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A new species of *Pharaxonotha* Reitter (Coleoptera: Erotylidae) from central South America

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Abstract

Pharaxonotha cerradensis, **new species** (Coleoptera: Erotylidae), is described from Bolivia and Brazil. It belongs in a complex of species from Mexico and Central America that radiated on host cycads of the genus *Zamia* L. (Cycadales: Zamiaceae) and is associated with *Zamia boliviana* (Brongniart) A. DC. (Cycadales: Zamiaceae). *Pharaxonotha cerradensis* is compared with other species of *Pharaxonotha* Reitter.

Key words: Neotropical, Cerrado, Cucujoidea, Pharaxonothinae, host plants

Resumo

Pharaxonotha cerradensis, **nova espécie** (Coleoptera: Erotylidae), da Bolívia e do Brasil é descrita. Pertence a um complexo de espécies do México e da América Central que se irradiaram em cycads hospedeiras do gênero *Zamia* L. (Cycadales: Zamiaceae) e está associado a *Zamia boliviana* (Brongniart) A. DC. (Cycadales: Zamiaceae). *Pharaxonotha cerradensis* é comparada com outras espécies de *Pharaxonotha* Reitter.

Palavras-chave: Neotropical, Cerrado, Cucujoidea, Pharaxonothinae, plantas hospedeiras

Introduction

Much recent taxonomic work has been conducted on cycad pollinating beetles (e.g., O'Brien & Tang 2015; Skelley *et al*. 2017; Tang *et al*. 2018b), and there are scattered works describing species from the New World (Pakaluk 1988; Chaves & Genaro 2005; Franz & Skelley 2008; Tang *et al*. 2018a), all from Mexico, Central America and/or the Caribbean.

Current work on the natural history of *Zamia boliviana* (Brongniart) A. DC. (Cycadales: Zamiaceae) in Bolivia and Brazil resulted in the discovery of a new species of *Pharaxonotha* Reitter (Coleoptera: Erotylidae). The purpose of this paper is to describe this new species to make the name available for ongoing research.

Materials and methods

Only label data for the Brazilian holotype are given verbatim. For paratypes, when a locality is the same but presented differently on labels, the data are abbreviated as "same locality" referring to the initial full label data. Date and latitude/longitude data have been standardized for presentation. Morphological terminology follows Lawrence *et al*. (2010). Measurements were taken with an ocular micrometer on a Leica MS5 Stereomicroscope.

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Photographs of beetle specimens were taken with a Syncroscopy Automontage system and arranged into plates using PaintShop Pro 7.

Materials studied are deposited in:

BMNH	The Natural History Museum, London, United Kingdom
CEMT	Setor de Entomologia da Coleção Zoológica da Universidade Federal de Mato Grosso, Cuiaba, Brazil
CMNC	Canadian Museum of Nature, Ottawa, Canada
DZUP	Museu de Entomologia Pe. Jesus Santiago Moure, Universidade Federal do Paraná, Curitiba, Paraná, Brazil
FSCA	Florida State Collection of Arthropods, Gainesville, Florida, USA
MNKM	Museo de Historia Natural Noel Kempff Mercado, Santa Cruz, Bolivia
UFMI	Instituto de Biociências, Universidade Federal de Mato Grosso, Cuiabá, Mato Grosso, Brazil
USNM	National Museum of Natural History, Smithsonian Institution, Washington D.C., USA

Pharaxonotha cerradensis Skelley and Segalla, new species

Figures 1–10, 12

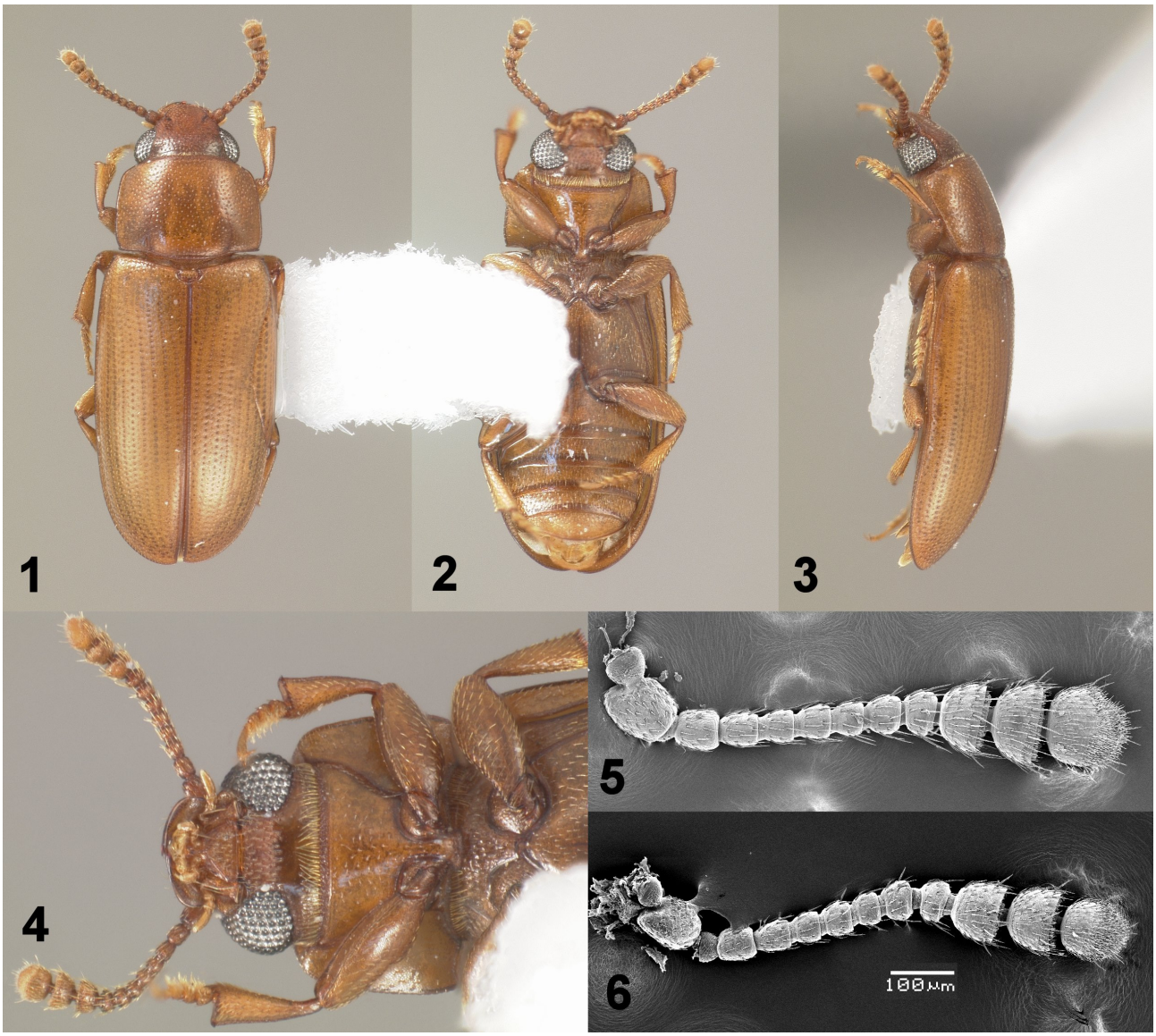
Diagnosis. *Pharaxonotha cerradensis* can be distinguished from other members of the genus by the pronotal anterior angles being rounded, antennomeres VII and VIII each with width = length, pronotal and elytral setae short and not reaching next puncture, protibia narrowly triangular with a distinct apical lateral tooth, and pronotal disc with distinct sulcus at base on each side. *Pharaxonotha cerradensis* is readily distinguished from all other species of *Pharaxonotha* by its enlarged antennomere XI, 1.6× longer than antennomere X. In addition, this is the only member of the genus known to occur in central South America on the host cycad *Zamia boliviana*.

Description. Length 2.60–3.44 mm, width 0.93–1.28 mm (n = 20). Body in dorsal view elongate-oval (Figs. 1–2), greatest width at middle of elytra; in lateral view convex dorsally (Fig. 3). General body color entirely orange brown; dorsal surface punctate, shining and appearing glabrous, short procumbent hairs associated with punctation on pronotum and elytra, ventrally shining and appearing glabrous except mesoventrite and abdomen mostly covered with short procumbent setae.

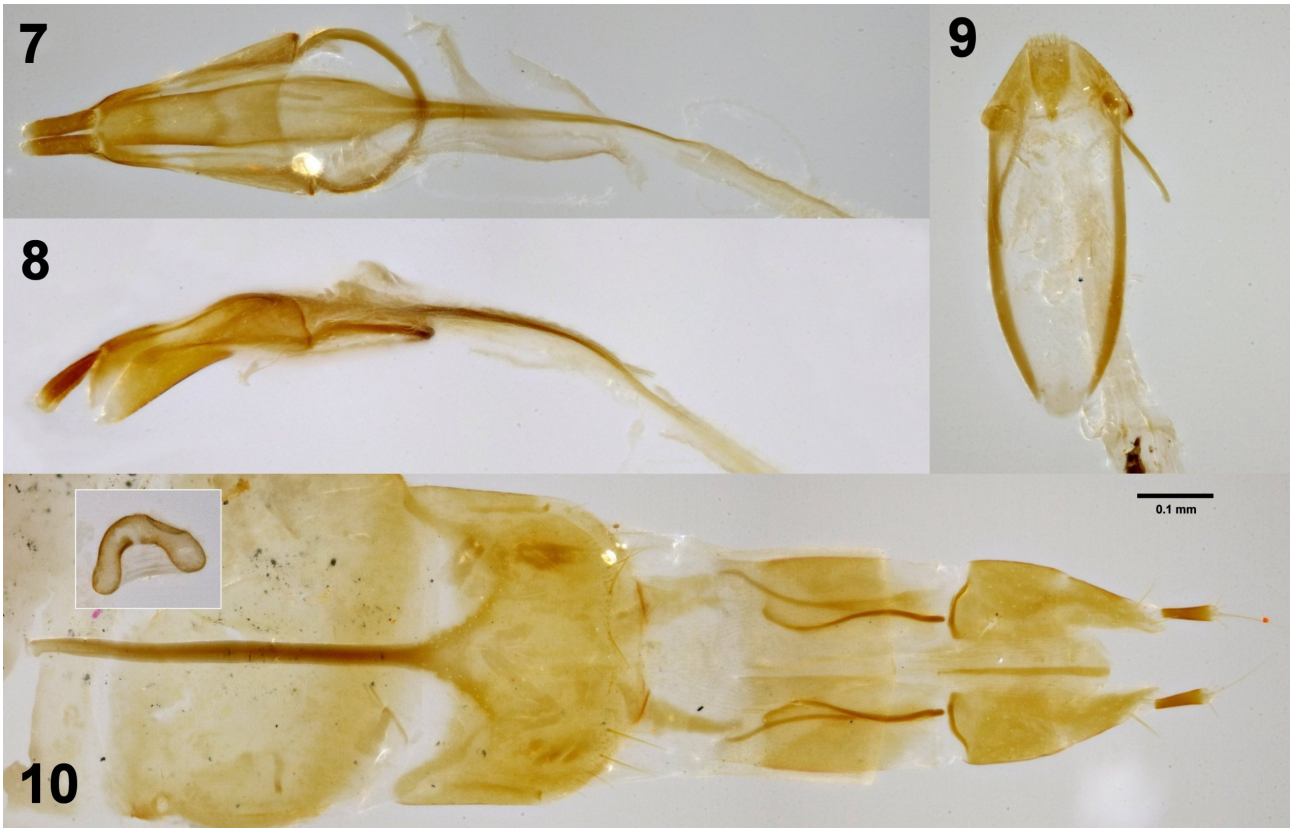
Head not broad, width = 0.67–0.74× pronotal width; in dorsal view conical, gradually narrowed anteriorly, surface flat to slightly convex, finely, moderately punctured, average distance between closest punctures 2–3× width of puncture; head width 0.56–0.67 mm; dorsal interocular distance 0.37–0.40 mm, head width/dorsal interocular distance ratio 1.51–1.68, ventral interocular distance 0.23–0.30 mm, head width/ventral interocular distance ratio 2.23–2.43. Eye with large black facets, about 3× diameter of head punctures. Antennal length slightly shorter than pronotal width, 1.5× head width; antennomere I (scape) fairly large, slightly elongate; antennomere II slightly shorter than III; IV–VIII small, width equals length; club fairly large, IX and X similar in length; XI enlarged, 1.6× longer than X, globular with rounded apex (Fig. 5). Clypeus weakly concave anteriorly, moderately punctate. Mentum (Fig. 4) finely punctate, submentum more coarsely punctured, 2–3× diameter of those on mentum, distance between nearest punctures approximately 1× own diameter, each puncture with a short seta. Gular area smooth, without punctation or setae, border with submentum marked by change in punctuation and with a shallow transverse depression.

Thorax with pronotum transversely quadrate in dorsal view, length/width ratio 0.72–0.74; with distinct marginal beads laterally and basally, anteriorly with fine marginal bead medially; convex; anterior angles broadly rounded, not projecting forward; posterior angles weakly developed, with small denticle at angle; in dorsal view lateral carina parallel-sided or evenly shallowly arcuate for entire length, carina in lateral view of similar narrow thickness for entire length; posterior margin slightly projecting medially, projection beginning approximately by pair of small, dark pores in margin located ¼ width from posterior angles, each pore marks base of a distinct sulcus extending anteriorly onto disc ¼ length of pronotum. Prosternum in ventral view convex, with few scattered punctures; anterior margin slightly emarginate, finely denticulate with row of long, anteriorly directed setae, longest setae approximately 1/3 length of eye; prosternal process expanded apically, truncate and convex at apex. Hypomeron laterally with few minute punctures, medially lacking distinct longitudinal striations. Scutellar shield

distinctly transverse, posterior margin weakly roundly pentagonal. Elytra in dorsal view elongate-oval, convex; length/width ratio1.64–1.77, greatest width near midlength; with distinct marginal line basally; 10 complete striae of moderate puncture size; scutellary striole extending ¼ elytral length, with 10–15 punctures; punctures of elytral striae as large as pronotal punctures, weakly impressed; intervals of striae with fine, shallow punctures, 1.2× size of strial punctures; all punctures of elytra bearing a single short seta; seta only visible in profile, extending slightly out of puncture. Mesoventrite with strong punctation, distance between nearest punctures approximately equal to diameter of punctures, puncture depth moderate. Metaventrite glossy, with strong lateral punctation separated by 2–3× own diameter; medial surface finely punctured, separated by 5–6× own diameter; entire surface convex, metathoracic discrimen extending approximately 3/4 metaventrite length. Legs narrow, relatively similar in length and shape. Procoxa oval; mesocoxa globular; metacoxa transversely elongate-oval; trochanters obliquely truncate apically; femora robust, moderately compressed laterally; tibiae shorter than femora, gradually dilated to obliquely truncate apices; protibia with apical lateral tooth distinct, with apical fringe of short spinules of concave ventral apical margin usually lacking near lateral tooth; meso- and metatibia with apical fringe of short spinules on anterior margin, finer setae on posterior margins.



FIGURES 1–6. *Pharaxonotha cerradensis* **new species**, paratype [BOLIVIA: Santa Cruz, Portrerillos del Guenda, 40 km. NW Santa Cruz de la Sierra, 17°40.26'S, 63°27.44'W]: 1) dorsal habitus; 2) ventral habitus; 3) lateral habitus; 4) head and prothorax, ventral view. Antenna: 5) *P. cerradensis*; 6) *Pharaxonotha* sp. (nr. *P. confusa* Pakaluk) [Costa Rica: Osa Peninsula, ex *Zamia fairchildiana*]. Figures 5–6 to same scale.



FIGURES 7–10. *Pharaxonotha cerradensis* **new species**, genitalia, paratypes [BOLIVIA: Santa Cruz, Portrerillos del Guenda, 40 km. NW Santa Cruz de la Sierra, 17°40.26'S -063°27.44'W]. 7–8) Male tegmen and penis, dorsal and lateral view. 9) Male spiculum gastrale. 10) Female genitalia, inset spermatheca. All images to the same scale.

Abdomen. Ventrite I with intercoxal process narrow, with triangular point anteromedially; lateral edges slightly projected, lateral and posterior margins arcuate, converging posteriorly; anterior and posterior margins of ventrites more or less straight; ventrite I longer medially than II; II–IV subequal in length; V slightly longer than IV with lateral margins converging posteriorly to a rounded apex; apical margin bearing short, sparse setae; all ventrites bearing moderate, shallow punctation across surface, distance to nearest puncture approximately 2× diameter of puncture, punctures bearing mostly reclining setae; ventrite V with setae length nearly uniformly approximately 2× diameter of puncture; I–IV each with 2 or more median pairs of longer, semi-erect sensory hairs (difficult to see in poor lighting, often abraded). Male genitalia similar to all others in the genus (Figs. 7–9), with dorsoventrally flattened tegmen, elongate cylindrical median lobe, and long coiled flagellum.

Female. Similar to male, no sexual dimorphism observed. Genitalia elongate (Fig. 10); gonostylus set apically on gonocoxite, gonostylus length = 4–5× width. Spermatheca C-shaped.

Type locality. BRASIL: Mato Grosso, Chapada dos Guimarães, Bela Vista, 15°13'02"S, 55°20'15"W, 420m.

Range. Known from Santa Cruz Department, Bolivia, and the neighboring state of Mato Grosso, Brazil, on male strobili of the cycad *Zamia boliviana*.

Material examined. Holotype (by designation) male of *Pharaxonotha cerradensis* with the following labels: 1) [rectangular; white; printed in black ink] "BRASIL: Mato Grosso, Chapada dos Guimarães, Bela Vista, 15°13'2"S, 55°20'15"W, 420m, on *Zamia boliviana*, 14.x.2017, R. Segalla". 2) [rectangular; red; printed in black ink] "HOLOTYPE ♂ *Pharaxonotha cerradensis* Skelley and Segalla 2018". Deposited in the CEMT.

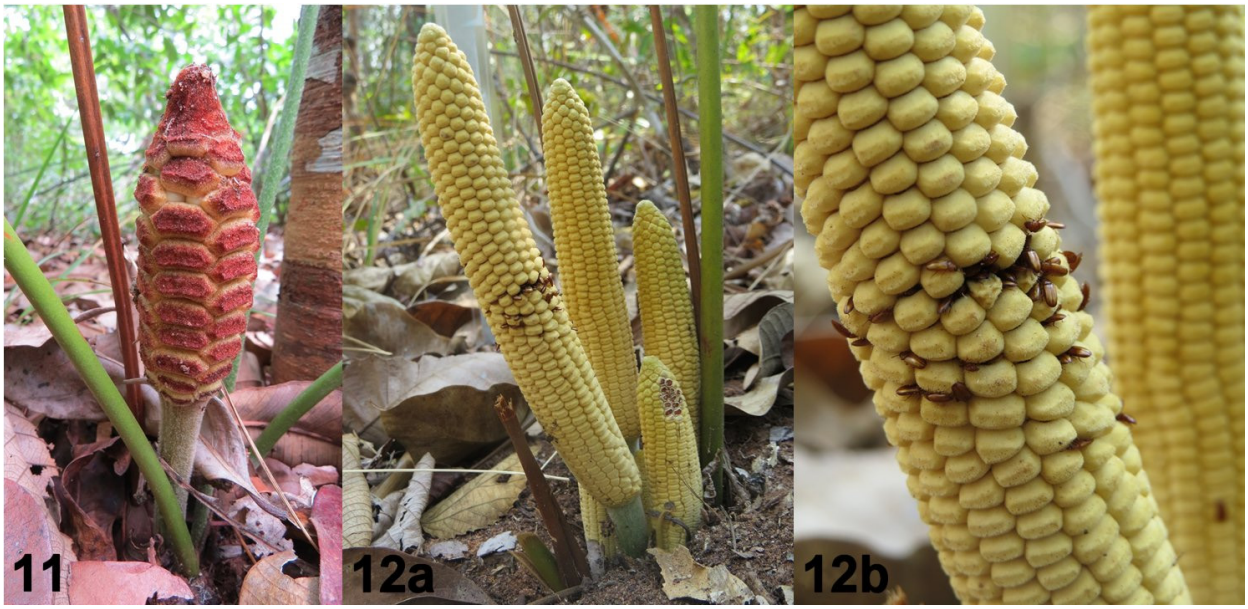
Allotype and adult paratypes (n = 586): **BOLIVIA: Santa Cruz**, Buena Vista, 410m, 29-X-1999, C. Porter, L. Stange, disturbed tropical forest, at light (1-FSCA); Potrerillos de Guenda, 17°40.82'S, 63°27.60'W, 4–7-IV-1998, H. & A. Howden (48-CMNC); Portrerillos del Guenda, 40 km. NW Santa Cruz de la Sierra, 17°40.26'S, 63°27.44'W, 5–20-XI-2004, B. K. Dozier (46-FSCA, 8-BMNH, 8-CMET, 20-MNKM, 8-USNM); same locality, 17°40.30'S, 63°27.40'W, 22-XI–12-XII-2005, B. K. Dozier (6-FSCA); same locality, 9–28-XI-2006, B. K. Dozier (1-FSCA); same locality, 10–29-XI-2006, B. K. Dozier, blacklight (2-FSCA); same locality, 7–9-IX-2012, P. Skelley, male *Zamia* cone (14-FSCA); same locality, 22–24-IX-2012, P. Skelley, 12w. UV light trap (5-FSCA);

same locality, 22–24-SEPT-2012, P. Skelley, J. Wappes, MV+UV light (1-FSCA). **BRAZIL: Mato Grosso**: same data as holotype, 15°13.03'S, 55°20.25'W (allotype ♀ and 168-CEMT, 115-FSCA); Bela Vista, Chapada dos Guimarães, 15°13.04'S, 55°20.25'W, 6-IX-2018, Elev.: 422 m; R. Segalla, male cone *Zamia boliviana* (10-CEMT); same data except 8-IX-2018; R. Segalla, P. Skelley, male cone *Zamia boliviana* (31-FSCA); Cáceres (Serra Mangaval, Rodovia BR 070), 16°14.89'S, 57°29.73'W, 411m high, 11-VIII-2017, R. Segalla, Host: Palma-zamia, *Zamia boliviana* (Zamiaceae), *Pharaxonotha* sp., GHRosado-Neto det. 2017, 0133/2017-RN (DZUP 458708-458723: 16-UFMI; DZUP 458724-458727: 4-FSCA); Gloria do Oeste, 15°52.35'S, 58°08.13'W, 07-XII-2016, R. Segalla, Host: Palma-zamia, *Zamia boliviana* (Zamiaceae), *Pharaxonotha* sp., GHRosado-Neto det. 2017, 0133/2017-RN (DZUP 458688-458703: 16-UFMI; DZUP 458704-458707: 4-FSCA); Poconé, 15°57.53'S, 57°02.55'W, 7-XII-2016, R. Segalla, male cone *Zamia boliviana* (44-FSCA).

Etymology. The host cycad of this beetle occurs in the biome known as the Cerrado in Brazil and Savanna in Bolivia. The species epithet *cerrad-ensis* means "of the Cerrado".

Remarks. In a phylogenetic analysis using the 16S rRNA gene, Tang *et al*. (2018b; D0053 from Bolivia) found that *Pharaxonotha cerradensis* belongs in the "recent radiation" clade of *Pharaxonotha* which includes *P. clarkorum* Pakaluk, *P. confusa* Pakaluk, and several undescribed species that occur from Mexico to Colombia. Within this group, *P. cerradensis* is the most geographically isolated and is easily identifiable by its enlarged terminal antennomere XI (compare Fig. 5 vs. Fig. 6).

Cycads are dioecious and produce morphologically distinct reproductive strobili (Figs. 11–12) (Jones 1993; Whitelock 2002). *Pharaxonotha cerradensis* was frequently found *in situ* colonizing male strobili (Fig. 12a–b) of *Z. boliviana* in surveys conducted in 2016, 2017 and 2018, except in small and isolated refuges of the Cáceres subpantanal (Segalla *et al*., in prep.). These recurring observations in successive reproductive periods of the cycad suggest the existence of an ecological interaction, probably mutualistic. The association of *Z. incognita* with *Pharaxonotha* sp. and other insects was shown by Valencia-Montoya *et al*. (2017). These authors argue that the maintenance of cycads also implies the maintenance of a surprising web of insect-plant interactions, with consequences for the conservation of species. The association between *P. cerradensis* and *Z. boliviana* as well as the ecology, distribution, and conservation status of *Z. boliviana* along with various insect-plant interactions are currently under study by Segalla *et al*. (in prep.).



FIGURES 11–12. *Zamia boliviana* plants. 11) Female plant with seeds in development. 12) Male plant, a) fresh strobili, b) same, close-up showing *P. cerradensis* **new species** on host.

The lack of knowledge on the biology and ecology of *Z. boliviana* and *P. cerradensis* impair predictions about the behavior and persistence of these species in response to anthropic effects. The specializations found in species of Zamiaceae demonstrate that their interactions are under the same regime and causes of threats, thus presenting conservation status and demands for similar studies (Lopez-Gallego 2015; Valencia-Montoya *et al*. 2017). The Savanna (Cerrado) Biome is one of four biomes that supports higher endemism and greater beta-diversity levels

than those found in other biomes (Dinerstein *et al*. 2017) and is among those currently most threatened. In Brazil, only 8.3% of this biome is legally protected (Françoso *et al*. 2015).

Within the Savanna (Cerrado) Biome, the geographical distribution of *Z. boliviana* is limited, with the cycad known to occur in Bolivia (Beni, Cochabamba, La Paz and Santa Cruz) and in the state of Mato Grosso of Brazil (Stevenson 2004; Jørgensen *et al*. 2014; GBIF 2018; Tropicos 2018; SpeciesLink 2018). The main habitats where *Z. boliviana* occur include Cerrado *sensu stricto* (Figs. 13–14), mosaic of Cerrado with rocky outcrops, disturbed fields, semideciduous forest and gallery forests in Bolivia and Brazil (Segalla *et al*., in prep.). Most *Z. boliviana* populations are located in habitats affected by land use both in Bolivia and Brazil (Figs. 15–16). In Bolivia, cycad populations occur in both protected parks and private properties (GBIF 2018). In Brazil, records indicate they only occur in private areas, mainly in natural fragments of the Cerrado Biome (GBIF 2018; Segalla *et al*., in prep.).

The fact that most populations of *Z. boliviana* and *P. cerradensis* are outside of protected areas is a cause for concern. Habitat alterations, motivated by recurrent and continuous anthropic interference (Figs. 15–16), has negative effects on species of Zamiaceae (Lopez-Gallego & Idárraga 2001; Lopez-Gallego 2015; Mankga & Yessoufou 2017). It is suggested that similar alterations of habitats in Bolivia and Brazil accelerates the population decline of *Z. boliviana* (Whitelock 2002) which will have implications extending to *P. cerradensis*.

FIGURES 13–16 *Zamia boliviana* in its natural habitat. 13) In Cerrado *sensu stricto* with fire history. 14) On outcrops rocky in Cerrado *sensu stricto*. 15–16) In fragments with anthropic interference.

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