

IGOR DE SOUZA GONÇALVES

**ECOLOGIA E TAXONOMIA DE CIIDAE (COLEOPTERA) DA ÁFRICA DO
SUL**

Dissertação apresentada à Universidade
Federal de Viçosa, como parte das exigências
do Programa de Pós-Graduação em Ecologia,
para obtenção do título de *Magister Scientiae*.

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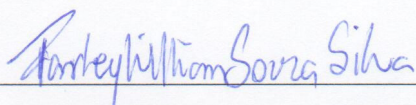
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IGOR DE SOUZA GONÇALVES

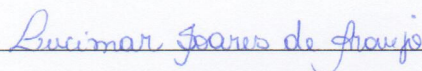
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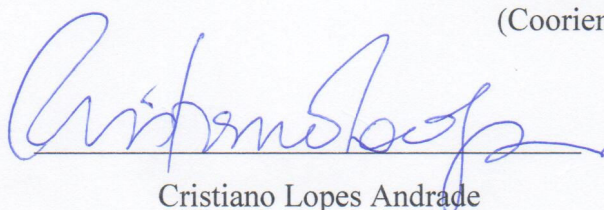


Farley William Souza Silva



Lucimar Soares de Araujo

(Coorientadora)



Cristiano Lopes Andrade

(Orientador)

“Depois de escalarmos uma montanha muito alta,
descobrimos que há muitas outras
montanhas por escalar.”

Nelson Mandela

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RESUMO

SOUZA-GONÇALVES, Igor de, M.Sc., Universidade Federal de Viçosa, fevereiro de 2017. **Ecologia e taxonomia de Ciidae (Coleoptera) da África do Sul**. Orientador: Cristiano Lopes Andrade. Coorientadoras: Lucimar Soares de Araujo e Vivian Eliana Sandoval Gómez.

Os besouros micetobiontes são aqueles que dependem de fungos como hábitat e alimento, e são organismos importantes para estudos ecológicos e evolutivos. Ciidae é o táxon mais diverso e abundante de besouros micetobiontes, com mais de 700 espécies em 51 gêneros. *Cis* Latreille é o gênero mais diverso dentro da família, e as espécies que ocorrem na América do Norte, Austrália, Europa e Japão são relativamente bem conhecidas, mas as das faunas das Américas Central e do Sul, África e áreas subtropicais e tropicais da Ásia carecem de estudos taxonômicos abrangentes. *Ceracis tabellifer* (Mellié), originalmente da região Neotropical, atualmente é a espécie de ciídeo mais encontrada na África subsaariana. Entretanto, não se sabe ainda os efeitos dessa invasão nas populações locais. Com o objetivo de compreender as relações ecológicas entre ciídeos e seus fungos hospedeiros, esta dissertação é dividida em dois capítulos. No primeiro, descrevemos sete novas espécies de *Cis* da África do Sul: *C. aster* Souza-Gonçalves & Lopes-Andrade, *C. mandelai* Souza-Gonçalves & Lopes-Andrade, *C. makebae* Souza-Gonçalves & Lopes-Andrade, *C. masekelai* Souza-Gonçalves & Lopes-Andrade, *C. nesesorum* Souza-Gonçalves & Lopes-Andrade, *C. stalsi* Souza-Gonçalves & Lopes-Andrade e *C. urbanae* Souza-Gonçalves & Lopes-Andrade. No segundo, analisamos as possíveis influências da espécie invasora no padrão de interação entre ciídeos locais e seus fungos hospedeiros. A partir dos resultados, concluímos que a espécie invasora *Cer. tabellifer* não está deslocando as espécies locais de seus recursos, mas provavelmente apenas utilizando fungos que não eram utilizados previamente; e mostra manter o comportamento do seu habitat nativo, onde apresenta hábito alimentar polífago e grandes populações.

ABSTRACT

SOUZA-GONÇALVES, Igor de, M.Sc., Universidade Federal de Viçosa, February, 2017. **Ecology and taxonomy of Ciidae (Coleoptera) from South Africa.** Advisor: Cristiano Lopes Andrade. Co-advisors: Lucimar Soares de Araujo and Vivian Eliana Sandoval Gómez.

Micetobiont beetles are that depends on fungi as habitat and food, and are important organisms to ecological and evolutionary studies. Ciidae is the most diverse and abundant taxon of micetobiont beetles, with more than 700 species in 51 genera. *Cis* Latreille is the most diverse genus inside the family, and species that occurs at North America, Australia, Europe and Japan are relatively well known, but the fauna from Central and South America, Africa, subtropical and tropical Asian areas needs comprehensive taxonomic studies. *Ceracis tabellifer* (Mellié) is originally from Neotropical region and actually is the most found ciid species at Sub-Saharan Africa. However, it is not known the effects of these invasions on local populations. Aiming to understand the ecological relations between ciid beetles and their host-fungi, this dissertation is divided in two chapters. At first, we described seven new species of *Cis* from South Africa: *C. aster* Souza-Gonçalves & Lopes-Andrade, *C. mandelai* Souza-Gonçalves & Lopes-Andrade, *C. makebae* Souza-Gonçalves & Lopes-Andrade, *C. masekelai* Souza-Gonçalves & Lopes-Andrade, *C. nesesorum* Souza-Gonçalves & Lopes-Andrade, *C. stalsi* Souza-Gonçalves & Lopes-Andrade e *C. urbanae* Souza-Gonçalves & Lopes-Andrade. In the second, was analyzed possible influences of invader species on pattern of interaction between native ciids and their host-fungi. From the results, we concluded that invader species is not shifting the local species out of their resources, but probably only using fungi that were not previously used; and seems to keep the behaviour from its native habitat, where presents polyphagous feeding habits and large populations.

INTRODUÇÃO GERAL

Há um crescente interesse pelos insetos micetócolos, que são aqueles que possuem algum grau de associação com fungos (Hanski 1989; Jonsell *et al.* 1999; Jonsell & Nordlander 2002; Komonen 2003; Amat-García *et al.* 2004; Graf-Peters *et al.* 2011; Araujo *et al.* 2015). Esse interesse é resultante da alta diversidade desses insetos, das suas características ecológicas (especialização na utilização de partes dos fungos hospedeiros) (Lawrence 1989), comportamentais (usualmente gregários, com adultos e larvas construindo galerias, e com até milhares de indivíduos em um mesmo fungo) (Lawrence & Britton 1991; Lawrence 1973; Costa *et al.* 1988) e fisiológicas (desenvolvimento de mecanismos contra intoxicações com compostos químicos provenientes dos fungos) (Martin 1979), do potencial uso como modelos para estudos em ecologia e evolução, e por preencherem uma lacuna dentro da biologia, onde há mais trabalhos sobre insetos herbívoros e predadores.

Os insetos micetócolos são divididos em micetoxenos (visitam o fungo ocasionalmente, utilizando-o normalmente como refúgio), micetófilos (utilizam o fungo como recurso, abrigo ou alimento em alguma fase do desenvolvimento) e micetobiontes (associação obrigatória, em que tanto larvas quanto adultos dependem exclusivamente do fungo como alimento). Poucos grupos de besouros (Coleoptera) são predominantemente micetobiontes, valendo citar os Diaperini (Tenebrionidae), Dorcatominae (Ptinidae), Erotylidae e os Ciidae (Jonsell & Nordlander 2002; Komonen 2003; Komonen *et al.* 2003).

Ciidae é o táxon mais diverso e abundante de besouros micetobiontes, sendo uma família de pequenos besouros com mais de 700 espécies descritas, agrupadas em 51 gêneros (Lawrence & Lopes-Andrade 2008; Antunes-Carvalho *et al.* 2012; Lawrence 2016). Esses besouros ocorrem em quase todas as terras continentais e insulares do planeta, com exceção dos polos (Lawrence & Lopes-Andrade 2010). As larvas e adultos da maioria das espécies vivem em basidiomas de macrofungos poroides, conhecidos vulgarmente como “orelhas-de-pau”. Esses besouros dependem exclusivamente dos basidiomas como alimento, abrigo, local de cópula e oviposição (Lawrence 1973; Navarrete-Heredia 1991; Lopes-Andrade 2002; Lawrence & Lopes-Andrade 2010; Graf-Peters *et al.* 2011). Registros de ocorrência de ciídeos em outros habitats são escassos, sendo os casos mais frequentes em serapilheira e não se sabe se

são micetobiontes ou não (Lawrence 1971; Lopes-Andrade 2007). Com relação à utilização de fungos hospedeiros, há ciídeos monófagos (alimentam-se somente de uma espécie de hospedeiro), oligófagos (utiliza com hospedeiro, preferencialmente ou exclusivamente, uma família de fungo) e polífagos (várias famílias de fungo utilizadas como hospedeiro) (Gumier-Costa *et al.* 2003; Orledge & Reynolds 2005; Graf-Peters *et al.* 2011).

Ciídeos apresentam uma importância ambiental considerável, uma vez que são parte essencial no processo de degradação de macrofungos (Lawrence 1973; Orledge & Reynolds 2005; Graf-Peters *et al.* 2011). A maior parte das orelhas-de-pau que não são colonizadas pelos ciídeos pode permanecer por décadas no ambiente até que processos naturais mais lentos de degradação os degradem. Em casos como estes, os nutrientes retidos nessas estruturas reprodutivas, com altas concentrações de zinco, cádmio e outros elementos, demoram mais tempo para retornarem ao ambiente (Thunes *et al.* 2000; Graf-Peters *et al.* 2011).

Dentro de Ciidae, *Cis* Latreille é o gênero mais diverso, com cerca de 410 espécies – mais da metade das espécies descritas de Ciidae – e apresenta distribuição cosmopolita (Lopes-Andrade *et al.* 2009; Sandoval-Gómez *et al.* 2011). Parte das espécies de *Cis* foram anteriormente incluídas em outros gêneros, como por exemplo *Eridaulus* Thomson e *Macrocis* Reitter, e é definido pelas seguintes características: (i) antena com 10 antenômeros, sendo três na clava (ocasionalmente dois); (ii) processo porternal largo; (iii) protíbia sem espinhos no ângulo externo (podem apresentar no ápice). Entretanto, a definição de *Cis* ainda é insatisfatória e trabalhos de filogenia molecular apontam que o gênero é polifilético (Buder *et al.* 2008; Lopes-Andrade & Grebennikov 2015). Lawrence (2016), sugere que o grupo será provavelmente dividido, baseado em análises realizadas em várias partes do mundo e envolvendo diversos caracteres e táxons. Atualmente, nenhuma classificação subgenérica de *Cis* é adotada e parte de suas espécies está organizada artificialmente em grupos de espécies (Lawrence 1971; Lopes-Andrade *et al.* 2003; Lopes-Andrade 2008a, b).

As espécies de *Cis* que compõe as faunas da América do Norte, Europa, Austrália e áreas de clima temperado da Ásia são relativamente bem documentadas. Os *Cis* das Américas Central e do Sul, da África e das áreas subtropicais e tropicais da Ásia foram pouco estudados até o momento. Dentre estes últimos, a África é heterogênea do

ponto de vista biogeográfico e possui três faunas de besouros características (*sensu* Morrone 2002): (i) Paleártica (no norte, acima do deserto do Saara); (ii) Afrotropical (subsaariana, com exceção do extremo sul); (iii) Afrotemperada (extremo sul do continente, compreendendo Botsuana, Lesoto, Namíbia, África do Sul e Suazilândia).

Nas faunas Afrotropical e Afrotemperada, há registros de invasão biológica pelo ciídeo *Ceracis tabellifer* (Mellié), cujos exemplares históricos depositados em museus datam desde o princípio do século XIX (Mellié 1849; Antunes-Carvalho & Lopes-Andrade 2013). *Ceracis tabellifer* é originária da região Neotropical (Antunes-Carvalho & Lopes-Andrade 2013) e, em quase dois séculos de expansão após a invasão, a espécie já atingiu ilhas do Oceano Índico e chegou ao Sul e Sudeste da Ásia. Atualmente, ela é a espécie de Ciidae encontrada com maior frequência na África subsaariana. O fato de *Cer. tabellifer* apresentar hábito alimentar polífago sugere um considerável potencial de sucesso em eventos de invasão (Antunes-Carvalho & Lopes-Andrade 2013). Apesar da espécie se espalhar pela África e Ásia e apresentar características biológicas – vários descendentes em uma mesma estação (espécie multivoltina); maior tamanho em áreas invadidas, em comparação com o hábita natural; capacidade de de auto-sustentar em ampla variedade de habitats; e grandes populações – que conferem ótimas habilidades competitivas, ainda não se sabe os efeitos dessas invasões nas populações locais (Antunes-Carvalho & Lopes-Andrade 2013).

Com o objetivo de compreender as relações ecológicas entre ciídeos e seus fungos hospedeiros, esta dissertação apresenta dois capítulos. No primeiro capítulo, o objetivo foi descrever sete novas espécies de *Cis* da África do Sul, fornecendo dados de distribuição geográfica e fungos hospedeiros. No segundo capítulo, o objetivo foi analisar as possíveis interferências da espécie invasora *Ceracis tabellifer* na estrutura da fauna nativa de ciídeos da África do Sul.

RESULTADOS GERAIS

Os resultados são apresentados em dois capítulos:

Capítulo 1: Seven new species of *Cis* Latreille (Coleoptera: Ciidae) from southern Africa – Neste capítulo, descrevemos sete novas espécies: *C. aster* Souza-Gonçalves & Lopes-Andrade, *C. mandelai* Souza-Gonçalves & Lopes-Andrade, *C. makebae* Souza-Gonçalves & Lopes-Andrade, *C. masekelai* Souza-Gonçalves & Lopes-Andrade, *C. nesesorum* Souza-Gonçalves & Lopes-Andrade, *C. stalsi* Souza-Gonçalves & Lopes-Andrade e *C. urbanae* Souza-Gonçalves & Lopes-Andrade. *Cis nesesorum* foi a espécie que apresentou a maior distribuição geográfica, ocorrendo tanto no nordeste, quanto na costa leste e sul da África do Sul; já as demais espécies apresentaram distribuição restrita ao nordeste do país.

Capítulo 2: Effects of invasive species *Ceracis tabellifer* (Mellié) on the structure of native fauna of Ciidae (Coleoptera) at South Africa – Neste capítulo, avaliamos os possíveis efeitos da espécie invasora *Cer. tabellifer* na estrutura da fauna nativa de ciídeos na África do Sul, e comparando com papel de *Cer. tabellifer* em sua terra nativa no Cerrado brasileiro. *Ceracis tabellifer* demonstrou não estar deslocando as espécies locais de seus recursos, mas provavelmente apenas utilizando fungos que não eram utilizados previamente na comunidade. Além disso, *Cer. tabellifer* mostra manter o comportamento do seu habitat nativo, onde apresenta hábito alimentar polífago e grandes populações.

CAPÍTULO 1: Seven new species of *Cis* Latreille (Coleoptera: Ciidae) from southern Africa

(Accepted for publication by the journal Entomological Science. The manuscript presented here, in the form of a chapter of this dissertation, is not considered valid according to the International Code of Nomenclature Zoological – ICNZ)

Seven new species of *Cis* Latreille (Coleoptera: Ciidae) from southern Africa

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Abstract

Here we describe seven new species of *Cis* Latreille from southern Africa: *Cis aster* **sp. nov.**, *Cis makebae* **sp. nov.**, *Cis mandelai* **sp. nov.**, *Cis masekelai* **sp. nov.**, *Cis nesororum* **sp. nov.**, *Cis stalsi* **sp. nov.** and *Cis urbanae* **sp. nov.** We also provide information on their host fungi and geographic distributions.

Key words: Ciinae, Ciini, minute tree-fungus beetles, mycetobionts

INTRODUCTION

The genus *Cis* Latreille, 1796 has more than 350 described species that are widespread throughout numerous biogeographic regions (Lopes-Andrade *et al.* 2009; Sandoval-Gómez *et al.* 2011). This genus accounts for more than half of all described Ciidae. However, the genus may be polyphyletic (Buder *et al.* 2008; Lopes-Andrade & Grebennikov 2015). The previously proposed subgeneric division of *Cis* is not in use, so many species are organized in artificial species-groups (Lawrence 1971; Lopes-Andrade *et al.* 2003; Lopes-Andrade 2008).

The sub-Saharan Ciidae comprises 43 described species (Lopes-Andrade *et al.* 2009; Orsetti & Lopes-Andrade 2016), nine occurring in southern Africa: *Cis afer* Fähræus, *C. bimucronatus* Motschoulsky, *C. caffer* Fähræus, *C. capensis* Mellié, *C. delagoensis* Pic, *C. muriceus* Mellié, *C. pickeri* Lopes-Andrade *et al.*, *Cis regius* Orsetti & Lopes-Andrade and *Cis testaceus* Fähræus.

Our objective in this paper is to describe seven new species of *Cis* from southern Africa and to provide information on their host fungi and geographic distribution.

MATERIALS AND METHODS

Museum abbreviations are as follows (curators between parentheses):

CELC Coleção Entomológica do Laboratório de Sistemática e Biologia de Coleoptera da Universidade Federal de Viçosa, Viçosa, Minas Gerais, Brazil (Cristiano Lopes-Andrade)

VSPC Vivian Sandoval private collection, Araguaína, Tocantins, Brazil (Vivian E. Sandoval-Gómez)

SANC South African National Collection of Insects, Pretoria, South Africa (Riaan Stals)

SNSD Senckenberg Naturhistorische Sammlungen Dresden, Dresden, Germany (Klaus-Dieter Klass)

The new species described here were organized and collected by the staff of the SANC, mostly during ten years of a project on the parasitoids of Ciidae (Neser 2012). The ciid morphospecies with populations bearing parasitoids were identified at first and led to 17 morphospecies (Neser 2012), coded as *Cis* sp. A to *Cis* sp. Q. After that work, the ciids without parasitoids were identified and led to eight more morphospecies, giving a total of 25 morphospecies of *Cis*. *Cis regius* was formerly coded as *Cis* sp. T and described recently (Orsetti & Lopes-Andrade 2016). The other morphospecies were restudied by us and the new species proposed here do not necessarily correspond to the previously recognized morphospecies. We cite correspondence of morphospecies and the new species below subheadings of each new species.

Terms for external morphology and male terminalia of ciids follow Lawrence *et al.* (2011), Lawrence (2016) and Lopes-Andrade & Lawrence (2005, 2011), but see also Oliveira *et al.* (2013) for an explanation on the use of “tegmen”. The following abbreviations are used for measurements (in mm) and ratios: BW (basal width of scutellar shield), CL (length of antennal club measured from base of the eighth to apex of the tenth antennomere), EL (elytral length along the midline), EW (greatest width of both elytra), FL (length of antennal funicle measured from base of the third to apex of the seventh antennomere), GD (greatest depth of body measured in lateral view), GW (greatest diameter of eye), PL (pronotal length along midline), PW (greatest pronotal width), TL (total length counted as EL+PL, *i.e.* excluding head). The GD/EW and TL/EW ratios indicate the degree of body convexity and elongation, respectively.

Labels were printed on white paper, unless otherwise specified between square brackets. Pin labels transcriptions are placed within quotations marks, with each label separated by a backslash. The number, gender and depository of specimens bearing these labels are stated immediately before the label data. Data on host fungi extracted from labels were summarized in the sections “Host fungi”, together with corresponding number of records in each fungus species and indicating breeding records. We follow the criteria provided in Orledge & Reynolds (2005) for determining breeding records.

We measured exemplar specimens from all localities of all species. The number of measured specimens depended on the number of available specimens and the observed variation in size. Differences are given in “Variation”, together with standard measurements (mean and standard deviation) and ratios (*sensu* Lawrence 2016). Measurements were performed using a Zeiss Stemi 2000-C stereomicroscope. Digital

images were taken using Zeiss Discovery V20 equipped with a Zeiss 506 digital camera, at different focal lengths and merged into a single image using the extended focus module of Zeiss ZEN 2012 software. For whole mount preparations of male abdominal terminalia we followed the protocol provided by Lopes-Andrade (2011), and those dissected structures were photographed using a Zeiss AxioLab compound microscope equipped with a Zeiss MRc digital camera. The distribution map (Figs 53–54) was created in the freeware QGIS 2.14.2-Essen. The elevation raster layer was downloaded from the WorldClim webpage (<http://www.worldclim.org/>; as accessed on May 16th, 2016) and the ArcGIS mapserver raster layer was used for the ocean (<http://www.server.arcgisonline.com/ArcGIS/raste/services/>; as accessed on May 16th, 2016).

TAXONOMY

All species described below are very similar and females are usually indiscernible between species. Therefore, we based diagnoses mostly on males, and morphology of male terminalia is of great importance to distinguish species. We recommend careful examination of male terminalia in any attempt to identify ciids from southern African and avoid relying only on secondary sexual features and other traditional characters.

Female terminalia of all species described below, except for *C. aster* **sp. nov.** of which females are unknown, have gonocoxites transversely divided into three parts, distal gonocoxites with conspicuous gonostyli, paraprocts as long as or longer than gonocoxites together and proctigeral opening (anus) positioned before the bacula of proximal gonocoxites. In most *Cis* species (more than a hundred examined to date; Lopes-Andrade pers. obs.), the gonocoxites are transversely divided in four parts and the proctigeral opening is positioned after the bacula of proximal gonocoxites. Aside from these two differences, female terminalia of species described below are very similar in shape to the ones of most *Cis* species. It is important to note here that female terminalia in *C. pickeri* has gonocoxites transversely divided into two parts, paraprocts are short (about 0.75X the length of gonocoxites together) and proctigeral opening positioned near the middle of apical gonocoxites (Lopes-Andrade *et al.* 2009; Lopes-Andrade pers. obs.). In *Cis regius*, gonocoxites are transversally divided into three parts,

each apical gonocoxite bears an inner protuberance bearing an apical seta, paraprocts are short (about 0.75X the length of gonocoxites together) and proctigeral opening positioned near the bacula of proximal gonocoxites (Orsetti & Lopes-Andrade 2016).

The sclerites of aedeagi shown in Figs 5–8, 15, 16, 32, 33, 35, 41–44, 59–61 are of paratypes from type localities. The sclerites of aedeagi shown in Figs 14, 17, 23, 24–26, 34, 50–53 are of paratypes from other localities, but were compared to the ones from the type locality. In the latter case, aedeagi extracted from males of the type locality were a little damaged during dissection or laid in a bad position in the slides.

All species described below have dual and confused elytral punctation, pronotal and elytral vestiture indistinctly to distinctly dual, and males with head and pronotum barely to strongly emarginate forming two short prominences or subtriangular plates. They are morphologically similar to each other and will possibly comprise a new species-group of *Cis*, but we prefer to define it after describing the other South African species of *Cis* and compare them all to *Cis* from other biogeographic regions. At this moment it is difficult to provide differential diagnoses for the species described here considering all sub-Saharan *Cis*. We prefer to confine comparisons only to other southern African *Cis*. Among the nine *Cis* occurring in southern Africa described before (see Introduction), *C. afer*, *C. caffer*, *C. capensis* and *C. testaceus* are more than 2 mm long and have the anterior edge of head and pronotum in males projected forming two short plates. These four species also have dual, dense and confused elytral punctation, except for *C. capensis* with subseriate punctation. Among these four species, *C. capensis* is also unique in possessing a median longitudinal unpunctate line on pronotum. *Cis bimucronatus* was described as possessing the anterior edge of both head and pronotum projected forward into two horns, but without any further information (Motschoulsky 1851), therefore we prefer not to consider it in the diagnoses. *Cis delagoensis* was described as a large species (3 mm long) in which males have the anterior edge of head and pronotum barely emarginated forming two short teeth (see Pic 1916).

Cis pickeri has dual elytral punctation, but the anterior portion of male head is projected upward as a single plate (Lopes-Andrade *et al.* 2009). *Cis muriceus* is known only from a female specimen, which is about 1.6 mm long and has coarse, single elytral punctation and shiny surface (Mellié 1849); although males are not available for comparison, it is certainly not related to any of the species described here. The recently

described *C. regius* is quite distinct: it is less than 1.7 mm long, with seriate elytral vestiture; in males, the anterior edge of the head is modified into four short plates and bears a conspicuous occipital tubercle. As *C. muriceus*, *C. pickeri* and *C. regius* are quite distinct from the species described here, they will not be considered in the diagnoses provided below.

***Cis aster* Souza-Gonçalves et Lopes-Andrade, sp. nov.**

(Figs 1–8, 62)

Diagnosis. The pronotum is devoid of median unpunctate line, and in males its anterior portion is devoid of concave impression. The first abdominal ventrite lacks a sex patch. The tegmen has somewhat a mace-like shape, with each lateral edge hardened near middle and bearing a small concave emargination with an acute angulation at base (Fig. 7, arrows). The penis is very elongate (Fig. 8). Among the species described here, *C. aster* **sp. nov.** is morphologically closely related to *C. nesororum* **sp. nov.** and *C. urbanae* **sp. nov.**, but may be distinguished by its parallel-sided prosternal process with truncate apex (apex rounded in *C. nesororum* **sp. nov.** and base of process narrow in *C. urbanae* **sp. nov.**). Among other similar southern African *Cis*, male *C. aster* **sp. nov.** differs from male *C. testaceus* in being devoid of concave impression at the anterior portion of pronotum, from *C. affter* in bearing comparatively longer pronotal plates, and from *C. caffer* in possessing much closer plates on head and pronotum.

Description. Male holotype (Figs 1–4). Adult apparently not fully pigmented but in good condition, except for lacking the left antenna. Measurements in mm: TL 2.46, PL 0.77, PW 1.07, EL 1.69, EW 1.09, GD 0.90. Ratios: PL/PW 0.71, EL/EW 1.55, EL/PL 2.21, GD/EW 0.74, TL/EW 2.25. **Body** elongate, convex; dorsal and ventral surfaces yellowish brown; antennae a bit lighter with club dark brown, palpi and tarsi a bit lighter. **Head** concealed by pronotum when seen from above; dorsal punctures coarse and shallow, with decumbent bristles arising from them; frontoclypeal ridge projected upward into two triangular plates with rounded apices. **Antennae** with ten antennomeres, lengths as follows (in mm, right antennae measured): 0.10, 0.06, 0.09, 0.03, 0.04, 0.03, 0.03, 0.06, 0.06, 0.09 (FL 0.25 mm, CL 0.21 mm, CL/FL 0.84 mm).

Eyes finely faceted; each bearing about 70 ommatidia; GW 0.18 mm. **Pronotum** (Fig. 4) with shallow and coarse punctation, devoid of a median unpunctate line; punctures separated from each other by a puncture-width or less, with microreticulate interspaces; indistinctly dual vestiture, with little difference between the longest (0.04 mm) and the shortest (0.02–0.03 mm) suberect yellowish bristles; anterior edge projected forward into two triangular plates with rounded apices; anterior portion equally convex; lateral edges not visible from above, except for posteriormost portions, not explanate and weakly crenulated. **Scutellar shield** subtriangular, bearing a few punctures and bristles; BW 0.10 mm and SL 0.08 mm. **Elytra** with confused, dual punctation; large punctures coarse, irregular, moderately deep, about twice as large as small punctures; interspaces a bit rugose, shiny; vestiture dual, consisting of long (0.05–0.06 mm) and short (~0.03 mm) suberect yellowish bristles, both arising from minute punctures. **Hind wings** developed, apparently functional. **Prosternum** biconcave, subglabrous; microreticulate surface; prosternal process parallel-sided, about as long as prosternum disc at midline, apex truncate and not expanded. **Hypomera** subglabrous; microreticulate surface. **Protibia** with maximum width about one-fourth of its length; apical edge devoid of spines; outer apical angle angulate. **Meso- and metatibia** without spines on apical edge. **Metaventricle** subglabrous, bearing sparse slender setae; punctation sparse, irregular, interspaces microreticulate; discrien about half as long as the metaventricle at midline. Subglabrous **abdominal ventrites**, bearing sparse slender setae, coarsely punctate, microreticulate surface; length of ventrites (in mm, from base to apex at the longitudinal midline) as follows: 0.32, 0.14, 0.12, 0.11, 0.13; first abdominal ventrite without sex patch. **Male terminalia in a paratype** (Figs 5–8); **sternite VIII** (Fig. 5) with posterior edge rounded, bearing small setae medially and longer setae at sides; anterior edge membranous. **Tegmen** (Fig. 7) elongate, about twice as long as penis, with somewhat a mace-like shape; lateral edges hardened near middle, each bearing a concave emargination with a basal acute angulation (Fig. 7, arrows); mostly membranous at base and gradually hardening to middle; struts about half as long as tegmen, joint at base, then diverging and reaching lateral edges of tegmen and ending at lateral angulations (Fig. 7, arrows). **Basal piece** (Fig. 6) subtriangular, about twice as long as wide. **Penis** (Fig. 8) subparallel-sided, very elongate.

Female. Unknown.

Variation. Males, measurements in mm (n=2, including the holotype): TL 1.85–2.46 (2.16 ± 0.43), PL 0.65–0.77 (0.75 ± 0.08), PW 0.80–1.07 (0.94 ± 0.19), EL 1.20–1.69 (1.45 ± 0.35), EW 0.85–1.09 (0.97 ± 0.17), GD 0.60–0.81 (0.70 ± 0.15), PL/PW 0.71–0.81 (0.76 ± 0.07), EL/EW 1.41–1.95 (1.48 ± 0.10), EL/PL 1.85–2.21 (2.03 ± 0.26) GD/EW 0.71–0.74 (0.72 ± 0.02), TL/EW 2.18–2.25 (2.21 ± 0.05).

Type series. Holotype ♂ (SANC) “SOUTH AFRICA, KZN, Twin Streams Nursery Forest, nr Mtunzini, 28°57’S 31°54’E, 13.vii.2008, RP Urban \ Ex bracket fungus, BF#111 \ Ex bracket fungus *Hexagonia tenuis*, BF#111 \ *Cis aster* Souza-Gonçalves & Lopes-Andrade HOLOTYPUS [red paper]”. Paratype ♂ (CELC, dissected), same data as the holotype and additionally labeled “*Cis aster* Souza-Gonçalves & Lopes-Andrade PARATYPUS [yellow paper]”.

Etymology. The specific epithet is derived from the Latin word “disaster”, initially used to refer to disastrous events caused by stars, but subsequently used to refer to any calamity. Dissection of the unique available male of this species, aside from the holotype, was almost a complete disaster, leaving the specimen in poor condition.

Host fungi. *Hexagonia tenuis* (Hook.) Fr. (Polyporaceae), with a single record. The holotype is not fully pigmented, indicating that it has possibly bred in the fungus.

Distribution. *Cis aster* was collected only in Grassland (Fig. 62), situated in a tropical area on the north coast of KwaZulu-Natal at 42 meters of altitude.

Comments. *Cis aster* is known from a single collection and was found together with the morphospecies *Cis* sp. Q, without parasitoid.

***Cis makebae* Souza-Gonçalves et Lopes-Andrade, sp. nov.**

(Figs 9–17, 62)

Cis sp. B (in part) in Naser (2012)

Diagnosis. The pronotum is devoid of median unpunctate line, and males lack the anterior concave impression. The apical portion of tegmen has sclerotizations at middle and laterals, which give the appearance of a trident (Fig. 16); the penis has about half the width of tegmen and three-fourths of its length, with two struts inwardly curved and about three-fifths of its length (Fig. 17). Among the species described here, *C. makebae* sp. nov. is morphologically closely related to *C. masekelai* sp. nov. and *C. stalsi* sp.

nov. but possesses comparatively shorter and more separate plates on the male head and pronotum. Among other southern African *Cis*, it may be related to *C. delagoensis*, of which we have not examined any specimen.

Description. Male holotype (Figs 9–12). Adult fully pigmented. Measurements in mm: TL 1.96, PL 0.62, PW 0.90, EL 1.34, EW 0.90, GD 0.68. Ratios: PL/PW 0.69, EL/EW 1.49, EL/PL 2.16, GD/EW 0.75, TL/EW 2.17. **Body** elongate, moderately convex; dorsal surface dark brownish and ventral reddish brown; antennae, palpi and tarsi yellowish brown. **Head** with anteriormost portion visible from above; dorsum with coarse punctures bearing suberect bristles; frontoclypeal ridge projected upward into two triangular plates with subacute apices. **Antennae** bearing ten antennomeres with the following lengths (in mm, left antennae measured): 0.07, 0.05, 0.05, 0.03, 0.02, 0.02, 0.02, 0.05, 0.05, 0.09 (FL 0.14 mm, CL 0.19 mm, CL/FL 1.38 mm). **Eyes** finely faceted; each bearing about 50 ommatidia; GW 0.13 mm. **Pronotum** (Fig. 12) with deep and coarse, single punctation, with a short, narrow unpunctate median line beginning about three punctures from the posterior edge and extending until center; punctures separated from each other by about a puncture-width on disc and two puncture-widths close to the laterals, interspaces barely microreticulate, shiny; vestiture indistinctly dual, consisting of longer (~0.04 mm) suberect and smaller (~0.03 mm) decumbent yellowish bristles; anterior edge projected forward into two short triangular plates with subacute apices; lateral edges not visible from above, except for posteriormost portions, not explanate and weakly crenulate. **Scutellar shield** triangular, bearing a few punctures and bristles; BW 0.09 mm and SL 0.06 mm. **Elytra** with confused, dual punctation; large punctures deep and coarse, irregular and about twice as large as smaller ones; interspaces a bit rugose, shiny; vestiture indistinctly dual, consisting of longer (~0.04–0.05 mm) and smaller (~0.03 mm) suberect yellowish bristles arising from the smallest punctures. **Hind wings** developed, apparently functional. **Prosternum** biconcave, subglabrous; microreticulate surface; prosternal process subparallel-sided, about as long as prosternal disc at midline, apex rounded. **Hypomera** subglabrous; microreticulate surface. **Protibia** with maximum width about one-third of its length; apical edge devoid of spines; outer apical angle projected in a small tooth. **Meso- and metatibia** without spines on apical edge. **Metaventrite** subglabrous, bearing sparse slender setae; punctation coarse, irregular, sparse; interspaces microreticulate; discrien about half the length of the metaventrite at

midline. **Abdominal ventrites** subglabrous, bearing sparse slender setae, coarsely punctate, microreticulate surface; length of ventrites (in mm, from base to apex at the longitudinal midline) as follows: 0.25, 0.11, 0.09, 0.10, 0.12; first abdominal ventrite bearing a margined, suboval sex patch located posterad of center and with a tuft of slender setae, with a transverse diameter of 0.5 mm. **Male terminalia in a paratype** (Figs 14–17); **sternite VIII** (Fig. 14) with posterior edge bearing a short median emargination, forming two rounded lobes that bear long setae; anterior edge membranous. **Tegmen** (Fig. 16) with apical portion mostly membranous, with sclerotizations at middle and laterals, which give the appearance of a trident. **Basal piece** (Fig. 15) subtriangular, about as long as wide. **Penis** (Fig. 18) about three-fourths the length of tegmen, bearing two struts not linked at base, inwardly curved and about three-fifths the length of penis; base and apex membranous.

Females (Fig. 13). Similar to males but devoid of an abdominal sex patch, head and pronotal plates; anterior edge of head, truncate; anterior edge of pronotum, rounded.

Variation. Males, measurements in mm (n=11, including the holotype): TL 1.65–2.35 (2.11 ± 0.21), PL 0.50–0.95 (0.74 ± 0.12), PW 0.75–1.00 (0.90 ± 0.07), EL 1.10–1.50 (1.37 ± 0.14), EW 0.80–1.05 (0.95 ± 0.07), GD 0.55–0.80 (0.69 ± 0.06), PL/PW 0.67–1.06 (0.81 ± 0.11), EL/EW 1.30–1.58 (1.43 ± 0.12), EL/PL 1.47–2.30 (1.88 ± 0.28), GD/EW 0.65–0.83 (0.72 ± 0.05), TL/EW 2.06–2.47 (2.20 ± 0.14). Females, measurements in mm (n=10): TL 1.95–2.30 (2.10 ± 0.12), PL 0.55–0.80 (0.66 ± 0.07), PW 0.75–0.95 (0.88 ± 0.07), EL 1.35–1.55 (1.44 ± 0.08), EW 0.85–1.10 (0.98 ± 0.08), GD 0.60–0.80 (0.72 ± 0.07), PL/PW 0.67–0.84 (0.75 ± 0.06), EL/EW 1.36–1.65 (1.48 ± 0.09), EL/PL 1.88–2.55 (2.20 ± 0.25), GD/EW 0.67–0.84 (0.73 ± 0.06), TL/EW 2.05–2.29 (2.15 ± 0.09).

Type series. Holotype ♂ (SANC) “SOUTH AFRICA, LIMP, Sekororo Kloof, nr. Penge, 24°25’S 30°27’E, 27.vii.2008, S. Naser \ Ex bracket fungus *Trametes cingulata*, BF#155 \ *Cis makebae* Souza-Gonçalves & Lopes-Andrade HOLOTYPUS [red paper]”. Paratypes 17 ♂ (6 CELC, one dissected; 12 SANC) and 12 ♀ (4 CELC, one dissected; 8 SANC), same data as the holotype; 32 ♂ (10 measured) and 33 ♀ (10 measured) as follows: 15 ♂ (5 CELC, one dissected; 10 SANC) and 13 ♀ (4 CELC; 9 SANC) “SOUTH AFRICA, KZN, Nr. Ndumo, 26°55’S 32°15’E, 15.vii.2008, R. P. Urban \ Ex bracket fungus, *Trametes cingulata*, BF#106”. All paratypes additionally

labelled \Cis makebae Souza-Gonçalves & Lopes-Andrade PARATYPUS [yellow paper]\.

Etymology. The new species is named in honor of Zenzile Miriam Makeba (1932 to 2008), who is also known as “Mama Africa”, a South African singer and a great activist defending human rights and against Apartheid.

Host fungi. *Trametes cingulata* Berk. (Polyporaceae), two breeding records.

Distribution. *Cis makebae* was collected in two localities of Savanna (Fig. 62), separated by approximately 600 linear km, one being a lowland and another at the base of a mountain chain.

Comments. We extracted aedeagi of males from the type locality and from Nr. Ndumo, and no difference was observed. This species was collected together with *C. mandelai* **sp. nov.** and the morphospecies *Cis* sp. C and *Cis* sp. O, and the parasitoid *Astichus micans* Neser, 2012 (Hymenoptera: Eulophidae: Entiinae).

***Cis mandelai* Souza-Gonçalves et Lopes-Andrade, sp. nov.**

(Figs 18–26, 62)

Cis sp. A in Neser (2012)

Diagnosis. The pronotum is devoid of median unpunctate line, and in males its anterior portion bears a concave impression. The tegmen has three deep emarginations at the anterior portion (Fig. 25). The penis is about 0.7 times as long as tegmen and gradually expanding to apex; apical portion membranous and with a V- shaped sclerotization (Fig. 26). Among the species described here, *C. mandelai* **sp. nov.** may be distinguished by its prosternal process, which is conspicuously narrow near the base and gradually expands to a rounded apex. *Cis urbanae* **sp. nov.** bears a similar prosternal process, but differs in the less robust body and males with comparatively shorter pronotal plates. Among other southern African *Cis*, male *C. mandelai* **sp. nov.** differs from male *C. affter* and *C. caffer* in bearing a concave impression at the anterior portion of pronotum; from male *C. testaceus* in bearing head covered by pronotum and comparatively shorter pronotal plates with straight sides.

Description. Male holotype (Figs 18–21). Adult apparently not fully pigmented but in good condition. Measurements in mm: TL 2.59, PL 0.85, PW 1.25, EL 1.74, EW

1.30, GD 1.05. Ratios: PL/PW 0.68, EL/EW 1.34, EL/PL 2.06, GD/EW 0.81, TL/EW 1.99. **Body** elongate, convex; dorsal and ventral surfaces reddish brown; antennae, palpi and tarsi a bit lighter. **Head** concealed by pronotum when seen from above; dorsum with coarse shallow punctures bearing suberect bristles; frontoclypeal ridge projected upwards into two subtriangular plates with rounded apex. **Antennae** bearing ten antennomeres with the following lengths (in mm, left antennae measured): 0.08, 0.05, 0.06, 0.04, 0.03, 0.02, 0.02, 0.05, 0.05, 0.07 (FL 0.17 mm, CL 0.17 mm, CL/FL 1.00 mm). **Eyes** finely faceted, each bearing about 70 ommatidia; GW 0.20 mm. **Pronotum** (Fig. 21) with single punctation that is deep and coarse. The punctation may be indistinctly dual in some areas, with minute punctures between coarse ones. The pronotum is devoid of a median unpunctate line; punctures are separated by half to a full puncture-width and are usually closer to each other at the disc, with microreticulate interspaces; vestiture indistinctly dual, consisting of longer suberect (0.04–0.05 mm) and shorter decumbent (~0.03 mm) yellowish bristles; anterior edge projected forward into two subtriangular plates, which are bent slightly upwards; anterior portion with a conspicuous, broad concave impression at the base of the anterior plates, where the punctures are sparser than on the disc, and bristles are decumbent and small (0.02–0.03 mm); lateral edges not visible from above, except for posteriormost portions, not explanate and weakly crenulated. **Scutellar shield** triangular, bearing a few punctures and suberect bristles; BW 0.17 mm and SL 0.09 mm. **Elytra** with confused, dual punctation; large punctures coarse, irregular, deep, about twice as large as small punctures; interspaces a bit rugose, shiny; vestiture distinctly dual, consisting of long suberect (0.05–0.06 mm) and small decumbent (~0.03 mm) yellowish bristles, both arising from minute punctures. **Hind wings** developed, apparently functional. **Prosternum** biconcave, subglabrous; microreticulate surface; prosternal process about as long as prosternum disc at midline; conspicuously narrow near base and gradually expanding to a rounded apex. **Hypomera** subglabrous; microreticulate surface. **Protibia** with maximum width about one-fourth of its length; apical edge devoid of spines; outer apical angle projected into a small tooth. **Meso- and metatibia** without spines on apical edge. **Metaventrite** subglabrous, bearing sparse slender setae; punctation coarse, irregular, sparse, interspaces microreticulate; discrimen about half the length of the metaventrite at midline. **Abdominal ventrites** subglabrous, bearing sparse slender setae, coarsely punctate, microreticulate surface; length of ventrites (in mm, from base

to apex at the longitudinal midline) as follows: 0.35, 0.15, 0.13, 0.14, 0.15; first abdominal ventrite bearing a margined, circular sex patch located posterad of center and with a transverse diameter of 0.10 mm and bearing a tuft of slender setae. **Male terminalia in a paratype** (Figs 23–26): **sternite VIII** (Fig. 23) with posterior edge almost straight, bearing small setae medially and longer setae at sides, which are rounded; anterior edge membranous. **Tegmen** (Fig. 25) with apical portion membranous and bearing three emarginations, the lateral ones being deeper and narrower than the median. **Basal piece** (Fig. 24) subtrapezoidal, about as long as wide. **Penis** (Fig. 26) about 0.7 times as long as tegmen, gradually expanding to apex and devoid of struts; apical portion membranous and with a V- shaped sclerotization; basal portion membranous.

Females (Fig. 22). Similar to males but devoid of an abdominal sex patch, concave impression and plates on the pronotum and head; anterior edge of head, truncate; anterior edge of pronotum, rounded.

Variation. Males, measurements in mm (n=22, including the holotype): TL 2.30–2.85 (2.55 ± 0.17), PL 0.63–1.00 (0.84 ± 0.09), PW 0.90–1.25 (1.11 ± 0.10), EL 1.55–1.90 (1.72 ± 0.10), EW 1.00–1.35 (1.13 ± 0.10), GD 0.70–1.05 (0.86 ± 0.09), PL/PW 0.50–1.00 (0.76 ± 0.09), EL/EW 1.30–1.75 (1.53 ± 0.13), EL/PL 1.70–2.92 (2.07 ± 0.20), GD/EW 0.64–0.90 (0.76 ± 0.07), TL/EW 1.99–2.70 (2.27 ± 0.20). In smaller males, pronotal plates and the concave impression at their bases are reduced. Females, measurements in mm (n=26): TL 2.05–2.90 (2.47 ± 0.20), PL 0.70–0.95 (0.79 ± 0.06), PW 0.85–1.30 (1.11 ± 0.10), EL 1.35–2.05 (1.68 ± 0.16), EW 0.90–1.35 (1.18 ± 0.10), GD 0.70–1.05 (0.91 ± 0.09), PL/PW 0.32–0.45 (0.36 ± 0.03), EL/EW 0.63–0.82 (0.72 ± 0.06), GD/EW 0.32–0.48 (0.39 ± 0.03), TL/EW 0.96–1.25 (1.05 ± 0.07).

Type series. Holotype ♂ (SANC) “SOUTH AFRICA, NW, Marethwane, Magaliesberg, 25°47’S 27°29’E, 24.viii.2002, S. Naser \ Adults ex bracket fungus \ *Cis mandelai* Souza-Gonçalves & Lopes-Andrade HOLOTYPE [red paper]”. Paratypes 27 ♂ (21 measured) and 39 ♀ (26 measured) as follows: 8 ♂ (3 CELC; 5 SANC) and 9 ♀ (3 CELC; 6 SANC) “SOUTH AFRICA, NW, Mhlabatini Kloof, Magaliesberg, 25°29’S 27°19’E, 16.vi.2002, S. Naser \ Adults ex bracket fungus on dead *Croton gratissimus* (EUPHORBIACEAE) \ Ex bracket fungus *Ganoderma* sp., BF#19”; one ♂ and one ♀ (SANC) “SOUTH AFRICA, NW, Mhlabatini Kloof, Magaliesberg, 25°29’S 27°19’E, 16.vi.2002, S. Naser \ Adults ex bracket fungus on dead *Croton gratissimus*

(EUPHORBIACEAE) \ Ex bracket fungus, BF#14”; 2 ♂ (1 CELC, one dissected; one SANC) and 4 ♀ (1 CELC; 3 SANC) “SOUTH AFRICA, LIMP, Sekororo Kloof, nr. Penge, 24°25’S 30°27’E, 27.vii.2008, S. Naser \ Ex bracket fungus *Trametes cingulata*, BF#155”; one ♂ (CELC, dissected) and 3 ♀ (1 CELC; 3 SANC) “SOUTH AFRICA, MPU, Die Hel Nature Res., nr. Loskop Dam, 25°31’S 29°48’E, 10.viii.2008, S. & O. C. Naser \ Ex bracket fungus *Trametes* sp., BF#147”; 7 ♂ (2 CELC; 5 SANC) and 4 ♀ (1 CELC; 3 SANC) “SOUTH AFRICA, LIMP, Thabaphaswa (Groenkom Farm), near Mokopane, 24°03’S 29°02’E, 30.vii.2003, S. Naser \ Ex bracket fungus on dead tree trunk”; 3 ♂ (1 CELC, one dissected; 2 SANC) and 6 ♀ (2 CELC, one dissected; 4 SANC) same data as the holotype; 5 ♂ (2 CELC; 3 SANC) and 12 ♀ (4 CELC; 8 SANC) “SOUTH AFRICA, GAU, Pretoria, Rietondale Experimental Station, 25°44’S 28°13’E, 14.ii.2003, S. Naser \ Ex bracket fungus”. All paratypes additionally labeled \ *Cis mandelai* Souza-Gonçalves & Lopes-Andrade PARATYPUS [yellow paper] \.

Etymology. The new species is named in honor of Nelson Rolihlahla Mandela (1918–2013), the most powerful symbol of the fight against the segregationist regime of Apartheid.

Host fungi. *Ganoderma* sp. P. Karst. (Ganodermataceae), one breeding record; *Trametes* sp., one breeding record; and *Trametes cingulata* Berk. (Polyporaceae), one breeding record.

Distribution. All specimens of *Cis mandelai* were collected in six localities of Grassland and Savanna, all above 1000 meters of altitude and including urban areas (Fig. 62).

Comments. We extracted aedeagi of males from the type locality and from Sekororo and Die Hel, and no difference was observed. This species was collected together with *C. makebae* **sp. nov.**, *C. naserorum* **sp. nov.**, the morphospecies *Cis* sp. C, *Cis* sp. D, *Cis* sp. J, *Cis* sp. H, *Cis* sp. O, *Cis* sp. Q, *Cis* sp. X, *Cis* sp. Y and *Orthocis* sp. A, the invasive species *Ceracis tabellifer* (Mellié, 1849) and the parasitoid *A. micans*.

***Cis masekelai* Souza-Gonçalves et Lopes-Andrade, sp. nov.**

(Figs 27–35, 62)

Diagnosis. The pronotum is devoid of median unpunctate line, and in males its anterior portion is devoid of concave impression. The tegmen has membranous apical portion, narrowest at apex and bearing an emargination (Fig. 34). The penis is about three-fourths the length of tegmen and enlarged before a membranous apex (Fig. 35). Among the species described here, *C. masekelai* **sp. nov.** is morphologically closely related to *C. makebae* and *Cis stalsi* **sp. nov.** However, the anterior pronotal edge in males has only a shallow emargination forming two very short projections. Among other southern African *Cis*, it may be related to *C. delagoensis*, of which we have not examined any specimen.

Description. Male holotype (Figs 27–30). Adult apparently not fully pigmented but in good conditions. Measurements in mm: TL 2.03, PL 0.65, PW 0.87, EL 1.38, EW 0.91, GD 0.66. Ratios: PL/PW 0.75, EL/EW 1.51, EL/PL 2.11, GD/EW 0.72, TL/EW 2.22. **Body** elongate, medially convex; dorsal surface reddish dark brown and ventral surface a bit lighter; antennae, palpi and tarsi yellowish brown. **Head** concealed by pronotum when seen from above; dorsum with coarse and dense punctures, each bearing a suberect bristles; frontoclypeal ridge emarginated anteriorly, forming two short subtriangular plates with acute apices. **Antennae** bearing ten antennomeres with the following lengths (in mm, left antennae measured): 0.07, 0.05, 0.04, 0.04, 0.03, 0.02, 0.02, 0.05, 0.05, 0.08 (FL 0.15 mm, CL 0.18 mm, CL/FL 1.20 mm). **Eyes** are finely faceted, each bearing about 60 ommatidia; GW 0.15 mm. **Pronotum** (Fig. 30) with deep and coarse punctation, with a short, narrow unpunctate median line beginning about three punctures from the posterior edge and extending until center; punctures separated by about a puncture-width or less, interspaces microreticulate and a bit rugose; vestiture indistinctly dual, consisting of longer suberect (~0.03 mm) and shorter decumbent (~0.02 mm) yellowish bristles; anterior edge with a shallow emargination, forming two very short projections; lateral edges weakly crenulated, narrow but visible from above, except for anteriormost portion. **Scutellar shield** subtriangular, bearing a few punctures and bristles; BW 0.09 mm and SL 0.07 mm. **Elytra** with confused, dual punctation; punctures irregular, the smallest being about two-thirds the diameter of the largest; interspaces rugose, shiny; vestiture indistinctly dual, consisting of longer suberect (0.04–0.05 mm) and smaller decumbent (~0.03 mm) yellowish bristles, both arising from minute punctures. **Hind wings** developed, apparently functional. **Prosternum** biconcave, subglabrous; microreticulate surface; prosternal process

subparallel-sided, about as long as prosternal disc at midline, apex rounded. **Hypomera** subglabrous; microreticulate surface. **Protibia** with maximum width about one-fifth of its length; apical edge devoid of spines; outer apical angle projected into a small tooth. **Meso- and metatibia** without spines on apical edge. **Metaventrite** subglabrous, bearing sparse slender setae; punctation coarse, irregular, sparse, interspaces microreticulate; discrimen about half as long as the metaventrite at midline. **Abdominal ventrites** subglabrous, bearing sparse slender setae, coarsely punctate, microreticulate surface; length of ventrites (in mm, from base to apex at the longitudinal midline) as follows: 0.28, 0.13, 0.11, 0.11, 0.13; first abdominal ventrite bearing a margined, small, ovoid sex patch at center, bearing a tuft of setae and with a transverse diameter of 0.06 mm. **Male terminalia in a paratype** (Figs 32–35): **sternite VIII** (Fig. 32) with posterior shallowly emarginated, sides rounded and bearing long setae; anterior edge membranous. **Tegmen** (Fig. 34) with apical portion membranous, with sides converging and bearing a narrow emargination at middle forming two lobes. **Basal piece** (Fig. 33) subsquare. **Penis** (Fig. 35) about three-fourths the length of tegmen, expanding from base to about two-thirds; struts not linked at base, forming the laterals of penis and widening to about two-thirds forming conspicuous sclerotizations; apex subtriangular and membranous.

Females (Fig. 31). Similar to males but devoid of an abdominal sex patch, emargination on the pronotum and plates on the head; anterior edge of the head, truncate; anterior edge of pronotum, rounded.

Variation. Males, measurements in mm (n=12, including the holotype): TL 1.95–2.40 (2.12 ± 0.14), PL 0.65–0.95 (0.72 ± 0.08), PW 0.85–0.95 (0.89 ± 0.05), EL 1.25–1.50 (1.40 ± 0.09), EW 0.85–1.00 (0.96 ± 0.05), GD 0.60–0.75 (0.68 ± 0.04), PL/PW 0.74–1.12 (0.81 ± 0.10), EL/EW 1.25–1.59 (1.46 ± 0.11), EL/PL 1.53–2.31 (1.95 ± 0.21), GD/EW 0.65–0.79 (0.71 ± 0.03), TL/EW 1.95–2.53 (2.22 ± 0.15). Females, measurements in mm (n=11): TL 2.15–2.50 (2.31 ± 0.12), PL 0.65–0.95 (0.76 ± 0.09), PW 0.85–1.10 (0.96 ± 0.08), EL 1.40–1.70 (1.55 ± 0.08), EW 0.95–1.15 (1.03 ± 0.06), GD 0.70–0.90 (0.75 ± 0.06), PL/PW 0.68–0.95 (0.80 ± 0.07), EL/EW 1.39–1.70 (1.50 ± 0.09), EL/PL 1.58–2.46 (2.05 ± 0.24), GD/EW 0.67–0.80 (0.73 ± 0.04), TL/EW 2.13–2.50 (2.24 ± 0.12).

Type series. Holotype ♂ (SANC) “SOUTH AFRICA, MPU, Die Hel Nature Res., nr. Loskop Dam, 25°31'S 29°48'E, 10.viii.2008, S. & O. C. Neser \ Ex bracket

fungus *Trametes meyenii*, BF#162” \ *Cis masekelai* Souza-Gonçalves & Lopes-Andrade HOLOTYPUS [red paper]”. Paratypes 16 ♂ (11 measured) and 18 ♀ (11 measured) as follow: one ♂ and 2 ♀ (SANC) “SOUTH AFRICA, TvL, D’Nyala Nature Res., near Ellisras, 25°45’S 27°49’E, 850m, 28.ix.1989, E. Grobbelaar \ Collected from bracket fungus body”; 6 ♂ (2 CELC, one dissected; 4 SANC) and 12 ♀ (4 CELC, one dissected; 8 SANC) “SOUTH AFRICA, NW, Dome Kloof, Magaliesberg, 25°45’S 27°33’E, 8.vi.2002, S. Naser \ Adults and larvae ex bracket fungus on dead *Ozoroa* tree (ANACARDIACEAE)”; 8 ♂ (2 CELC; 6 SANC) and 3 ♀ (1 CELC; 2 SANC) “SOUTH AFRICA, MPU, Die Hel Nature Res., nr. Loskop Dam, 25°31’S 29°48’E, 10.viii.2008, S. & O. C. Naser \ Ex bracket fungus *Trametes meyenii*, BF#162”; one ♂ (CELC, dissected) and one ♀ (CELC) “SOUTH AFRICA, MPU, Die Hel Nature Res., nr. Loskop Dam, 25°31’S 29°48’E, 10.viii.2008, S. & O. C. Naser \ Ex bracket fungus *Trametes meyenii*, BF#163”. All paratypes additionally labelled \ *Cis masekelai* Souza-Gonçalves & Lopes-Andrade PARATYPUS [yellow paper] \.

Etymology. The new species is named in honor of Hugh Ramopolo Masekela, a South African composer, musician and singer of jazz, whose songs protested slavery and Apartheid.

Host fungi. *Trametes meyenii* (Klotzsch) Lloyd (Polyporaceae), two records, one being a breeding record.

Distribution. *Cis masekelai* was collected in three localities of Grassland and Savanna (Fig. 62), all above 1200 meters of altitude.

Comments. We extracted aedeagi of males from the type locality and from Dome, and no difference was observed. The species was collected together with *Cis nesororum* **sp. nov.** and *Cer. tabellifer*, without parasitoid.

***Cis nesororum* Souza-Gonçalves et Lopes-Andrade, sp. nov.**

(Figs 36–44, 63)

Cis sp. E in Naser (2012)

Diagnosis. The pronotum bears a median unpunctate line, and in males its anterior portion bears a concave impression. The aedeagus is very similar to that of *C. urbanae* **sp. nov.**, but the first abdominal ventrite is devoid of sex patch. The tegmen is devoid of

lateral excavations or angulations, and bears struts linked at base and diverging to about three-fifths of its length, forming part of the laterals (Fig. 43). The penis is subcylindrical and about two-fifths the length of tegmen (Fig. 44). Among the species described here, *C. nesororum* **sp. nov.** is morphologically closely related to *C. aster* and *C. urbanae* **sp. nov.**, but may be distinguished by its parallel-sided prosternal process with rounded apex (apex truncate in *C. aster* and base of process narrow in *C. urbanae* **sp. nov.**). Among other southern African *Cis*, male *C. nesororum* **sp. nov.** differs from male *C. affter* and *C. caffer* in bearing a concave impression at the anterior portion of pronotum, and from *C. testaceus* in possessing comparatively shorter and closer pronotal plates.

Description. Male holotype (Figs 36–39). Adult fully pigmented. Measurements in mm: TL 2.73, PL 1.00, PW 1.23, EL 1.73, EW 1.23, GD 1.00. Ratios: PL/PW 0.82, EL/EW 1.41, EL/PL 1.73, GD/EW 0.82, TL/EW 2.22. **Body** elongate, convex; dorsal and ventral surfaces reddish dark brown; palpi and tarsi a bit lighter. **Head** with anteriormost portion visible from above; dorsal punctures coarse and shallow, with decumbent bristles arising from them; frontoclypeal ridge projected upward into two subtriangular plates with rounded apices. **Antennae** bearing ten antennomeres with the following lengths (in mm, left antennae measured): 0.09, 0.08, 0.05, 0.02, 0.04, 0.04, 0.03, 0.07, 0.08, 0.11 (FL 0.18 mm, CL 0.26 mm, CL/FL 1.44 mm), antennal club darker than funicle. **Eyes** finely faceted; each bearing about 80 ommatidia; GW 0.20 mm. **Pronotum** (Fig. 39) with deep and coarse, indistinctly dual punctation, with a short, narrow unpunctate median line beginning about three punctures from the posterior edge and extending until center; punctures separated from each other by a puncture-width or less, interspaces microreticulate, shinny; vestiture indistinctly dual, consisting of longer suberect yellowish bristles (~0.03 mm) and shorter yellowish setae (~0.02 mm); anterior edge projected upward into two short triangular plates with rounded apices; anterior portion with a conspicuous concave impression at the base of anterior plates, in which the punctures are sparser than on disc and bristles are decumbent and smaller (0.02–0.03 mm); lateral edges not visible from above, except for posteriormost portions, not explanate and weakly crenulate. **Scutellar shield** subtriangular, bearing a few punctures and decumbent bristles; BW 0.14 mm and SL 0.07 mm. **Elytra** with confused, dual punctation; large punctures coarse, irregular, deep, about twice as large as small punctures; interspaces shiny, a bit rugose; vestiture

indistinctly dual, consisting of long (0.04–0.05 mm) and short (~0.03 mm) suberect yellowish bristles, both arising from minute punctures. **Hind wings** developed, apparently functional. **Prosternum** biconcave, subglabrous; microreticulate surface; prosternal process parallel-sided, about as long as prosternum disc at midline, apex rounded. **Hypomera** subglabrous; microreticulate surface. **Protibia** with maximum width about one-third of its length; apical edge devoid of spines; outer apical angle projected into a small tooth. **Meso- and metatibia** without spines on apical edge. **Metaventricle** subglabrous, bearing sparse slender setae; punctation coarse, sparse, irregular, interspaces microreticulate; discrimen about three-fifths as long as the metaventricle at midline. **Abdominal ventrites** subglabrous, bearing sparse slender setae, coarsely punctate, microreticulate surface; length of ventrites (in mm, from base to apex at the longitudinal midline) as follows: 0.33, 0.15, 0.14, 0.14, 0.16; first abdominal ventrite without sex patch. **Male terminalia in a paratype** (Figs 41–44): **sternite VIII** (Fig. 41) with posterior edge straight, bearing small setae medially and long setae at the rounded sides; anterior edge membranous. **Tegmen** (Fig. 43) elongate, devoid of lateral excavations or angulations; struts linked at base and diverging to about three-fifths of its length, forming part of the laterals; apical portion with sides converging and with a narrow emargination at middle. **Basal piece** (Fig. 42) subtriangular, as long as wide. **Penis** (Fig. 44) subcylindrical, about two-fifths the length of tegmen and a bit wider at the basal half.

Females (Fig. 40). Similar to males but devoid of an abdominal sex patch, concave impression and plates on the pronotum and head; anterior edge of head, truncate; anterior edge of pronotum, rounded.

Variation. Males, measurements in mm (n=86, including the holotype): TL 1.70–3.10 (2.52 ± 0.35), PL 0.50–1.30 (0.87 ± 0.16), PW 0.75–1.40 (1.07 ± 0.15), EL 1.10–2.10 (1.65 ± 0.90), EW 0.85–1.40 (1.15 ± 0.15), GD 0.60–1.10 (0.87 ± 0.11), PL/PW 0.58–1.39 (0.82 ± 0.11), EL/EW 1.04–1.83 (1.45 ± 0.12), EL/PL 1.45–2.70 (1.93 ± 0.23) GD/EW 0.59–1.00 (0.76 ± 0.06), TL/EW 1.63–2.56 (2.20 ± 0.16). In smaller males, pronotal plates and the concave impression are inconspicuous; in a few large males, the pronotal concave impression is not well defined. Females, measurements in mm (n=99): TL 1.75–3.15 (2.55 ± 0.27), PL 0.55–1.25 (0.82 ± 0.11), PW 0.70–1.40 (1.05 ± 0.14), EL 1.10–2.20 (1.74 ± 0.21), EW 0.75–1.40 (1.15 ± 0.13), GD 0.55–1.10 (0.87 ± 0.09), PL/PW 0.61–1.43 (0.79 ± 0.13), EL/EW 1.27–1.77 (1.51

± 0.11), EL/PL 1.45–2.87 (2.14 ± 0.27) GD/EW 0.64–0.91 (0.76 ± 0.05), TL/EW 1.96–2.65 (2.22 ± 0.12).

Type series. Holotype ♂ (SANC) “SOUTH AFRICA, LIMP, Wesfalia Estate, nr. Politsi, 23°44’S 30°07’E, 13.x.2009, D van Heerden \ Ex bracket fungus #218 on avocado tree \ Ex bracket fungus *Coriolus versicolor*, BF#218 \ *Cis nesororum* Souza-Gonçalves & Lopes-Andrade HOLOTYPUS [red paper]”. Paratypes 223 ♂ (85 measured) and 309 ♀ (99 measured) as follow: 4 ♀ (2 CELC; 2 SANC) same data as the holotype; 4 ♂ and 2 ♀ (SANC) “Pretoria, TP., Nov., 1948, Dr. Talbot, SN. 3427 \ Damaging specimens Mycological Herbarium \ COM. INST. ENT. COLL. NO. 11190”; ♂ (CELC, dissected) “SOUTH AFRICA, Ixopo Mt, 20.viii.1983, A. Lexton \ AcCA 1335 \ *Cisidae* det. R. Oberprieler 198”; ♂ (CELC, dissected) and 3 ♀ (1 CELC; 2 SANC) “SOUTH AFRICA, TVL, Sabie, Bergvliet Plant, 25.07S 30.46E, 21.xi.1984, A. P. Baxter”; 6 ♂ (2 CELC) and 4 ♀ (1 CELC; 3 SANC) “SOUTH AFRICA, TVL, Pretoria, Gardens of Union Buildings, 25.45S 28.12E, 02.v.1986, C. Roux”; 2 ♂ (1 CELC; one SANC) and 3 ♀ (one CELC; 2 SANC) “SOUTH AFRICA, NTL, Montaux-Sources, Royal Natal Nat. Park, 26.46S 28.53E, 21.v.1986, C. Roux”; 4 ♂ (1 CELC, dissected; 3 SANC) and 7 ♀ (2 CELC; 5 SANC) “SOUTH AFRICA, VENDA, Thohoyandou, 22.57S 30.27E, 11.vi.1987, C. Roux”; ♂ (CELC, dissected) “SOUTH AFRICA, CP, Rosebank, Cape Town, 33.57S 18.28E, 09.xii.1988, G. D. Tribe \ AcCa 1526”; ♂ and 3 ♀ (CELC) “SOUTH AFRICA, WCAPE, Saasveld Forestry Res. Centre, E of George, 33°57’S 22°32’E, 11.iv.1990, AJ Urban \ ex *Celtis sinensis* (ULMACEAE)”; 3 ♀ (SANC) “SOUTH AFRICA, WCAPE, Heatherlands, George, 33°57’S 22°27’E, 11.iv.1990, AJ Urban \ Emerged from *Dais cotinifolia*, THYMELAEACEAE, with fruiting body of fungus ?*Lenzites* \ UA 601”; 6 ♀ (SANC) “SOUTH AFRICA, WCAPE, Saasveld Forestry Coll., 33°57’S 22°32’E, 11.iv.1990, AJ Urban & AAJ Hendricks \ Emerged from dead branch of *Celtis sinensis* with bracket fungus *Pseudotrametes*, UA 600”; 5 ♂ (2 CELC; 3 SANC) and 3 ♀ (1 CELC; 2 SANC) “SOUTH AFRICA, WCAPE, Garden of Eden Indig. Forest, nr. Knysna, 34°02’S 23°12’E, 1.iii.1991, AJ Hendricks \ Emerged from log on forest floor of *Olea capensis macrocarpa*, OLEACEAE, UA 679”; 6 ♂ (2 CELC, one dissected; 4 SANC) and 11 ♀ (4 CELC; 7 SANC) “SOUTH AFRICA, NW, Tonquani, Magaliesberg, 25°50’S 27°29’E, 13.x.2002, O. C. Nesor \ Adults ex bracket fungus”; 3 ♂ (1 CELC; 2 SANC) and 11 ♀ (4 CELC; 7 SANC) “SOUTH AFRICA, NW, Easter Kloof, Magaliesberg,

25°50'S 27°31'E, 2.i.2004, S. Naser \ Adults ex bracket fungus (APHYLLOPHORALES) on *Heteromorpha trifoliata* (APIACEAE)"; 4 ♂ (1 CELC; 3 SANC) and 6 ♀ (2 CELC; 4 SANC) "SOUTH AFRICA, NW, Easter Kloof, Magaliesberg, 25°50'S 27°31'E, 2.i.2004, S. Naser \ Ex bracket fungus on *Heteromorpha trifoliata* 1, APIACEAE"; 8 ♂ (3 CELC; 5 SANC) "SOUTH AFRICA, NW, Easter Kloof, Magaliesberg, 25°50'S 27°31'E, 2.i.2004, S. Naser \ Ex bracket fungus on *Heteromorpha trifoliata* 2, APIACEAE"; ♀ (SANC) "SOUTH AFRICA, NW, Easter Kloof, Magaliesberg, 25°50'S 27°31'E, 2.i.2004, S. Naser \ Adults ex bracket fungus cf. *Daedelopsis* sp. (APHYLLOPHORALES) on *Heteromorpha trifoliata* (APIACEAE)"; 5 ♀ (3 CELC; 2 SANC) "SOUTH AFRICA, NW, Easter Kloof, Magaliesberg, 25°50'S 27°31'E, 2.i.2004, S. Naser \ Adults ex bracket fungus *Pycnoporus sanguineus* (APHYLLOPHORALES) on *Heteromorpha trifoliata* (APIACEAE)"; 7 ♂ (2 CELC; 5 SANC) and 9 ♀ (3 CELC; 6 SANC) "SOUTH AFRICA, LIMPOPO, Tzaneen, 23°50'S 30°09'E, 11.iii.2004, R. N. Heath \ Adults and larvae ex bracket fungus *Lenzites elegans* (APHYLLOPHORALES) in *Eucalyptus* plantation (MYRTACEAE) \ Ex bracket fungus *Lenzites elegans*, BF#30"; 20 ♀ (7 CELC; 13 SANC) "SOUTH AFRICA, NW, Tonquani Kloof, Magaliesberg, 25°50'S 27°29'E, 4.xii.2004, S. Naser \ Ex bracket fungus on dead tree trunk, BF#24"; 5 ♂ (2 CELC; 3 SANC) and 16 ♀ (5 CELC; 11 SANC) "SOUTH AFRICA, ECAPE, Grahamstown, 33°19'S 26°32'E, 15.vii.2005, S. Naser \ Beetles ex orange bracket fungus on pine log, Parasitoids HYMC 05645"; 5 ♂ (2 CELC; 3 SANC) and 7 ♀ (2 CELC; 5 SANC) "SOUTH AFRICA, WCAPE, Palmiet River, nr Kleinmond, 34°20'S 18°58'E, 01.i.2006, S. Naser \ Collected from orange bracket fungus (APHYLLOPHORALES) on dead ?*Acacia longifolia* (FABACEAE)"; 3 ♂ (1 CELC; 2 SANC) and 7 ♀ (2 CELC; 5 SANC) "SOUTH AFRICA, WCAPE, De Hoop Nature Reserve, 34°25'S 20°39'E, 4.xi.2006, S. & O. C. Naser \ Collected from orange bracket fungus (APHYLLOPHORALES) on dead stems of *Acacia saligna* (FABACEAE)"; 13 ♂ (4 CELC, one dissected; 9 SANC) and 6 ♀ (2 CELC; 4 SANC) "SOUTH AFRICA, WCAPE, Palmiet River, nr. Kleinmond, 34°20'S 18°58'E, 23.xii.2006, S. Naser \ Collected from orange bracket fungus (APHYLLOPHORALES) on dead ?*Acacia longifolia* (FABACEAE)"; ♂ (CELC, dissected) "SOUTH AFRICA, NW, Krantz Kloof, Magaliesberg, 25°45'S 27°42'E, 21.ii.2008, OC Naser \ Ex bracket fungi on fallen log, BF#49 \ Ex bracket fungi *Trametes* sp., BF#49"; ♂ and 5 ♀ (SANC)

“SOUTH AFRICA, KZN, Monk’s Cowl Foothills Drakensberg, 29°03’S 29°23’E, 24.iii.2008, S. & O. C. Naser \ Ex bracket fungi on fallen log, BF#66 \ Ex bracket fungus *Trametes meyenii*, BF#66”; ♀ (SANC) “SOUTH AFRICA, NW, Tonquani, south Magaliesberg, 8.v.2008, O. C. Naser \ Ex unidentified bracket fungus, BF#72”; 14 ♂ (5 CELC; 9 SANC) “SOUTH AFRICA, NW, Tonquani Kloof, Magaliesberg, 25°50’S 27°29’E, 12.vi.2008, S Naser \ Ex bracket fungi on dead branch, BF#51 \ Ex bracket fungus *Trametes meyenii*, BF#51”; ♀ (SANC) “SOUTH AFRICA, KZN, Mpisini Nature Res., Unkomaas, 30°12’S 30°48’E, 9.vii.2008, S. & O. C. Naser \ Ex bracket fungus, BF#161”; 4 ♂ (1 CELC; 3 SANC) and 2 ♀ (1 CELC; one SANC) “SOUTH AFRICA, KZN, Strathdene Farm, nr. Nottingham Rd., 29°21’S 30°01’E, 13.vii.2008, S & O C Naser \ Ex bracket fungus *Coriolus polyzona*, BF#133”; 2 ♂ and ♀ (SANC) “SOUTH AFRICA, MPU, Mooihoek Farm, nr. Wakkerstroom, 27°13’S 30°32’E, 15.vii.2008, O & S Naser \ Ex bracket fungus *Trametes* sp., BF#113”; 3 ♂ and 2 ♀ (SANC) “SOUTH AFRICA, MPU, Mooihoek Farm, nr. Wakkerstroom, 27°13’S 30°32’E, 15.vii.2008, O & S Naser \ Ex bracket fungus *Thelephora* sp., BF#125”; 5 ♂ (CELC, one dissected) and 5 ♀ (CELC, one dissected) “SOUTH AFRICA, MPU, Mooihoek Farm, nr. Wakkerstroom, 27°13’S 30°32’E, 15.vii.2008, O & S Naser \ Ex bracket fungus *Stereum ostrea*, BF#144”; 6 ♂ (2 CELC; 2 VSPC; 2 SANC) and 7 ♀ (2 CELC; 5 SANC) “SOUTH AFRICA, MPU, Mooihoek Farm, nr. Wakkerstroom, 27°13’S 30°32’E, 15.vii.2008, O & S Naser \ Ex bracket fungus *Coriolus hirsutus*, BF#137”; 7 ♂ (2 CELC; 5 SANC) and 12 ♀ (4 CELC; 8 SANC) “SOUTH AFRICA, MPU, Mooihoek Farm, nr. Wakkerstroom, 27°13’S 30°32’E, 15.vii.2008, O & S Naser \ Ex bracket fungus, BF#112 \ Ex bracket fungus *Pycnosporus sanguineus*, BF#112”; 9 ♂ (3 CELC; 6 SANC) and 2 ♀ (1 CELC; 1 SANC) “SOUTH AFRICA, MPU, Mooihoek Farm, nr. Wakkerstroom, 27°13’S 30°32’E, 15.vii.2008, O & S Naser \ Ex bracket fungus *Lenzites elegans*, BF#164”; 39 ♂ (11 CELC; 2 VSPC; 26 SANC) and 16 ♀ (1 CELC; 4 VSPC; 11 SANC) “SOUTH AFRICA, MPU, Mooihoek Farm, nr. Wakkerstroom, 27°13’S 30°32’E, 15.vii.2008, O & S Naser \ Ex bracket fungus, BF#129 \ Ex bracket fungus *Coriolus versicolor*, BF#129”; ♂ and 2 ♀ (SANC) “SOUTH AFRICA, MPU, Mooihoek Farm, nr. Wakkerstroom, 27°13’S 30°32’E, 15.vii.2008, O & S Naser \ Ex bracket fungus, BF#99 \ Ex bracket fungus *Coriolus hirsutus*, BF#99”; 3 ♂ (1 CELC; 2 SANC) and 33 ♀ (11 CELC; 22 SANC) “SOUTH AFRICA, MPU, Mooihoek Farm, nr. Wakkerstroom, 27°13’S 30°32’E, 15.vii.2008, O &

S Naser \ Ex bracket fungus, BF#132”; ♂ (SANC) “SOUTH AFRICA, MPU, Mooihoek Farm, nr Wakkerstroom, 27°13’S 30°32’E, 15.vii.2008, O & S Naser \ Ex bracket fungus, BF#80 \ Ex bracket fungus *Coriolus versicolor*, BF#80”; 3 ♂ (1 CELC; 2 SANC) “SOUTH AFRICA, MPU, Mooihoek Farm, nr Wakkerstroom, 27°13’S 30°32’E, 15.vii.2008, O & S Naser \ Ex bracket fungus *Coriolus polyzona*, BF#145”; 8 ♂ (3 CELC; 5 SANC) and 8 ♀ (3 CELC; 5 SANC) “ SOUTH AFRICA, NW, Groblerskloof, nr. Buffelspoort Dam, 25°51’S 27°28’E, 7.viii.2008, S. Naser \ Ex bracket fungus *Coriolus hirsutus*, BF#102”; ♂ and ♀ (SANC) “SOUTH AFRICA, MPU, Die Hel Nature Res., nr. Loskop Dam, 25°31’S 29°48’E, 10.viii.2008, S. & O. C. Naser \ Ex bracket fungus, BF#119 \ Ex bracket fungus *Trametes* sp., BF#119”; 2 ♂ (1 CELC; one SANC) and 4 ♀ (2 CELC; 2 SANC) “SOUTH AFRICA, LIMP, Wesfalia Estate, nr. Politsi, 23°44’S 30°07’E, 13.x.2009, D van Heerden \ Ex bracket fungus #220 on avocado tree \ Ex bracket fungus *Lenzites elegans*, BF#220”; 4 ♂ (CELC, one dissected) and 2 ♀ (CELC) “SOUTH AFRICA, LIMP, Wesfalia Estate, nr. Politsi, 23°44’S 30°07’E, 13.x.2009, D van Heerden \ Ex bracket fungus #222 on avocado tree \ Ex bracket fungus *Pycnoporus sanguineus*, BF#222”; ♂ and 3 ♀ (SANC) “SOUTH AFRICA, LIMP, Wesfalia Estate, nr Politsi, 23°44’S 30°07’E, 13.x.2009, D van Heerden \ Ex bracket fungus #221 on fallen tree trunk \ Ex bracket fungus *Lenzites elegans*, BF#221”; 2 ♀ (SANC) “ SOUTH AFRICA, WCAPE, Montagu Pass, N of George, 33°54’S 22°24’E, 4.xi.2009, S & OC Naser \ Ex bracket fungus #210 on fallen tree trunk \ Ex bracket fungus *Coriolus hirsutus*, BF#210”; ♀ (SANC) “SOUTH AFRICA, WCAPE, Montagu Pass, N of George, 33°54’S 22°24’E, 4.xi.2009, S & OC Naser \ Ex bracket fungus *Coriolopsis polyzona*, BF#202”; 3 ♂ and 2 ♀ (CELC) “SOUTH AFRICA, WCAPE, Montagu Pass, N of George, 33°54’S 22°24’E, 4.xi.2009, S & OC Naser \ Ex bracket fungus #209 on fallen tree trunk \ Ex bracket fungus *Pycnoporus sanguineus* on fallen tree trunk, #BF209”; 5 ♂ (2 CELC; 3 SANC) “SOUTH AFRICA, WCAPE, Montagu Pass, N of George, 33°54’S 22°24’E, 4.xi.2009, S & OC Naser \ Ex bracket fungus #205 on fallen tree trunk \ Ex bracket fungus *Coriolus versicolor*, BF#205”; 2 ♂ and 3 ♀ (SANC) “SOUTH AFRICA, WCAPE, Montagu Pass, N of George, 33°54’S 22°24’E, 4.xi.2009, S & OC Naser \ Ex bracket fungus #200 on fallen tree trunk”; ♂ and ♀ (CELC) “SOUTH AFRICA, WCAPE, Montagu Pass, N of George, 33°54’S 22°24’E, 4.xi.2009, S & OC Naser \ Ex bracket fungus #203 on stinkwood \ Ex bracket fungus *Ganoderma applanatum*, BF#203”; ♂

and 2 ♀ (SANC) “SOUTH AFRICA, WCAPE, Prince Alfred’s Pass, N of Knysna, 35°58’S 23°09’E, 5.xi.2009, S & OC Naser \ Ex bracket fungus #214 on fallen tree trunk \ Ex bracket fungus *Lenzites elegans*, BF#214”; 3 ♂ and 3 ♀ (CELC) “SOUTH AFRICA, WCAPE, Prince Alfred’s Pass, N of Knysna, 35°58’S 23°09’E, 5.xi.2009, S & OC Naser \ Ex bracket fungus #206 on fallen tree trunk \ Ex bracket fungus *Coriolus versicolor*, BF#206”; 2 ♂ and 2 ♀ (SANC) “SOUTH AFRICA, WCAPE, Prince Alfred’s Pass, N of Knysna, 35°58’S 23°09’E, 5.xi.2009, S & OC Naser \ Ex bracket fungus #213 on fallen tree trunk \ Ex bracket fungus *Coriolus versicolor*, BF#213”; ♂ (CELC) “SOUTH AFRICA, WCAPE, Prince Alfred’s Pass, N of Knysna, 35°58’S 23°09’E, 5.xi.2009, S & OC Naser \ Ex bracket fungus #212 on fallen tree trunk \ Ex bracket fungus *Pycnoporus sanguineus*, BF#212”; 2 ♀ (CELC) “SOUTH AFRICA, WCAPE, Prince Alfred’s Pass, N of Knysna, 35°58’S 23°09’E, 5.xi.2009, S & OC Naser \ Ex bracket fungus #188 on fallen tree trunk \ Ex bracket fungus *Coriolus* sp., BF#188”; 2 ♂ (1 CELC, dissected; one SANC) and 2 ♀ (1 CELC; one SANC) “SOUTH AFRICA, GAU, Tarlton, nr Krugersdorp, 6.xi.2009 \ Ex bracket fungus #224 on fallen tree trunk \ Ex bracket fungus *Trametes* sp., BF#224”; 2 ♂ (1 CELC; one SANC) and 2 ♀ (1 CELC; one SANC) “SOUTH AFRICA, GAU, Colbyn, Pretoria, 25°44’S 28°15’E, 28.iii.2010, S. Naser \ Ex bracket fungus #226 on *Acacia karoo* \ Ex bracket fungus *Lentinus elegans*, BF#226”; ♂ and 7 ♀ (2 CELC; 4 SANC) “SOUTH AFRICA, GAU, Goodland Estate, 25°33’S 28°29’E, 20.ii.2011, R. P. Urban \ Bred from bracket fungus *Funalia polyzona* (Pers.) Niemela (2003)”; 2 ♀ (SNSD) “Cap. b. sp. \ Coll. C. Felsche Geschenk 1907 [blue paper] \ Staatl. Museum für Tierkunde Dresden”; 3 ♂ (1 dissected) and ♀ (SNSD) “Coll. Maerker, Cap. b. sp. [blue paper] \ Staatl. Museum für Tierkunde Dresden”; 2 ♂ and ♀ (dissected) (SNSD) “Coll. Maerker, Cap. b. sp. [blue paper] \ Staatl. Museum für Tierkunde Dresden \ *Cis muriceus* Kz [Kunzer] Cap. [handwritten]”. All paratypes additionally labelled \ *Cis naserorum* Souza-Gonçalves & Lopes-Andrade PARATYPUS [yellow paper].

Host fungi. *Trametes polyzona* (Pers.) Justo (Polyporaceae), four records, three of which are breeding records; *Ganoderma applanatum* (Pers.) Pat. (Ganodermataceae), one record; *Lenzites elegans* (Spreng.) Pat. (Polyporaceae), six breeding records; *Pycnoporus sanguineus* (L.) Murrill (Polyporaceae), nine records, eight being breeding records (obs.: we considered the label information “orange bracket fungus” as being *P. sanguineus*); *Stereum ostrea* (Blume & T. Nees) Fr. (Steraceae), one breeding record;

Trametes hirsuta (Wulfen) Lloyd (Polyporaceae), four records, three being breeding records; *Trametes meyenii* (Klotzsch) Lloyd (Polyporaceae), two breeding records; *Trametes versicolor* (L.) Lloyd (Polyporaceae), seven records, six being breeding records; *Trametes* sp., six records, three being breeding records (obs.: we are not sure whether these correspond to a single fungus species or several unidentified *Trametes*); and *Thelephora* sp. Ehrh. Ex Willd (Thelephoraceae), one breeding record. Doubtful identifications of genera were not listed here.

Etymology. The new species is named in honor of Stefan Naser and Otilie C. Naser that collected many specimens of this species during a work on parasitoids of ciids from South Africa.

Distribution. *Cis naserorum* has the largest known distribution of a *Cis* species in southern Africa (Fig. 63). Specimens were collected in areas of Grassland, Savanna and Temperate Rainforest (Afromontane forest), including urban areas. It is interesting to note that, among the species described here, only *C. naserorum* is distributed along localities in the south and southeastern coasts; and it occurs in a wide range of altitudes, from about sea level to mountainous areas.

Comments. We extracted aedeagi of males from the type locality and from Mooihoek, Tonquani, Palmiet River, Krantz, Sabie, Thohoyandou, Tarlton, Rosebank and Ixopo, and no difference was observed. This species was collected together with *C. mandelai* **sp. nov.**, *C. masekelai* **sp. nov.**, *C. stalsi* **sp. nov.**, *C. pickeri*, the morphospecies *Cis* sp. C, *Cis* sp. D, *Cis* sp. H, *Cis* sp. I, *Cis* sp. J, *Cis* sp. N, *Cis* sp. Q, *Cis* sp. S, *Cis* sp. V, *Cis* sp. W, *Cis* sp. Y, *Orthocis* sp. A, *Xylographus madagascariensis* Mellié, 1849, the invasive species *Cer. tabellifer* and the parasitoids *A. micans*, *A. silvani* Naser, 2012, *A. naiadis* Naser, 2012 and *A. gracilis* Naser, 2012.

***Cis stalsi* Souza-Gonçalves et Lopes-Andrade, sp. nov.**

(Figs 37–44, 53)

Diagnosis. The pronotum has a median unpunctate line, and in males its anterior portion bears a concave impression. The tegmen is subparallel-sided, its apical portion emarginated forming two lateral lobes rounded at apices, with inner edges close to each other (Fig. 52). The penis is about three-fifths the length of tegmen and bears struts not

linked at base (Fig. 53). Among the species described here, *C. stalsi* **sp. nov.** is morphologically closely related to *C. makebae* and *C. masekelai*, but males bear comparatively longer and closer plates on head and pronotum. Among other southern African *Cis*, it may be related to *C. delagoensis*, of which we have not examined any specimen.

Description. Male holotype (Figs 45–48). Adult apparently not fully pigmented but in good conditions. Measurements in mm: TL 1.75, PL 0.60, PW 0.81, EL 1.15, EW 0.85, GD 0.69. Ratios: PL/PW 0.74, EL/EW 1.36, EL/PL 1.91, GD/EW 0.81, TL/EW 2.07. **Body** elongate, convex; dorsal surface reddish brown and ventral surface a bit darker; antennae yellowish brown with club dark brown, palpi and tarsi yellowish brown. **Head** with anteriormost portion visible from above; dorsal punctures coarse and shallow, with decumbent bristles arising from them; frontoclypeal ridge projected upward into two triangular plates that are very close to each other and bear rounded apices. **Antennae** bearing ten antennomeres with the following lengths (in mm, left antennae measured): 0.07, 0.04, 0.04, 0.04, 0.02, 0.02, 0.02, 0.05, 0.05, 0.08 (FL 0.14 mm, CL 0.18 mm, CL/FL 1.29 mm). **Eyes** finely faceted; each bearing about 70 ommatidia; GW 0.15 mm. **Pronotum** (Fig. 48) with shallow and coarse punctation, with a short, narrow unpunctate median line beginning about three punctures from the posterior edge and extending until center; punctures separated from each other by about a puncture-width, interspaces microreticulate; vestiture indistinctly dual, consisting of longer suberect (~0.04–0.05 mm) and shorter decumbent (~0.02 mm) yellowish bristles; anterior edge projected upward into two short subtriangular plates with rounded apices; anterior portion with a conspicuous concave impression at the base of anterior plates, in which the punctures are sparser than on disc and bristles are decumbent and smaller (0.02–0.03 mm); lateral edges not visible from above, except for posteriormost portions, not explanate and weakly crenulate. **Scutellar shield** subtriangular, bearing a few punctures and apparently glabrous; BW 0.09 mm and SL 0.06 mm. **Elytra** with confused, dual punctation; large punctures coarse, irregular, deep, about three-fifths as large as small punctures; interspaces microreticulate; dual vestiture, consisting of intercalated long (0.05 mm) and small (~0.03 mm) suberect yellowish bristles, both arising from minute punctures. **Hind wings** developed, apparently functional. **Prosternum** biconcave, subglabrous; microreticulate surface; prosternal process subparallel-sided, about as long as prosternum disc at midline and apex rounded.

Hypomera subglabrous; microreticulate surface. **Protibia** with maximum width about one-sixth of its length; apical edge devoid of spines; outer apical angle projected into a small tooth. **Meso- and metatibia** without spines on apical edge. **Metaventrite** subglabrous, bearing sparse slender setae; punctation coarse, sparse, irregular, interspaces microreticulate; discrimen about half as long as the metaventrite at midline. **Abdominal ventrites** subglabrous, bearing sparse slender setae, coarsely punctate, microreticulate surface; length of ventrites (in mm, from base to apex at the longitudinal midline) as follows: 0.23, 0.12, 0.11, 0.11, 0.12; first abdominal ventrite bearing a margined, oval, very small sex patch a bit posterad of center, bearing a tuft of setae and with a transverse diameter of 0.02 mm. **Male terminalia in a paratype** (Figs 50–53): **sternite VIII** (Fig. 50) with posterior edge straight, bearing small setae medially and long setae at the rounded sides; anterior edge membranous. **Tegmen** (Fig. 52) subparallel-sided, its apical portion emarginated forming two lateral lobes rounded at apices, with inner edges close to each other. **Basal piece** (Fig. 51) subtriangular, about as long as wide. **Penis** (Fig. 53) about three-fifths the length of tegmen, with struts not linked at and forming the laterals until the middle of penis.

Females (Fig. 49) similar to males, but devoid of abdominal sex patch, concave impression and plates on pronotum and head; anterior edge of head truncate; anterior edge of pronotum rounded.

Variation. Males, measurements in mm (n=10, including the holotype): TL 1.35–2.25 (1.97 ± 0.27), PL 0.60–0.80 (0.71 ± 0.07), PW 0.65–0.90 (0.81 ± 0.08), EL 0.75–1.50 (1.26 ± 0.21), EW 0.80–1.00 (0.89 ± 0.07), GD 0.50–0.70 (0.66 ± 0.07), PL/PW 0.74–1.00 (0.88 ± 0.08), EL/EW 0.75–1.63 (1.43 ± 0.26), EL/PL 1.25–2.07 (1.77 ± 0.23) GD/EW 0.50–0.88 (0.75 ± 0.10), TL/EW 1.35–2.56 (2.23 ± 0.35). Females, measurements in mm (n=7): TL 1.60–2.20 (1.86 ± 0.21), PL 0.50–0.80 (0.61 ± 0.10), PW 0.70–0.85 (0.80 ± 0.06), EL 1.05–1.40 (1.24 ± 0.13), EW 0.80–0.95 (0.87 ± 0.05), GD 0.55–0.70 (0.66 ± 0.06), PL/PW 0.65–0.94 (0.77 ± 0.09), EL/EW 1.24–1.65 (1.43 ± 0.14), EL/PL 1.75–2.55 (2.05 ± 0.28) GD/EW 0.69–0.82 (0.75 ± 0.05), TL/EW 1.88–2.59 (2.13 ± 0.22).

Type series. Holotype ♂ (SANC) “SOUTH AFRICA, KZN, Hlabisi, N Hluhluwe - Umfolozi Park, 28°08’S 31°52’E, 14.vii.2008, AJ & RP Urban \ Ex bracket fungus, BF#109 \ *Cis stalsi* Souza-Gonçalves & Lopes-Andrade HOLOTYPUS [red paper]”. Paratypes 13 ♂ (10 measured) and 15 ♀ (7 measured) as follow: 7 ♂ (2 CELC,

one dissected; 5 SANC) and 13 ♀ (4 CELC, one dissected; 9 SANC), same data as the holotype; 6 ♂ (2 CELC, 2 dissected; 3 SANC) and 2 ♀ (1 CELC; one SANC) “SOUTH AFRICA, NW, Mhlabatini Kloof, Magaliesberg, 25°48’S 27°19’E, 24.viii.2008, O & S Nesar \ Ex bracket fungus *Polyscypha parvula*, BF#153”. All paratypes additionally labeled \Cis stalsi Souza-Gonçalves & Lopes-Andrade PARATYPUS [yellow paper]\.

Etymology. The new species is named in honor of Riaan Stals, who organized and loaned to the junior author a great amount of South African ciids belonging to the SANC.

Host fungi. *Podoscypha parvula* (Lloyd) D. A. Reid (Meruliaceae), one breeding record.

Distribution. *Cis stalsi* was collected in two localities, one of Grassland and the other of Savanna (Fig. 62), separated by approximately 1000 linear km and practically isolated by a mountain chain.

Comments. We extracted aedeagi of males from the type locality and from Mhlabatini, and no difference was observed. The species was collected together with *C. nesarorum* **sp. nov.** and the invasive *Cer. tabellifer*, without parasitoid.

***Cis urbanae* Souza-Gonçalves et Lopes-Andrade, sp. nov.**

(Figs 54–61, 63)

Cis sp. F in Nesar (2012)

Diagnosis. The pronotum is devoid of median unpunctate line, and in males its anterior portion bears a concave impression. The tegmen (Fig. 60) is very similar to that of *C. nesarorum* (see diagnosis and description above), but it’s comparatively longer and bears membranous areas around sclerotizations of apical portion, forming lateral lobes rounded at apex. The penis (Fig. 61) is about three-eighths the length of tegmen. Among the species described here, *C. urbanae* **sp. nov.** is morphologically closely related to *C. aster* and *C. nesarorum*, but may be distinguished by its prosternal process conspicuously narrow near base and gradually expanding to a rounded apex. *Cis mandelai* bears has a similar prosternal process, but differs in the more robust body and males with comparatively longer pronotal plates. Among other southern African *Cis*, male *C. urbanae* **sp. nov.** differs from male *C. affter* and *C. caffer* in bearing a concave

impression at the anterior portion of pronotum, and from *C. testaceus* in possessing a more robust body.

Description. Male holotype (Figs 54–57). Adult fully pigmented but in good condition, except for a lack of antennae. Measurements in mm: TL 2.83, PL 1.03, PW 1.40, EL 1.80, EW 1.45, GD 1.13. Ratios: PL/PW 0.73, EL/EW 1.24, EL/PL 1.76, GD/EW 0.78, TL/EW 1.95. **Body** elongate, convex; dorsal and ventral surfaces reddish dark brown; palpi and tarsi a bit lighter. **Head** concealed by pronotum when seen from above; dorsal punctures coarse and shallow, with decumbent bristles arising from them; frontoclypeal ridge projected forward into two close subtriangular plates with rounded apices. **Antennae** lost in all male specimens. **Eyes** finely faceted; each bearing about 90 ommatidia; GW 0.25 mm. **Pronotum** (Fig. 57) with shallow and coarse punctation and devoid of median unpunctate line; punctures separated from each other by about a puncture-width, interspaces microreticulate; vestiture indistinctly dual, consisting of longer suberect (0.05–0.06 mm) and shorter decumbent (~0.03 mm) yellowish bristles; anterior edge projected upward into two subtriangular plates with rounded apices; anterior portion with a broad, conspicuous concave impression at the base of anterior plates, in which the punctures are sparser than on disc and bristles are more decumbent and smaller (0.02–0.03 mm); lateral edges not visible from above, except for posteriormost portions, very narrow and not explanate, almost smooth. **Scutellar shield** triangular, bearing a few punctures and apparently glabrous; BW 0.13 mm and SL 0.11 mm. **Elytra** with confused, dual punctation; large punctures coarse, irregular, deep, about three times as large as small punctures; interspaces weakly rugose, shiny; dual vestiture, consisting of long suberect (~0.06 mm) and short decumbent (~0.03 mm) yellowish bristles, both arising from minute punctures. **Hind wings** developed, apparently functional. **Prosternum** biconcave, subglabrous; microreticulate surface; prosternal process about as long as prosternum disc at midline; very narrow near base and gradually expanding to a rounded apex. **Hypomera** subglabrous; microreticulate surface. **Protibia** with maximum width about one-fourth of its length; apical edge devoid of spines; outer apical angle projected into a small tooth. **Meso- and metatibia** without spines on apical edge. **Metaventrite** subglabrous, bearing sparse slender setae; punctation coarse, sparse, irregular, interspaces microreticulate; discrimen about half as long as the metaventrite at midline. **Abdominal ventrites** subglabrous, bearing sparse slender setae, coarsely punctate, microreticulate surface; length of ventrites (in mm,

from base to apex at the longitudinal midline) as follows: 0.37, 0.17, 0.16, 0.14, 0.18; first abdominal ventrite bearing a circular, large, fully exposed sex patch close to the posterior edge and with a transverse diameter of 0.15 mm. **Male terminalia in a paratype** (Figs 59–61): **sternite VIII** (Fig. 59) with posterior edge straight, bearing small setae medially and longer setae at the rounded sides; anterior edge membranous. **Tegmen** (Fig. 60) elongate, devoid of lateral excavations or angulations; struts linked at base and diverging, reaching about three-fifths of tegmen length and forming part of the laterals; apical portion with membranous areas around sclerotizations, forming lateral lobes subparallel-sided and rounded at apex. **Basal piece** (barely damaged during dissection and not shown in figures) subtriangular, about twice as long as wide. **Penis** (Fig. 61) subcylindrical, about three-eighths the length of tegmen and a bit wider at the basal half.

Females (Fig. 58). Similar to males but devoid of an abdominal sex patch, concave impression and plates on the pronotum and head; anterior edge of head, truncate; anterior edge of pronotum, rounded.

Variation. Males, measurements in mm (n=3, including the holotype): TL 2.40–2.83 (2.63 ± 0.21), PL 0.75–1.03 (0.86 ± 0.15), PW 1.00–1.40 (1.20 ± 0.20), EL 1.60–1.80 (1.77 ± 0.15), EW 1.10–1.45 (1.15 ± 0.18), GD 0.75–1.13 (0.94 ± 0.19), PL/PW 0.67–0.75 (0.74 ± 0.04), EL/EW 1.24–1.73 (1.43 ± 0.26), EL/PL 1.76–2.53 (2.10 ± 0.40) GD/EW 0.68–0.79 (0.75 ± 0.06), TL/EW 1.95–2.41 (2.12 ± 0.25). Females, measurements in mm (n=3): TL 2.10–2.80 (2.52 ± 0.37), PL 0.80–0.90 (0.83 ± 0.06), PW 0.80–1.30 (1.08 ± 0.26), EL 1.30–1.96 (1.68 ± 0.33), EW 0.90–1.40 (1.18 ± 0.26), GD 0.90–1.05 (0.98 ± 0.08), PL/PW 0.69–1.00 (0.80 ± 0.18), EL/EW 1.36–1.48 (1.43 ± 0.06), EL/PL 1.63–2.31 (2.02 ± 0.35) GD/EW 0.75–1.00 (0.85 ± 0.13), TL/EW 2.00–2.33 (2.15 ± 0.17).

Type series. Holotype ♂ (SANC) “SOUTH AFRICA, MPU, Nelspruit, 25°29’S 30°59’E, 14.viii.2009, D van Heerden \ Ex bracket fungus #178 on *Acacia sieberiana* var *woodii* \ Ex bracket fungus *Trametes* sp., BF#178 \ *Cis urbanae* Souza-Gonçalves & Lopes-Andrade HOLOTYPUS [red paper]”. Paratypes 2 ♂ (2 measured) and 3 ♀ (3 measured) as follow: 2 ♂ (1 CELC, one dissected; one SANC) and 3 ♀ (1 CELC; dissected; 2 SANC), same data as the holotype. All paratypes additionally labeled \ *Cis urbanae* Souza-Gonçalves & Lopes-Andrade PARATYPUS [yellow paper].

Etymology. The new species is named in honor of Ros Urban, who helped in collecting and organizing South African ciids loaned by the SANC.

Host fungi. *Trametes* sp. (Polyporaceae), one breeding record.

Distribution. All specimens of *Cis urbanae* **sp. nov.** were collected only in the urban area of Grassland (Fig. 62).

Comments. *Cis urbanae* is known from a single collection and was collected with the morphospecies *Cis* sp. G, the invasive *Cer. tabellifer* and the parasitoid *A. micans*.

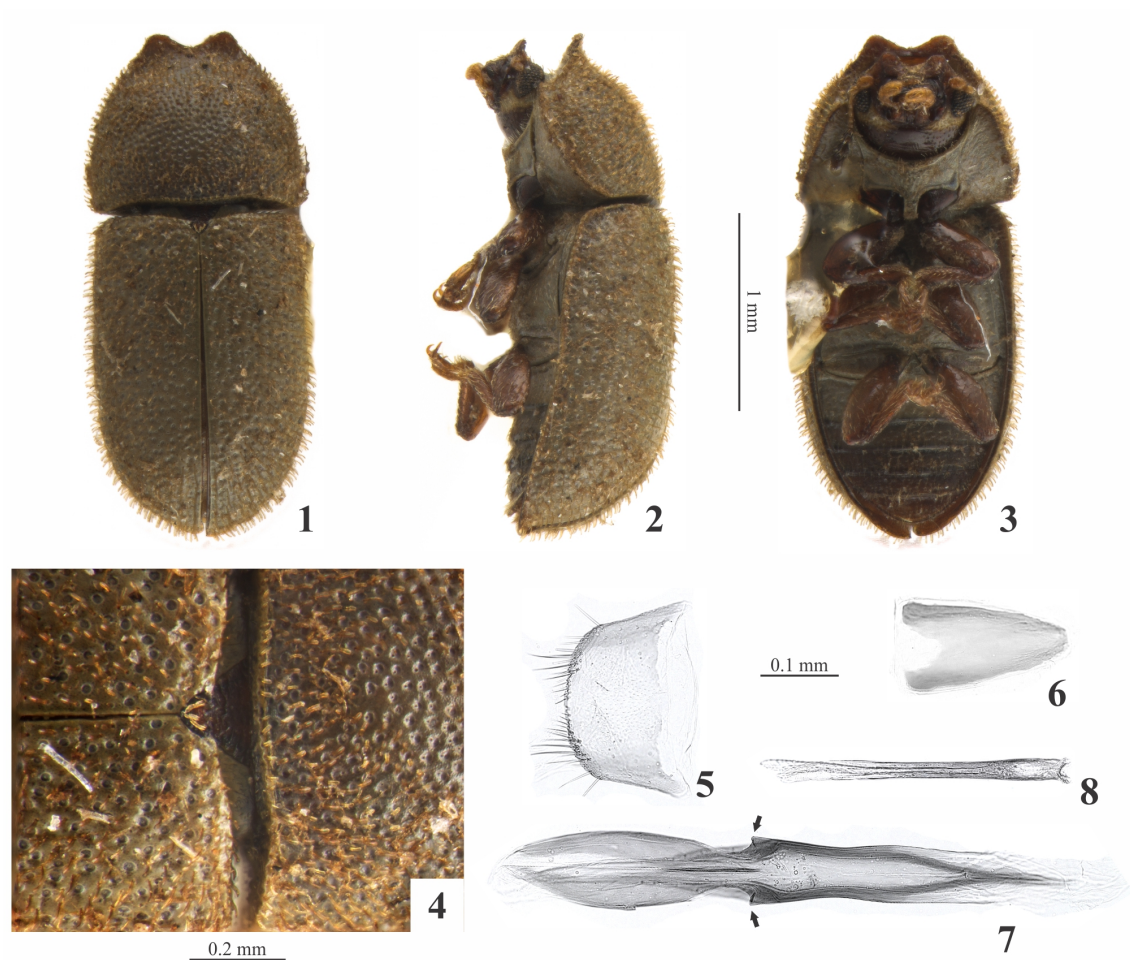
ACKNOWLEDGMENTS

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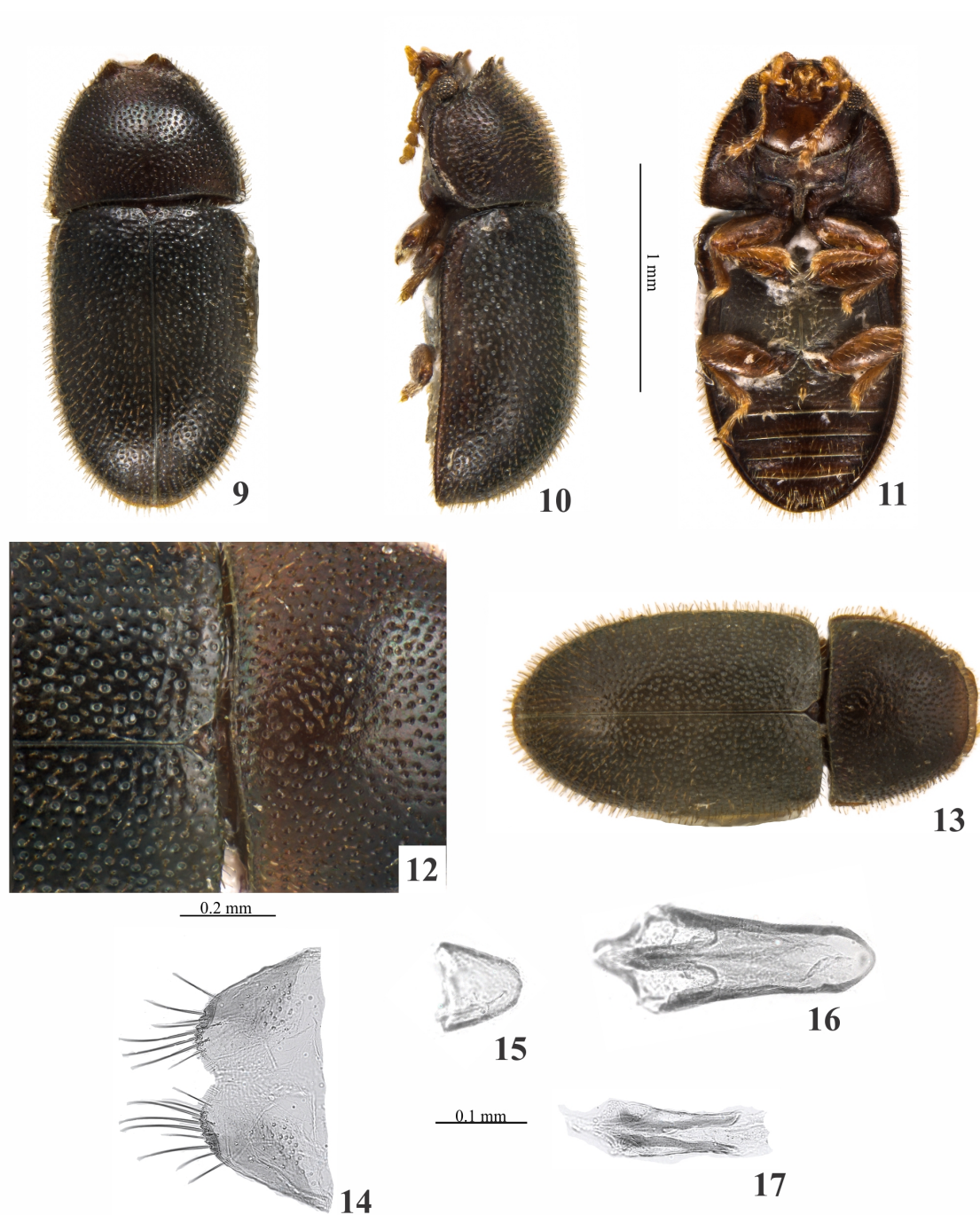
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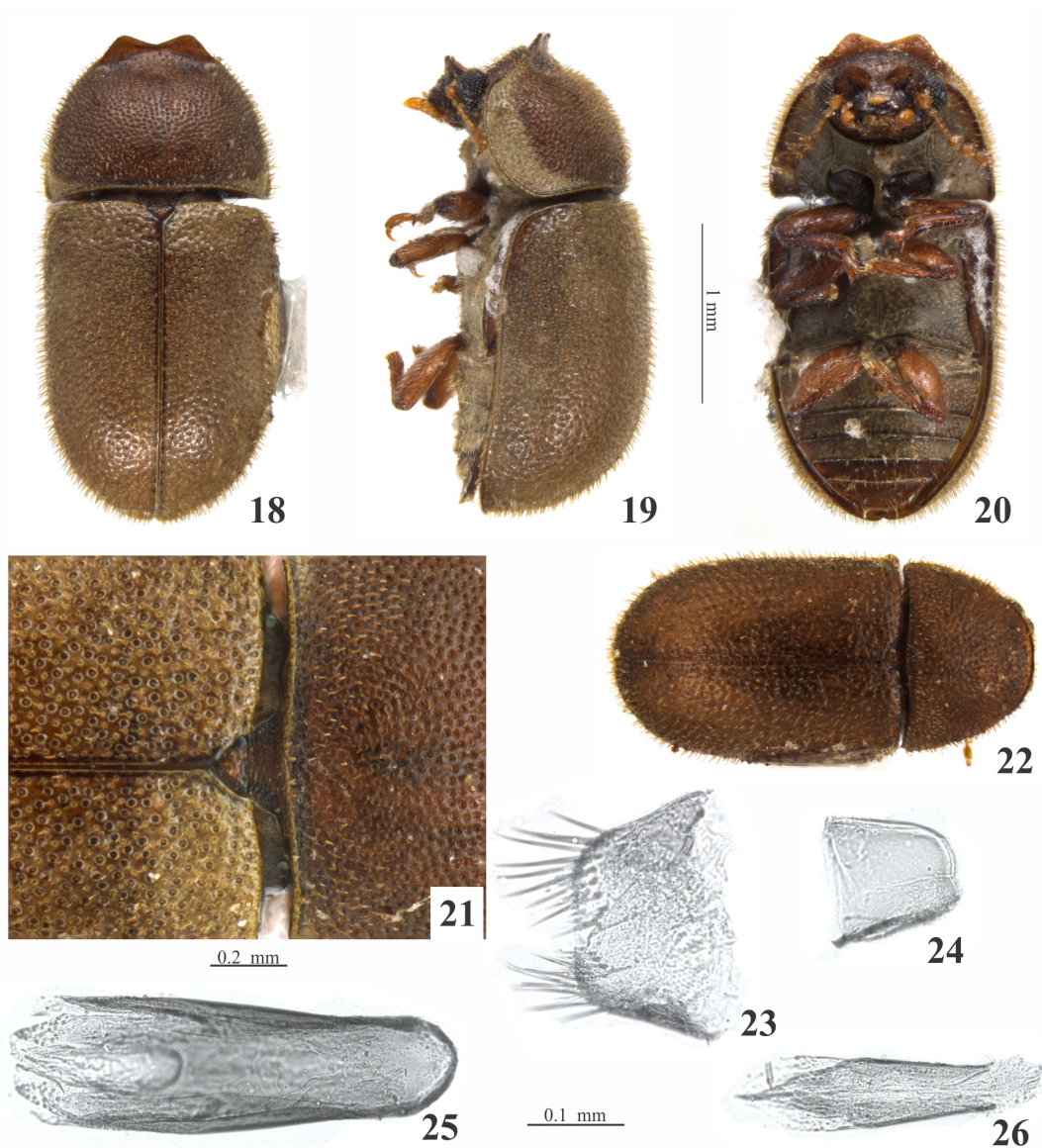
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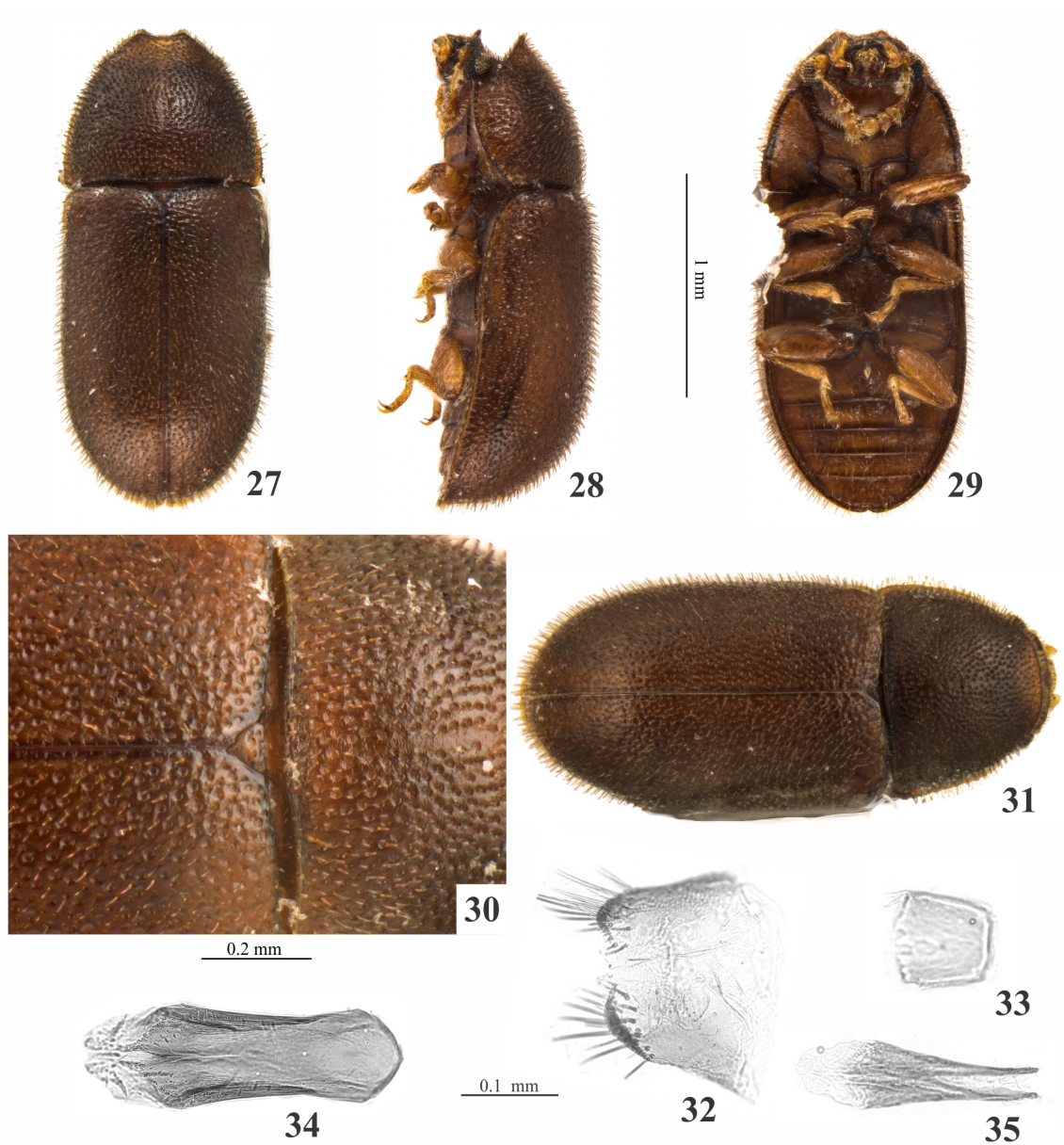
Figures 1–8 *Cis aster* sp. nov., male holotype (1–4) and aedeagus of the unique paratype (5–8). **1.** Dorsal view. **2.** Lateral view. **3** Ventral view. **4.** Scutellar shield and part of the pronotum and elytra. **5.** Sternite VIII. **6.** Basal piece. **7.** Tegmen showing acute angulations at the base of concave emarginations (arrows). **8.** Penis.



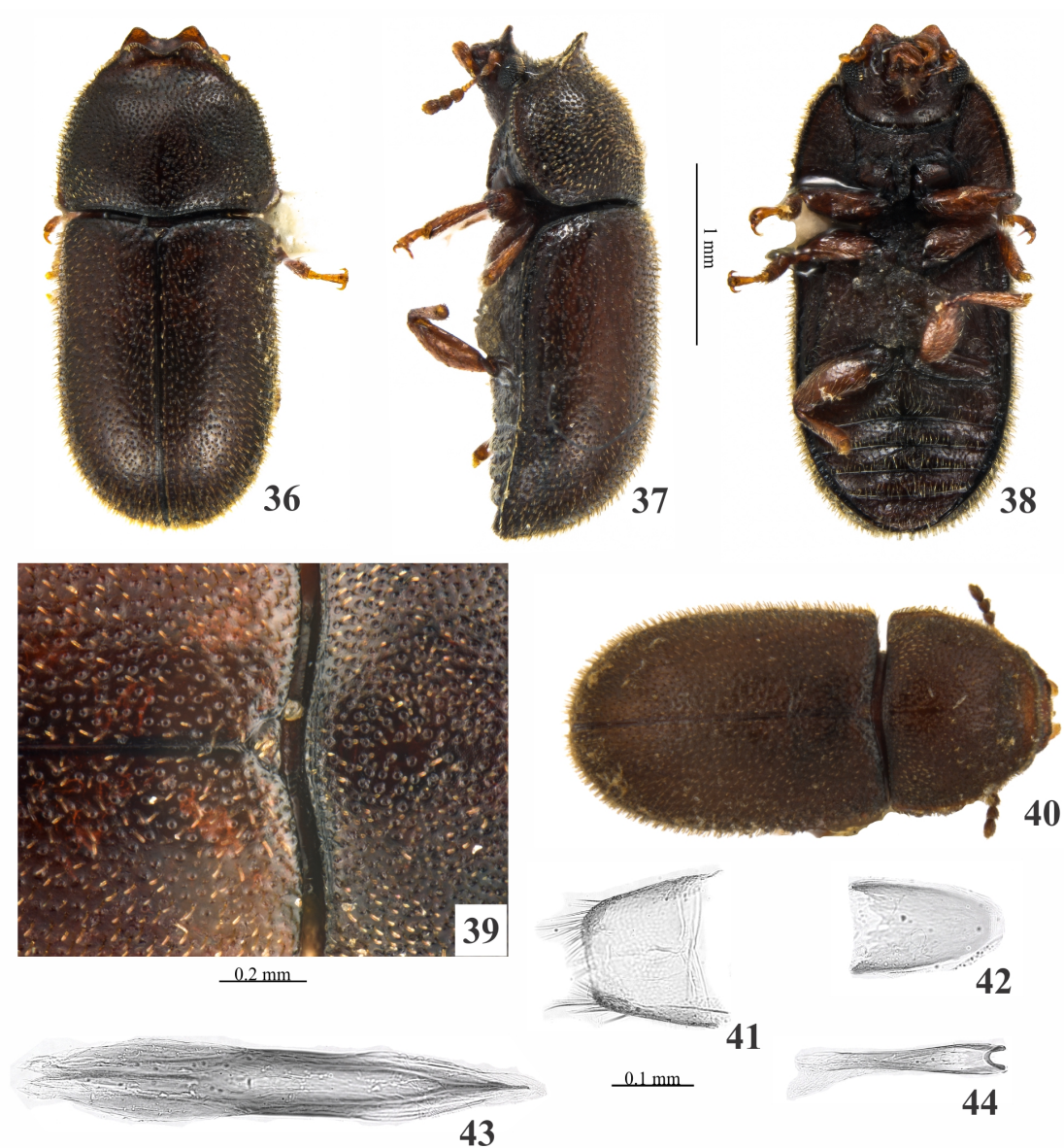
Figures 9–17 *Cis makebae* sp. nov., male holotype (9–12), female paratype (13) and sclerites of aedeagus of paratypes from the type locality (15, 16) and from Nr. Ndumo (14, 17). **9.** Dorsal view. **10.** Lateral view. **11.** Ventral view. **12.** Scutellar shield and part of the pronotum and elytra. **14.** Sternite VIII. **15.** Basal piece. **16.** Tegmen. **17.** Penis.



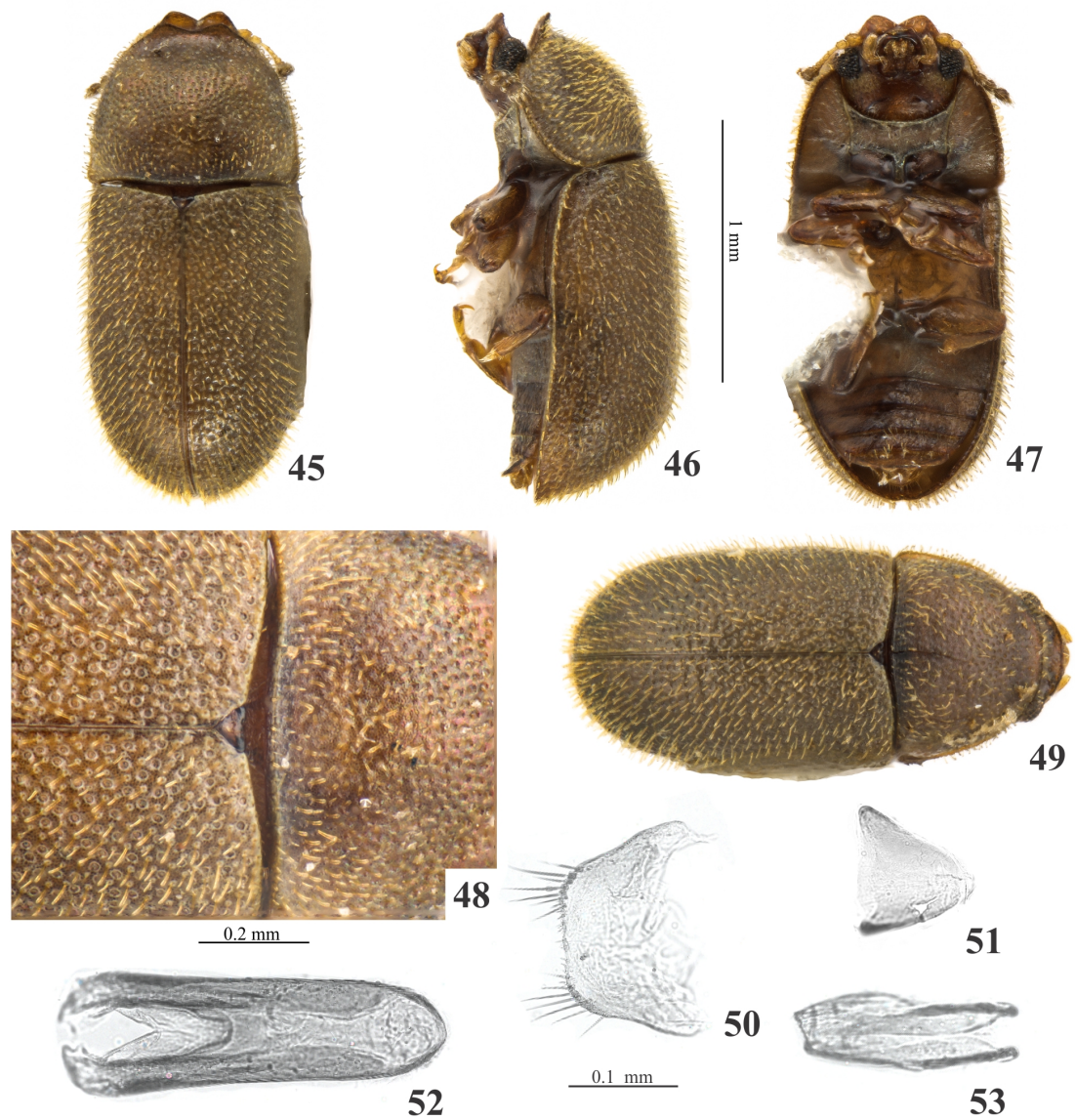
Figures 18–26 *Cis mandelai* **sp. nov.**, male holotype (18–21), female paratype (22) and sclerites of aedeagus of paratypes from Sekororo (23) and Die Hel (24–26). **18.** Dorsal view. **19.** Lateral view. **20.** Ventral view. **21.** Scutellar shield and part of the pronotum and elytra. **23.** Sternite VIII. **24.** Basal piece. **25.** Tegmen. **26.** Penis.



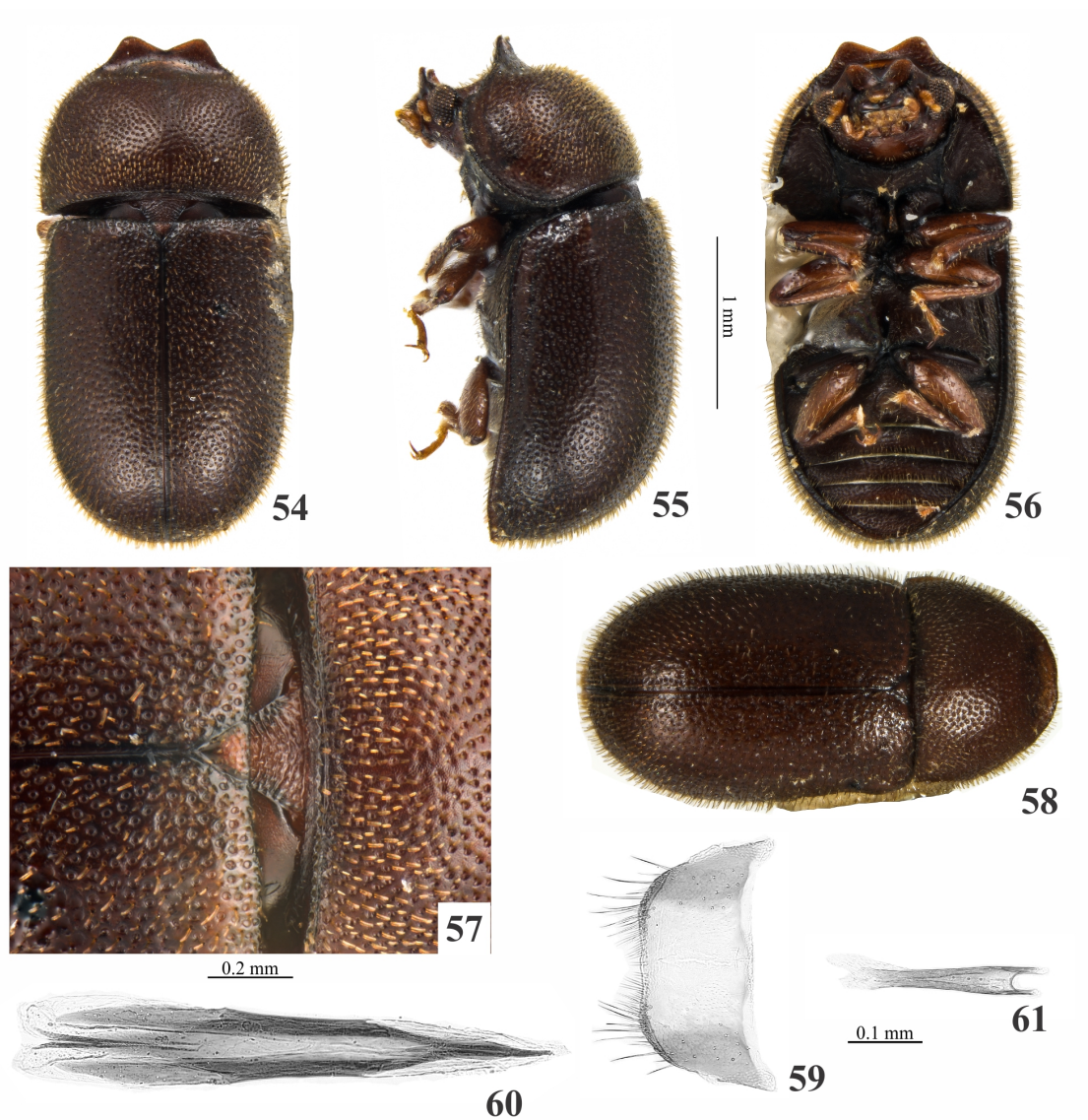
Figures 27–35 *Cis masekelai* sp. nov., male holotype (27–30), female paratype (31) and sclerites of aedeagus of paratypes from the type locality (32, 33, 35) and from Dome Kloof. (34). **27.** Dorsal view. **28.** Lateral view. **29.** Ventral view. **30.** Scutellar shield and part of the pronotum and elytra. **32.** Sternite VIII. **33.** Basal piece. **34.** Tegmen. **35.** Penis.



Figures 36–44 *Cis nesororum* sp. nov., male holotype (36–39), female paratype (40) and aedeagus of paratype from the type locality (41–44). **36.** Dorsal view. **37.** Lateral view. **38.** Ventral view. **39.** Scutellar shield and part of the pronotum and elytra. **41.** Sternite VIII. **42.** Basal piece. **43.** Tegmen. **44.** Penis.



Figures 45–53 *Cis stalsi* sp. nov., male holotype (45–48), female paratype (49) and aedeagus of paratype from Mhlabatini (50–53). **45.** Dorsal view. **46.** Lateral view. **47.** Ventral view. **48.** Scutellar shield and part of the pronotum and elytra. **50.** Sternite VIII. **51.** Basal piece. **52.** Tegmen. **53.** Penis.



Figures 54–61 *Cis urbanae* sp. nov., male holotype (54–57), female paratype (58) and aedeagus of paratype from type locality (59–61). **54.** Dorsal view. **55.** Lateral view. **56.** Ventral view. **57.** Scutellar shield and part of the pronotum and elytra. **59.** Sternite VIII. **60.** Tegmen. **61.** Penis.

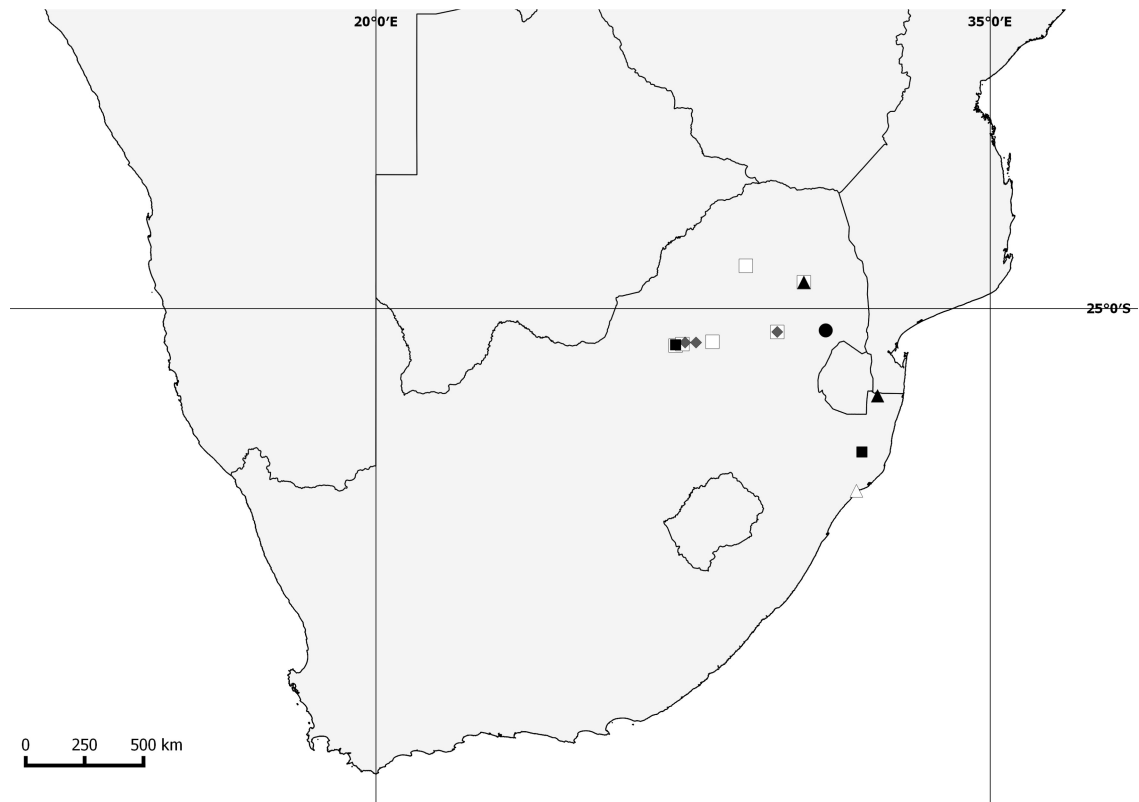


Figure 62 Known distribution of new species of *Cis* in southern Africa: *Cis aster* **sp. nov.** (white triangle); *Cis makebae* **sp. nov.** (black triangle); *Cis mandelai* **sp. nov.** (white square); *Cis masekelai* **sp. nov.** (gray diamond); *Cis stalsi* **sp. nov.** (black square); *Cis urbanae* **sp. nov.** (black circle).

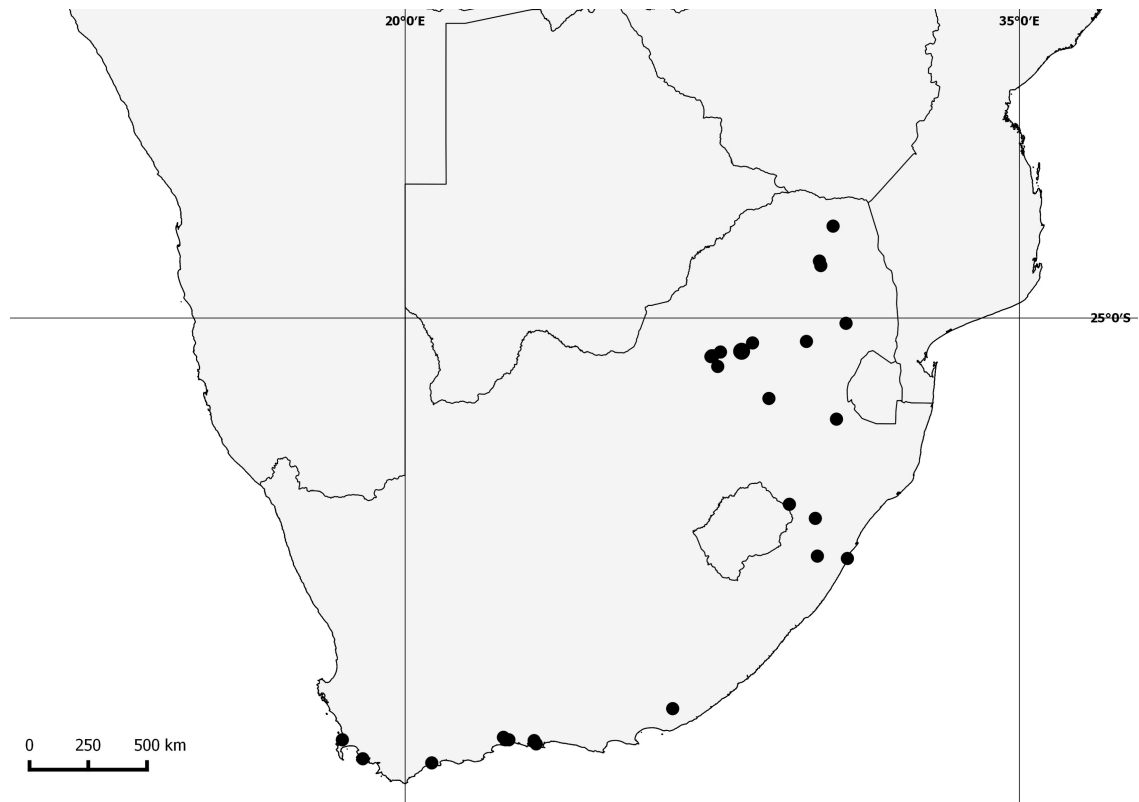


Figure 63 Known distribution of *Cis nesororum* **sp. nov.** in southern Africa.

**CAPÍTULO 2: Effects of invasive species *Ceracis tabellifer* (Mellié) on
the structure of native fauna of Ciidae (Coleoptera) at South Africa**

(Biological Invasions)

Effects of invasive species *Ceracis tabellifer* (Mellié) on the structure of native fauna of Ciidae (Coleoptera) at South Africa

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Abstract

Recent studies on community ecology have focused in understanding the ecological process of colonization of new habitats, mainly through the description of biological interactions based in network theory and co-occurrence analyses. Thus, is possible to know how the communities behave in events as biological invasion, for example. This event is study focus in many countries due the damages that it can induce, principally by the effects beneath the local biodiversity. However, these effects are unknown yet especially in the case of fungivorous insects in different regions in the world. *Ceracis tabellifer* (Mellié) represent one of these cases. We investigate the pattern of interaction between ciids and their host-fungi in the presence of invasive species *Cer. tabellifer* at South Africa. We tested two hypothesis: i) *Cer. tabellifer* excludes competitively the native ciid species from the host fungi used by it, shifting them from their original resources; and ii) *Cer. tabellifer* keeps the behaviour from its native habitat, where presents polyphagous feeding habits and large populations. We have used two dataset to perform our analyses, one from South Africa and other from Brazilian Cerrado at Alto Paranaíba, where it is a native species. Our results rejected the second one, suggesting that *Cer. tabellifer* possibly is utilizing fungus species that are not used by other Ciidae on community; corroborate the first hypothesis. Moreover, our results suggest that communities studied here resembles to mutualistic system, due some features as asymmetric nested pattern of specialization and high heterogeneity in species strength.

Keywords

Biological invasion, bipartite, co-occurrence, minute tree-fungus beetles, network analyses

Introduction

Recognize patterns on ecological communities and their development have been the major research topics and challenge for ecologists, and continue to be (Lewinsohn et al. 2006a; Campbell et al. 2011). Community ecologists, for many years, have focused in to develop methods, which can detect interaction patterns in species groups; and identify the processes that promote each pattern (Lewinsohn et al. 2006b). The interaction patterns in species groups can be visualized and accessed by matrices or bipartite networks or ordination graphics as multivariate sets through correspondence analysis. (Mommott 1999; Jordano et al. 2003; Lewinsohn et al. 2006a). The analysis of structure and properties of the bipartite networks are the aim of network theory (Strogatz 2001). Bipartite networks use has some advantageous: i) higher taxonomic resolution in which species are well separated, solving desigal resolutions which are harmful in most part of analysis with full networks; and ii) all links belong to the same ecological interaction (e.g. predation, herbivory or dispersion of seeds), keeping the structural integrity as well as the sharing ecological and evolutionary process common to all community (Lewinsohn et al. 2006a, b).

Studies on community ecology have focused in understanding the ecological process of colonization, mainly through the description of biological interactions, recently based in network theory and co-occurrence analyses (Campbell et al. 2011; Roy and Handley 2012; Williams et al. 2014). These studies were carried out with ecological networks of species sets that interact through predation, pollination, dispersion of seeds and parasitism (Ings et al. 2009). Such researches are important to determine how communities behave under several ecological events as, for instance, biological invasion.

Studies on biological invasions usually focus on the damages caused by invasive species on the local diversity (Williamson 1999). Invasion success depends on biological traits of the invasive species and ecological characteristics of the colonized ecosystem. However, describing the invasion capacity of a species and predicting its establishment success in a new environment is a challenge yet (Williamson and Fitter 1996; Williamson 1999; Lonsdale 1999; Rosecchi et al. 2001; Kolar and Lodge 2001; Shea and Chesson 2002; Heger and Trepl 2003; Hayes and Barry 2008; Antunes-Carvalho and Lopes-Andrade 2013). The effects of invasive species on community structure are known, but not yet in the case of fungivorous insects.

Fungivorous insects are interesting models for ecological and evolutionary studies due their behavioral (e.g. usually gregarious with adults and larvae constructing galleries and with until thousands of individuals in the same fungus) (Lawrence and Britton 1991; Lawrence 1973; Costa et al. 1988), physiological (e.g. development of mechanisms against intoxications by chemical compounds from host fungi) (Martin 1979) and ecological characteristics (e.g. specialization in the utilization of host fungi parts) (Lawrence 1989). Studies on these organisms are essentially necessary to fill a gap within biology, of which most available studies are on herbivorous and predatory

insects. Among fungivorous insects, it is worth highlighting the minute tree-fungus beetles (Coleoptera: Ciidae), whose larvae and adults live on basidiomes of bracket fungi, which are their food resource, as far as mating and oviposition site (Lawrence 1973; Navarrete-Heredia 1991; Lawrence and Lopes-Andrade 2010).

There are a few ciid species known to be invasive, as *Cis bilamellatus* Wood in northern Europe and Chile (Orledge et al. 2010; Lopes-Andrade and L  er 2014), *Cis chinensis* Lawrence in Europe, Brazil, La R  union (Indian Ocean) and Australia (Lopes-Andrade 2008; Rose 2009; Lawrence 2016) and *Ceracis tabellifer* (Melli  ) in Africa, South and Southeast Asia (Antunes-Carvalho and Lopes-Andrade 2013; Lawrence 2016). The latter species is considered to be of Neotropical origin and have records from localities in the sub-Saharan Africa dating back to the earlier XIX century. Nowadays, *Cer. tabellifer* is the most frequently encountered ciid species in sub-Saharan Africa, and its polyphagous habits have been pointed out as a key feature of its invasive capacity (Antunes-Carvalho and Lopes-Andrade 2013). But the effects of the presence of *Cer. tabellifer* on the community structure of native ciid species were not evaluated yet.

We investigated the patterns of interactions between native ciid beetles and their host-fungi in the presence of the invasive species *Cer. tabellifer* in South Africa, compared to the role of this species in its native land at the Brazilian Cerrado. Our hypotheses were: i) *Cer. tabellifer* excludes competitively the native ciid species from the host fungi used by it, shifting them from their original resources; and ii) *Cer. tabellifer* keeps the behaviour from its native habitat, where presents polyphagous feeding habits and large populations.

Materials and methods

Identification of species and composition of datasets

The analyses were based on two datasets: Ciidae and their host fungi from South Africa (hereafter SA) and Ciidae and their host fungi from the Brazilian Cerrado at Alto Parana  ba (hereafter BC). Both datasets contain ciid species considered to be native at the sampled areas, except for *Ceracis tabellifer* (Melli  ), which is native in BC but invasive in SA. These allow the comparison of the ecological role of the invasive species *Cer. tabellifer* at its native and non-native environments. SA data was obtained throughout a project of ten years on parasitoids of ciids, in which 19 ciid species with parasitoids were recognized: 17 species of *Cis* Latreille coded as “*Cis* sp. A” to “*Cis* sp. Q”, *Cer. tabellifer* (Melli  , 1849) and *Xylographus madagascariensis* Melli  , 1849 (Neser 2012; Sandoval-G  mez et al. 2014). In the field collections of that work there were other nine morphospecies of *Cis* which were collected without parasitoids, sequentially coded by us as “*Cis* sp. R” to “*Cis* sp. Z”. Therefore, our first counting was of 28 ciid species in the SA dataset. These provisional identifications were revised by us, after examination of types or photographs of types and careful study of literature on sub-Saharan ciids (Melli   1849; F  hraeus 1871; Reitter 1908; Ferrer 1997; Scott 1926;

Antunes-Carvalho and Lopes-Andrade 2013; Sandoval-Gómez et al. 2014). Most examined *Cis* species from SA were considered to be new, and part of them was described recently (Orsetti and Lopes-Andrade 2016; Souza-Gonçalves and Lopes-Andrade 2017), as follows: *Cis* sp. A as *Cis mandelai* Souza-Gonçalves & Lopes-Andrade, i.l.; *Cis* sp. B has showed to be a cryptic species and was split in *Cis makebae* Souza-Gonçalves & Lopes-Andrade, i.l., *Cis masekelai* Souza-Gonçalves & Lopes-Andrade, i.l. and *Cis stalsi* Souza-Gonçalves & Lopes-Andrade, i.l.; *Cis* sp. E has also showed to be cryptic and was split in *Cis aster* Souza-Gonçalves & Lopes-Andrade, i.l. and *Cis nesororum* Souza-Gonçalves & Lopes-Andrade, i.l.; *Cis* sp. F as *Cis urbanae* Souza-Gonçalves & Lopes-Andrade, i.l.; and *Cis* sp. T as *Cis regius* Orsetti & Lopes-Andrade, 2016. The morphospecies *Cis* sp. O was joined with *Cis* sp. G. The remaining new species of *Cis* from SA will be treated in forthcoming taxonomic works by C. Lopes-Andrade, I. Souza-Gonçalves and A. Orsetti. The taxonomy of *Cer. tabellifer* and its status as an invasive species in South Africa and a native species in the Brazilian Cerrado was proposed by Antunes-Carvalho and Lopes-Andrade (2013) after a careful study of types, historical material and specimens from several American, African and Asian populations of the species. The morphological limits of *Cer. tabellifer* used here follow the propositions of that work, but it shall be noted that *Cer. tabellifer* is morphologically similar to *Ceracis communis* Lawrence, 2016 from Australia and *Cer. christmasensis* Lawrence, 2016 from the Christmas Island (Lawrence 2016), and may be conspecific to those species (Lopes-Andrade pers. obs). However, we think that our doubts relying on these species from the Australian region do not affect our identifications of Neotropical and African populations as *Cer. tabellifer* and the results provided here. Our current counting is of 30 ciid species in the complete SA dataset, but we excluded four species from the analyses: *X. madagascariensis*, because it was barely represented in samples; and three *Cis* species, because they lack data on host fungi. In accord to Naser (2012), bracket fungi from SA were frozen to kill any remaining beetles and submitted to R. Jacobs at the National Collection of Fungi of the Plant Protection Research Institute (PPRI). These data were made available to us by the SANC staff. The SA dataset used in the present analyses represents a community composed by 26 ciid species and 33 host fungi.

BC data was obtained during a research on the ciids from the Brazilian Cerrado at Rio Paranaíba, state of Minas Gerais, politic mesoregion of Alto Paranaíba (Souza 2013). This dataset is comprised by 12 ciid species and ten host fungus species. Ciid species on BC dataset do not correspond to ciid species of SA except for one species, *Ceracis tabellifer* (Mellié). The provisional identification of BC ciid species was made by C. Lopes-Andrade and supported by works on Neotropical ciids (Lopes-Andrade et al. 2003; De Almeida and Lopes-Andrade 2004; Lopes-Andrade 2011; Antunes-Carvalho and Lopes-Andrade 2013; Oliveira et al. 2013; Oliveira and Lopes-Andrade 2013; Sandoval-Gómez et al. 2014; Pecci-Maddalena and Lopes-Andrade 2017). The evidences supporting that *Cer. tabellifer* is native to the Brazilian Cerrado and invasive in Africa are provided by Antunes-Carvalho and Lopes-Andrade (2013). Identification of host fungi from BC were made by C. Lopes-Andrade and N. Resende Souza. Fungal nomenclature used here was updated following the fungal taxonomy available in the

online database Index Fungorum (<http://www.indexfungorum.org/>; as accessed on January 17th, 2017).

Data on ciids and their host fungi from SA and BC were organized in binary matrices, in which beetle species (higher-trophic level) were displayed in the columns and fungus species (lower-trophic level) in the rows. The entries represent the absence (0) or presence (1) of a beetle species in a particular host fungus. Such matrices have been pointed as essential units to studies on biogeography and community ecology (McCoy and Heck 1987; Gotelli and Rohde 2002).

Network and co-occurrence analyses

The community structure in SA and BC was analyzed using the “networklevel” function, which calculated five indices describing the entire bipartite network (connectance, web asymmetry, links per species, nestedness and robustness; for the last one at higher- and lower-trophic levels). Connectance index computes the realized proportion of possible links number between the species of the community (Dunne et al. 2002). Web asymmetry index show the balance between the higher- and lower-trophic levels; the negative values indicate more lower-trophic level species and positive more higher-trophic level species (Blüthgen et al. 2007). The links per species represent the mean links per species at network.

Nestedness index calculates the temperature of the matrix, in which values close to zero mean cold (highest nestedness) and values close to 100 mean hot (chaos) (Rodríguez-Girónes and Santamaria 2006). However, we follow Bascompte et al. (2003) to estimate nestedness, N , as $N = (100 - T/100)$, in which T is the matrix temperature (nestedness index) previously calculated by “networklevel” function as described above, because this metric is more often used in this kind of work (Bascompte et al. 2003; Guimarães Jr et al. 2006; Guimarães Jr et al. 2007a, b). Values of nestedness close to one indicate strong asymmetrical patterns in specialization, intermediate values are normally produced assuming random interaction among species, and low values may indicate compartmentalization (Bascompte and Jordano 2006; Guimarães Jr et al. 2006). Robustness index computes the system robustness to species extinction.

Per-species contribution to community nestedness was estimated using the “nestedcontribution” function, which compares the observed nestedness to an ensemble of nestedness values generated by a random null model (default with 99 simulations). Nestedness contributions are the z-score from this comparison. Negative contributors (i.e. species whose interactions decrease overall nestedness) will range values less than zero and a positive contributor will range values greater than zero (Bascompte et al. 2003; Saavedra et al. 2011).

Additionally, the “robustness” function was resorted to calculate the system robustness to fungus species extinction. This function calculates the area below the extinction curve generated by second extinction (Memmott et al. 2004; Burgos et al. 2007); we removed fungus species systematically from most-linked to least-linked to forecast what happen on community if fungus species are lost. Values close to zero is

consistent with a fragile system in which even if a small number of the fungus is eliminated, most of the beetles loose their interactions and go extinct. Conversely, values close to one is consistent with a robust system in which most beetle species survive even if a large fraction of fungus species is eliminated. The matter of each fungi and ciid species to interactions in the network was measured by the “strength” function, conducting proposed methods by Barrat et al. (2004) and Bascompte et al. (2006) (default of the function), which were subjected to a correlation test.

Co-occurrence patterns were accessed performing analyses under the “C.score” function, which calculates the mean number of checkerboard combinations in a matrix for each unique species pair (for details see Stone and Roberts 1990; Gotelli and Rohde 2002). Values equal to zero means total co-occurrence and equal to one the opposite.

All analyses were performed in the R software (R-Development-Core-Team 2013) using the bipartite package version 2.05 for both datasets. The “visweb” function was utilized to draw a food web as a grid (Figs. 1–2) and the “plotweb” function to draw the networks (Figs. 3–4).

Results

The analysed network of SA had 59 species, showing values of connectance, web asymmetry, links per species and nestedness of 0.12, -0.12, 1.69 and 0.95, respectively. The robustness to the higher-trophic level (ciid species) was 0.67 and to lower-trophic level (fungus species) was 0.69. In contrast, BC had 23 species, with values of 0.35, 0.09, 1.91 and 0.79 to connectance, web asymmetry, links per species and nestedness, respectively. The robustness to the higher- and lower-trophic levels was respectively 0.74 and 0.79.

The analyses showed that *Cer. tabellifer* is a generalist species and dominant on SA, using 31 out of 33 fungus species (Figs. 1 and 3). It is followed by *C. nesororum* i.l., which used 13 out of 33 fungus species. When compared to the BC community, where *Cer. tabellifer* is a native species, it is the second most generalist species together with *Ceracis* sp. B, using seven out of ten fungus species, and *Cis* sp. C that used eight out of ten fungus species (Figs. 2 and 4). The fungi species used by the highest number of ciid species at SA was *Trametes versicolor*, with 13 out of 26 ciid species (Figs. 1 and 3). At BC, *Pycnoporus* sp. (Polyporaceae) was the host fungus used by the highest number of ciid species, with seven out of 13 ciid species (Figs. 2 and 4).

Analyses of the contributions of each species to nestedness of the network has shown that *Cer. tabellifer* had the highest values of contribution to the community nestedness at SA (6.41), followed by *C. nesororum* i.l. (2.91) and *C. mandelai* i.l. (2.21), whereas *C. stalsi* i.l. and *Cis* sp. M have the lowest values (-1.37 and -0.92 respectively) of all eight ciid species which showed to be negative contributors (*C. makebae* i.l., *Cis* sp. I, *C. regius* Orsetti & Lopes-Andrade, *C. aster* i.l., *Cis* sp. K, *Cis* sp. D, *Cis* sp. M and *C. stalsi* i.l.) (Fig. 5). At the lower-trophic level, *Tr. versicolor*, *Trametes* sp. 1 and *Pycnoporus sanguineus* (L.) Murrill had the highest values (3.01,

2.63 and 1.68 respectively), whereas *Russula capensis* A. Pearson (-1.57) was the only fungus species contributing negatively to the community nestedness (Fig. 6). On the other hand, at BC the most positive contributor to the community nestedness was *Cis* sp. C (2.08) followed by *Cer. tabellifer* (1.30) and *Cer. cornifer* (Mellié) (1.07), whereas *Malacocis* sp. A, *Strigocis vicosensis* Lopes-Andrade and *Ceracis* sp. A showed up as negative contributors (-0.69, -0.25 and -0.20 respectively) (Fig. 7). At the lower trophic level, *Pycnoporus* sp., *Pleurotus* sp. (Pleurotaceae) and *Hexagonia* sp. (Polyporaceae) had the highest values (1.81, 1.57 and 1.55 respectively), whereas *Earliella* sp. (Polyporaceae) and *Ganoderma* sp. (Ganodermataceae) contributed negatively to community nestedness (-0.40 and -0.34 respectively) (Fig. 8).

The robustness of the community to the extinction of fungus species proved to be lower than the robustness of the entire network for extinction at both datasets (0.29 and 0.49 to SA and BC, respectively). The removal of the most linked fungus species resulted in a linear decline of ciid species in both datasets (Figs. 9–10). Strength of fungus and ciid species to interactions in the network was significant with 95% of correlation in both datasets, with both methods used in analyses. At SA, fungus species with the highest strength values were *Tr. versicolor* (5.08), *Trametes* sp. 1 (3.74), *Tr. cingulata* (2.38), *Tr. hirsuta* (2.11), *Tr. meyenii* (1.95), *Trametes* sp. 2 (1.37), *H. tenuis* (1.30), *Stereum ostrea* (1.23), *G. applanatum* (1.11) and *P. parvula* (1.11), all the others species had values lower than one. Only six ciid species had strength values higher than one: *Cer. tabellifer* (17.41), *C. nesororum* (3.91), *Cis* sp. Q (1.88), *C. mandelai* i.l. (1.51), *Cis* sp. J (1.21) and *Cis* sp. W (1.08). At BC, five fungus species had strength values higher than one: *Phellinus* sp. (3.16), *Stereum* sp. (1.97), *Ganoderma* sp. (1.64), *Pycnoporus* sp. (1.63) and *Earliella* sp. (1.43); to ciids species, four had values higher than one: *Cis* sp. C (2.71), *Cer. tabellifer* (1.74), *Ceracis* sp. B (1.54) and *Cer. cornifer* (1.18).

The co-occurrence analyses of SA showed that *Cer. tabellifer* co-occurred with all ciid species of the community (Table 1) and almost in all fungus species, except for *C. nesororum* i.l. and *Cis* sp. W (C-score = 0.48; table 1) that occurred in fungus species in which *Cer. tabellifer* did not occur (*Pycnoporus* sp. and *R. capensis*; fig. 1). *Cis nesororum* i.l., the second most generalist species, did not co-occur only with three ciid species (*C. makebae* i.l., *Cis* sp. M and *C. aster* i.l.; table 1). *Cis aster* i.l. was the species with the lowest number of co-occurrences, only with three species (*Cer. tabellifer*, *Cis* sp. Q and *C. mandelai* i.l.; Table 1). In contrast, analyses of BC showed that *Cer. tabellifer* did not co-occur only with three species (*Ceracis* sp. A, *Ceracis* sp. C and *Cis* sp. C; table 2). The most generalist species *Cis* sp. C did not occur with two species (*Cer. tabellifer* and *Ceracis* sp. B; table 2). *Ceracis cornifer* and *X. rufipes* were the species with the greatest number of co-occurrences, either co-occurring with ten species (Table 2). Three species had the lowest number of co-occurrences, with only five species (*Ceracis* sp. A, *Ceracis* sp. C and *Cis* sp. A; table 2).

Discussion

The invasion success of a species is determined by its biological traits, for instance its abundance, reproductive cycle, body size, niche breadth, intrinsic rate of population increase, and also by characteristics of the invaded environment, as absence of natural enemies, weather conditions and “empty niche” (Williamson and Fitter 1996; Williamson 1999; Shea and Chesson 2002; Emiljanowicz et al. 2017). The invasion success of *Cer. tabellifer* may be related to its generalist habits, small body size and abundance higher than those of other ciid species using the same host fungi. As shown here, *Cer. tabellifer* is the most generalist species at SA and uses most available host fungi of ciid species. But we have not found evidence that *Cer. tabellifer* affect native ciid species by competitive exclusion, neither by shift of its resources as proposed in our second hypothesis. Possibly, *Cer. tabellifer* has been favored by the availability of empty niches (i.e. niche opportunity) at the invaded community (Shea and Chesson 2002). Host fungi that are not used by native ciid species are resource opportunities to *Cer. tabellifer*, and the unnecessary of competition may enhance population growth (Shea and Chesson 2002). *Ceracis tabellifer* seems to keep the polyphagous feeding habits observed in its native habitat in invaded areas, as in SA, which potentially contributed for its establishment in the invaded environment and its subsequent spread.

The polyphagous habit of *Cer. tabellifer* in South Africa resembles that of *Cer. communis* in Australia, which is the most common species there (Lawrence 2016). *Ceracis communis* and *Cer. christmasensis* (from the Christmas Island) are morphologically closely related to *Cer. tabellifer*, and further studies, mainly based on molecular data, are necessary to understand species limits in this complex. There’s no report of the expansion rate of *Cer. tabellifer* after established in a new environment. Indeed, such reports are available only for *Cis bilamellatus* Wood, a well-studied invasive ciid of Australasian origin. *Cis bilamellatus* was accidentally introduced in eastern England during the XIX century. In the decades that followed the introduction event, the initial population spread to almost all British islands, expanding approximately thirteen kilometers per year (Orledge et al. 2010).

Our results of network analyses showed that the SA ciid community had less connectance (closer to 0.1) and links per species than the BC community (0.35). A possible explanation to these results is that the BC ciid community has a high number of generalist species, while in the SA community is less skewed toward specialists and generalists. Network from BC had more ciids than fungus species (positive web asymmetry), but SA had the opposite (negative web asymmetry), which suggested that *Cer. tabellifer* may be increasing the integration of community at SA by using fungus species previously not utilized. The nestedness at SA was higher than BC, but both communities share an asymmetrical specialization called nested, a very common and characteristic of mutualistic webs; which differs from antagonist and symbiotic webs that present compartmented pattern (Bascompte et al 2003; Bascompte et al. 2006; Guimarães Jr et al. 2006; Guimarães Jr et al. 2007a, b). This pattern is characterized by: (i) generalist forming a core of interacting species, (ii) specialist normally interacting only with generalist and (iii) absence of specialist interacting with specialist (Guimarães Jr et al. 2006; Guimarães Jr et al. 2007b), that may be visualized at networks. The robustness of the higher-trophic level as well as lower-trophic demonstrate that both communities share a relative tolerance to extinction, which has been related in previous

works to nested networks (Memmott et al. 2004; Burgos et al. 2007), suggesting again that BC and SA communities resembles mutualistic webs.

The contribution of each species to nestedness community of higher-trophic level at SA as well as BC showed that the most generalist species are essential to maintain the nestedness. Analyses with the lower-trophic level at SA demonstrate that the two fungus species most utilized as resources (*Tr. versicolor* and *Trametes* sp. 1) and *P. sanguineus*, the fungus species utilized only by the most generalist ciid species, the fungus species that most contribute to the nestedness of that community. At BC, the negative contributors to nestedness was the fungus species utilized as resource by ciids species together with the most generalist ciid species. This difference between the influence of *Cer. tabellifer* at contribution of lower-trophic level to nestedness in both datasets suggested again that it is the most important species to nestedness of the SA community. The nestedness can result in some implications for community persistence (e.g. heterogeneous distribution of the number of links per species, cohesive pattern of interactions) providing alternative routes to perturbation events and pathways to maintain rare species at the community (Bascompte et al. 2003).

Analyses of communities robustness to fungus extinction showed that ciid species decline linearly with removal of most linked fungus species, and the their outcomes for entire network are different of those obtained simulating the extinction of the most linked first. Our results showed that simulating the effects of possible second extinction in a community is better to estimate the robustness of all system on the understanding what can happen with loss of species. The robustness to fungus species extinction was smaller at SA in comparison to BC, which may be due to the presence of rarer fungus species utilized only by *Cer. tabellifer* on that dataset (13 fungus species). These results do not correspond either to loose system or to robust system, but resembles an intermediate value of robustness to extinction. Previous works showed similar pattern in plant-pollinators communities, with a decline not different of linear removing the most linked pollinators (Memmott et al. 2004; Burgos et al. 2007), which may be a common pattern in nested system, but a careful attempting and analyses with others dataset are needed to a better conclusion. Moreover, studies simulating possible extinctions can be useful tools to management and preservation of threatened ecosystems.

Our analyses showed that in both dataset, the most important ciids species to interactions in the network are the most generalist. At lower-trophic level, fungus species more utilized as resources are the most important to the interactions in the communities. These species have a greater mean at each community and may be considered to be keystone species, forming a cohesive pattern of interactions that may provide more resilience to environment perturbations (Bascompte et al. 2003). The importance of keystone species for the ecosystem need to be more discussed and considered than rare species in conservation biology practices, once that they cause indirect and direct positive effects on functioning and integrity of ecosystems, which help on the persistence of rare species too (Jordán 2009). Bascompte et al (2006) suggested that mutualistic networks architecture are characterized by high heterogeneity in species strength, their asymmetry and low number of strong dependences, which promotes the community coexistence. These features were found in our analyses too,

suggesting that over there our communities behave as mutualistic systems; their community coexistence may favor selective forces (e.g. coevolutionary complementarity and coevolutionary convergence) for the coevolution of species-rich assemblages (Thompson 1994; Thompson 2005; Bascompte et al. 2006).

The co-occurrence analyses showed that *Cer. tabellifer* at SA co-occur with all ciid species and in almost all fungus species (exception to *Pycnoporus* sp. and *R. capensis*), which confirmed its generalist habits. In contrast, at BC the invasive species does not co-occur either with the most generalist ciid species (*Cis* sp. C) or with the two most specialist (*Ceracis* sp. A and *Ceracis* sp. C). These results may be due to the difference of fungus richness at the two localities. The greater richness of fungus species at SA provide most resources opportunities for the invasive species (Shea and Chesson 2002), reducing the competition between it and the native species; while at BC the lower richness of fungus species results on lesser resources opportunities to *Cer. tabellifer*, reducing the number of host fungus utilized for it and the co-occurrence with the most generalist and more specialist by competition. This co-occurrence pattern at SA suggests that *Cer. tabellifer* apparently does not exclude competitively the native species and utilize fungus species usually not used by native ciids.

Biological invasions previsions and their effects on natural environments are questions discussed a lot by ecologists, conservationists and countries authorities. Our results rejected our second hypothesis that the invasive species exclude competitively the native species of *Cis*, shifting them of their resources. Alternatively our results suggested that *Cer. tabellifer* is only utilizing fungus species not previously utilized by other ciids at that locality. The results confirmed our first hypothesis that the *Cer. tabellifer* seems to keep the behaviour from its native habitat, where presents polyphagous feeding habits and large populations. Asides, analyses performed here suggests that communities of fungus and ciids species resembles mutualistic systems.

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Figures and tables

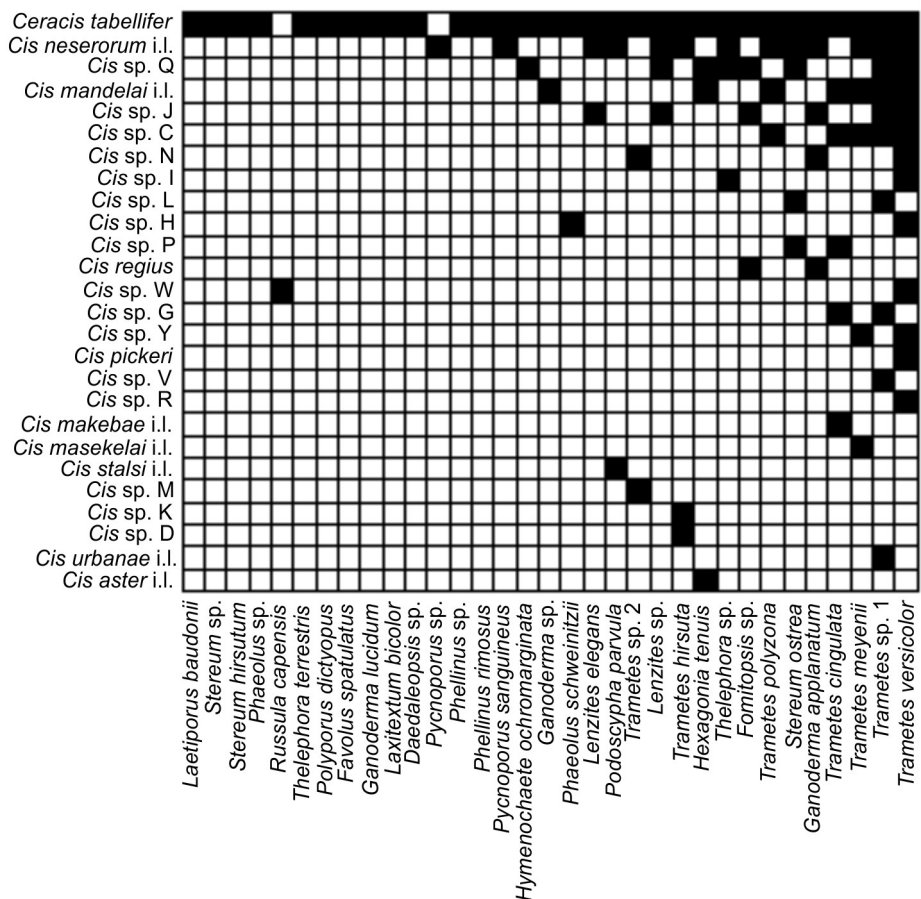
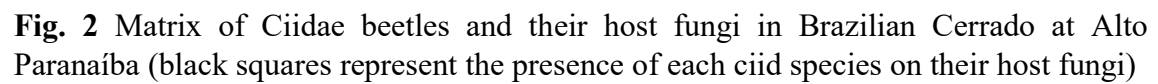


Fig. 1 Matrix of Ciidae beetles and their host fungi in South Africa (black squares represent the presence of each ciid species on their host fungi)



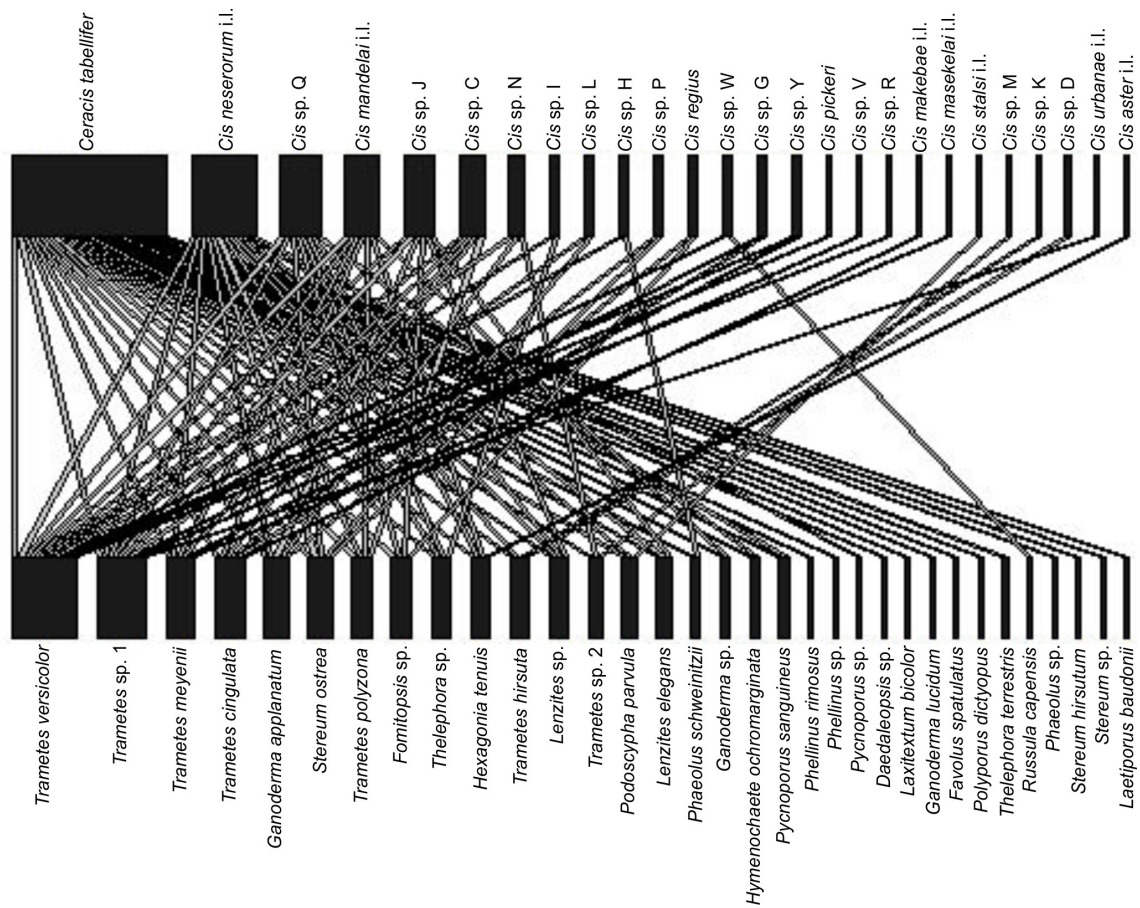


Fig. 3 Network of Ciidae beetles and their host fungi in South Africa (lines represent the presence of each ciid species on their host fungi)

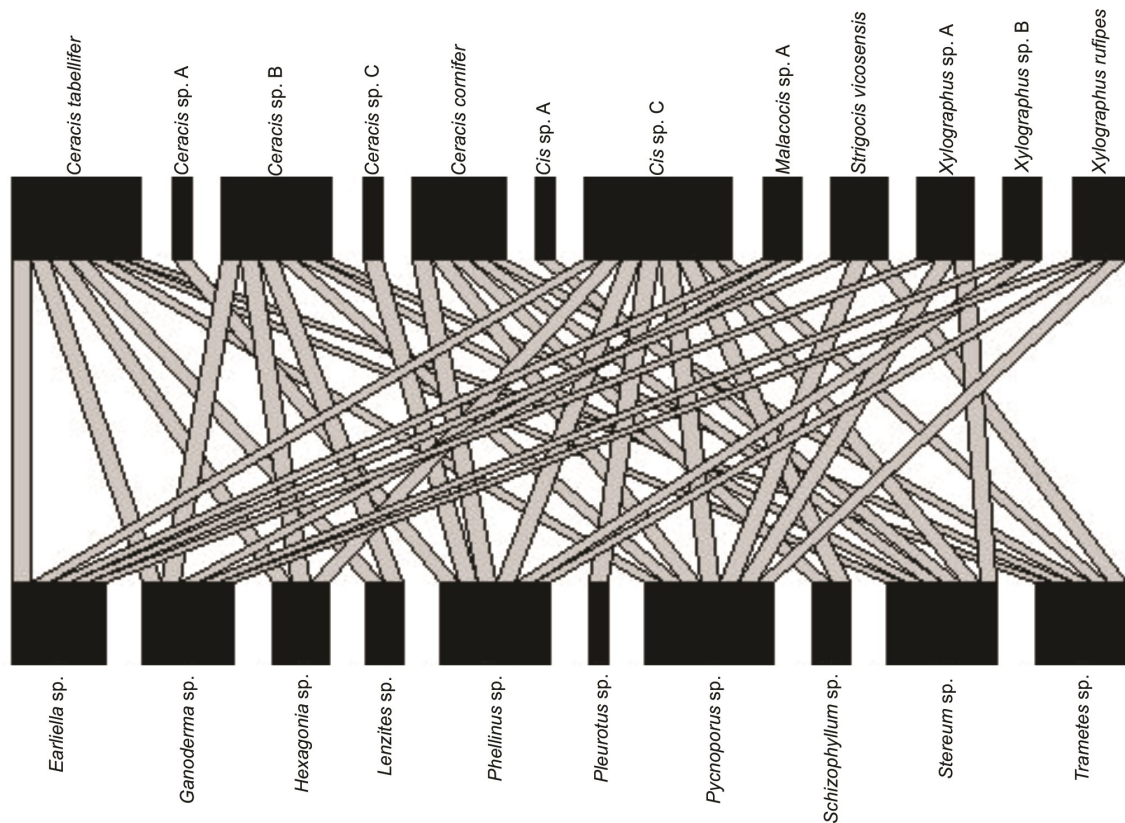


Fig. 4 Network of Ciidae beetles and their host fungi in Brazilian Cerrado at Alto Paranaíba (lines represent the presence of each ciid species on their host fungi)

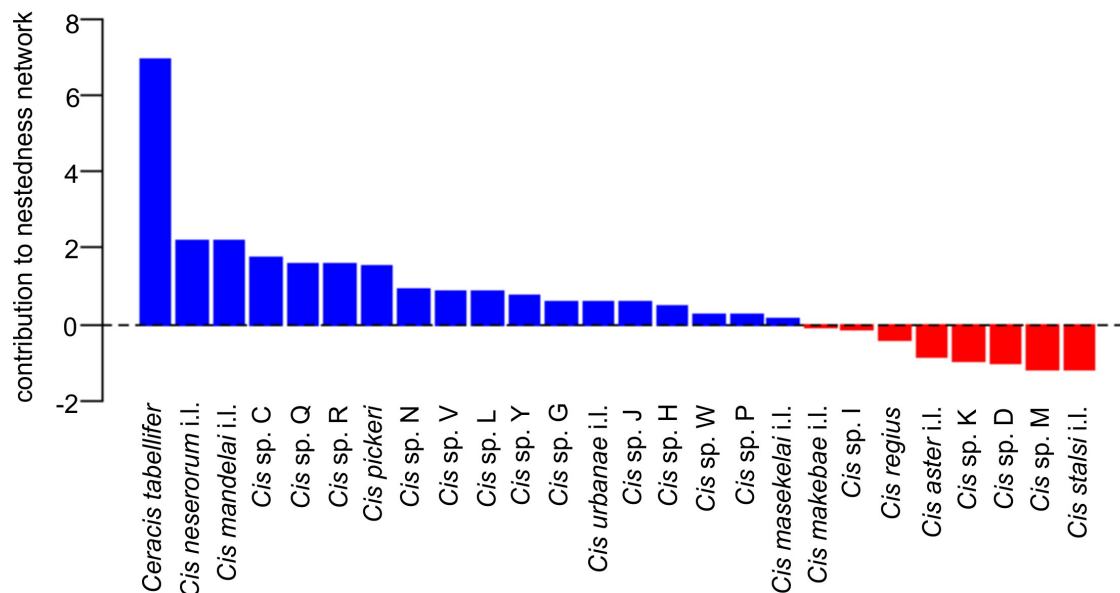


Fig. 5 Contribution of each ciid species to network nestedness from South African community (ciid species that increase the nestedness of community was represented by blue bars and those decrease the nestedness by red bars)

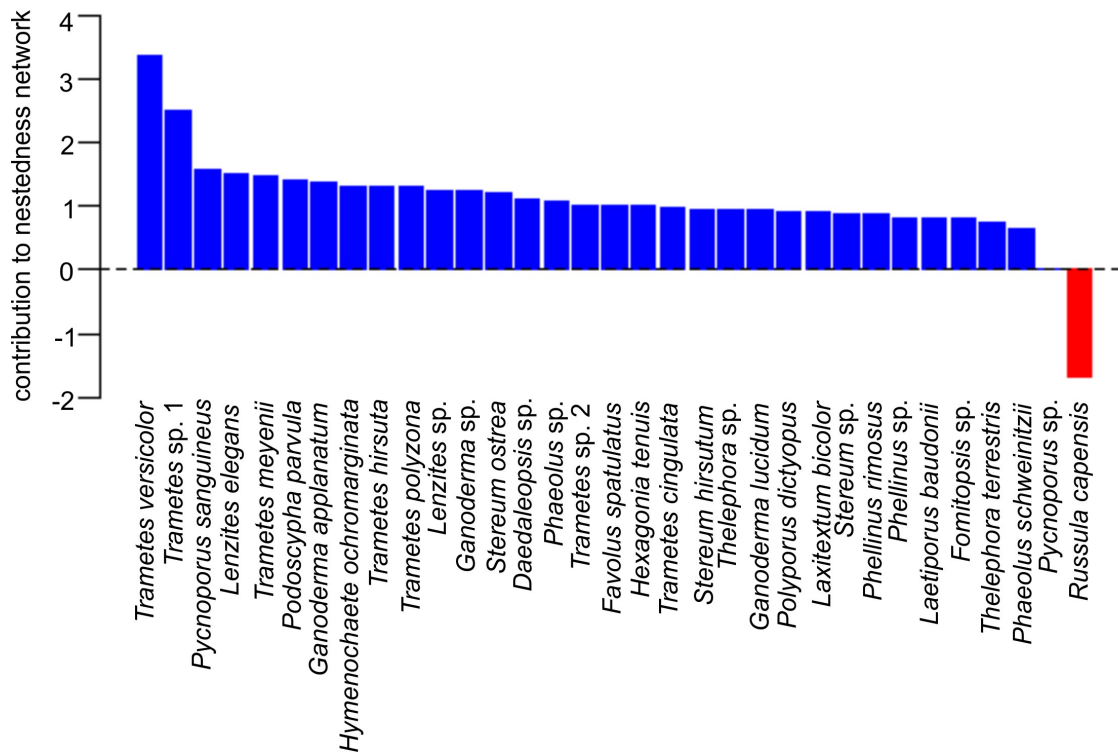


Fig. 6 Contribution of each fungi species to network nestedness from South African community (fungi species that increase the nestedness of community was represented by blue bars and those decrease the nestedness by red bars)

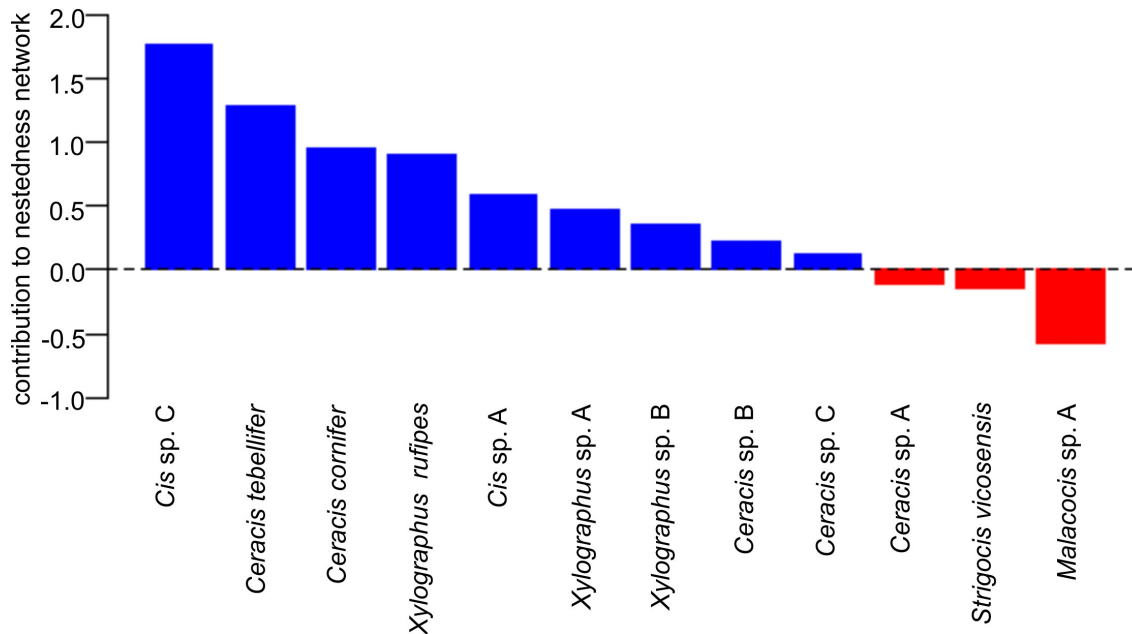


Fig. 7 Contribution of each ciid species to network nestedness from Brazilian Cerrado at Alto Paranaíba community (ciid species that increase the nestedness of community was represented by blue bars and those decrease the nestedness by red bars)

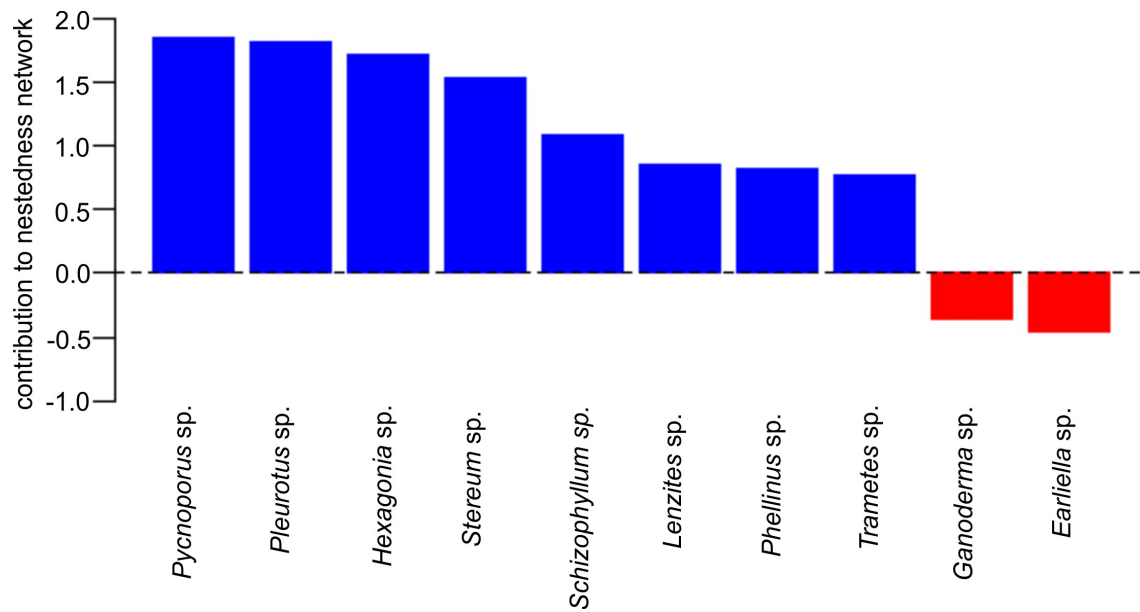


Fig. 8 Contribution of each fungi species to network nestedness from Brazilian Cerrado at Alto Paranaíba community (fungi species that increase the nestedness of community was represented by blue bars and those decrease the nestedness by red bars)

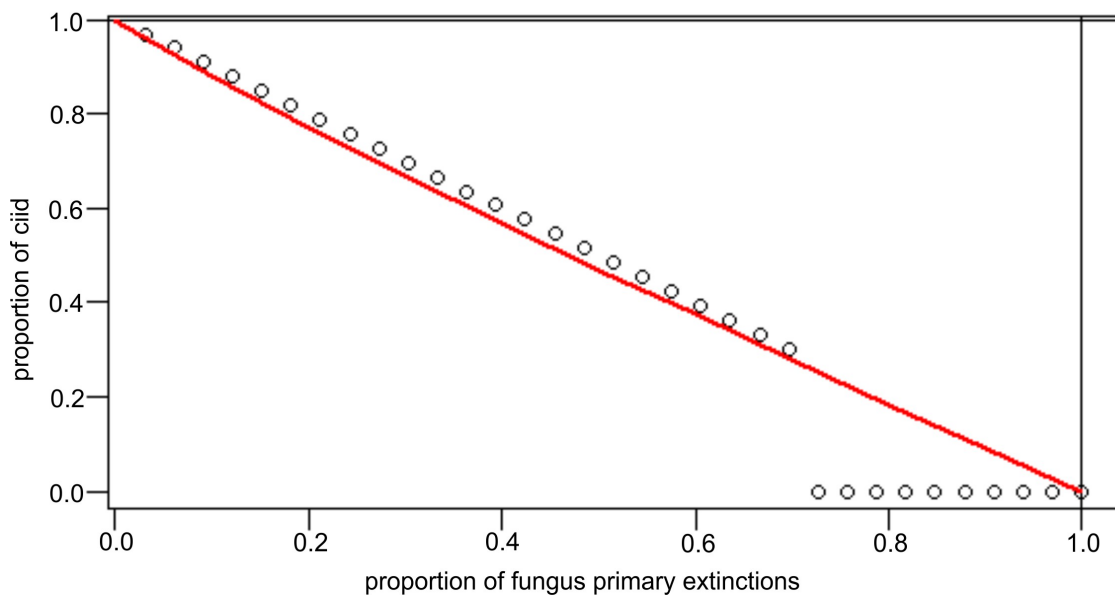


Fig. 9 Simulated ciids extinction proportion follow by primary extinction of fungus with most linked species removal from South African community (circles represent each fungi species lost by primary extinctions and red line represent the proportion of ciid species in the community after the lost of each fungi species)

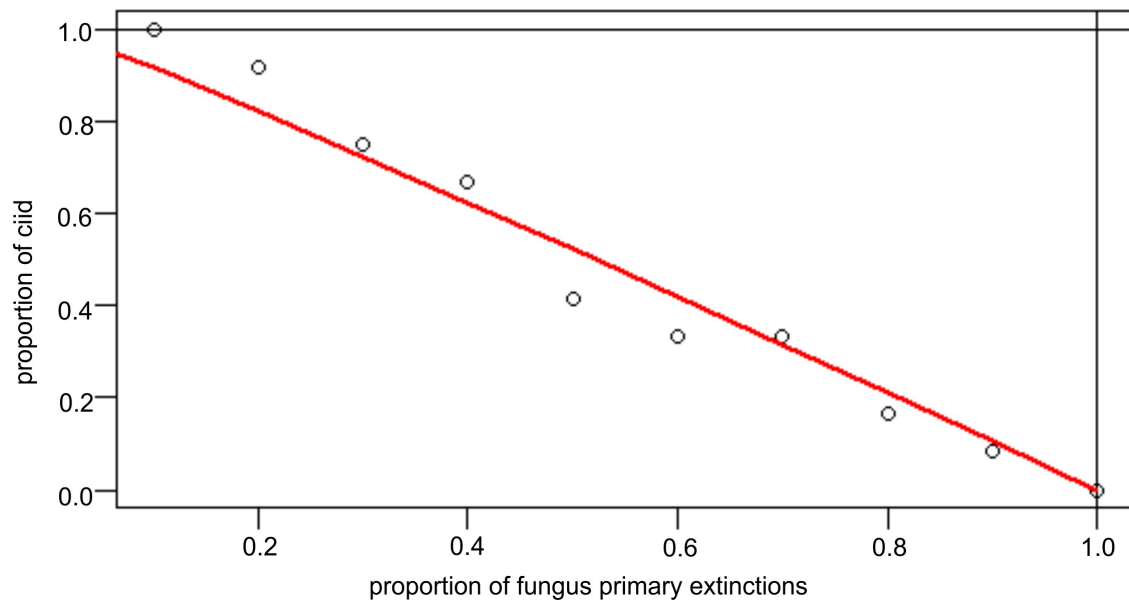


Fig. 10 Simulated ciids extinction proportion follow by primary extinction of fungus with most linked species removal from Brazilian Cerrado at Alto Paranaíba community (circles represent each fungi species lost by primary extinctions and red line represent the proportion of ciid species in the community after the lost of each fungi species)

Table 1 C-scores of co-occurrence analyses for ciid beetles presence-absence matrices from South African community

	<i>Ceracis tabellifer</i>	<i>Cis neserorum</i> i.l.	<i>Cis</i> sp. Q	<i>Cis mandelai</i> i.l.	<i>Cis</i> sp. J	<i>Cis</i> sp. C	<i>Cis</i> sp. N	<i>Cis</i> sp. I	<i>Cis</i> sp. L	<i>Cis</i> sp. H	<i>Cis</i> sp. P	<i>Cis regius</i>	<i>Cis</i> sp. W	<i>Cis</i> sp. G	<i>Cis</i> sp. Y
<i>Cis neserorum</i> i.l.	0.48	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Cis</i> sp. Q	0.00	0.23	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Cis mandelai</i> i.l.	0.00	0.30	0.36	-	-	-	-	-	-	-	-	-	-	-	-
<i>Cis</i> sp. J	0.00	0.10	0.17	0.48	-	-	-	-	-	-	-	-	-	-	-
<i>Cis</i> sp. C	0.00	0.14	0.45	0.00	0.40	-	-	-	-	-	-	-	-	-	-
<i>Cis</i> sp. N	0.00	0.28	0.58	0.57	0.22	0.53	-	-	-	-	-	-	-	-	-
<i>Cis</i> sp. I	0.00	0.00	0.00	0.43	0.42	0.40	0.33	-	-	-	-	-	-	-	-
<i>Cis</i> sp. L	0.00	0.00	0.00	0.43	0.42	0.40	1.00	1.00	-	-	-	-	-	-	-
<i>Cis</i> sp. H	0.00	0.46	0.44	0.43	0.42	0.40	0.33	0.25	1.00	-	-	-	-	-	-
<i>Cis</i> sp. P	0.00	0.46	0.44	0.43	1.00	0.40	1.00	1.00	0.25	1.00	-	-	-	-	-
<i>Cis regius</i>	0.00	0.46	0.44	1.00	0.00	1.00	0.33	1.00	1.00	1.00	1.00	-	-	-	-
<i>Cis</i> sp. W	0.48	0.46	0.44	0.43	0.42	0.40	0.33	0.25	1.00	0.25	1.00	1.00	-	-	-
<i>Cis</i> sp. G	0.00	0.46	0.44	0.00	0.42	0.00	1.00	1.00	0.25	1.00	0.25	1.00	1.00	-	-
<i>Cis</i> sp. Y	0.00	0.00	0.44	0.00	0.42	0.00	0.33	0.25	1.00	0.25	1.00	1.00	0.25	1.00	-
<i>Cis pickeri</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	1.00	1.00	0.00	1.00	0.00
<i>Cis</i> sp. V	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	0.00	1.00
<i>Cis</i> sp. R	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	1.00	1.00	0.00	1.00	0.00
<i>Cis makebae</i> i.l.	0.00	1.00	1.00	0.00	1.00	0.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
<i>Cis masekelai</i> i.l.	0.00	0.00	1.00	0.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
<i>Cis stalsi</i> i.l.	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
<i>Cis</i> sp. M	0.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
<i>Cis</i> sp. K	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
<i>Cis</i> sp. D	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
<i>Cis urbanae</i> i.l.	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	0.00	1.00
<i>Cis aster</i> i.l.	0.00	1.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table 1 (continued)

	<i>Cis pickeri</i>	<i>Cis</i> sp. V	<i>Cis</i> sp. R	<i>Cis</i> <i>makebae</i> i.l.	<i>Cis</i> <i>masekelai</i> i.l.	<i>Cis</i> <i>stalsi</i> i.l.	<i>Cis</i> sp. M	<i>Cis</i> sp. K	<i>Cis</i> sp. D	<i>Cis</i> <i>urbanae</i> i.l.
<i>Cis</i> <i>neserorum</i> i.l.	-	-	-	-	-	-	-	-	-	-
<i>Cis</i> sp. Q	-	-	-	-	-	-	-	-	-	-
<i>Cis mandelai</i> i.l.	-	-	-	-	-	-	-	-	-	-
<i>Cis</i> sp. J	-	-	-	-	-	-	-	-	-	-
<i>Cis</i> sp. C	-	-	-	-	-	-	-	-	-	-
<i>Cis</i> sp. N	-	-	-	-	-	-	-	-	-	-
<i>Cis</i> sp. I	-	-	-	-	-	-	-	-	-	-
<i>Cis</i> sp. L	-	-	-	-	-	-	-	-	-	-
<i>Cis</i> sp. H	-	-	-	-	-	-	-	-	-	-
<i>Cis</i> sp. P	-	-	-	-	-	-	-	-	-	-
<i>Cis regius</i>	-	-	-	-	-	-	-	-	-	-
<i>Cis</i> sp. W	-	-	-	-	-	-	-	-	-	-
<i>Cis</i> sp. G	-	-	-	-	-	-	-	-	-	-
<i>Cis</i> sp. Y	-	-	-	-	-	-	-	-	-	-
<i>Cis pickeri</i>	-	-	-	-	-	-	-	-	-	-
<i>Cis</i> sp. V	1.00	-	-	-	-	-	-	-	-	-
<i>Cis</i> sp. R	0.00	1.00	-	-	-	-	-	-	-	-
<i>Cis makebae</i> i.l.	1.00	1.00	1.00	-	-	-	-	-	-	-
<i>Cis masekelai</i> i.l.	1.00	1.00	1.00	1.00	-	-	-	-	-	-
<i>Cis stalsi</i> i.l.	1.00	1.00	1.00	1.00	1.00	-	-	-	-	-
<i>Cis</i> sp. M	1.00	1.00	1.00	1.00	1.00	1.00	-	-	-	-
<i>Cis</i> sp. K	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-	-	-
<i>Cis</i> sp. D	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	-	-
<i>Cis urbanae</i> i.l.	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-
<i>Cis aster</i> i.l.	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table 2 C-scores of co-occurrence analyses for ciid beetles presence-absence matrices from Brazilian Cerrado at Alto Paranaíba community

	<i>Ceracis tabellifer</i>	<i>Ceracis</i> sp. A	<i>Ceracis</i> sp. B	<i>Ceracis</i> sp. C	<i>Ceracis cornifer</i>	<i>Cis</i> sp. A	<i>Cis</i> sp. C	<i>Malacocis</i> sp. A	<i>Strigocis vicosensis</i>	<i>Xylographus</i> sp. A	<i>Xylographus</i> sp. B
<i>Ceracis</i> sp. A	1.00	-	-	-	-	-	-	-	-	-	-
<i>Ceracis</i> sp. B	0.00	1.00	-	-	-	-	-	-	-	-	-
<i>Ceracis</i> sp. C	1.00	0.00	1.00	-	-	-	-	-	-	-	-
<i>Ceracis cornifer</i>	0.53	0.00	0.30	0.00		-	-	-	-	-	-
<i>Cis</i> sp. A	0.00	1.00	0.00	1.00	0.00	-	-	-	-	-	-
<i>Cis</i> sp. C	1.00	0.00	1.00	0.00	0.00	0.00	-	-	-	-	-
<i>Malacocis</i> sp. A	0.00	1.00	0.42	1.00	1.00	1.00	0.44	-	-	-	-
<i>Strigocis vicosensis</i>	0.00	1.00	0.22	1.00	0.20	1.00	0.00	0.33	-	-	-
<i>Xylographus</i> sp. A	0.00	1.00	0.22	1.00	0.20	0.00	0.00	0.33	0.11	-	-
<i>Xylographus</i> sp. B	0.43	0.00	0.42	0.00	0.40	1.00	0.44	0.25	1.00	1.00	-
<i>Xylographus rufipes</i>	0.24	0.00	0.22	0.00	0.20	1.00	0.43	0.33	0.44	0.44	0.00

CONCLUSÕES GERAIS

O atual trabalho buscou ampliar o conhecimento sobre a fauna de besouros ciídeos da África do Sul, bem como compreender melhor as possíveis influências da espécie invasora *Cer. tabellifer* na fauna nativa.

No primeiro capítulo descrevemos sete novas espécies de *Cis* da África: *C. aster* Souza-Gonçalves & Lopes-Andrade, *C. mandelai* Souza-Gonçalves & Lopes-Andrade, *C. makebae* Souza-Gonçalves & Lopes-Andrade, *C. masekelai* Souza-Gonçalves & Lopes-Andrade, *C. nesesorum* Souza-Gonçalves & Lopes-Andrade, *C. stalsi* Souza-Gonçalves & Lopes-Andrade e *C. urbanae* Souza-Gonçalves & Lopes-Andrade. Juntamente com a descrição das espécies fornecemos dados da distribuição geográfica e fungos hospedeiros dos mesmos.

No segundo capítulo, chegamos à conclusão de que a espécie invasora, *Cer. tabellifer*, não está deslocando as espécies locais de seus recursos, mas provavelmente apenas utilizando fungos que não eram utilizados previamente. Além disso, *Cer. tabellifer* mostra manter o comportamento do seu habitat nativo, onde apresenta hábito alimentar polífago e grandes populações.

Desta maneira, esta dissertação cumpre com seu objetivo em contribuir para expansão do conhecimento da fauna de ciídeos da África do Sul e também na discussão das influências das invasões biológicas nas comunidades locais.

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