral margin tri-lobed; proximal part laterally directed, prominent, narrow triangular shape, with acute apex (Figs 162C-D); sternum of anterior gonopods broad and pentagonal, with lateral margins of median extension convex about halfway along length; apex broad and blunt; last 14 pairs of legs without tarsal pads; body in general red with large black spots laterally and dorso-medianly and six black bands from body ring 17 onwards and at intervals of four body rings; head, antennae, legs, anal valves and segment bright red; collum red with black transverse band in the middle. Females robust in size and larger than the males and other species of the genus.

Redescription.: *Measurements*: ♂ Total length 57-65mm, greatest width 5-6mm, 43+0+Tor 43+0+T body rings, n=10. ♀ Total length 63mm, greatest width 4.2mm, 43+0+T body rings, n=7.

Body sculpturing: Body very polished and smooth with minute punctation and longitudinal parallel striae; scobinae present and small; anal valves quite smooth with a shallow depression laterally (Figs 161E-F).

Legs: Legs very long, exceeding the lateral margins of body rings when extended (male legs longer than female); all legs with tarsal pads except the first two pairs and the last 14 in male; tibia standard length with one apical bristle (Fig. 164A).

Colour (after 74 years in ethanol): Body in general red with large black spots dorso-medianly and laterally in the region of the ozopores, and with six black bands that extend over two body rings each; head, antennae, legs, anal valves and segment bright red; collum red with thick black transverse band in the middle (Figs 160, 161A-E); body rings with black and red metazonites, bright red mesozonites and reddish-yellow prozonites (Fig. 161F); the anterior half of the body without transverse bands; posterior half of the body with six transverse bands extending across two body rings each, at intervals of four body rings 17 and 18, 22 and 23, 27 and 28, 32 and 33, 37 and 38 and 41 and 42 (Figs 160, 161E).

Gonopods: *Anterior gonopods*: Sternum of the anterior gonopods long, reaching more than halfway up the telopodite; broad and pentagonal, with lateral margins of median extension

convex about halfway along length; apex broad and blunt (Figs 162A-B). Coxa with straight lateral margins proximally, with distal half bent at about a 34° angle, broad and tapered to narrow apex (Figs 162A-B). Distal telopodite process with two parts, the distal one folded medianly, broad and with lateral margin tri-lobed; proximal process laterally directed, prominent and narrow triangular shape, with acute apex (Figs 162C-D).

Posterior gonopods: Tibial processes short and broad with seminal duct opening at base; efferent groove longitudinal and well developed running along lateral margin of telopodite, inflated lobe present and situated at base of telopodite; coxa completely fused with telopodite; distal processes of telopodite extended, angular, with rounded corners with broad attached lamella (Fig. 163).

Female sexual characters: Second leg pair with distal margin of coxosternum extension with distinct, bluntly triangular bulge (Fig. 164B); vulva with anterior valve with one straight margin, one convex margin and one with corner extended; both valves basally with two to three irregular rows of setae; operculum poorly sclerotized; posterior valve overlaps anterior valve (Figs 164C-D).

Type locality: SOUTH AFRICA: *Eastern Cape*: Port St. John.

Type material (examined). Topotypes: 4♂ 1♀ SOUTH AFRICA: Eastern Cape, Port St. John, 1945-07, Lawrence R.F. (NMSA-4491).

Other material examined. SOUTH AFRICA: *Eastern Cape*: 1♂ 5♀ Port St. Johns, 1937-08, Rump W. G. (NMSA-1630); 5♂ 1♀ Port St. Johns, Umngazi River Mouth, 1955-01, Lawrence R.F. (NMSA-6230).

Distribution. This species has only been confirmed to occur at Port St Johns on the coast of the Eastern Cape province. The specimens listed as *C. vastus* by Lawrence (1967) from Gwaliweni (NMSA-9613) are misidentified and upon examination of gonopods of this species, it was found to be *Centrobolus vulpinus* (Attems, 1928) and not *C. vastus*. Other specimens that were recorded by Lawrence (1967) for *C. vastus* were from Kranskop (NMSA-2697, 6223); Ingwavuma (NMSA-2241); Trafalgar, near Ramsgate (NMSA-8954) and Port Edward (NMSA-4020) but these may not be *C. vastus* (see Remarks below). The Ifafa locality recorded by Attems (1934) may also not be accurate.

Remarks. Lawrence (1967) designated the topotypes because it appears that only a damaged female specimen was returned to the KZN Museum by Attems. This species has been confused with *C. vulpinus* because of the black transverse bands on the posterior half of the body, which are present in both species, but the two species are distinguished by body size, colour of the

collum, the arrangement of the black bands and the gonopods. The specimens listed as *C. vastus* by Lawrence (1967) from Gwaliweni (NMSA-9613) are not *C. vastus* but *C. vulpinus*.

There are doubts about the specimens from KwaZulu-Natal that were listed as *C. vastus* by Lawrence (1967), and these are more likely to be *C. vulpinus*. Lawrence (1967) did describe differences in the colour pattern of the specimens from KwaZulu-Natal and those from Port St Johns, stating that in the latter "the black spots take up a larger proportion of the tergites than in the Natal ones from Trafalgar and Port Edward" so that in the Port St Johns specimens "the reverse is the case and red is much more predominating colour". Lawrence (1967) also stated that in the specimens from north of Ifafa on the KZN south coast the specimens only have the black spots and the black bands are absent, and that he considered these specimens as the more typical form of *C. vastus*. Lawrence (1967) suggested a new subspecies, *vastus sexfasciatus* for the specimens that have the black bands and indicated that these are from the localities further south in KwaZulu-Natal and Port St Johns. Lawrence (1967) also stated that "north of Durban specimens of *vastus* progressively assume the colour pattern of *inscriptus*; the two species are then very similar and it becomes difficult to tell which species is indicated by the descriptions of Attems." He did, however say that *C. vastus* and *C. inscriptus* occur together at Trafalgar on the KZN south coast. The gonopods of these two species are similar, but the distal process of the anterior gonopod telopodite is distinct.

The illustrations of the gonopods of this species by Attems (1934) in the original description are lacking in details and no detailed description of the species was provided.

One specimen appears to have been removed from the other type material catalogued as NMSA 4491 (the topotypes) and to have been allocated a new number (NMSA 23082) but the reason for this is unclear.

Conservation assessment

This is a South African species described from Eastern Cape in 1934. The species has only been recorded from Port St Johns in Eastern Cape. Very few specimens have been collected. The EOO is estimated as 500km and the AOO as 170km, if the potential forest habitat in the area is included. The number of locations is one. The exact locality where this species was collected is unknown but the habitat is likely to be coastal forest. There has been some development at Port St Johns, but whether this overlaps with the habitat of this species is unknown, and so it is unclear whether there has been habitat loss or whether this is ongoing. Based on the small number of locations, and the small AOO, this species does qualify as Vulnerable (VU) D2.

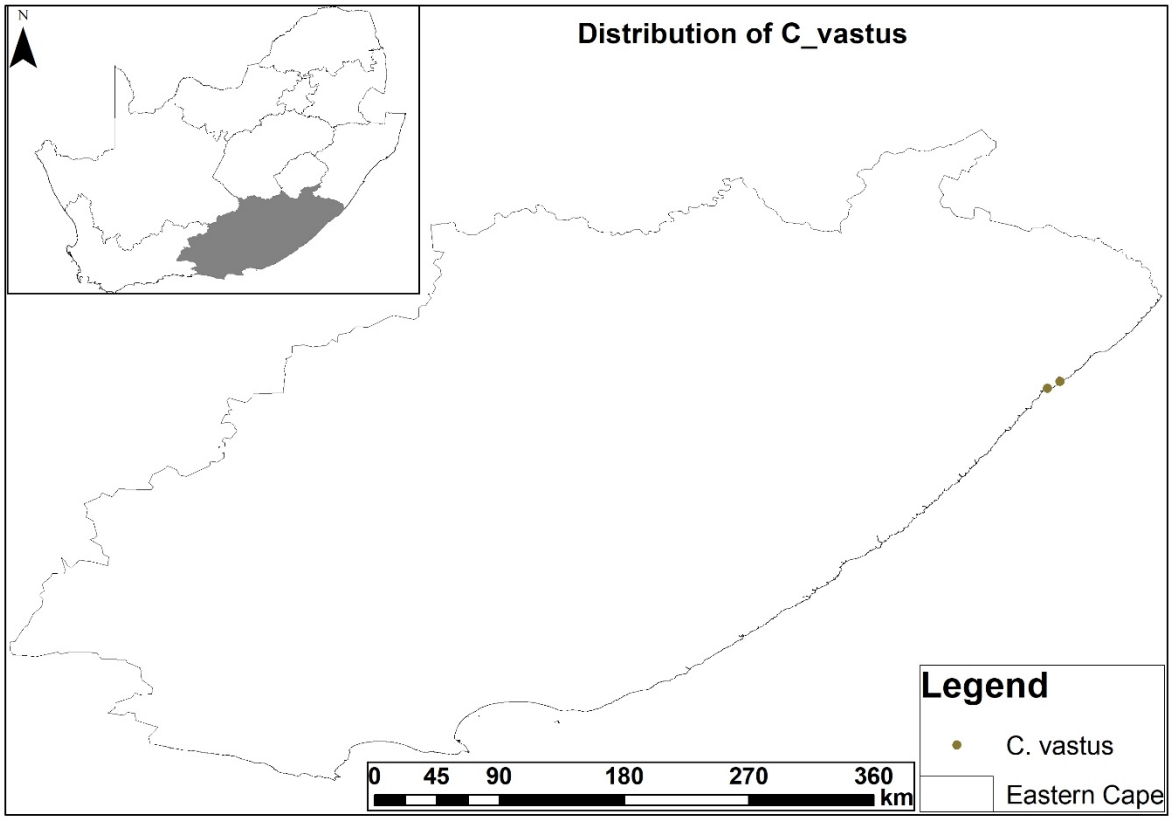

Figure 159: Distribution of *Centrobolus vastus* in South Africa, Eastern Cape.

Figure 160: *Centrobolus vastus*. Port St Johns, Eastern Cape, South Africa. **A** Photographer: Shaun Swanepoel (CC-BY-NC), **B** Photographer: Guido Coza (CC-BY-NC). Source iNaturalist.

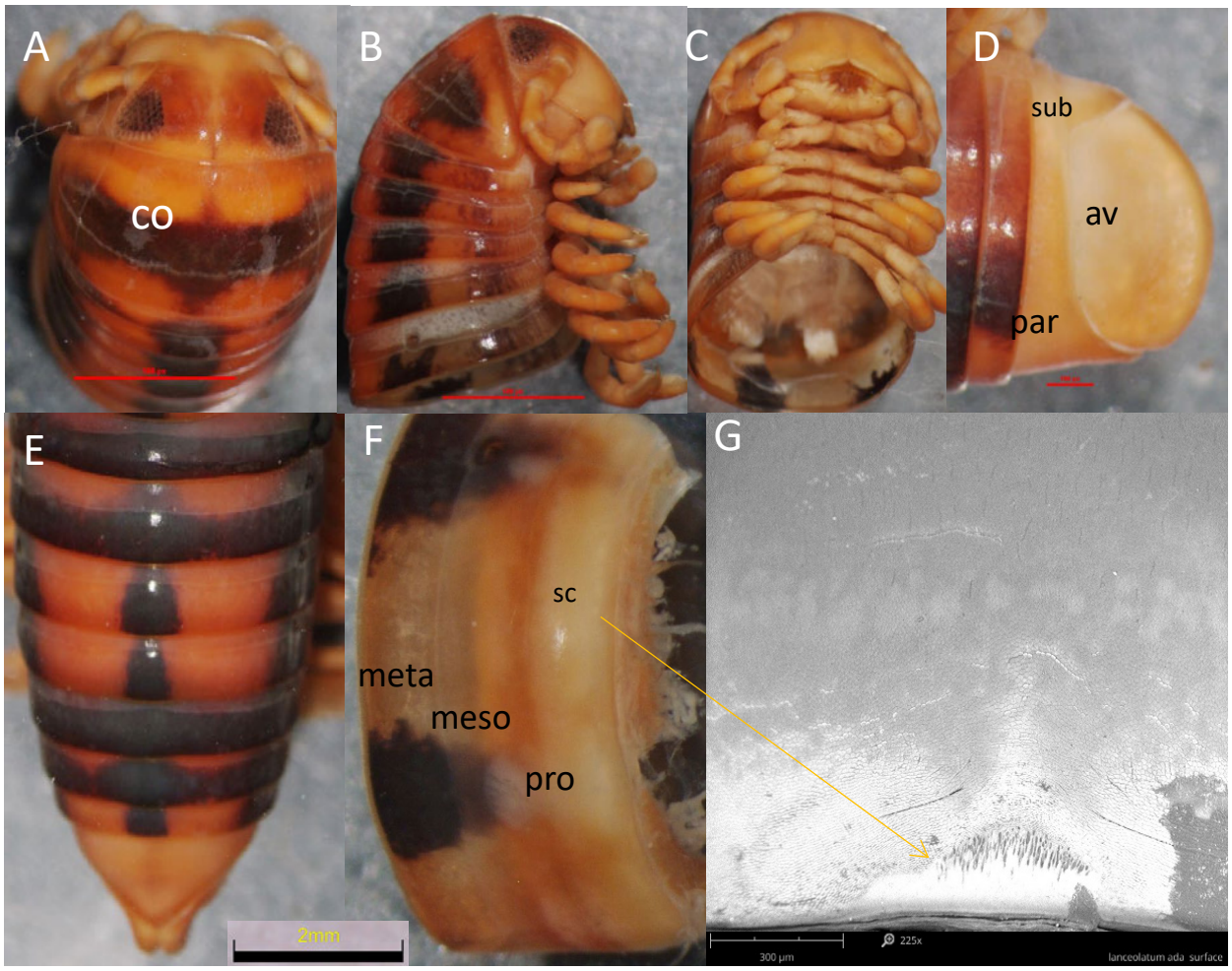

Figure 161: *Centrobolus vastus* (Port St John, Eastern Cape) ♂ (NMSA-04491). **A** anterior view of the head and collum, **B** lateral view, **C** ventral view, **D-E** terminal region of body, **F-G** body ring. Abbreviations: av - anal valve; co – collum; meso – mesozonite; meta – metazonite; par - preanal ring; pro – prozonite; sc - scobina. Scale bars: 2.0 mm (**A-F**); 0.3 mm (**G**).

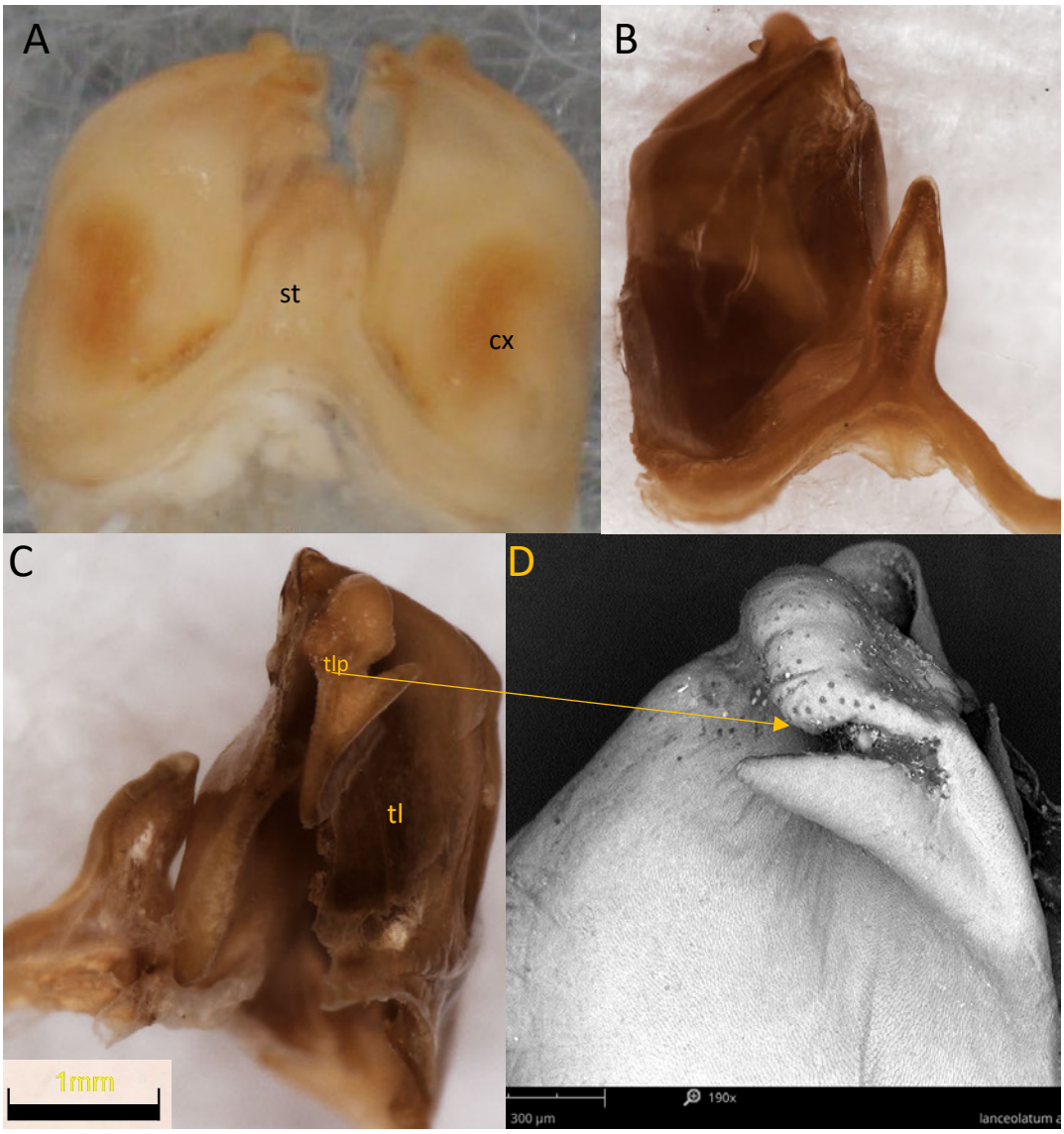

Figure 162: *Centrobolus vastus* ♂ (NMSA-04491). **A-D** anterior gonopods; **A-B** anterior view, **C**-D posterior view. Abbreviations: cx – coxa; st – sternum; tl – telopodite; tlp - telopodite process. Scale bars: 1.0 mm (**A-D**, **F**); 0.3 mm (**E**).

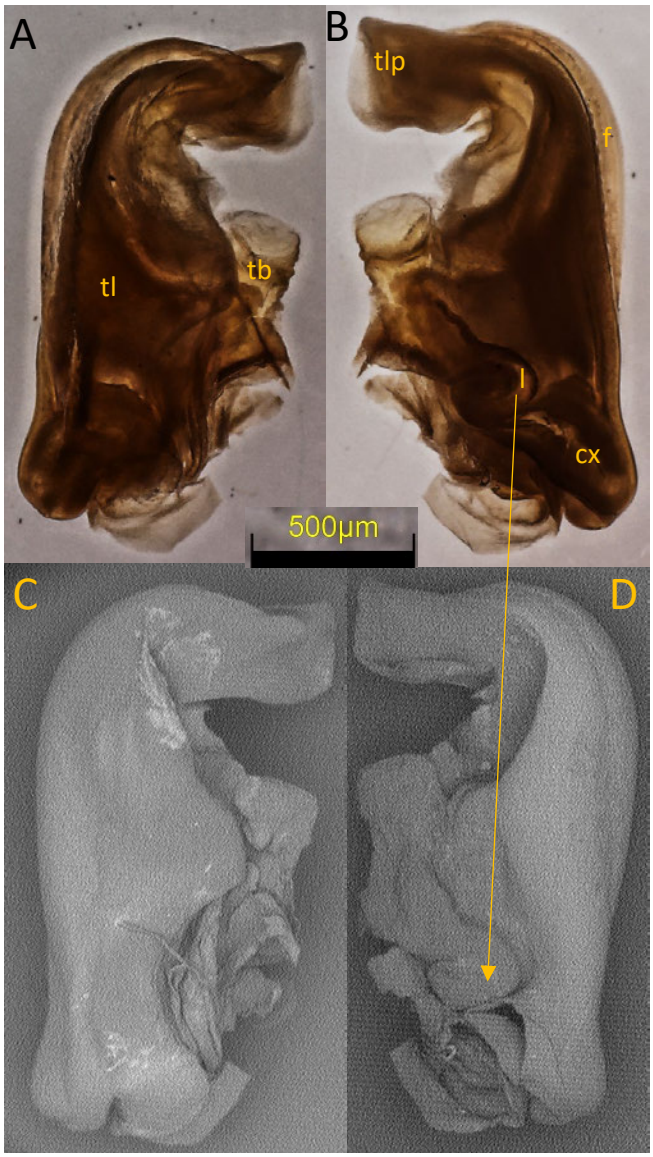

Figure 163: *Centrobolus vastus* ♂ (NMSA-04491). **A-D** posterior gonopod; **A** & **C** posterior view, **B** & **D** anterior view. Abbreviations: cx – coxa; f - efferent groove; l – inflated basal lobe; tb - tibial process; tl – telopodite; tlp - telopodite process. Scale bars: 0.5 mm.

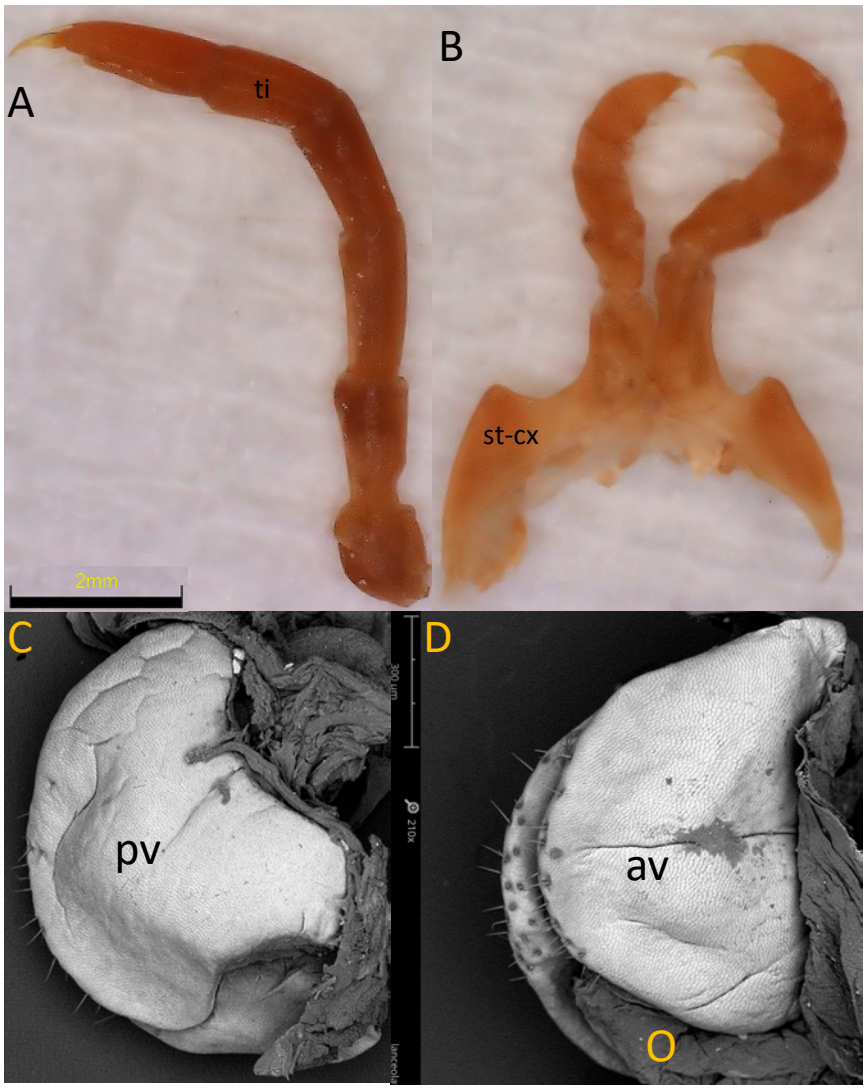

Figure 164: *Centrobolus vastus* ♀ (NMSA-04491). **A** male leg, **B** female second pair leg, **C-D** vulva, **C** posterior view, **D** anterior view. Abbreviations: av - anterior valve; o – operculum; pv - posterior valve; st-cx – coxosternite; ti-tibia. Scale bars: 2.0 mm (**A-B**); 0.3 mm (**C-D**).

***Centrobolus vulpinus* (Attems, 1928)**

Figs 165-170

Hamer 1998: 41.

Chersastus vulpinus Attems, 1928: 3045-306; Attems 1934: 497

Chersastus ruber vulpinus Lawrence, 1967: 635-634.

Diagnosis. Differs from congeners in anterior gonopods having distal process of telopodite with two parts, distal part prominent, rounded and bulbous with slightly concave basal margin, and proximal part a finger-like structure; distal part of coxa strongly tapered and with almost tooth-like appearance; median extension of sternum short, broad triangular shape, strongly tapered to narrow apex (Figs 168C-D). Colour red with dorso-median and lateral longitudinal rows of small black spots (Fig. 167).

Redescription. *Measurements*: ♂ Total length 45-55mm, greatest width 4.0-5.9, 41+0+T body rings, n=29. ♀ Total length 53mm, greatest width 7.0mm, 42+0+T body rings, n=7.

Body sculpturing: Scobinae present, small and half-oval shaped (Fig. 167E). Mesozonites with striae, metazonites smooth (Fig. 167E-F).

Legs: Legs fairly long, exceeding the lateral margin of body rings when extended; the first two and the last 14 pairs of legs without tarsal pads in male; tibia standard length with one apical bristle (Fig. 170A).

Colour (after 10 years in ethanol): Body generally red with longitudinal rows of black spots, one dorso-median and one along each side; irregular transverse black bands at the posterior half of the body in some specimens (Figs 167A-B); head, antennae and collum red (Figs 167, 167A-C); preanal ring and anal valves lighter red (Fig. 167D); body rings with red metazonites, brown mesozonites with black dorso-median and lateral spots and prozonites light brown (Fig. 167E); legs orange-yellow.

Gonopods: *Anterior gonopods*: Sternum of the anterior gonopods short, reaching about a third of height of telopodites; triangular and strong tapered distally to an acute point (Figs 168A-B). Lateral margin of coxa very slightly convex; distal half bent at about 45° and strongly tapered to apical point, with almost tooth-like appearance (Figs 168A-B). Distal process of telopodite with two parts, the distal one a prominent, rounded and bulbous structure with slightly concave basal margin; proximal part a finger-like structure; both parts of the distal process with widely spaced, very short setae (Figs 168C-D).

Posterior gonopods: Tibial process broad and projecting outwards with seminal duct opening on distal end; longitudinal efferent groove well developed and runs straight along length of telopodite; inflated basal lobe present but indistinct; distal process of telopodite rectangular with rounder corners and moderately extended (Fig. 169).

Female sexual characters: Second pair of legs with distal margin of lateral extensions of coxosternum with slight rounded bulge (Fig. 170B). Vulva roughly bean-shaped, and posterior valve with extended corner. Both valves basally with two to three irregular rows of setae; operculum poorly sclerotized (Figs 170C-D).

Type locality: MOZAMBIQUE: Masiene, Chai Chai.

Type material (not examined). Holotype: ♂ MOZAMBIQUE: Masiene, Chai Chai, 1928, Attems C. (SAMC B 6030, 6009).

Material examined. SOUTH AFRICA: *KwaZulu-Natal*: 1♀ Oribi Gorge, Port Shepstone, 1936-10, Lawrence R.F. (NMSA-00980); 1♂ Ismont, 8 miles S of Mid Illovo, 1966-01, Schofield T. (NMSA-9392); 2♀ Izotsha, 1930-02, Rump W.G. (NMSA-23085); 1♂ Mtamvuma Gorge, forest near pond, 1994-12, Lucas D. (NMSA-15542); 1♂ Hluhluwe Game Reserve, Mbombe Forest, 2002-09, Armstrong A. & Sibiya A. (NMSA-20165); 1♂ Nkandla Forest Nature Reserve, Armstrong A.J. (NMSA-25949); 1♂ Hluhluwe, Umfolozi, 28°4'41.45"S/32°02'28.64"E, Armstrong A.J. (NMSA-25965); 1♂ Amanzimtoti, 1946-02, Thomarset H.P. (NMSA-4507). *Eastern Cape*: 3♂ 1♀ Hole-in-the-wall, 1979-01, Lamoral B. (NMSA-15523); 4♂ 1♀ Qolora River Mouth, 1962-01, Lawrence R.F. (NMSA-8246); 1♂ Mkhambathi Nature Reserve, 31.29052°S, 29.97692°E, 2008-01, Hamer M. (III-UKZN 1313); 1♂ same locality, date and collector data as the preceding (III-UKZN 6304); 3♂ same locality, date and collector data as the preceding (III-UKZN 6149); 1♂ same locality, date and collector data as the preceding (III-UKZN 6342); 2♂ same locality, date and collector data as the preceding (III-UKZN 2052); 1♂ same locality, date and collector data as the preceding (III-UKZN 2869); 1♂ same locality, date and collector data as the preceding (III-UKZN 4196); 1♂ same locality, date and collector data as the preceding (III-UKZN 754); 1♂ same locality and collector data as the preceding, 2008-01, (III-UKZN 4024); 2♂ same locality and collector data as the preceding, 2008-02, (III-UKZN 2639); 2♂ 1♀ Umtamvuma trail in front of Clearwater Farm, 2012-11, (MH59, UKZN).

Distribution. This species has been recorded from Mozambique, from the KwaZulu-Natal south coast and two more inland areas in KwaZulu-Natal and from the coast of the northern part of the Eastern Cape province. The species appears to be restricted to coastal and scarp forest. *Centrobolus vulpinus* has an interesting distribution because it has not been recorded

from the northern KwaZulu-Natal coast between Mozambique and Amanzimtoti on the KwaZulu-Natal south coast.

Remarks. The colour of this species does not resemble that of *C. ruber* as Attems (1928) alluded to in his description of *C. vulpinus*, but there are similarities in the posterior gonopods of the two species. Lawrence (1967) was convinced that *C. vulpinus* is not distinct from *C. ruber* based on the distribution and colour and he therefore concluded that *C. vulpinus* is a subspecies of *C. ruber*. However, upon examination of these two species, differences in the colour and the anterior gonopods are sufficient to recognise two full species.

Conservation assessment

This is a southern African species described from Mozambique in 1928 and it is widely distributed from the coastal area of Mozambique, to inland northern KwaZulu-Natal and the northern Eastern Cape coast. The species occurs in scarp and coastal forest. This species is known from several protected areas, including Nkhandla Forest Reserve, Hluhluwe-Imfolozi Game Reserve, and Oribi Gorge, Umtamvuma and Mkhambati Nature Reserves. The area around the type locality in Mozambique is largely transformed by housing and subsistence agriculture, and along the south coast of KwaZulu-Natal habitat has been lost through tourism development, agriculture and industry.

The estimated EOO = 50 000km² and the AOO = 50km² and number of locations = 11. *Centrobolus vulpinus* thus qualifies as Least Concern (LC).

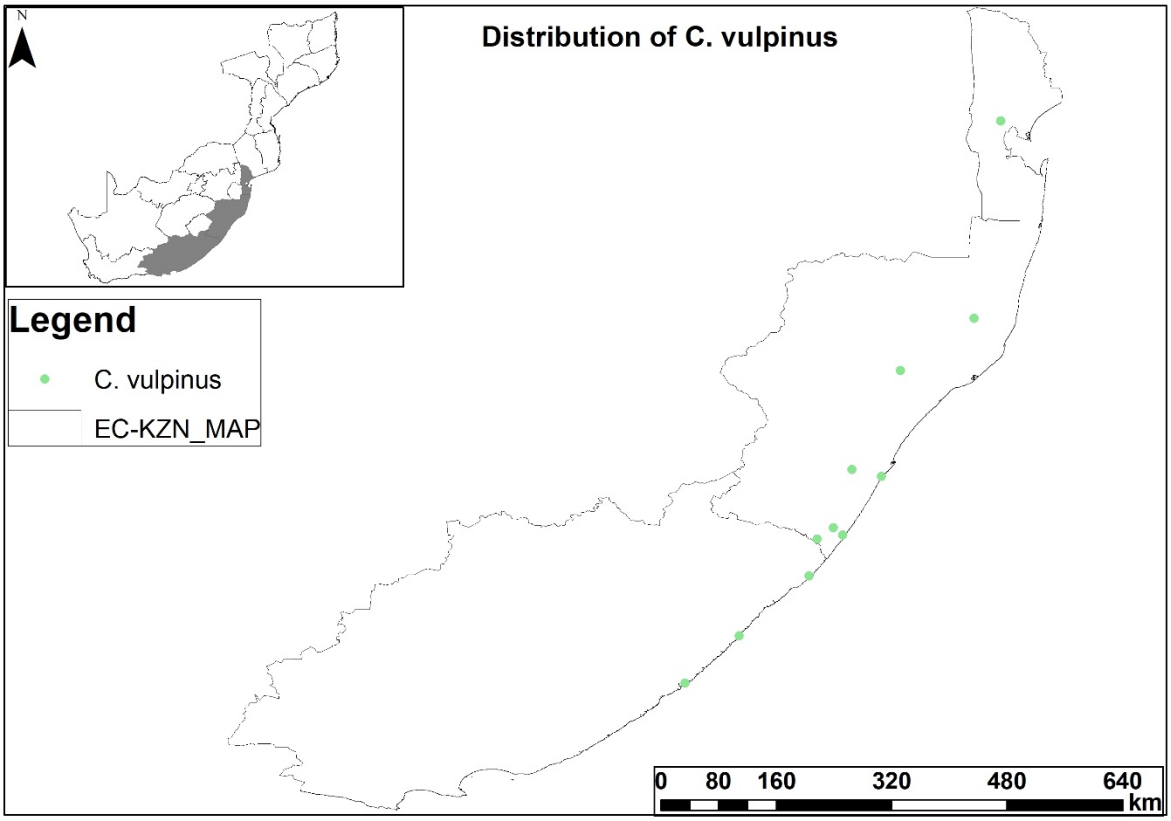

Figure 165: Distribution of *Centrobolus vulpinus* in southern Africa. EC= Eastern Cape, KZN= KwaZulu-Natal.

Figure 166: *Centrobolus vulpinus*. **A** Unknown locality, photo provided by M. Hamer, **B** Mkhambati Nature Reserve. Photographer: Grobler (CC-BY-NC). Source iNaturalist, **C** Umtamvuma Nature Reserve. Photographer: Vynbos (CC-BY-NC). Source Inaturalist.

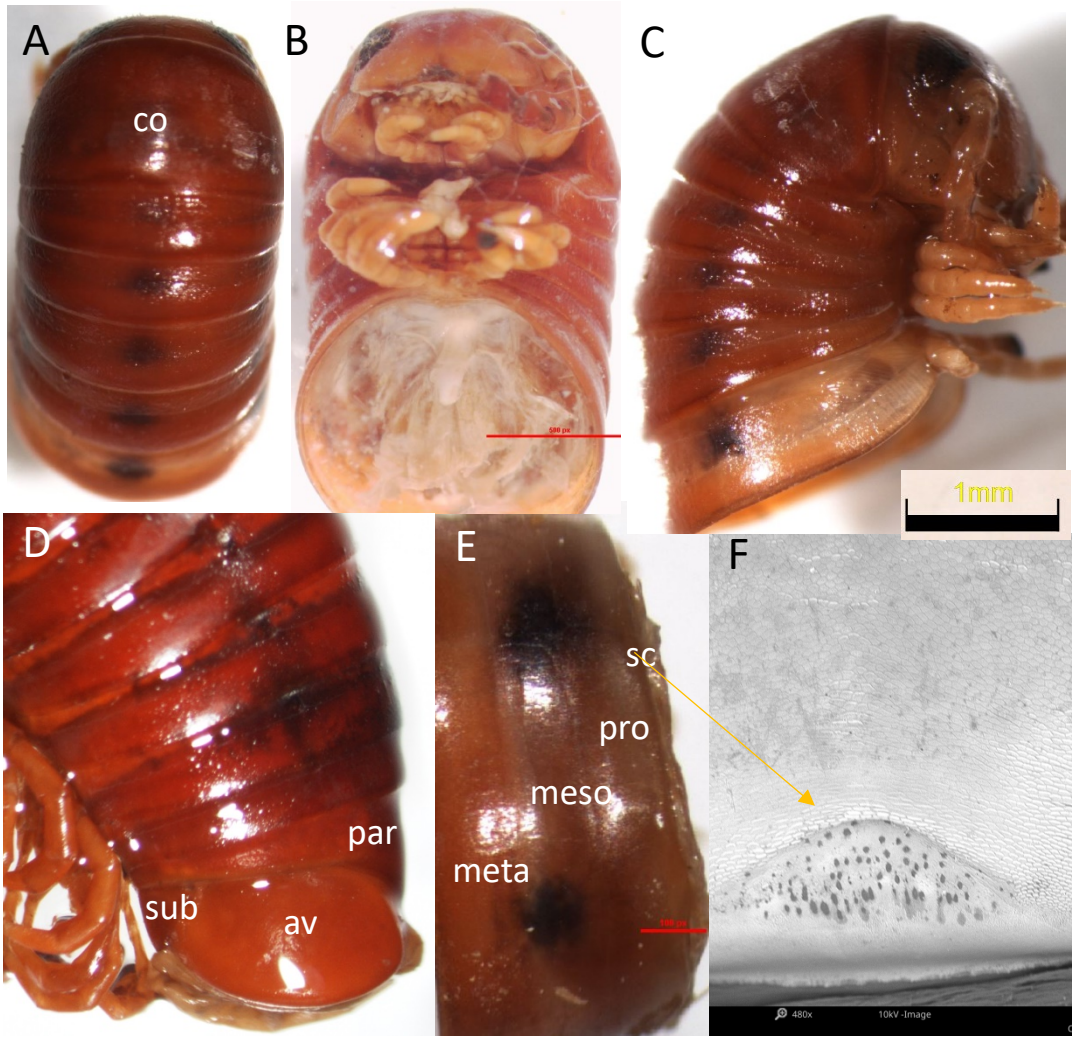

Figure 167: *Centrobolus vulpinus* (Mkhambathi Nature Reserve, Eastern Cape) ♂ (III-UKZN 6342). **A** anterior view of the head and collum, **B** ventral view, **C** lateral view, **D** terminal region of body, **E-F** body ring. Abbreviations: av - anal valve; co – collum; meso – mesozonite; meta – metazonite; par - preanal ring; pro – prozonite; sc - scobina. Scale bars: 1.0 mm (**A-E**); 0.1 mm (**F**).

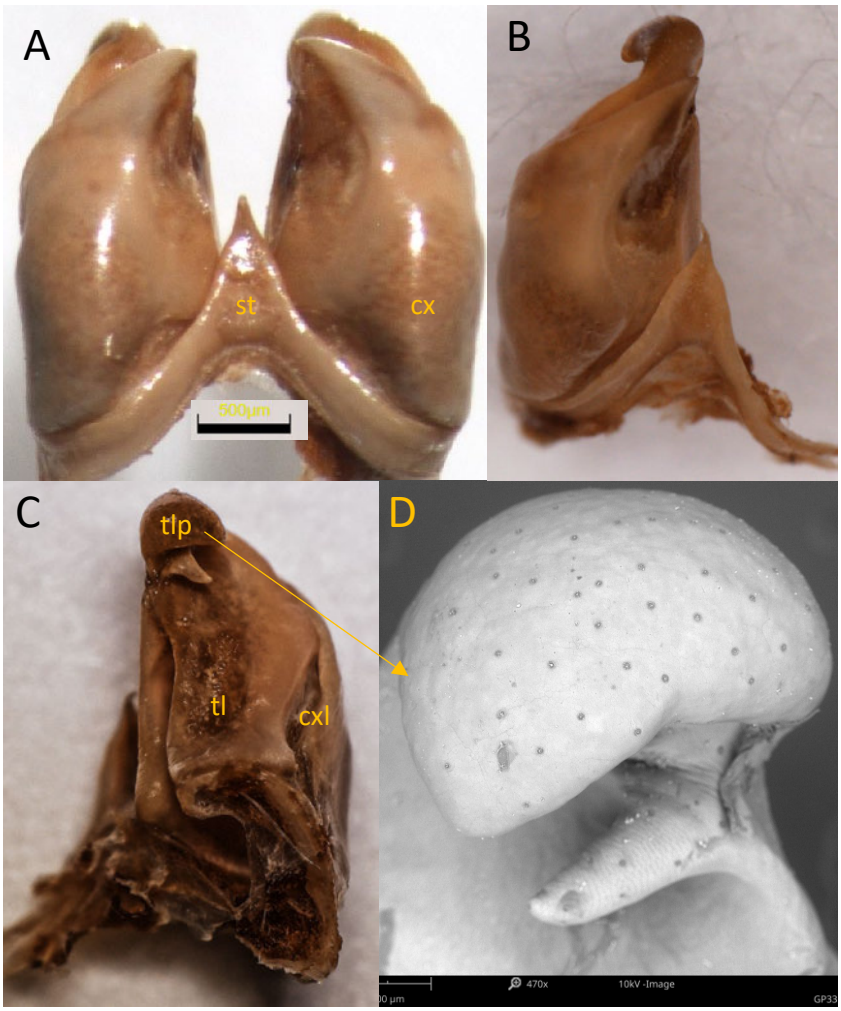

Figure 168: *Centrobolus vulpinus* ♂ (III-UKZN 6342). **A-D** anterior gonopod; **A-B** anterior view, **C-D** posterior view. Abbreviations: cx – coxa; cxl - coxal endite lobe; st – sternum; tl – telopodite; tlp - telopodite process. Scale bars: 0.5 mm (**A-C**); 0.1 mm (**D**).

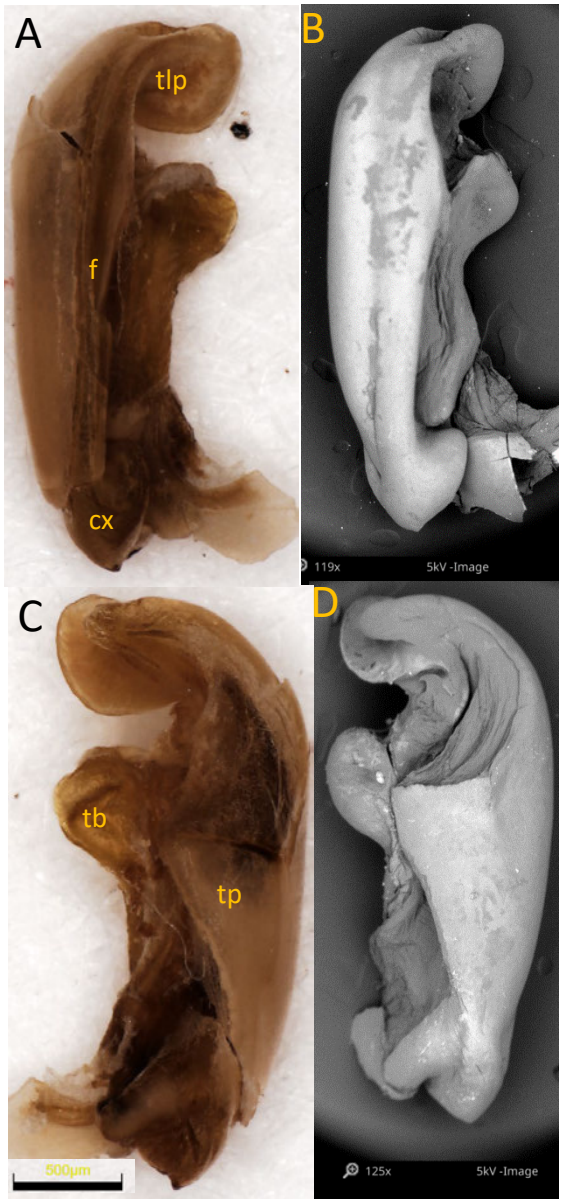

Figure 169: *Centrobolus vulpinus* ♂ (III-UKZN 6342). **A-D** posterior gonopod; **A-B** anterior view, **C-D** anterior view. Abbreviations: cx – coxa; f - efferent groove; tb - tibial process; tl – telopodite; tlp - telopodite process. Scale bars: 0.5 mm.

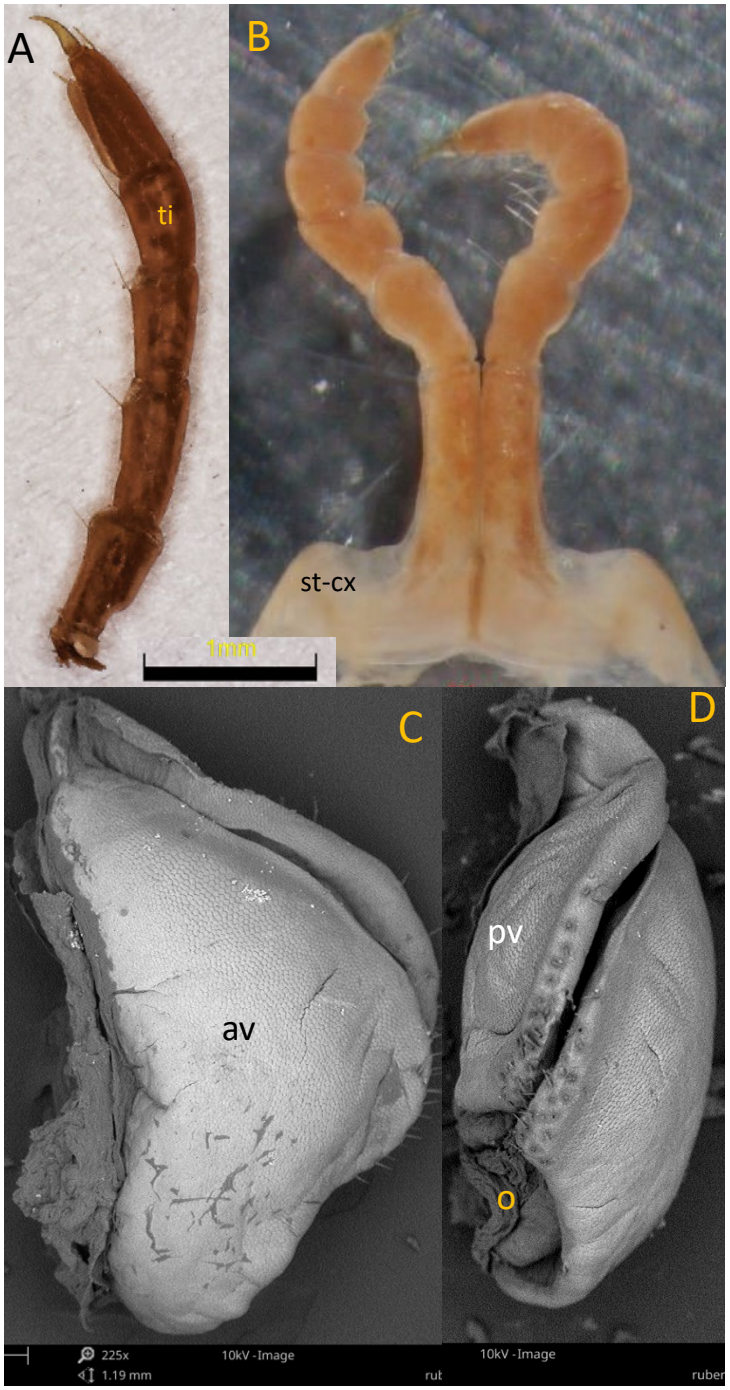

Figure 170: *Centrobolus vulpinus* ♀ (MH59). **A** male leg, **B** female second pair leg, **C-D** vulva, **D** lateral view, **C** anterior view. Abbreviations: av - anterior valve; o – operculum; pv - posterior valve; st-cx – coxosternite; ti –tibia. Scale bars: 1.0 mm (**A-B**); 0.3 mm (**C-D**).

***Centrobolus* sp. n1**

Figs 171-175

Diagnosis. Differs from congeners in the anterior gonopods with sternum with a broadly triangular-shaped structure apically (Figs 173A-B) and with coxa reduced, reaching only about half the length of the telopodite; distal process of anterior gonopod telopodite with two short, subequal parts, forming a structure resembling an open bird's beak, with the distal part more hooked than proximal part (Figs 173C-D); short legs with reduced tarsal pads on all legs except the first two pairs; scobinae absent; generally rusty-brown colour.

Description. *Measurements*: ♂ Total length 35-40mm, greatest width 5mm, 43+0+T body rings, n=3. ♀ Total length 32-40mm, greatest width 5-6mm, 43+0+T body rings, n=3

Body sculpturing: Collum and body rings shiny with very few transverse striae and concentric parallel striation longitudinally with minute punctures; scobinae absent (Figs 172E-F); preanal rings and anal valves with granulation.

Legs: Legs short, not exceeding lateral margin of body rings when extended, with indistinct tarsal pads on all legs excluding the first two pairs; tibia condensed with one apical bristle; the length shorter than width (Fig. 175A).

Colour (after 23 years in ethanol): The body in general rusty red-brown; head, antennae, legs (Figs 172A-C), preanal rings and anal valves reddish-brown (Figs 172D); collum red-brown with lighter markings; body rings with reddish-brown metazonites, mesozonites brown and prozonites light brown with dark brown margin (Fig. 172E).

Gonopods: *Anterior gonopods*: Sternum of the anterior gonopods long, extending almost two thirds length of telopodite, median extension broad, slightly tapered and with broadly triangular-shaped structure apically (Fig 173A-B). Coxa reduced, reaching only about half the length of the telopodite; distal process of telopodite with two short, subequal parts, forming a structure resembling an open bird's beak, with the distal part more hooked than proximal part; both parts with sparsely distributed short spines (Figs 173A-B).

Posterior gonopods: Suture line separating the telopodite and coxite visible; efferent groove and tibial processes absent; seminal duct opening at the base of the membrane/lamella; telopodite apically widening with lamella protruding outwards (Fig. 174).

Female sexual characters: Second pair of legs with distal margin of lateral extensions of the coxosternum with wide and bluntly triangular bulge (Fig. 175B). Vulva roughly kidney-shaped with margin below operculum extended; anterior valve overlapping the posterior one; both valves with two to three irregular rows of setae; operculum poorly sclerotized (Figs 175C-D).

Type locality: SOUTH AFRICA: *KwaZulu-Natal*: Pongola Bush Nature Reserve.

Type material. Holotype: ♂ SOUTH AFRICA: KwaZulu-Natal, Pongola Bush Nature Reserve, Escarpment, 1995-01, Hamer M. (NMSA-15666).

Paratype: SOUTH AFRICA: 1 ♂ same data as for holotype.

Additional material examined. SOUTH AFRICA: *KwaZulu-Natal*: 1♂ 3♀ Groenvlei catchment area, high dolerite/sandstone area, 1998-01, Hamer M. (NMSA-16359).

Distribution. This species has only been recorded from forest patches in two localities in inland north-western KwaZulu-Natal province.

Remarks: The reduced coxa of the anterior gonopods, the shape of the sternum and of the posterior gonopods and the absence of scobinae in this species distinguish it from other *Centrobolus* species, and are not typical of the genus. This may suggest that the new species represents a separate genus, but molecular data are required to confirm this. The posterior gonopods resemble those of the genus *Pseudocentrobolus* of Southwestern Madagascar.

Conservation assessment

This is a South African species described here from KwaZulu-Natal but collected in 1995 by M. Hamer. The species has been recorded in the Groenvlei area and the Pongola Bush Nature Reserve, about 35 km away, and occurs in forest or woodland. There are several other forest and woodland patches in the region where this species might occur, but it is likely to have a restricted distribution, with EOO estimated to be a maximum of 2000 km² and the AOO is estimated to be less than 50 km². While only two localities are known, if there are others, the distribution will be fragmented because of the pattern of habitat distribution in the area.

Pongola Bush Nature Reserve is a protected area, but the Groenvlei location is on private land. There are coal reserves in the area, and so there could be mining in future. There is also agriculture surrounding Pongola Bush Nature Reserve. These activities do not seem to have impacted on the forest habitat, much of which is along steep slopes or cliffs. Uncontrolled fires are a potential threat. Since there is no evidence that AOO or the EOO have declined or will decline in future, this does not qualify for any of the categories under B, Geographic range. However, the small number of locations (<5) means that it can be categorised as Vulnerable (VU) D2.

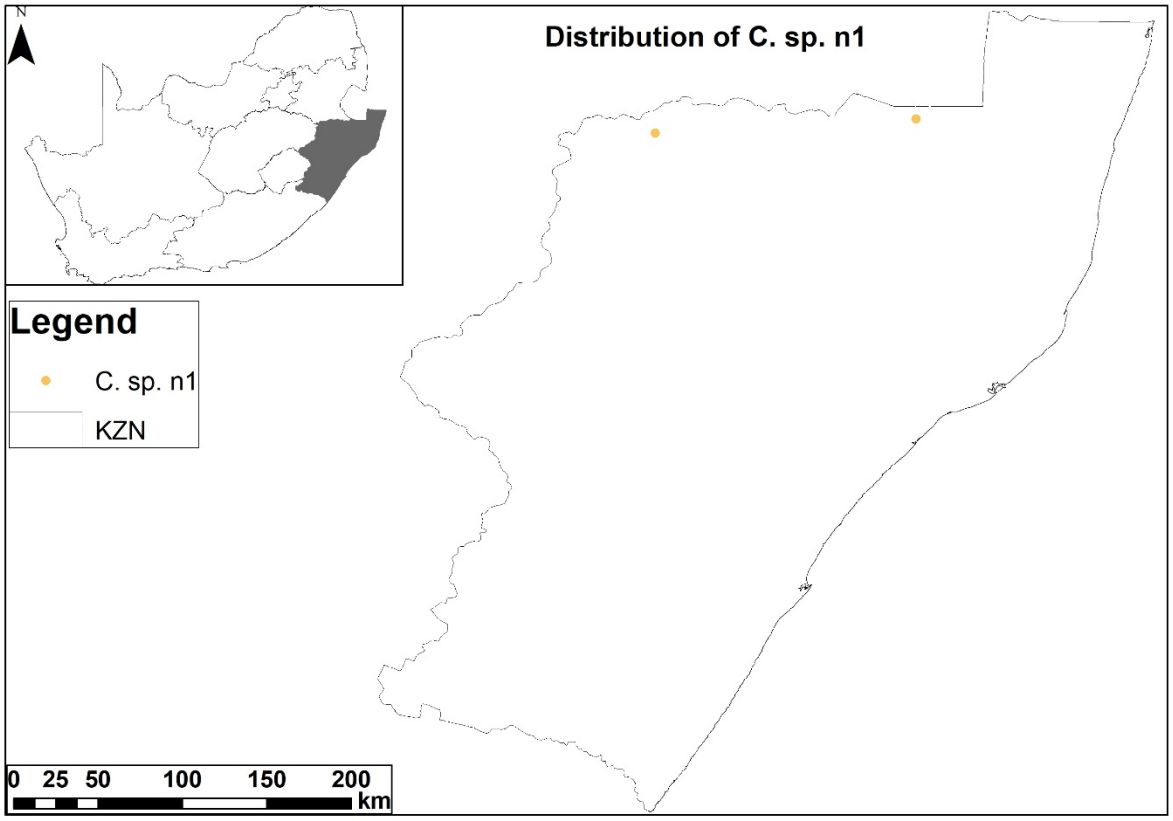

Figure 171: Distribution of *Centrobolus* sp. n1 in South Africa, KwaZulu-Natal.

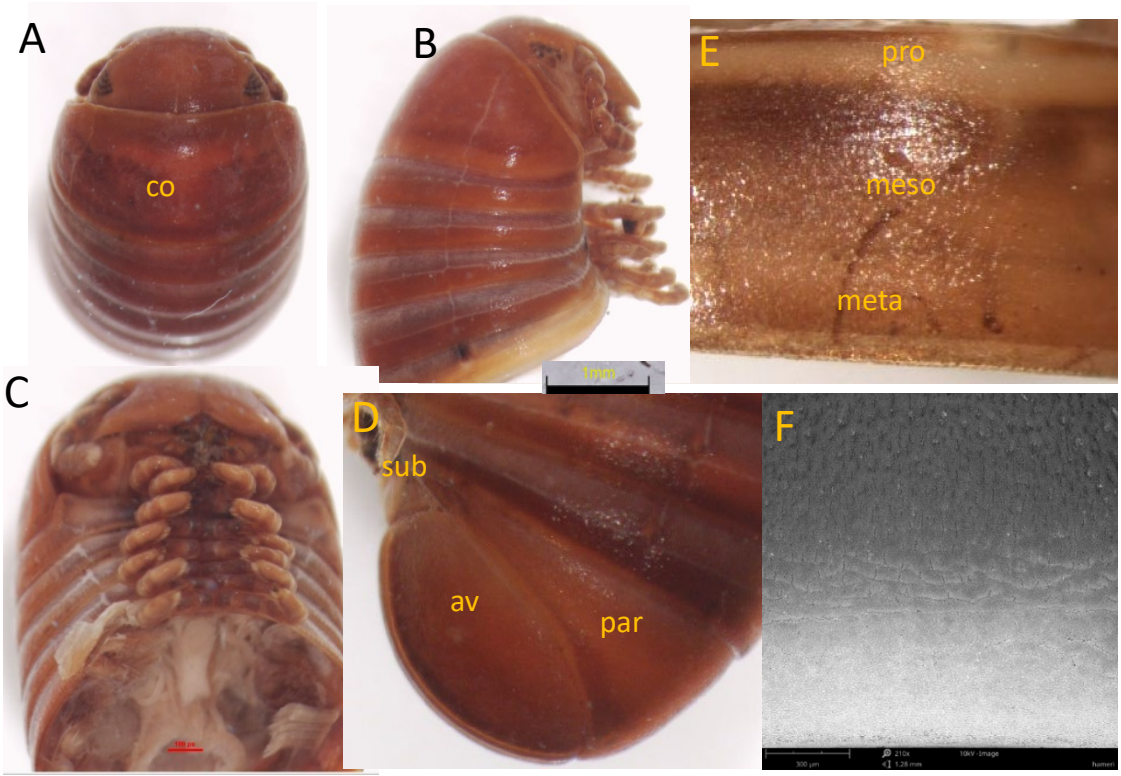

Figure 172: *Centrobolus* sp. n1 (Pongola Bush Nature Reserve, Escarpment, KwaZulu-Natal) ♂ (NMSA-15666). **A** anterior view of the head and collum, **B** lateral view, **C** ventral view, **D** terminal region of body, **E-F**body ring. Abbreviations: av - anal valve; co – collum; meso – mesozonite; meta – metazonite; par - preanal ring; pro – prozonite; sub - subanal scale. Scale bars: 1.0 mm (**A-E**); 0.3 mm (**F**).

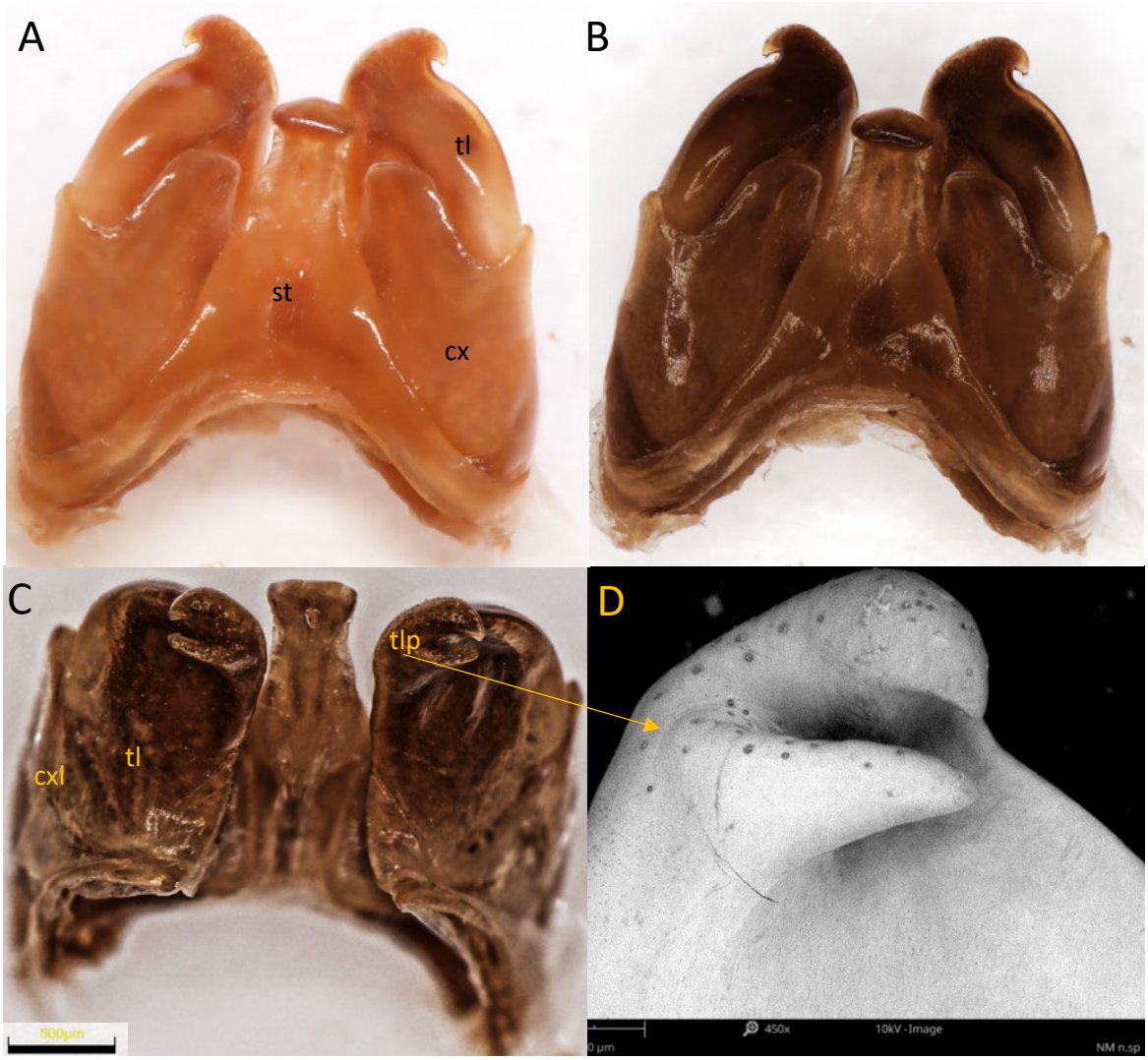

Figure 173: *Centrobolus* sp. n1 ♂ (NMSA-15666). **A-D** anterior gonopod; **A-B** anterior view, **C-D** posterior view. Abbreviations: cx – coxa; cxl – coxal endite lobe; st – sternum; tl – telopodite; tlp - telopodite process. Scale bars: 1.0 mm (**A-D**, **F**); 0.1 mm (**E**).

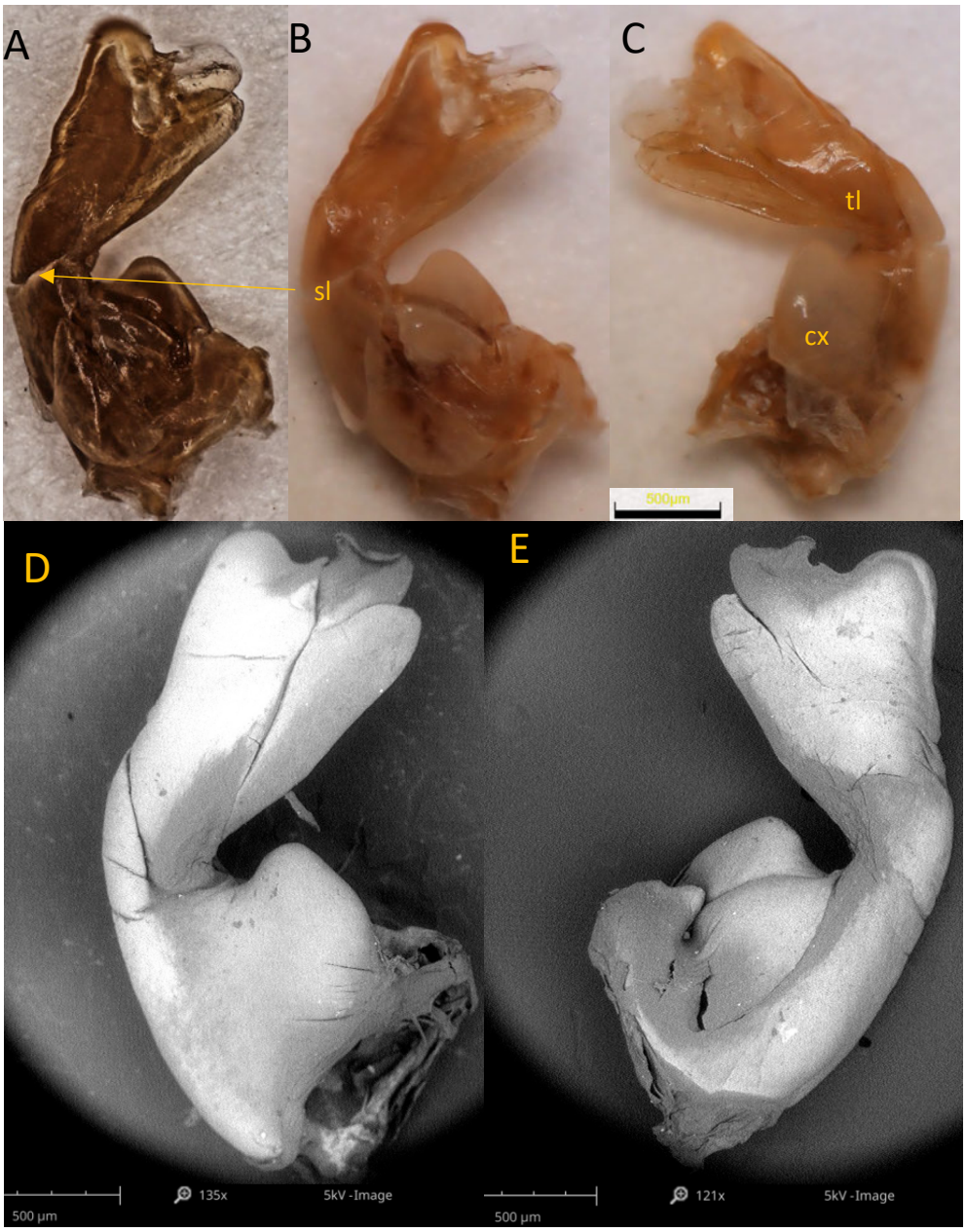

Figure 174: *Centrobolus* sp. n1 ♂ (NMSA-15666). **A-E** posterior gonopod, **A**, **B** & **E** anterior view, **C-D** posterior view. Abbreviations: cx – coxa; sl - suture line; tl – telopodite. Scale bars: 0.5 mm.

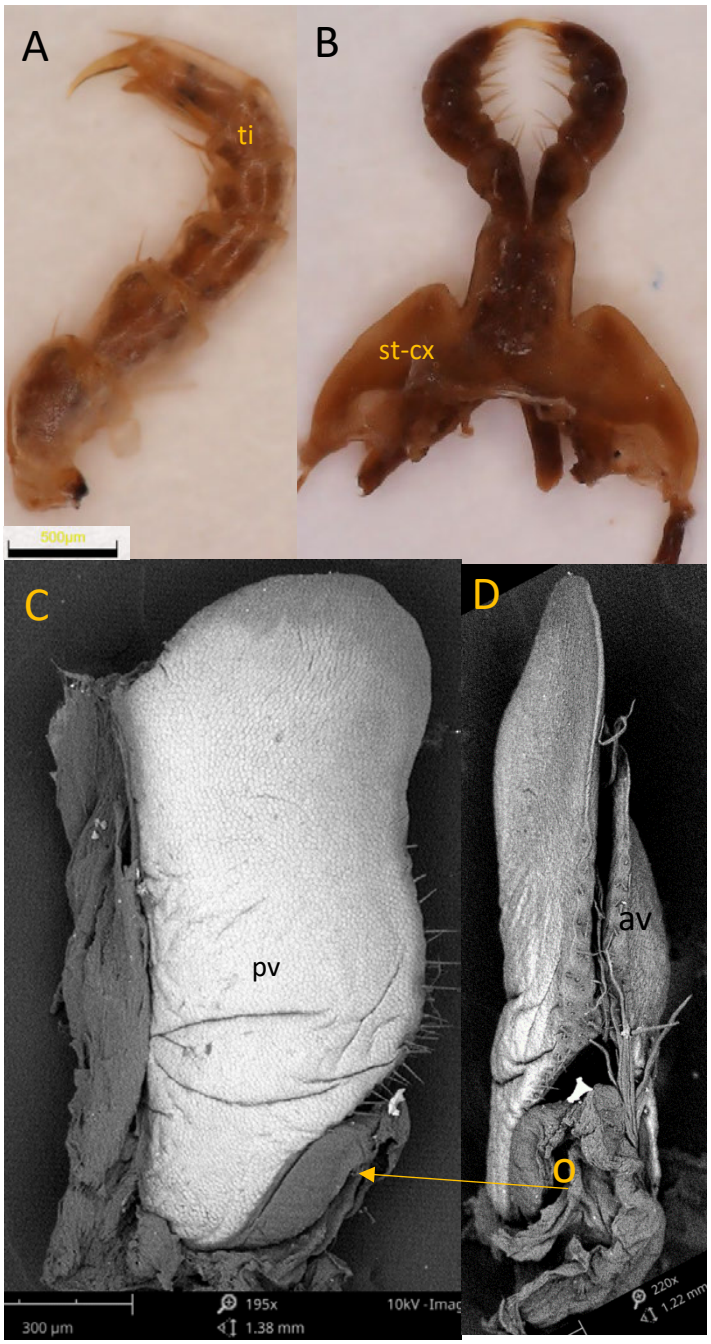

Figure 175: *Centrobolus* sp. n1 (Groenvlei, KwaZulu-Natal) ♀ (NMSA-16359). **A** male leg, **B** female second pair leg, **C-D** vulva, **D** lateral view, **C** posterior view. Abbreviations: av - anterior valve; o – operculum; pv - posterior valve; st-cx – coxosternite; ti –tibia. Scale bars: 0.5 mm (**A-B**); 0.3 mm (**C-D**).

***Centrobolus* sp. n2**

Figs 176-180

Diagnosis. Differs from congeners mainly in the colouration, body in general black; head reddish with black mask across eye region (Figs 177A-B); collum uniformly black; legs and antennae yellow (Fig. 177B); the wide, robust coxae of the anterior gonopods together with the shape of the distal telopodite processes which comprises two parts, the distal one indistinct and forming an elongated and narrow, slight inflation, with scattered minute setae; proximal part a short, triangular projection (Figs 178D-E); sternum of the anterior gonopods with median extension reaching beyond halfway length of telopodite, broad but strongly tapered and apically very narrow.

Description. *Measurements*: ♂ Total length 60mm, greatest width 6.5mm, 42+0+T body rings, n=2.

Body sculpturing: Body smooth and shiny with few coarse transverse striae and minute punctuation; scobinae present and crescent shape (Figs 177E-F).

Legs: Legs long, exceeding lateral margin of body rings when extended; all legs with prominent tarsal pads except the first two and the last 14 pairs in male; tibia standard length and width with two apical bristles (Fig. 180).

Colour ♂ (after 19 years in ethanol): The body in general black; head reddish with black mask across eye region (Figs 177A-B); collum uniformly black; legs and antennae yellow (Figs 177C); preanal ring and anal valves reddish (Fig. 177D.); body rings with black metazonites, mesozonites and prozonites with reddish sutures (Fig. 177E).

Gonopods: *Anterior gonopods*: Sternum of the anterior gonopods with median extension reaching beyond halfway up length of telopodite, broad but strongly tapered and apically very narrow (Figs 178A-C). Coxa with lateral margin straight, distal half bent medianly at about 45°; distal part with median margin concave (Figs 178A-C). Distal process of telopodite with two parts, the distal one indistinct and forming a slight elongated and narrow inflation, with scattered minute setae; proximal part a short, triangular projection (Figs 178E-F).

Posterior gonopods: Tibial processes broad, triangular, short and projected outwards with seminal duct opening on its proximal end; efferent groove longitudinal, well developed and runs up along basal half of telopodite; inflated lobe present and large; coxa completely fused with the telopodite; distal processes of the telopodite smoothly rounded (Figs 179).

Female sexual characters: Unknown.

Type locality: SOUTH AFRICA: *KwaZulu-Natal*: Richmond area.

Type material. Holotype: 1♂ SOUTH AFRICA: KwaZulu-Natal, Richmond area, moist valley area near Umkomaas River valley, 29.98828°S, 30.24749°E, 2000-11, Hamer M. (MH 69, UKZN).

Paratype: SOUTH AFRICA: 1♂ same data as the holotype.

Distribution. This species has only been recorded from one locality, at Hela Hela, along the Umkomaas River, outside Richmond in the midlands region of KwaZulu-Natal province.

Remarks. The colouring of this species resembles that of *C. sanguinipes* but it differs from that species in other characters such as shape of gonopods. The sternum of the anterior gonopods and the posterior gonopods are similar to those of *C. fulgidus* however, the two species differ in the shape of the distal process of the telopodite of the anterior gonopods and colour. The type locality needs to be sampled to collect females of this species to describe the female characters.

Conservation assessment

This is a South African species described here from KwaZulu-Natal and collected in 2000 by M. Hamer. There is insufficient information to make an assessment of the conservation status of this species, which has only been recorded in the Richmond area and occurs in Valley Bushveld type vegetation. There are fairly large areas of this habitat type along Umkomaas River valley, but much of it is difficult to access and so it has not been well surveyed. It is possible that this species is restricted to this river valley since other parts of KwaZulu-Natal have been well surveyed. Given the large area along the river, and the inaccessibility of much of this, there are few threats to the habitat apart from the proposed construction of a large dam on the Umkomaas River and some commercial and subsistence agriculture. The species is not known from a protected area. As a result of the lack of distribution data, this species is assessed as Data Deficient (DD).

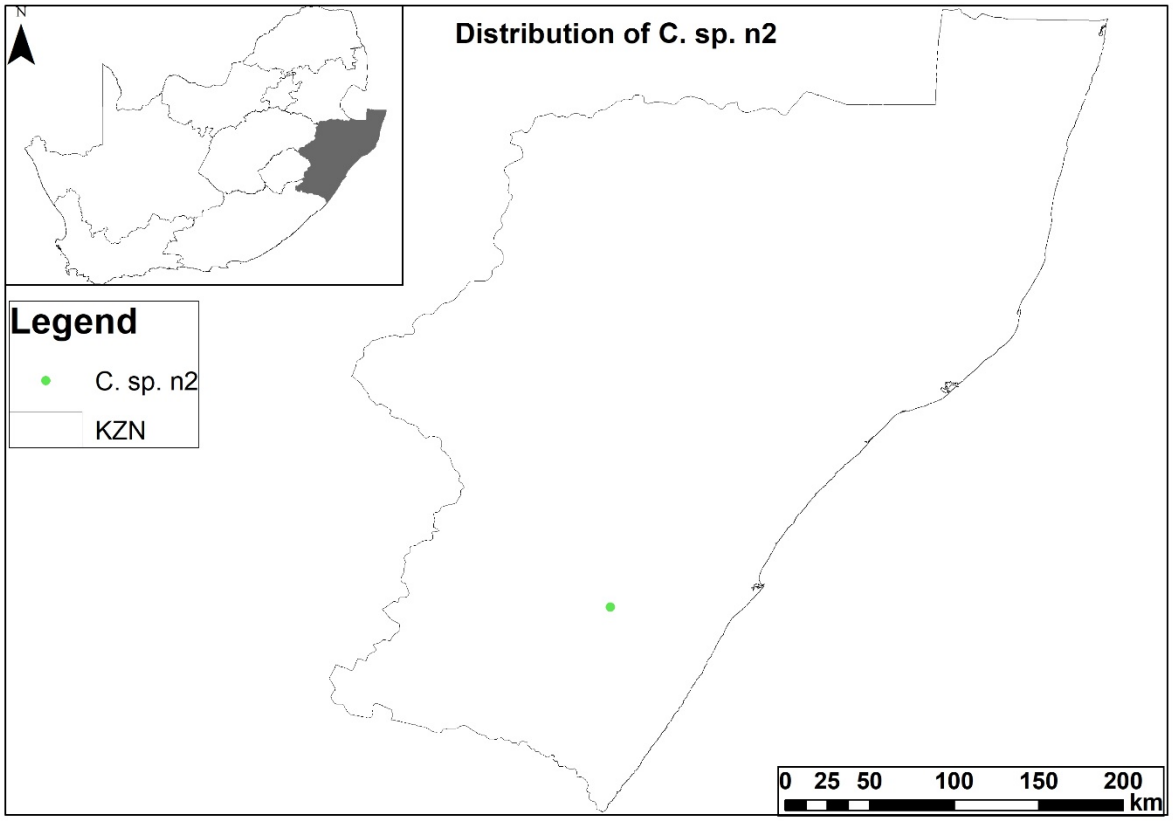

Figure 176: Distribution of *Centrobolus* sp. n2 in South Africa, KwaZulu-Natal.

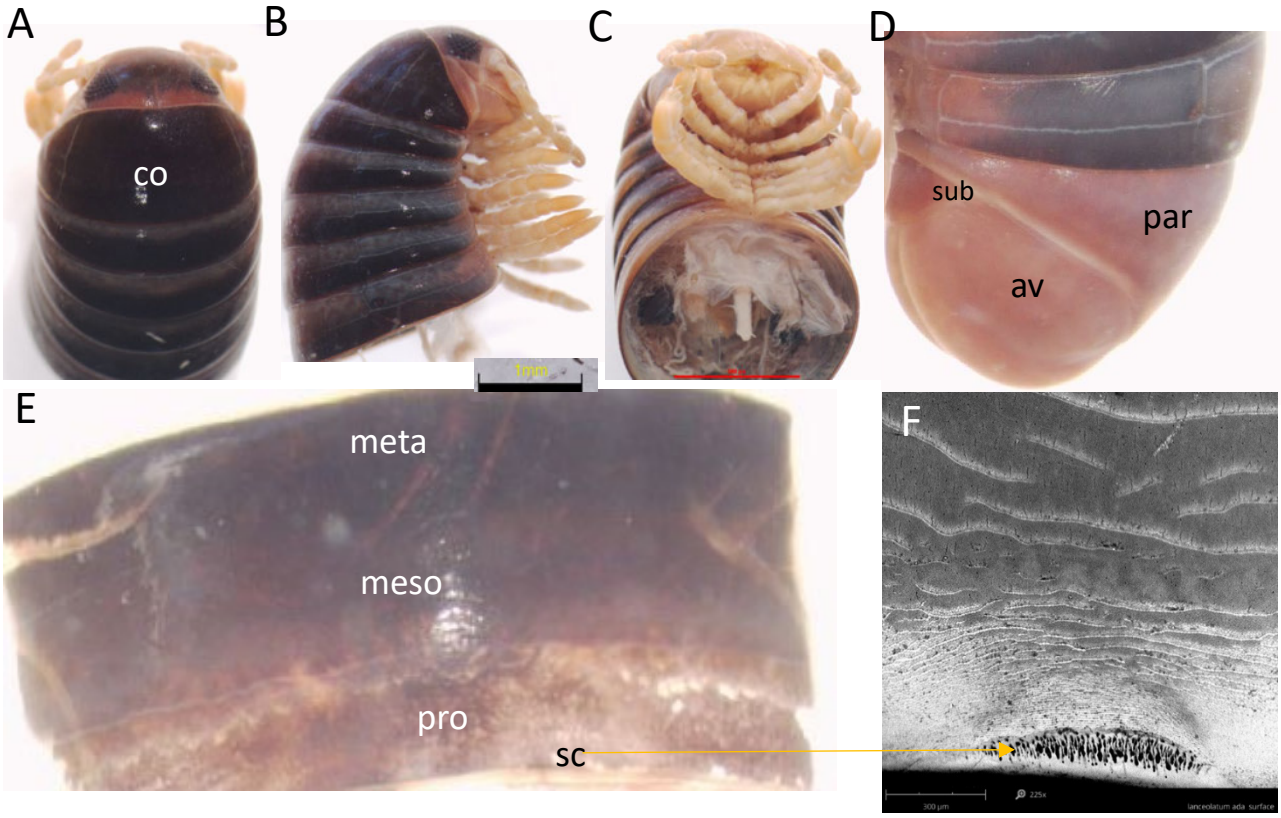

Figure 177: *Centrobolus* sp. n2 (Richmond area, KwaZulu-Natal) ♂ (MH 69). **A** anterior view of the head and collum, **B** lateral view, **C** ventral view, **D** terminal region of body, **E-F**body ring. Abbreviations: av - anal valve; co – collum; meso – mesozonite; meta – metazonite; par - preanal ring; pro – prozonite; sc – scobina; sub - subanal scale. Scale bars: 1.0 mm (**A-E**); 0.3 mm (**F**).

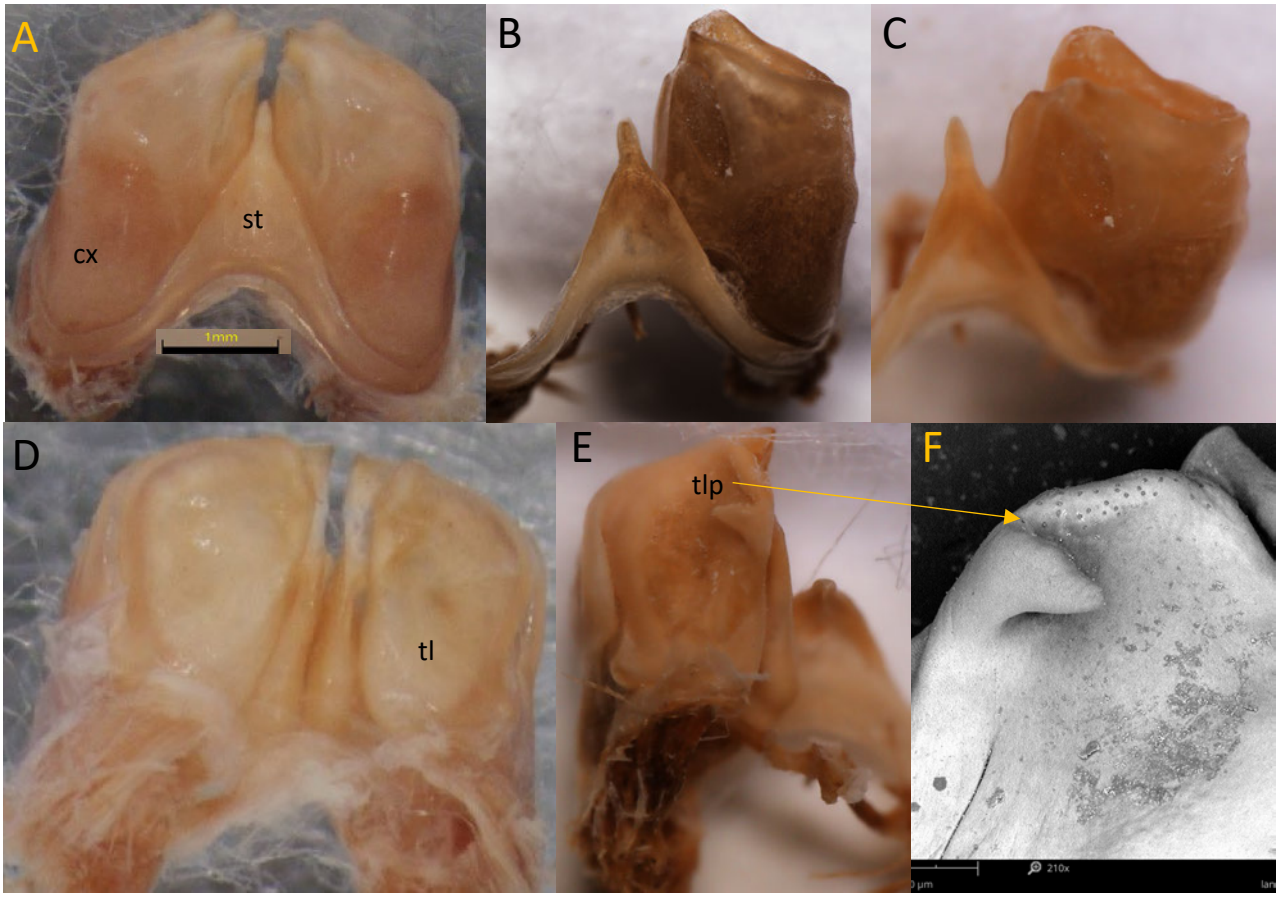

Figure 178: *Centrobolus* sp. n2 ♂ (MH 69). **A-F** anterior gonopods; **A-C** anterior view, **D-F** posterior view. Abbreviations: cx – coxa; st – sternum; tl – telopodite; tlp - telopodite process. Scale bars: 1.0 mm (**A-E**); 0.3 mm (**F**).

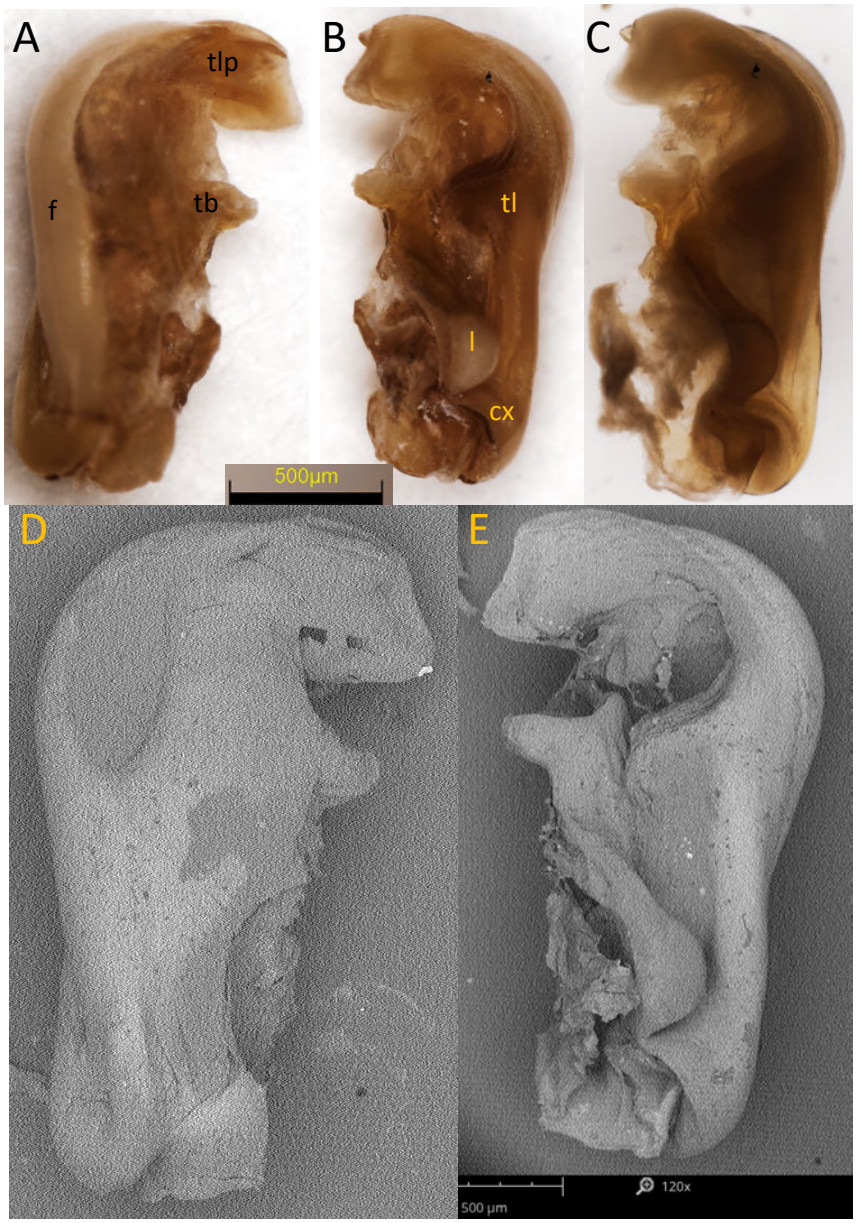

Figure 179: *Centrobolus* sp. n2 ♂ (MH 69). **A-E** posterior gonopod; **B-C** & **E** anterior view, **A** & **D** posterior view. Abbreviations: cx – coxa; f - efferent groove; l – inflated basal lobe; tb -tibial process; tl – telopodite; tlp - telopodite process. Scale bars: 0.5 mm.

Figure 180: *Centrobolus* sp. n2 ♂ (MH 69). Male leg. Abbreviations: ti –tibia. Scale: 0.5mm.

***Centrobolus* sp. n3**

Figs 181-185

Diagnosis. Differs from congeners in the narrow pentagonally and apically extended shape of sternum of anterior gonopods (Figs 183A-B), together with , distal process of telopodite of anterior gonopods with distal part bulbous and narrow oval shaped, and proximal part a straight finger-like structure (Figs 183C-D).

Description. *Measurements*: ♂ Total length 33mm, greatest width 4mm, 43+0+T body rings, n=7. ♀ Total length 31mm, greatest width 4.8mm, 43+0+T body rings, n=2.

Body sculpturing: Body with minute punctuation; scobinae present with elongate triangular shape (Figs 182E-F).

Legs: Legs long (male legs longer than female), exceeding lateral margin of body rings when extended; all legs with tarsal pads except the first two pairs in male; tibia standard length and width with one apical bristle (Fig. 185A).

Colour (after 86 years in ethanol): Body in general yellowish/light brown; head, antennae, legs, anal valves and segment and collum yellowish/light brown (Figs 182A-E); body rings with light brown metazonites, mesozonites and prozonites (Fig. 182F); head with two dark spots underneath each eye (Fig. 182A).

Gonopods: *Anterior gonopods*: Sternum of the anterior gonopods long, broad and roughly elongated pentagonal shape, with apical area extended, reaching more than half height of coxae (Figs 183A-B). Coxa with lateral margin of proximal half straight, distal region bent about 45°, and with distal margin very slightly convex; median margin not concave (Figs 183A-B). Distal process of telopodite with two parts, distal one with folded and bulbous appearance, narrow oval shaped, with scattered minute setae, proximal part straight and finger-shaped (Figs 183C-D).

Posterior gonopods: Tibial process short and broad with seminal duct opening at base; efferent groove transparent, well developed and running along lateral margin; inflated lobe present and situated at base of telopodite; coxa completely fused with telopodite; distal process of telopodite smoothly rounded with broad attached lamella (Fig. 184).

Female sexual characters: Second pair of legs with distal margin of lateral extensions of the coxosternum with prominent, narrow bulge (Fig. 185B). Vulva bivalved and irregular bean-shaped, anterior valve with margin opposite operculum with three shallow scallops; both valves

basally with two to three rows of irregular setae; operculum poorly sclerotized; posterior valve slightly overlaps the anterior valve (Figs 185C-D).

Type material. Holotype: 1♂ SOUTH AFRICA: Eastern Cape, Hogsback, 1933-02, (SAM-ENW-B008329, SAMC).

Paratypes: SOUTH AFRICA: 6♂ 2♀ same data as holotype**.**

Distribution. This species has been recorded from one locality in an inland-forested area in the Eastern Cape province.

Remarks. More material needs to sampled to confirm the colour of the species, as it has faded.

Conservation assessment

This is a South African species described here from one locality in the Eastern Cape and collected in 1933. There is insufficient information to make an assessment on this species. The species has only been recorded from forest at Hogsback. There are large areas of forest on mountain slopes in the Amatole and Hogsback areas, and it is possible that this species occurs in these forests, which have not been surveyed for millipedes. This would still mean that the EOO would be at most 2500 km² and the AOO, including the two main forest area, would be less than 150 km². There is likely to have been some loss of habitat over the years since these forests were logged, and there has been some development of settlements and agriculture. The extent to which this is continuing is not certain. Some of the forest in the area is protected, but the level of management is weak. While this species may qualify as Endangered, the lack of distribution data and the poor knowledge of the millipede fauna of the area result in it being assessed as Data Deficient (DD).

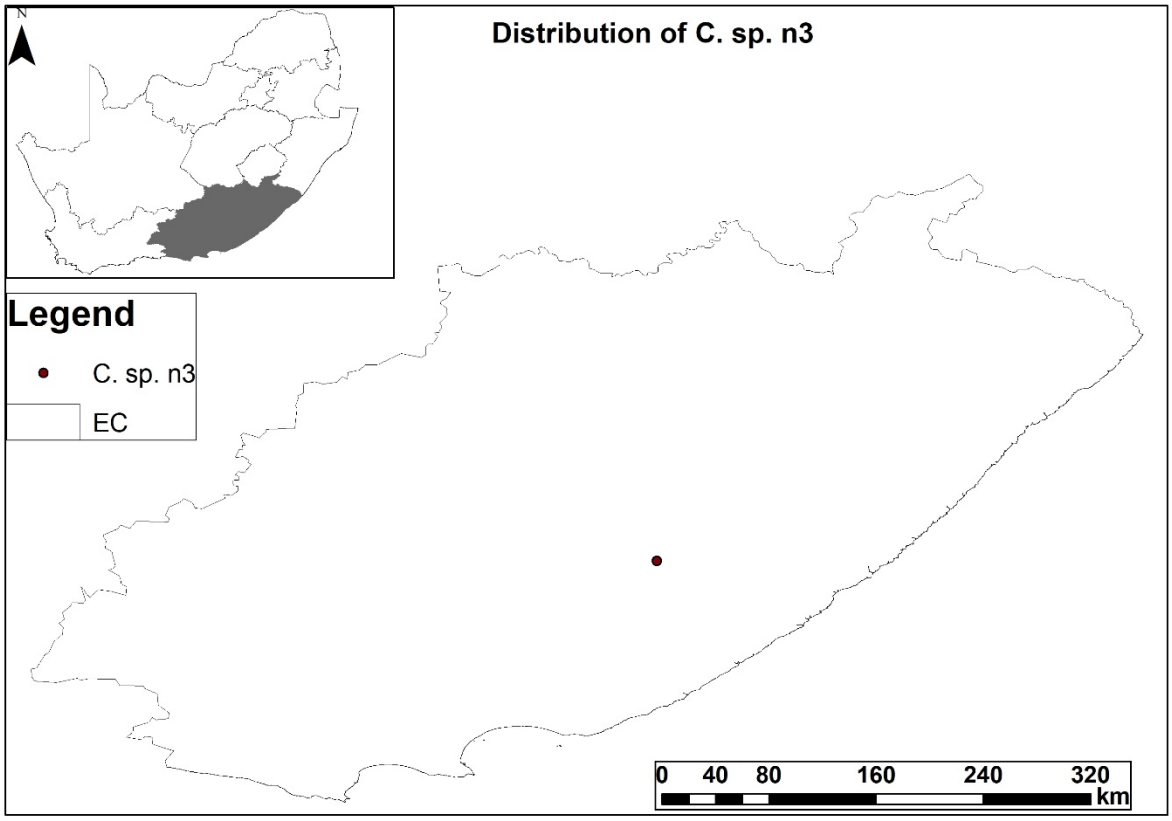

Figure 181: Distribution of *C.* sp. n3 in South Africa in Eastern Cape.

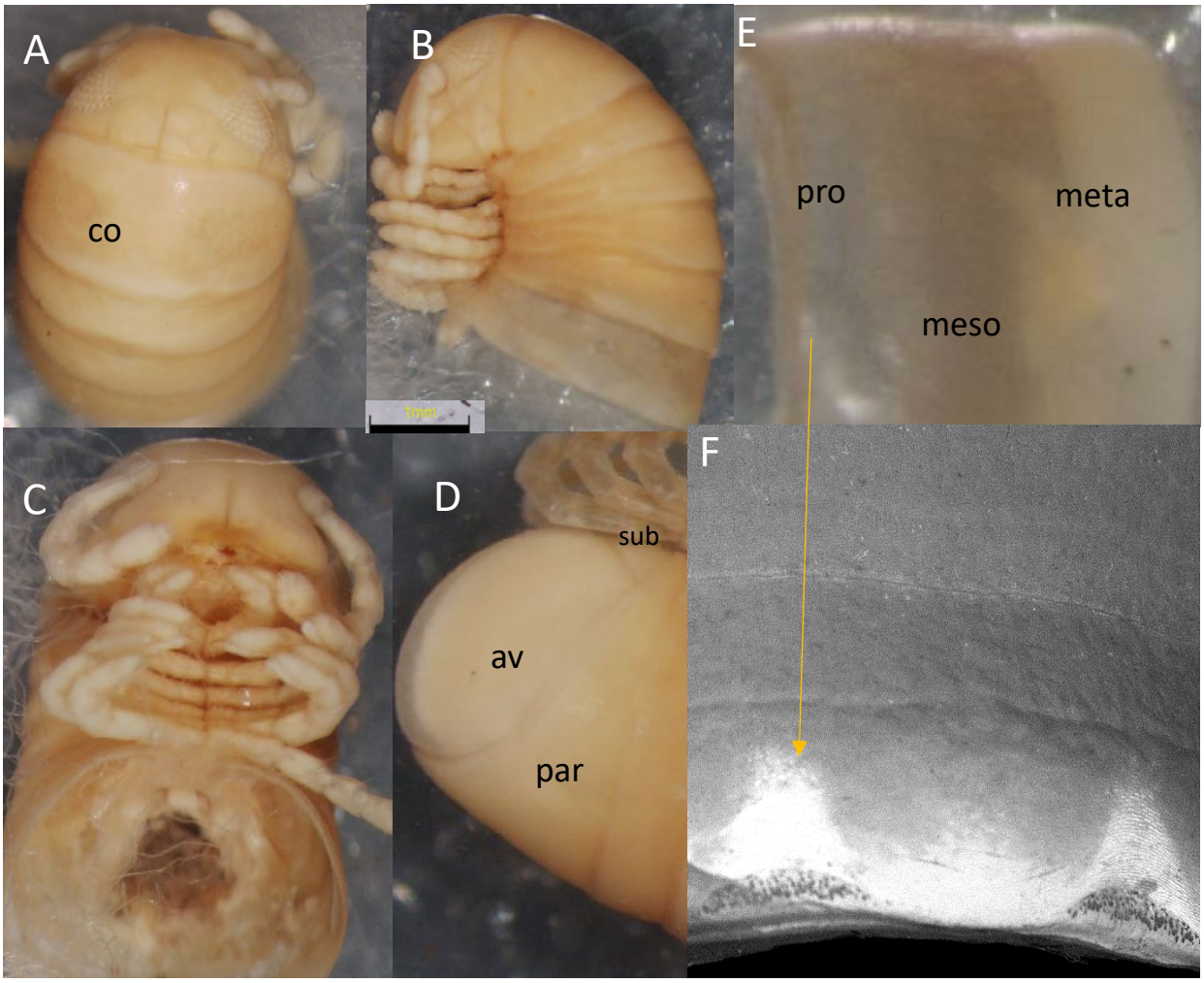

Figure 182: *Centrobolus* sp. n3 (Hogsback, Eastern Cape) ♂ (SAM-ENW-B008329) **A**-anterior view of the head and collum, **B** lateral view, **C** ventral view, **D** terminal region of body, **E-F**body ring. Abbreviations: av - anal valve; co – collum; meso – mesozonite; meta – metazonite; par - preanal ring; pro – prozonite. Scale bars: 1.0 mm (**A-E**); 0.3 mm (**F**).

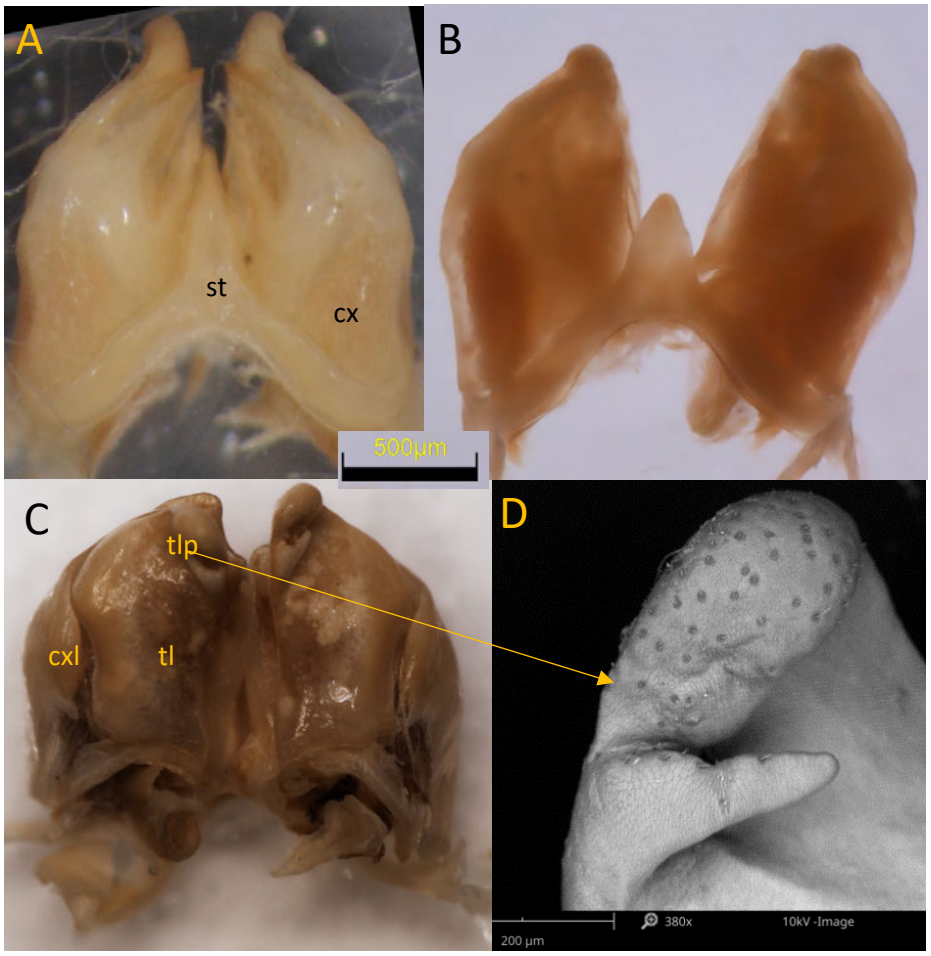

Figure 183: *Centrobolus* sp. n3 ♂ (SAM-ENW-B008329). **A-D** anterior gonopods, **A-B** anterior view, **C-D** posterior view. Abbreviations: cx – coxa; st – sternum; tl – telopodite; tlp - telopodite process. Scale bars: 1.0 mm (**A-C**); 0.2 mm (**D**).

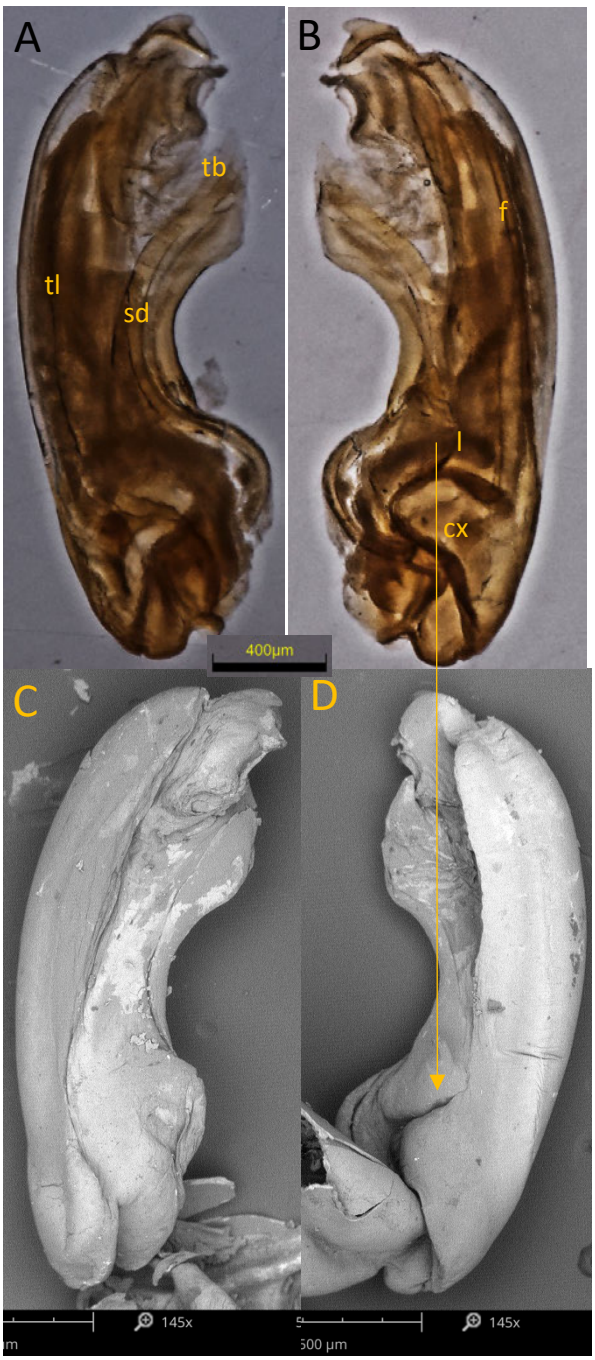

Figure 184: *Centrobolus* sp. n3 ♂ (SAM-ENW-B008329). **A-D** posterior gonopod, **B** & **D** anterior view, **A** & **C** posterior view. Abbreviations: cx –coxa; f - efferent groove; l – inflated basal lobe; tb - tibial process; tl – telopodite; tlp - telopodite process. Scale bars: 0.4 mm.

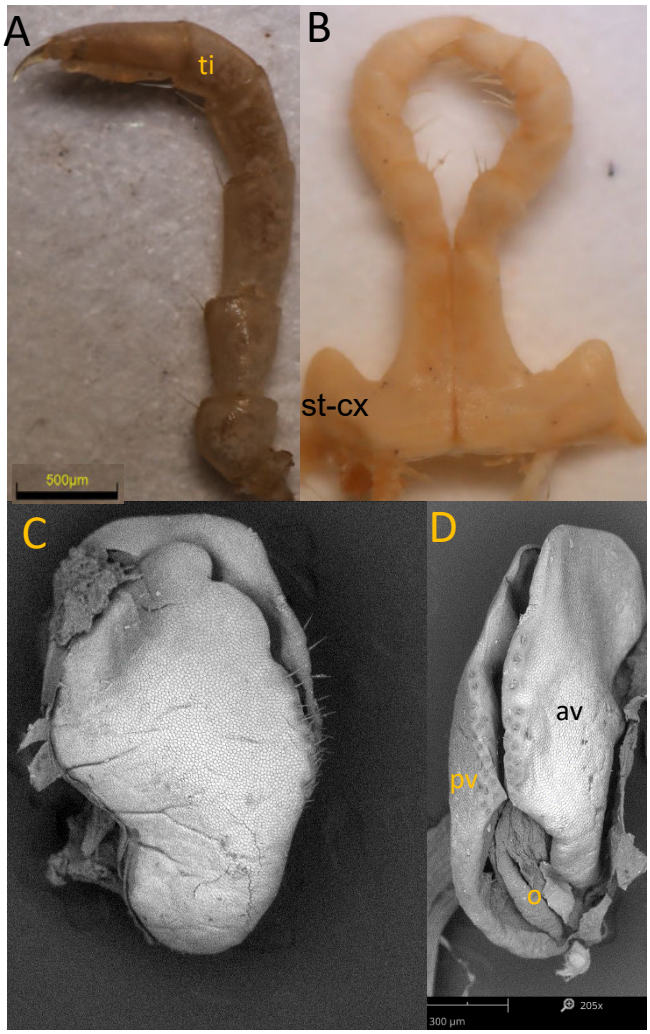

Figure 185: *Centrobolus* sp. n3 ♀(SAM-ENW-B008329). **A** male leg, **B** female second pair leg, **C-D** vulva, **D** lateral view, **C** anterior view. Abbreviations: av - anterior valve; o – operculum; pv - posterior valve; st-cx – coxosternite; ti –tibia. Scale bars: 0.5 mm (**A-B**); 0.3 mm (**C-D**).

***Centrobolus* sp. n4**

Figs 186-190

Diagnosis. Differs from congeners in the combination of black legs with white tibia and tarsi; last six pairs of legs without tarsal pads; sternum of anterior gonopods short and apically acute; distal process of telopodite of anterior gonopods with distal part bulbous and proximal part a straight finger-like structure (Figs 188C-D).

Description. *Measurements*: ♂ Total length 45mm, greatest width 5mm, 41+0+T body rings n=4.

Body sculpturing: Body shiny with microscopic punctures and minute striae; scobinae present and large, half-oval shaped (Fig. 187E).

Legs: Legs very long, exceeding lateral margin of body rings when extended, first two and the last six pairs of legs without tarsal pads in male; tibia standard length and width with one apical bristle (Fig. 190).

Colour (after 15 years in ethanol): Body in general red with longitudinal rows of small, dorso-median and dorso-lateral black spots; antennae black (Figs 187B-C); head black with red posterior margin (Fig. 187A); collum red (Fig. 187A), legs black with white tibia and tarsi (Figs 187A-B), preanal ring red with whitish yellow posterior margin and anal valves reddish (Fig. 187D); body rings with red metazonites, black mesozonites and dirty white/light brown prozonites (Figs 187A, C-D).

Gonopods: *Anterior gonopods*: Sternum of the anterior gonopods short, reaching about third height of telopodite and pointed at apex (Figs 188A-B). Coxa with lateral margin of proximal half straight, distally bent at about 35°, and with distal margin very slightly convex (Figs 188A-B). Distal process of telopodite with two parts, distal one with folded and bulbous appearance with scattered minute setae, proximal one well separated from distal one, straight and finger-shaped with few minute setae (Fig. 188C-D).

Posterior gonopods: Tibial process reduced; telopodite straight; inflated basal lobe present but indistinct; longitudinal efferent groove not well developed, situated along lateral margin; distal process of telopodite short and covered with membrane (Fig. 189).

Female sexual characters: unknown.

Type material. Holotype: 1♂ SOUTH AFRICA: KwaZulu-Natal, Phinda Game Reserve, Mountain Lodge, 2004-01, Slotow R. (RS54, UKZN).

Paratypes: South Africa 3 ♂; same data as holotype.

Distribution. This species has been recorded from a small part of northern KwaZulu-Natal province. Additional specimens that most likely represent this species were posted on iNaturalist from Mlawula Nature Reserve, Mahlabashana River, Mbuluzi Gorge, Eswatini.

Remarks. The specimens were labelled as *Centrobolus albitarsis* by Professor Michelle Hamer probably because of the white tarsi of this species however the gonopods do not match the description of that species and there are also differences in colour between the two species.

Conservation assessment

This is a South African species described from KwaZulu-Natal in 2019 but collected in 2000. There is insufficient information to make an assessment of this species which has only been recorded in Phinda Game Reserve, Mountain Lodge where it occurs in forest in a secure protected area with no evidence of reduced area of occupancy. There may be additional localities, as suggested by the iNaturalist posts but this needs to be confirmed. This species is therefore considered to be Data Deficient (DD).

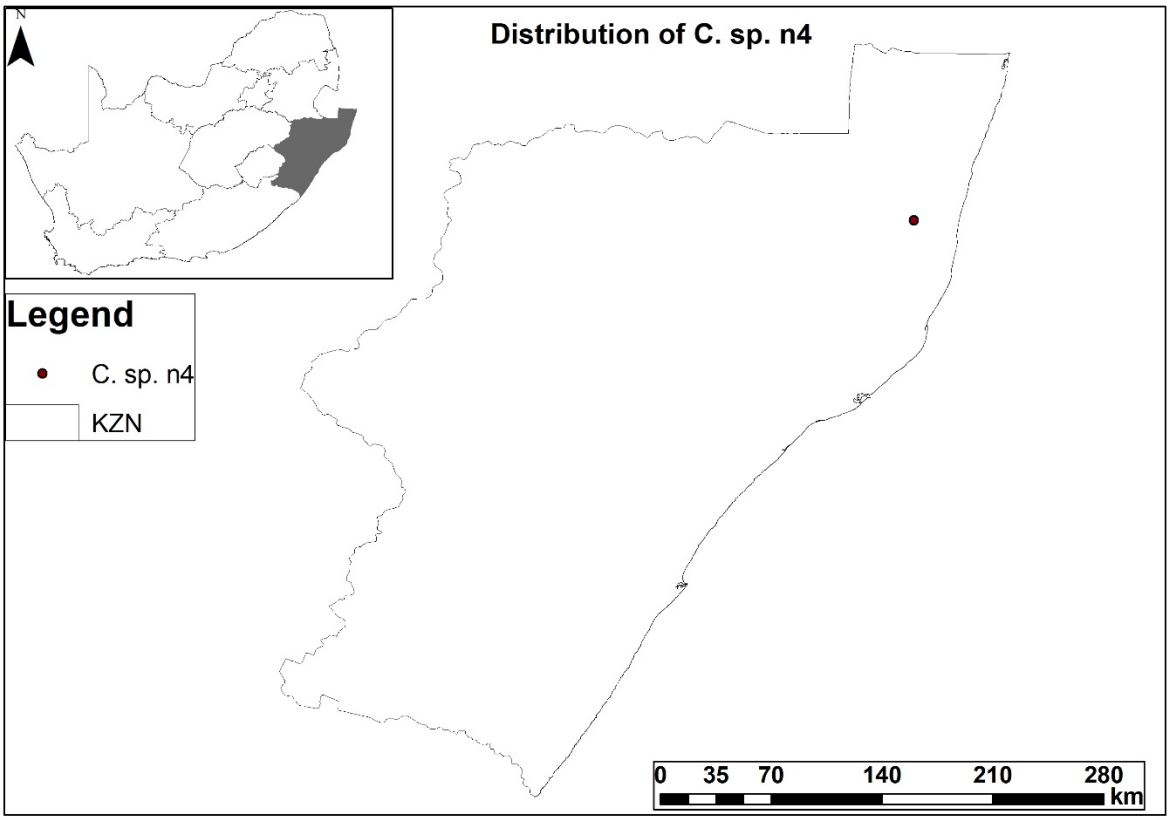

Figure 186: Distribution of *C.* sp. n4 in South Africa in KwaZulu-Natal.

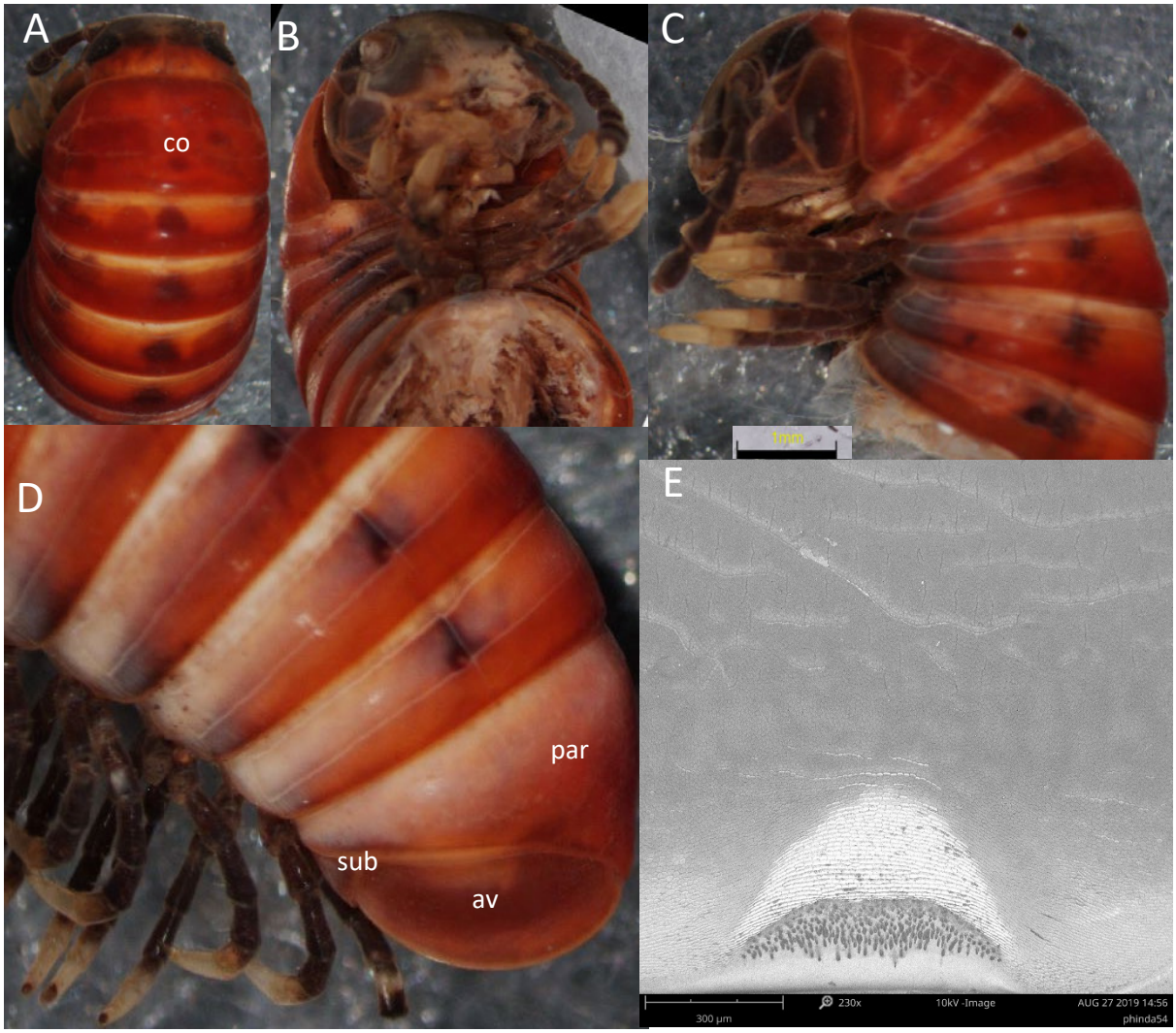

Figure 187: *Centrobolus* sp. n4 **(**Phinda Game Reserve, KwaZulu-Natal) ♂ (RS54). **A** anterior view of the head and collum, **B** ventral view, **C** lateral view, **D** terminal region of body, **E-F**body ring. Abbreviations: av - anal valve; co – collum; meso – mesozonite; meta – metazonites; par - preanal ring; pro – prozonites. Scale bars: 1.0 mm (**A-D**); 0.3 mm (**E**).

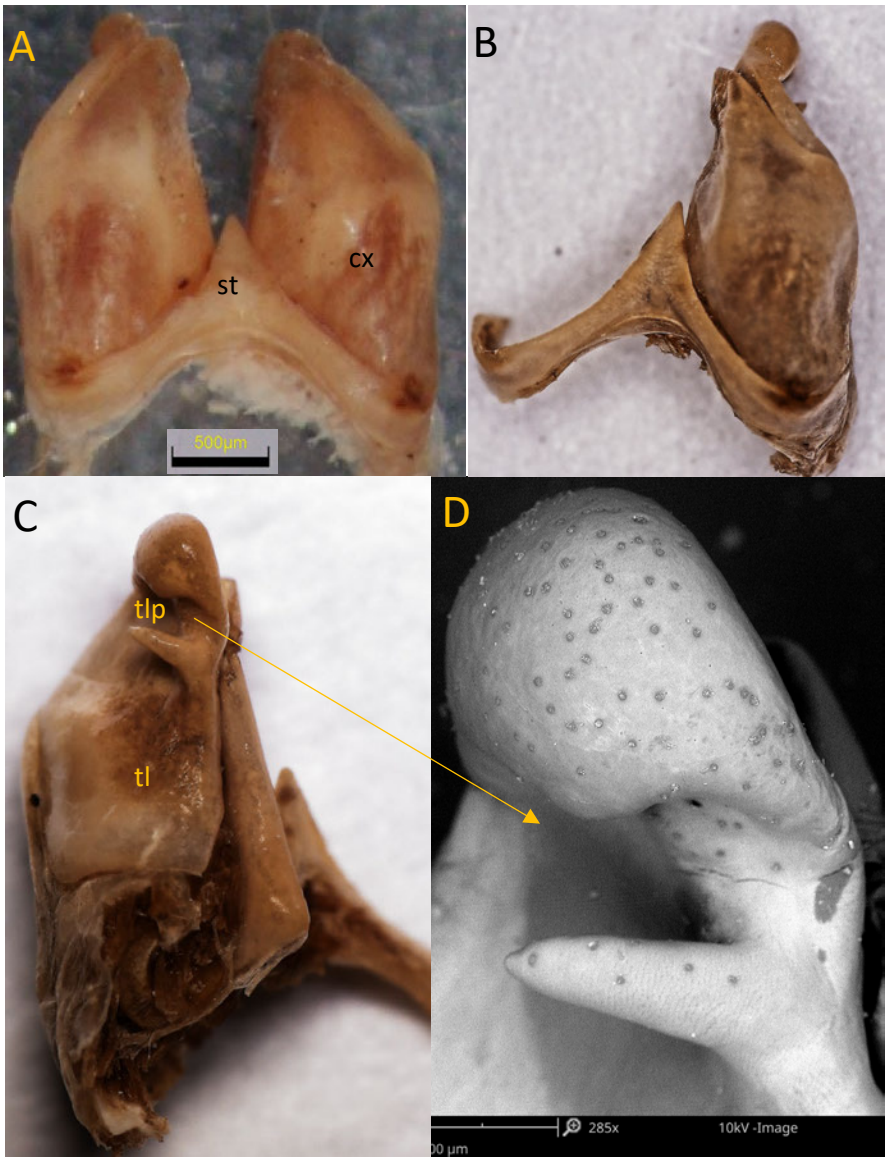

Figure 188: *Centrobolus* sp. n4 ♂ (RS54). **A-D** anterior gonopods; **A-B** anterior view, **C-D** posterior view. Abbreviations: cx – coxa; st – sternum; tl – telopodite; tlp - telopodite process. Scale bars: 0.5 mm (**A-C**); 0.3 mm (**D**).

Figure 189: *Centrobolus* sp. n4 ♂ (RS54). **A-D** posterior gonopod; **B** & **D** anterior view, **A** & **C** posterior view. Abbreviations: cx – coxa; f - efferent groove; tb - tibial process; tl – telopodite; tlp - telopodite process. Scale bars: 0.5 mm.

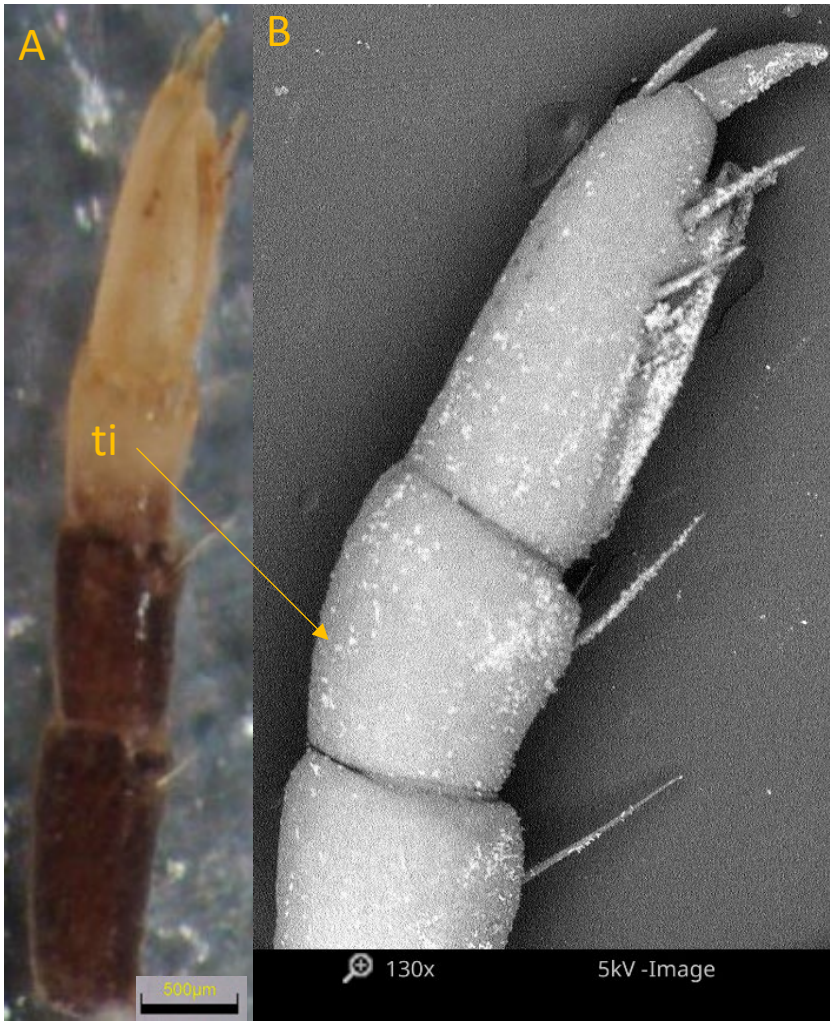

Figure 190: *Centrobolus* sp. n4 ♂ (RS54). Scale bars: 0.5 mm. Male leg. Abbreviations: ti – tibia.

2.6. Discussion and Conclusion

While the type material of *Centrobolus luctuosus* from Mozambique was not examined to confirm Hoffman's (2001) suggestion that the South African species belong to *Centrobolus* Cook, 1989 rather than *Chersastus* Attems, 1926, the evidence he presented is accepted here. In the revision presented here, 35 species were reviewed. Most of the species described by Porat (1872) were based on only female specimens and the type locality was stated as "Caffraria" which is too vague to allow additional material to be collected and matched to the original description. Lawrence (1967) suggested that these names must be considered as invalid.

The following species fall within this category of *incertae sedis*: *C. coriaceus* Porat, 1872; *C. strigosus* Porat, 1872; *C. formosus* Porat, 1872. Hoffman (1971) did, however, suggest that the female characters of *C. coriaceus* and *C. strigosus* seemed to be distinct, and he did provide details of the body sculpturing. Other species described from only females include *C. validus*, which was described by Lawrence (1967) from Haroni River in Zimbabwe, but he was unsure whether it is actually in the same genus as the other South African species. *Centrobolus striolatus* was described by Attems (1934) from Port St Johns in the Eastern Cape based on a female specimen, and *C. miniatomaculatus* was described by Schubart (1966) from Tsitsikama Forest based on a female. For these two species that have a type locality specified it may be possible to collect males and confirm the status of the species.

Centrobolus dubius was described by Schubart (1966) from Franches Kraal, near Gans Bay in the Western Cape. The illustrations of this species are incomplete, only the posterior gonopod is illustrated and this is similar to that of *C. digrammus* and *C. promontorius* which both occur in the same area. Thus *C. dubius* is likely a synonym of *C. digrammus*, but since the type material was not accessible, additional material is required to confirm this. There is also a possibility that *C. digrammus* and *C. promontorius* are the same species based on the illustrations of gonopods, colour and the distribution area. Upon examination of colour and anterior gonopods, the two previously known subspecies (*C. ruber vulpinus* and *C. ruber ruber*) are elevated to species level, based on distinct differences in several characters.

The status of several species was not reviewed in this study because of challenges with the type material. *Centrobolus splendidus* was described by Attems (1928) from "Masiene, Chai Chai" in Mozambique but this species is only known from the type specimen which is missing the gonopods. While the other characters are redescribed here, the gonopod structure is essential

to confirm the status. *Centrobolus titanophilus* was described by Schubart (1966) from De Hoop Vlei north east of Bredasdorp and Maanschijnkop east of Hermanus in the southern Western Cape but the type material was not accessible, being housed in the Lundt University collection. *Centrobolus promontorius* described by Schubart (1966) from Hout Bay, Cape Penisula in Western Cape, the illustration of gonopods were provided and agrees well with *C. digrammus* along with the colour of species and the type was not accessible, being housed in the Lundt University collection. *Centrobolus pococki* was described by Porat (1893) from "Cape Colony, De Vlyder", although Porat (1893) did not give an illustration, Hoffman (1971) gave the illustration of gonopods and the type was not accessible, being housed in the Naturhistorisches Museum. *Centrobolus saussarii* was described by Porat (1872) from "Caffraria", the exact locality is unknown. However, Hoffman (1971) gave illustration of gonopods and the type was not accessible, being housed in the Naturhistorisches Museum. Lastly *C. luctuosus*, a type species of this genus, described by Peters (1855) from Mozambique in Inhambane. They type is housed in ZMHB and is not accessible and the gonopods are missing.

In total 27 species were revised, seven additional species may be valid and four new species are described, bringing the total number of species in this genus to 34 as opposed to the total of 39 names which had been recorded, excluding possible new species. More materials are needed for some species to confirm descriptions, especially where there is some uncertainty about the status of species such as *C. litoralis* Koch, 1865 and *C. lugubris* Lawrence, 1967, and additional collecting in neglected areas is likely to provide more new species.

A combination of characters is usually required to confirm the identity of species rather than any one character. Colour was used by Lawrence (1967) in one of the keys provided but it is not always a useful character to separate the species because in some species there seems to be variation (*C. vulpinus*) and in other species colour may be very similar (*C. rubricollis*, *C. lawrencei*, *C. angelicus*) but other characters differ. Colour combinations of body segments, head, legs, antennae and anal valves are diagnostic in some species (*C. fulgidus*, *C. anulatus*, *C. inyanganus*, *C. ruber*, *C. digrammus*, *and C. sagatinus*). The significance of variation in colour needs to be assessed by using molecular approaches.

The gonopods are the strongest character to distinguish most millipede species, including in the genus *Centrobolus*. The shape of the anterior gonopod sternum and the distal process of the telopodite are especially useful for separating species and the distal process was included in

most of the species accounts and descriptions by Lawrence (1967), but details are not always very clear in the drawings he provided. Many species descriptions do not include illustrations or descriptions of the posterior gonopods but these structures were found to be useful for confirming the status of species. The images of the posterior gonopods presented in this chapter are the first for many species.

The female vulvae have never previously been used as a character for *Centrobolus*, and these structures were not illustrated or described in any of the original descriptions. The shape of the valves, their relative size and the arrangement of setae is useful for separating species, but they are not diagnostic in most cases.

The genus *Centrobolus* is confined to the temperate region of South Africa, Mozambique and Zimbabwe, occurring in forests of the coastal belt (Lawrence, 1967), but also in inland forest, including high altitude Afrotemperate forest in the Drakensberg, as well as in more north and south mountains ranges. South Africa is the centre of diversity for *Centrobolus*, particularly KwaZulu-Natal, Eastern and Western Cape. The highest number of *Centrobolus* species was recorded in KwaZulu-Natal (18) and the lowest number in Mpumalanga (1) province (Fig. 2). This may reflect the sampling effort rather than the actual pattern since KwaZulu-Natal has been much more extensively sampled than the other provinces. However, an extensive forest survey in Limpopo and Mpumalanga only provided material of two species which suggests that *Centrobolus* diversity in the northern parts of the range is low (Hamer pers. Comm.).

Most of the *Centrobolus* species have restricted distributions (see, Fig.1) and so sampling of forests in the Western and Eastern Cape should reveal additional, potentially new species and increase the number of known localities for other species. Increased survey work is important to better understand distribution patterns and assess the conservation or threat status of species and make recommendations about conservation of the genus. Additional, freshly collected material would also be important for molecular analyses which would allow confirmation of species and investigate of relationships between species,

The conservation status of 23 of the 37 species covered in this study could not be assessed because of lack of distribution and habitat data and/ or uncertain taxonomic status. Most of the existing records for all species are outdated, which means that a species may not still be present at a locality, and this could mean that both EOO and AOO estimates may not be accurate. Recent collection is crucial to make an informed decision on the threat status of species.

Twelve species were assessed as being threatened, and this includes three Endangered species, and nine Vulnerable species. Most of the threats to the survival of *Centrobolus* species are in KwaZulu-Natal coastal areas where there has been extensive loss of habitat through tourism and housing development, large scale monoculture agriculture and industry such as mining. Some species are Vulnerable because they have a limited number of populations and a narrow distribution, which means that they could go extinct in a short time through uncontrolled fires or if habitat is cleared for some form of development.

It is unlikely that population data will be appropriate for assessing conservation status because of fluctuations associated with climatic variation in activity and seasonality of appearance on the surface. Key areas for future research include more conservation and ecological studies and surveys to assess South African threatened *Centrobolus* species more accurately.

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