Dugesiana 9(1): 5-13, 2002.

Recents advances in the study of the Brazilian Ciidae (Coleoptera: Tenebrionoidea)

Cristiano Lopes-Andrade
Departamento de Biologia Geral, Universidade Federal de Viçosa, 36571-000, Viçosa, MG, Brasil,
E-mail: e37300@alunos.ufv.br

ABSTRACT

Ciidae is a widespread family of minute mycetobiont beetles which live in association with some macrofungi. Studies on this family may help to elucidate the phylogenetic relationship of the basal groups of Tenebrionoidea, as Pterogeniidae, Prostomidae, Archeocrypticidae and Mycetophagidae. There is no revisionary work giving emphasis to the Brazilian ciids, and that makes difficult the continuity of some researches. Here, a list of described genera and species already recorded from Brazil is presented, including two genera not cited before, and together with notes on some recent advances on the taxonomy and systematics of Brazilian ciids.

RESUMO

Ciidae é uma família de pequenos besouros cosmopolitas que vivem em associação obrigatória com alguns macrofungos, sendo portanto considerados micetobiontes. O estudo dessa família pode ajudar a elucidar as relações filogenéticas de alguns grupos basais de Tenebrionoidea, como Pterogeniidae, Prostomidae, Archeocrypticidae e Mycetophagidae. Não há nenhum estudo amplo sobre os ciídeos brasileiros, o que dificulta a continuidade de algumas pesquisas sobre estes insetos. Neste trabalho são apresentadas uma lista de gêneros e espécies descritas, incluindo dois gêneros não reportados anteriormente para o Brasil; e notas sobre alguns avanços recentes na taxonomia e sistemática dos ciídeos brasileiros.

The ciids are minute fungus-feeders beetles which live in obligatory association with the mycelia and fruiting bodies of some wood-rotting macrofungi (Basidiomycotina). They are considered to be mycetobiont beetles (Scheerpeltz and Höfler 1948, Klimaszewski and Peck 1987), as all their life cicle take place in the fungus, which is used as food and habitat (Navarrete-Heredia 1991). The majority of the species lives in Polyporaceae *sensu lato* (Holobasidiomycetes: Aphyllophorales), but the genus *Orthocis* Casey shows a greater preference to some Auriculareaceae (Phragmobasiodiomycetes: Auriculariales).

Due to their food dependence, ciids are important in the degradation of wood-rotten macrofungi. Therefore, they are in the basis of the trophic web, together with other scavengers such as necrophagous and saprophagous organisms. However, as a consequence of their habits, ciids are vulnarable to habitat fragmentation (Rukke 2000). In intensively managed forests, ciid populations are affected by the decrease of their resource, which is directly related to the availability of dead wood (Thunes *et al.* 2000).

This work aims to present an updated list of genera and species of Brazilian ciids, including two genera not cited before, with notes on some recent advances on their taxonomy, and systematics.

RESULTS AND DISCUSSION

Taxonomy and systematics panorama

The family Ciidae is a basal group of Tenebrionoidea (old Heteromera section), and is phylogenetically related to the families Mycetophagidae, Archaeocrypticidae, Tetratomidae, Prostomidae, and Pterogeniidae (Lawrence 1982). The latter family is probably its sister group.

The first and unique whole taxonomic treatment of the worldwide Ciidae was made by Mellié (1848). Since that work, only one revision of the group was made (Lawrence 1971), however it included only the Nearctic ciids and comments on some Neotropical species. Recently, there was an agreement about the taxonomic limits of the family (Lawrence 1974b), which nowadays comprises two subfamilies: (i) Ciinae, with over 40 genera and more than 500 described species; and (ii) Sphindociinae, which is restricted to the Nearctic Region (California, USA), and includes only *Sphindocis denticollis* Fall.

Ciinae species can be easily separated from the other tenebrionoid beetles by the presence of an abdominal fovea (Fig. 1A) and four sensillifers in each of the last three articles of the antenna (antennal club; Fig. 1B). *Sphindocis denticollis* do not have these sensillifers and the first two urosternites are connated, but it can be distinguished from Pterogeniidae by the presence of an antennal club and the tarsal formula 4-4-4. A whole characterization of Ciidae (Ciinae and Sphindociinae) is provided by Lawrence (1974b). The division of Ciinae into Orophiini and Ciini is being avoided (see Lawrence *et al.* 1999), but previous works of the same author considered these tribes as valid taxa (Lawrence 1982 and 1987). Further works are necessary to evaluate whether or not these tribes are phylogenetically plausible.

There is no revisionary work exclusively on the Brazilian ciids, and the last list of species was provided by Blackwelder (1945). In this list, seven genera were recorded from Brazil: *Cis* Latreille, *Ceracis* Mellié, *Ennearthron* Mellié, *Macrocis* Reitter, *Malacocis* Gorham, *Trichapus* Fried., and *Xylographus* Mellié. However, the species mentioned as *Ennearthron* were transferred to the genus *Ceracis* by Lawrence (1967b), *Macrocis* Reitter was synonymized with *Cis*, and *Malacocis bahiensis* Pic was excluded from this genus as it probably belongs to the *Cis taurus* group (Lawrence 1971). Afterwards, the genus *Porculus* was described based on five species, two distributed in Brazil (Lawrence 1987). Therefore, five genera were officially recognized from Brazil until this work.

Two collections of Brazilian ciids were analyzed: one pertaining to Museu de Zoologia da USP (MZ/USP, SP, Brazil) and the other to C. Lopes-Andrade (UFV, MG, Brazil). The former have specimens from Mellié and Friedenreich personal collections (probably type specimens), many recently collected specimens, and the holotype and paratypes of *Porculus grossus* Lawrence. The latter collection also have many recently collected specimens and some species belonging to genera not recorded from Brazil before.

A list of species and genera of Brazilian ciids, is presented in Table 1. A brief discussion of each genera is provided below.

Brazilian Ciidae genera

Ceracis Mellié

This genus was recently revised by Lawrence (1967b), who determined its taxonomic limits. Although the emphasis was on the Nearctic *Ceracis*, some Neotropical species was synonymized, included or excluded from the genus and put in a species group. However, some doubts concerning *Cer. furcatus* (Bosc), *Cer. militaris* Mellié, *Cer. furcifer* Mellié and *Cer. variabilis* Mellié (Fig. 2A) still exists, and synonyms may arose in a near future. To facilitate further works, all these species are here put together in the *Ceracis furcatus* group. For the same reason, *Cer. cornifer* (Mellié) is included here in the *Cer. furcifer* group (*sensu* Lawrence 1967b).

Table 1: List of genera and species of Ciidae (Coleoptera: Tenebrionoidea) cited for Brazil. The symbol * indicates that the genera are cited for the first time to Brazil in this work, and ** indicates doubtful information (see text for a better explanation). MZ/USP stands for "Museu de Zoologia da Universidade de São Paulo", and LAC indicates the specimens deposited in C. Lopes-Andrade personal collection. The column "Group" indicates the name of the species complex where each species is included.

Genera	Species	Group	Distribution	Collection
Ceracis Mellié, 1848				
	Ceracis bicornis (Mellié, 1848)	*Ceracis cucullatus*	Peru, Brazil, Mexico	MZ/USP
	Ceracis cornifer (Mellié, 1848)	*Ceracis furcifer*	Brazil	MZ/USP, LAC
	Ceracis cucullatus (Mellié, 1848)	*Ceracis cucullatus*	Latin America	
	Ceracis cf. *variabilis* Mellié, 1848	*Ceracis furcatus*	Brazil	LAC
	Ceracis ruficornis Pic, 1916	*Ceracis furcifer*	Brazil	MZ/USP
Cis Latreille, 1796				
	Cis apicipennis Pic, 1916		Brazil	
	Cis diadematus Mellié, 1848		Brazil	MZ/USP
	Cis fulvipes Mellié, 1848		Brazil	
	Cis gounellei Pic, 1916		Brazil	
	Cis grossus Mellié, 1848		Brazil	
	Cis pallidus Mellié, 1848	*Cis pallidus*	Brazil	MZ/USP
	Cis robustus Pic, 1916		Brazil	
	Cis testaceimembrius (Pic, 1916)	*Cis taurus*	Brazil	
	Cis testaceus (Pic, 1916)	*Cis taurus*	Brazil	
	Cis tricornis (Gorham, 1883)	*Cis tricornis*	Brazil, Mexico	MZ/USP
	Cis validithorax Pic, 1916		Brazil	
	Cis sp. nov.		Brazil	LAC
Ennearthron Mellié, 1847*				
	Ennearthron sp., undescribed species		USA, Brazil	LAC
Falsocis Pic, 1916*				
	Falsocis sp., undescribed species		Brazil	LAC
Porculus Lawrence, 1987				
	Porculus grossus Lawrence, 1987		Latin America	MZ/USP
	Porculus vianai (Pic, 1940)		South America	MZ/USP
Trichapus Friedenreich, 1881				
	Trichapus glaber Fried., 1881		Brazil	
	Trichapus pubescens Fried., 1881**		Brazil	MZ/USP
Xylographus Mellié, 1847				
	Xylographus brasiliensis Pic, 1940		Brazil	MZ/USP
	Xylographus contractus Mellié, 1848		Brazil	MZ/USP, LAC
	Xylographus rufipes Pic, 1930		Argentina, Brazil	MZ/USP

Cis Latreille

This genus has many described Brazilian species, but an undescribed species is being found (Fig. 2B). This group includes several species which are problematic in the taxonomical level, as far as the type series are small, many types are lost, some species were characterized based on females specimens or small-horned males, and the identification is sometimes almost impossible with the characteristics provided in the descriptions. This genus urges a revision, but due to the number of included species (more than 300) and its worldwide geographical distribution, it is surely a hard work.

Ennearthron Mellié

There are only two American species of this genus, *Enn. spenceri* (Hatch) (Canada) and *Enn. aurisquamosum* Lawrence (United States), both known by few specimens. It was believed that the New World representants of this genus were exclusively Nearctic, but recently a new species of *Ennearthron* (Fig. 3A) was collected in two Brazilian localities (Piracicaba, São Paulo State; and Viçosa, Minas Gerais State). This species is probably well distributed in Southeast Brazil, as these localities are very far from each other.

Falsocis Pic

This genus comprises just the nomynotypic species *Falsocis opacus* Pic (Guyane), and the subspecies *Falc. opacus flavus* Pic (Guyana). Recently, a new species of *Falsocis* (Fig. 3B) was found in Viçosa, Minas Gerais State.

Porculus Lawrence

This genus seems to be well-defined. It resembles some *Ceracis*, but lacks the spines at the apex of protibia, which bears a conspicuous external stout tooth. Although it is distributed throughout the Neotropical Region represented by five species (Lawrence, 1987), it was not found in recent collections on Brazil.

Trichapus Friedenreich

This is a problematic genus: the types are lost, there are no specimens identified by comparison and the characters provided in the description resemble that of some *Porculus* and *Ceracis*. *Trichapus pubescens* Friedenreich was designated as the type species of the genus by Lawrence (1987). There is one ciid in MZ/USP labelled "*Solenopus pubescens* i.l., Brasilien" from Friedenreich collection. It may be the holotype, but unfortunately it is not in good condition and there is no available information on this specimen.

Xylographus Mellié

This is a widespread genus easily found in any field collection on Brazil. Three species were already reported, but there are some doubtful identified specimens that may belong to new species. The New World *Xylographus* are restricted to the neotropics, and is phylogenetically related to *Octotemnus* Mellié and *Rhopalodontus* Mellié. One species, *Xyl. porcus* Gorham, was already recorded from Mexico (Navarrete-Heredia and Burgos-Solorio 2000), showing that species of this genus are well-distributed in the neotropics.

New perspectives in the study of Ciidae

Ciidae is a poorly studied group, and there are no data on many aspects of its biology. The greater part of the data concern the host preference, but there are available information mainly

for the Nearctic species. Some species seems to be monophagous (Lawrence 1973 and 1974a), but more researches are need to evaluate whether or not it is an artifact of low collection efforts.

Sometimes ciids present a gregarious behavior (Lawrence 1974a), and it may be related to secretion of aggregation pheromone. Field studies made by Jonsson *et al.* (1997) pointed out that the beetle *Dorcatoma robusta* Strand (Anobiidae), which is also a polypore feeder, uses long-range sex pheromone during the host colonization.

Internal morphology information was already provided for *Hadraule blaisdelli* (Casey). This species shows a meroistic telotrophic ovariole, which is a pattern for polyphagan beetles, and each ovariole presented three follicles (Klopfestein and Graves 1992). Karyotype information was provided by Lawrence (1967a), who mentioned the diploid number (2n=14 chromosomes) for the parthenogenetic species *Cis fuscipes* Mellié, however no details on the sex determination system and chromosome morphology of *C. fuscipes* were provided. Smith and Virkki (1978) also mentioned *Sulcacis lengi* Dury, with 2n = 20 (18 + Xyp), and *Octotemnus laevis* Casey, with 2n = 22 (20 + Xyp).

Studies on many biological aspects of the Brazilian Ciidae are being conducted, mainly concerning their etology and morphology. New species belonging to the genera *Cis*, *Ennearthron*, *Falsocis* and *Xylographus* are underdescription. However, a taxonomic revision of some groups and an approach to the phylogeny of the family are necessary for the continuity of these studies.

ACKNOWLEDGEMETS

I am in debt to the following individuals and institutions for providing space and conditions for the continuity of this work: Dr. José Henrique Schoereder (DBG/UFV) for providing space, equipment and material, and for the revision of the manuscript; Dr. Adilson Ariza Zacaro (DBG/UFV) and Fabiano Gumier Costa (DBA/UFV), who collaborated in many parts of this work; Dr. Cleide Costa (MZ/USP) and Dr. Miguel Moné (MNRJ/UFRJ) for the permission to consult the Coleoptera collections of Museu de Zoologia da USP, and Museu Nacional do Rio de Janeiro, respectively; and Dr. Elliot W. Kitajima for the permission to use the electron microscopes of NAP/MEPA (ESALQ/USP). I am specially grateful to Dr. John F. Lawrence and M.C. José Luis Navarrete-Heredia for helping in the identification of the species and for the revision of the manuscript, and for Dr. Carlos F. Sperber for helping with the digital photographs. The digital camera used (NIKON COOLPIX 995) was made available by the Entomology Graduation Program, DBA/UFV.

LITERATURE CITED

Blackwelder, R.E. 1945. Checklist of the coleopterous insects of Mexico, Central America, the West Indies, and South America. Part 3. *Bulletin of the United States Natural Museum*, 185: 343-550.

Jonsson, M., G. Nordlander and M. Jonsell. 1997. Pheromones affecting flying beetles colonizing the polypores *Fomes fomentarius* and *Fomitopsis pinicola*. *Entomologica Fennica*, 8: 161-165.

Klimaszewski, J. and S.B. Peck. 1987. Succession and phenology of beetle faunas (Coleoptera) in the fungus *Polyporellus squamosus* (Huds.: Fr.) Karst. (Polyporaceae) in Silesia, Poland. *Canadian Journal of Zoology*, 65: 542-550.

Klopfestein, W.G. and R.C. Graves. 1992. Morphology of the digestive and reproductive systems of *Hadraule blaisdelli* (Casey) (Coleoptera: Ciidae). *The Coleopterists Bulletin*, 44: 344-356.

Lawrence, J. F. 1967a. Biology of the parthenogenetic fungus beetle *Cis fuscipes* Mellié (Coleoptera: Ciidae). *Breviora*, 258: 1 - 14

Lawrence, J.F. 1967b. Delimitation of the genus *Ceracis* (Coleoptera) with a revision of North American species. *Bulletin of the Museum of Comparative Zoology*, 142: 419-522.

Lawrence, J.F. 1971. Revision of the North American Ciidae (Coleoptera). *Bulletin of the Museum of Comparative Zoology*, 136: 91-144.

Lawrence, J. F. 1973. Host preference in ciid beetles (Coleoptera: Ciidae) inhabiting the fruiting bodies of Basidiomycetes in North America. *Bulletin of the Museum of Comparative Zoology*, 145, 163-212.

Lawrence, J.F. 1974a. The ciid beetles of California (Coleoptera: Ciidae). *Bulletin of the California Insect Survey*, 17, 1-41.

Lawrence, J.F. 1974b. The larva of *Sphindocis denticollis* Fall and a new subfamily of Ciidae (Coleoptera: Heteromera). *Breviora*. 424: 1 - 14.

Lawrence, J.F. 1982. *A catalog of the Coleoptera of America North of Mexico. Family Ciidae*. USDA, Agricultural Handbook No. 529 - 105: 18 pp.

Lawrence, J.F. 1987. A new genus of Ciidae (Coleoptera: Tenebrionoidea) from the Neotropical Region. *Revista Brasileira de Entomologia*, 31: 41-47.

Lawrence, J.F., A.M. Hastings, M.J. Dallwitz, T.A. Paine and E.J. Zurcher. 1999. Beetles of the World: a Key and Information System for Families and Subfamilies. CD-ROM, Version 1.0 for MS-Windows. C.S.I.R.O. Publishing, Callingwood, Victoria, Australia.

Mellié, J. 1848. Monographie de l'ancien genre *Cis* des auteurs. *Annales de la Societe Entomologique de France*, 6: 205-274, 313-396.

Navarrete-Heredia, J. L. 1991. Nuevos registros de algunas especies de Ciidos (Insecta: Coleoptera) de Veracruz y el Estado de México con notas sobre sus hospederos y fauna acompañante. *Revista de la Sociedad Mexicana de Historia Natural*, 41: 53-56.

Navarrete-Heredia, J. L. and A. Burgos-Solorio. 2000. 21. Ciidae (Coleoptera). (pp. 413-420). *In*: Llorente-Bousquets, J.E., E.González-Soriano and N. Papavero. *Biodiversidad, Taxonomía y Biogeografía de Artrópodos de México: Hacia una Síntesis de su Conocimiento. Volumen II*. Conabio, Fac. de Ciencias, México.

Rukke, B.A. 2000. Effects of habitat fragmentation: increased isolation and reduced habitat size reduces the incidence of dead wood fungi beetles in a fragmented landscape. *Ecography*, 23: 492-502.

Scheerpeltz, O. and K. Höfler. 1948. Käfer und Pilze. Verlag fur Jugend und Volk, Vienna, 351pp.

Smith, S.G. and D. Virkki. 1978. Coleoptera. *In*: John, B. (ed.). *Animal Cytogenetics 3. Insecta 1*. Gebürder Borntraeger, Berlin-Stuttgart.

Thunes, K.H., F. Midtgaard and I. Gjerde. 2000. Diversity of coleoptera of the bracket fungus *Fomitopsis pinicola* in a Norwegian spruce forest. *Biodiversity and Conservation*, 9: 833-852.

Recibido: 22 de febrero del 2002
Aceptado: 25 de abril del 2002

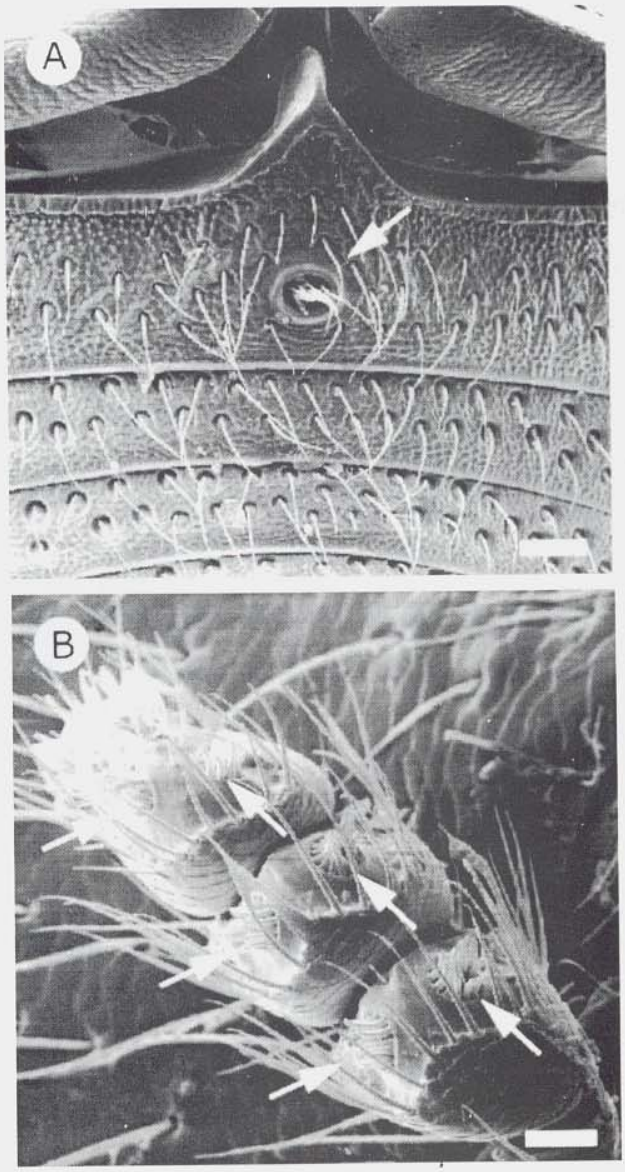

Figure 1. **A.** Urosternites of a male *Cis taurus* (Reitter), showing the abdominal fovea (arrow) of the first urosternite. **B.** Antenna of *Xylographus contractus* Mellié, showing the sensillifers (arrows) of the antennal club. Scale bars: 100m (A), 20m (B).

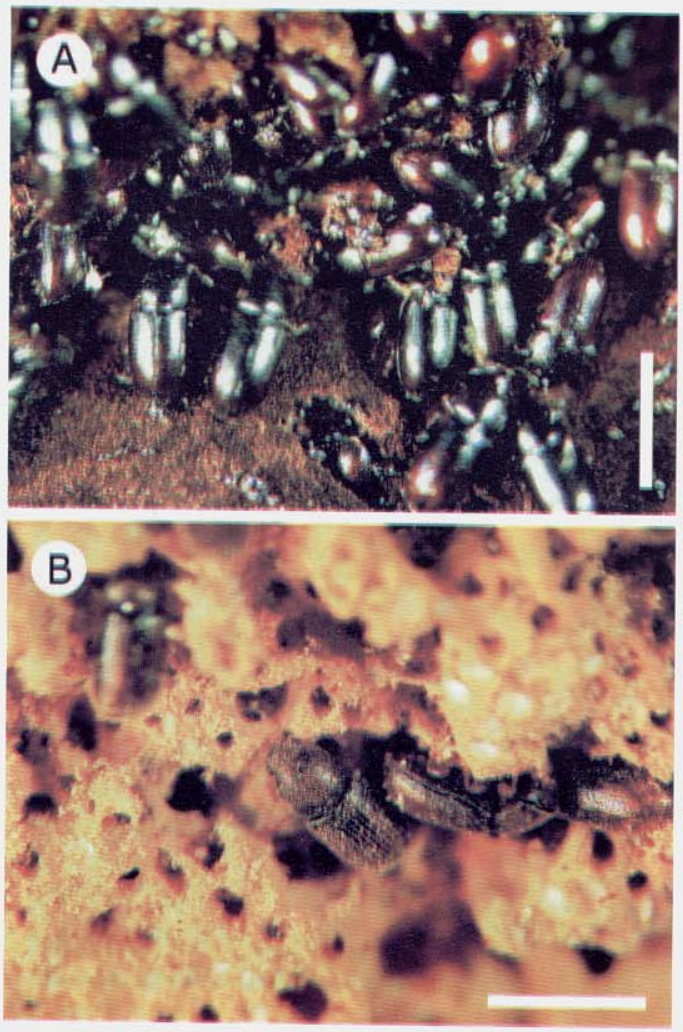

Figure 2. Two ciids populations from Southeast Brazil. A. *Ceracis* cf. *variabilis* Mellié. B. *Cis* sp., an undescribed species from Minas Gerais State. Scale bars: approximately 1.5mm.

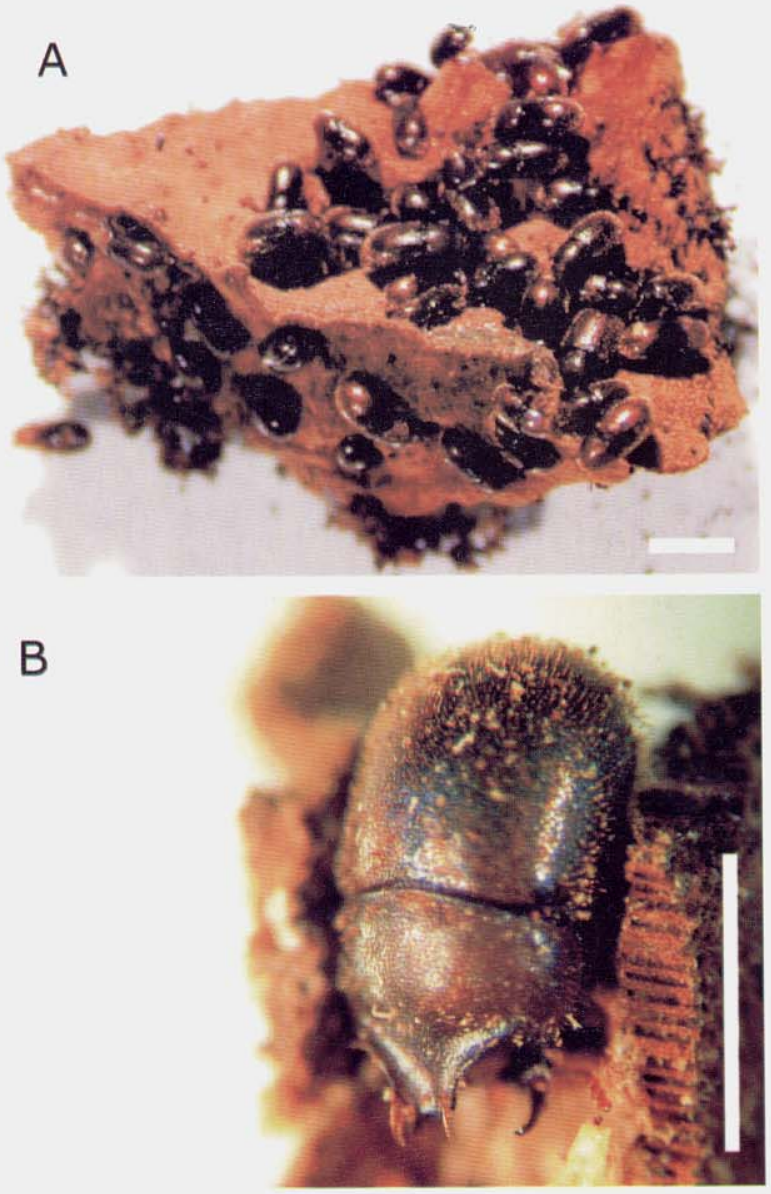

Figure 3. Two undescribed species of ciids from Southeastern Brazil, belonging to genera not previously recorded from Brazil. A. *Ennearthon* sp. B. male *Falsocis* sp. Scale bars: approximately 1.5mm.