A new species of burrowing snake (Serpentes: Dipsadidae: *Apostolepis*) from the state of Mato Grosso, Central-West region of Brazil

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ABSTRACT. During a faunal rescue conducted at a hydroelectric power station constructed in a Cerrado savanna area in the state of Mato Grosso, a sample of five small stripe-patterned individuals of snakes of the genus *Apostolepis* Cope, 1862 document the existence of an undescribed species, which is named herein. The new species can be distinguished from its congeners by a combination of scale counts, number of maxillary teeth and color pattern. The new species is most similar to *Apostolepis borellii* Peracca, 1904, *A. lineata* Cope, 1887, *A. nelsonjorgei* Lema & Renner, 2004, *A. nigroterminata* Boulenger, 1896, *A. serrana* Lema & Renner, 2006 and *A. underwoodi* Lema & Campbell, 2017 in its coloration pattern. However, it is distinguished from these species by having a pair of triangular blotches covering portions of the third to sixth supralabials, a white nuchal collar, the shape of the fourth supralabial and the shape of the tip of tail, the number of supralabials in contact with parietals, the size of the anterior chinshields, the color pattern of the paraventral side, parietal and terminal scales, the width of dorsal stripes, and a distinct number of subcaudals. The new species occurs in areas within the Cerrado biome.

KEY WORDS. Biodiversity, Cerrado, Chapada dos Guimarães, Elapomorphini, taxonomy.

INTRODUCTION

The taxonomic history of the South American Dipsadinae genus *Apostolepis* Cope, 1862 has been rather confusing, and researchers have long recognized the lack of a comprehensive review of taxonomy and phylogenetic relationships in this genus (Ferrarezzi et al. 2005, Nogueira et al. 2012). The genus presently comprises 38 species (Curcio et al. 2011, Lema 2016, Cabral et al. 2017, Lema et al. 2017 and Uetz et al. 2018) distributed in five groups – *dimidiata*, *dorbignyi*, *flavatorquata*, *longicaudata* and *nigroterminata* (Nogueira et al. 2012). Additional groups were referred to by Lema (2003a), Martins and Lema (2015) and Lema and Renner (2016) – including *ambinigra*, *assimilis*, *lineata*, *nigrolinigra*, *phillpsi*, *polypleis*, *quinquelineata* and a *borellii* group, which presently includes only *A. borellii* Peracca, 1904 and *A. underwoodi* Lema & Campbell, 2017. However, with the exception of the *ambinigra* (Lema and Martins 2016), *assimilis* (Ferrarezzi et al. 2005) and *dimidiata* groups (Nogueira et al. 2012), the remaining groups have not yet been formally described and we refrain from considering them.

*Apostolepis* is particularly speciose in Brazil, where 32 species have already been recorded (Costa and Bérnils 2018). Contributions to the taxonomy of these burrowing snakes in Central-West region of Brazil were initially made by Cope (1887),
who described two species – Apostolepis lineata and A. vittata – from the municipality of Chapada dos Guimarães, state of Mato Grosso. Subsequently, Koslowsky (1898) described A. intermedia from Miranda, state of Mato Grosso do Sul. A few years later, Peracca (1904) described A. borelli based on a specimen from Urumum massif, near Corumbá, Mato Grosso do Sul; Amaral (1925) described A. rondoni based on a specimen from “Matto Grosso” (=the former name of a huge region which presently comprises three Brazilian states: Mato Grosso do Sul, Mato Grosso, and Rondônia), and Prado (1942) described A. goiaisensis based on a specimen from Rio Verde, Goiás. More recently, Lema (2002a,b, 2003a), and Ferrarezzi et al. (2005), respectively, described A. abicolarius from Brasília, Distrito Federal, A. christinae from Barra do Bugres, presently Porto Estrela, Mato Grosso, A. cerradoensis from Minacu, Goiás, and A. ammodites from Palmas, Tocantins, whereas Lema and Renner (2006) and Lema (2016) described two new species from Serra do Roncador, Mato Grosso, A. serrana and A. roncadori, respectively. Additionally, Martins and Lema (2015) and Lema and Renner (2016) removed A. borelli from the synonymy of A. nigrotenuicinctata. During a faunal rescue conducted at a hydroelectric power station constructed in a Cerrado savanna area in the state of Mato Grosso, a sample of five small stripe-patterned individuals of snakes of the genus Apostolepis document the existence of an undescribed species, which is named herein.

**MATERIAL AND METHODS**


All measurements were made to the nearest 0.1 mm using digital calipers, except for snout-vent (SVL) and tail (TL) lengths, which were taken with a flexible ruler to the nearest 1.0 mm. Ventral scales were counted according to Dowling (1951). Bilateral variation is reported as right/left. When no everted hemipenis was available, the sex of each specimen was determined by making a post-cloacal incision between the eighth and tenth subcaudals to verify the presence of the hemipenes. The hemipenal description is based on right organs from two preserved specimens (UFMT-R 1933 and MCP 14524), which were prepared according to the method described in Pesantes (1994) and Zaher and Prudente (2003). UFMT-R 1933 was not expanded or inflated since it was irreversibly damaged during filling of the hemipenal body. On the other hand, MCP 14524 was fully inflated with red petroleum jelly. Terminology for hemipenal morphology followed Dowling and Savage (1960) and Zaher (1999). The distribution map was made using the free Quantum GIS software. We use the names A. quinquelineata and A. nigrotenuicinctata in the sense of Lema (1997) and Lema and Renner (1998), respectively (but see Curcio et al. 2011).

**TAXONOMY**

**Apostolepis kikoi sp. nov.**

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Figs 1–3, Table 1

**Apostolepis sp. – Strüssmann 2000: 163. [Cresonymy]**

**Apostolepis sp. 1 – Martins and Lema 2015: 102; Lema and Renner 2016: 71. [Cresonymy]**

**Apostolepis sp. 3 – Martins and Lema 2015: 102 (partim). [Cresonymy]**

**Apostolepis aff. borelli – Lema and Campbell 2017: 28 (partim). [Cresonymy]**

Holotype. A female (MCP 12096) collected in 2000 at the Manso multi-use reservoir and hydroelectric power plant – locally known as APM Manso – constructed at the confluence of the rivers Manso and Casca, Chapada dos Guimarães (15°27′39″S, 55°45′00″W; 811 m.a.s.l.), Mato Grosso, Brazil, by the faunal rescue team. Paratypes. three males and one female, same locality as the holotype: MCP 14524 (male), MCP 14525 (male) and MCP 11372 (female), date of collection unknown, collected by the faunal rescue team, and UFMT-R 1933 (male) collected on 1 December 1999 by the faunal rescue team.

Diagnosis and comparison with other species. Apostolepis kikoi sp. nov. can be distinguished from all other Apostolepis by the combination of having five dorsal stripes (vs. dorsal stripes absent in A. ambiniger, A. ammodites, A. assimilis, A. breviceps, A. cearensis, A. dorbignyi, A. flavotorquata, A. multicincta, A. roncadori and A. tertulianobeui; the presence of seven stripes on the dorsum in A. gaboi and A. niceforoi; three stripes on the dorsum in A. cerradoensis, A. goiaisensis, A. nigrotenuicinctata, A. quirogai and A. tenuis; a pair of narrow lateral stripes in A. barrioi; a pair of wide lateral stripes in A. abicolarius, A. dimidiata and A. polylepis); the presence of a white nuchal collar (vs. white nuchal collar absent in A. ambiniger, A. barrioi, A. breviceps, A. christinae, A. goiaisensis, A. intermedia, A. lineata, A. longicaudata, A. niceforoi, A. nigrotenuicinctata, A. polylepis, A. quinquelineata, A. roncadori, A. serrana, A. striata, A. thalesdelemai and A. vittata); the presence of a triangular blotch covering portions of the third, fourth, fifth and sixth supralabials (vs. a light lateral spot below the eye, usually occupying the third and fourth supralabials in A. mariiae); 15 scale rows at midbody (vs. 17 in A. polylepis); six supralabials (vs. five in A. breviceps, A. christinae, and A. vittata); second and third supralabials entering orbit (vs. only the third supralabial entering orbit in A. breviceps); preocular contacting nasal (vs. nasal and preocular separated by prefrontal in A. ammodites, A. arenaria, A. assimilis, A. breviceps, A. cearensis, A. dorbignyi, A. gaboi, A. goiaisensis, A. intermedia,
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Preserved specimens of Apostolepis kikoi sp. nov. are most similar to A. borelli, A. lineata, A. nelsonjorgei, A. nigroterminata, A. serrana and A. underwoodi in its general pholidosis and coloration pattern. However, the new species is distinguished from A. borelli by having its paravertebral sides cream and unbleached (vs. blackish), a pair of triangular blotches covering portions of the third, fourth, fifth and sixth supralabials (vs. a small, trapezoidal blotch covering only the posterior half of the third and the entire fourth supralabial); tip of the tail conical (vs. rounded) and fewer subcaudals (vs. 26–30 vs. 32). Apostolepis kikoi sp. nov. can be distinguished from A. nigroterminata by having a triangular blotch covering portions of the third, fourth, fifth and sixth supralabials (vs. an irregular blotch on the posterior margin of the third to the anterior margin of the fourth supralabial—see also Harvey 1999: 401, fig. 7 in Lema and Renner 2016, and Figs 4–5 below), a blackish blotch on rostral scale adjacent to anterior border of prefrontals (vs. blotch absent), darker parietals (vs. light blotches irregularly distributed on parietal scales) and a distinct number of maxillary teeth (4 + 2 vs. 3 + 2). Further, it differs from A. nigroterminata in having its background color beige (in living specimens) (vs. background color red-orange); paravertebrals distinct (vs. paravertebrals indistinct); first and fifth stripes wider, covering upper half of third and lower half of fourth row on each side (vs. first and fifth stripes also wider, but covering first and about 50% of fourth row of scales on each side). Apostolepis kikoi sp. nov. can be distinguished from A. underwoodi by having a vertebral stripe one scale wide (vs. vertebral stripe narrow; running on the medial line of each vertebral scale); paravertebrals stripes covering sixth row on each side (vs. paravertebral stripes covering half of fifth and half of sixth rows). Finally, Apostolepis kikoi sp. nov. is distinguished from A. lineata, A. nelsonjorgei and A. serrana by having its fourth supralabial scale rectangular (vs. triangular in A. nelsonjorgei), 4–6 supralabials contacting parietals (vs. 5–6 contacting parietals in A. nelsonjorgei), terminal scale black dorsolaterally (vs. terminal scale entirely white in A. lineata and A. nelsonjorgei), anterior chinshields longer than posterior (vs. anterior and posterior chinshields of about the same size in A. nelsonjorgei), the presence of a white nuchal collar (vs. white nuchal collar absent in A. lineata and A. serrana) and a distinct number of subcaudals (27–30 vs. 40–46 in A. nelsonjorgei and 33 in A. serrana).

Description of holotype (Figs 1–3). A small female, possibly juvenile, SVL 262 mm, TL 26 mm (9.92% of SVL). Body subcylindrical. Tail very short with tip conical and laterally compressed. Terminal scale pointed. Head slightly distinct from neck, narrower than diameter of midbody. Head length from quadrate-articular jaw joint to tip of snout (in lateral view) 6.56 mm (2.5% of SVL), 4 mm at widest point (60.9% of head length). Snout rounded in dorsal and lateral views, slender and slightly projected beyond jaws; snout length from tip of snout to anterior margin of right orbit 2.37 mm (36.12% of head length). Snout length from tip of snout to anterior margin of right orbit 2.37 mm (36.12% of head length).
length). Rostral wider than high, visible from above; portion of rostral trapezoidal from above, 1.52 mm wide; length of rostral visible from above 0.63 mm. Prefrontal-rostral contact broadly separating nasals. Suture between prefrontals 58.4% of length of frontal. Prefrontals almost as wide as long. Frontal hexagonal, longer (2.09 mm) than wide (1.42 mm at widest point). Nsotrill-orbit distance in right lateral view 1.23 mm (16.49% of head length). Interorbital width (shortest distance between dorsomedial margins of orbits) 2.51 mm (66.57% of head width). Nasal entire, contacting preocular. Preocular rectangular, about 34% of length of nasal. Loral absent. Parietal almost twice as long (3.08 mm) as wide (1.44 mm at widest point); suture between parietals 1.97 mm; length of suture between parietals 94.2% length of frontal. Supraoculars subretangular, almost twice as long as wide. Maximum diameter of eye 0.70 mm, pupils round.

Postoculars pentagonal, higher than wide. Temporals absent. Five occipitals wider than long; median occipital positioned between posterior tips of parietals, smaller than adjacent vertebral; two pairs of lateral occipitals twice as large as dorsals, contacting posterior edges of sixth supralabials. Supralabials 6/6, 1 contacting rostral, 1–2 contacting nasal, 2 contacting nasal and preocular, 2–3 entering orbit, 3–4 contacting single postocular, 4–6 contacting parietal. Supralabials in ascending order of size, with sixth supralabial higher and longer (1.46 mm long, 1.29 mm high) than remaining supralabials. Infracrinals 7/7, 1–4 contacting anterior chinshields, 4–7 contacting posterior chinshields. Mental subtriangular, wider (1.14 mm) than high (0.82 mm), separated from anterior chinshields by contact between first infralabials. Anterior chinshields elongated, longer than posterior chinshields. Suture between chinshields 1.82 mm. Chinshields separated from ventrals by four gulars and two preventrals. Gulars in four rows between last supralabial and
first preventral. Dorsal scales smooth in 15 rows at midbody. No apical pits. 205 ventrals. 26 paired subcaudals (tail complete). Anal scale divided. 4 + 2 maxillary teeth.

Coloration of holotype in life (Fig. 2). Head dorsally blackish with light blotches irregularly distributed on rostral, nasal, prefrontal, frontal, supraocular and parietal scales. Suture between prefrontals brownish. Dorsally, rostral scale has a blackish blotch adjacent to anterior border of prefrontals; ventrally, rostral scale has a blackish spot in its convex portion. Posterior upper margin of first and fourth supralabials brown. Second supralabial brown. Anterior portion and upper half of third supralabial brown. Brown head cap covers upper half of fifth and sixth (except for its lower anterior portion) supralabials. Posterior portion of nasal, preocular and postocular scales blackish. Infrafalabials and chinshields cream, except for small brown spots on third and fourth scales. Brown pigment of throat region restricted to more laterally positioned gular scales (i.e., evidencing an incomplete gular band). White nuchal collar two and half to three dorsals long. Black nuchal collar absent. Background color light brown, with five brown stripes; paravertebral stripes light brown and less distinct than remaining dorsal stripes. Venter immaculate. Dark brown band on tail extends for nine scales dorsally; seven subcaudals are dark brown. Terminal scale with band of melanophores dorsolaterally and entirely clear ventrally.

Color of holotype in preservative (Fig. 3). Head dorsally brownish with light blotches irregularly distributed on rostral, nasal, prefrontal, frontal, supraocular and parietal scales. Dorsally, rostral scale brown pigmented; this blotch covers anterior border of prefrontals; ventrally, rostral scale with brownish spot on its convex portion. Anterior and posterior parts of prefrontals brown. Anterior and posterior parts of suture between prefrontals brown. Posterior upper margin of first and fourth supralabials brown. Second supralabial brown. Anterior portion and upper half of third supralabial brown. Brown head cap covers upper half of fifth and sixth (except for its lower anterior portion) supralabials. Posterior portion of nasal, preocular and postocular scales brown. Infrafalabials and chinshields cream, except for small brown spots on third and fourth scales. Brown pigment of throat region restricted to more laterally positioned gular scales (i.e., evidencing an incomplete gular band). White nuchal collar two and half to three dorsals long. Black nuchal collar absent. Background color light brown, with five brown stripes; paravertebral stripes light brown and less distinct than remaining dorsal stripes. Venter immaculate. Dark brown band on tail extends for nine scales dorsally; seven subcaudals are dark brown. Terminal scale with band of melanophores dorsolaterally and entirely clear ventrally.

Variation. Measurements and morphological variation are summarized in Table 1. Largest male (MCP 14524) SVL 310 mm, TL 38 mm. Largest female (MCP 12096, holotype) SVL 262 mm, TL 26 mm. Smallest specimen measured is female (MCP 11372) with SVL 152 mm and TL 16 mm. Fifth and sixth supralabials in
Figure 8. Map of South America, illustrating the type locality (star) of Apostolepis kikoi sp. nov. – reservoir of Manso hydroelectrical power plant – Chapada dos Guimarães (15°27'39"S, 55°45'00"W, 811 m a.s.l.), Mato Grosso, Brazil, and locality records for Apostolepis nigroterminata (circles) in the Brazilian state of Acre and Peru based upon the material examined. Square indicates the type locality of Apostolepis nigroterminata.
Table 2. Variation in characters of five specimens of *Apostolepis nigroterminata*. Snout-vent length (SVL), tail length (TL), ventrals (VE) and subcaudals (SC). The UFAC specimens presumably are males; the FMNH 39646 specimen is a male. *Holotype, data from Lema and Renner (2016: 67). Measurements in mm.

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*A. borellii* (a specimen from Urucum massif, Mato Grosso do Sul, Brazil), one specimen collected at the confluence of Rio Araguaia and Tapirapé, Tapirapé Village, Mato Grosso do Sul (AMNH 87942) – that was subsequently re-identified as *A. phillipsi* by Martins and Lema (2015) – and several other specimens from Bolivia and Peru. Recently, Lema and Renner (2016) removed *A. borellii* from the synonymy of *A. nigroterminata* and restricted the distribution of the latter to some localities in Peru. However, these authors also listed a specimen of *A. nigroterminata* from “Brazil: Acre: Rio Branco” in Appendix as “UFAC w/n”. The species was also included in an updated list of Brazilian reptiles and referred to occur in the states of Acre, Mato Grosso, and Pará (Costa and Bérnils 2018). Besides the unvouched mention to Acre in Lema and Renner (2016), Lema et al. (2017) presented a picture of a specimen from Acre without a clear locality description or voucher number, which also provides little evidence for the occurrence of this species in Brazil. The record for Pará is also unvouched (Maschio et al. 2012), while the specimen (UFMT 10672) from Nobres, Mato Grosso, referred to the species by Santos et al. (2011) was examined and is reidentified here as *Apostolepis* sp. Therefore, we argue that the specimens examined herein (UFAC 383, UFAC 397, UFAC 504) represent not only three locality records of *A. nigroterminata* for the state of Acre, Brazil, but also the first documented record of the species for the country. The specimens collected in Rio Branco (UFAC 397, UFAC 504) extend the geographic distribution of *A. nigroterminata* about 760 km northeastward from Callaria. In particular, the specimen depicted in Figs 4–5 matches the original description of Boulenger (1896) and that given by Lema and Renner (2016) in most details of sculation and color pattern of this species (see Table 2).

Two other species of *Apostolepis* – *A. lineata* and *A. vittata* – were also described from Chapada dos Guimarães (Cope 1887). Although the only existing syntype of *A. lineata* is in very bad condition, Harvey’s (1999) redescription is sufficiently complete to allow it to be unambiguously distinguished from *Apostolepis kikoi* sp. nov. Together with *A. assimilis* (Fig. 9) and *A. vittata* (Fig. 10), the description of *Apostolepis kikoi* sp. nov. increases the number of species of *Apostolepis* reported to occur sympatrically in the Manso reservoir area to three.

Figure 9. *Apostolepis assimilis*. A specimen deposited at the Universidade Federal de Mato Grosso (UFMT-R 11088) from district of São Vicente, Santo Antonio do Leverger, Mato Grosso, Brazil (photo by Christine Strüssmann).

Figure 10. *Apostolepis vittata*. A specimen deposited at the Universidade Federal de Mato Grosso (UFMT-R 12259) from the National Park of Chapada dos Guimarães, Cuiabá, Mato Grosso, Brazil (photo by Christine Strüssmann).

An attempt was made to identify all the specimens of *Apostolepis kikoi* sp. nov. using Nogueira et al.’s (2012) key. However, the specimens could not be characterized beyond couplet 1, because of the many overlapping characters presented in the couplets. The assignment of *Apostolepis kikoi* sp. nov. into a formal group should await a more comprehensive phylogenetic arrangement than is available for the genus.

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occurrence of *Apostolepis nigroterminata* in Brazil. Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) provided a fellowship to FMS during his graduate studies at the Universidade Federal do Mato Grosso do Sul and to OME-N during his undergraduate studies at the Universidade Federal do Rio Grande, and a productivity research grant to CS (CNPq process 309541/2012-3).

**LITERATURE CITED**


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APPENDIX 1

Additional specimens examined

Apostolepis sp. Brazil, Mato Grosso: Nobres, Gruta da Cantina (UFMT-R 10672).
Apostolepis dimidiata. Brazil, Mato Grosso do Sul: Aquidauana (ZUFMS-REP 96, ZUFMS-REP 97, ZUFMS-REP 235); Aquidauana, Camisão (ZUFMS-REP 100); Aquidauana, Vila Cidade Nova (ZUFMS-REP 98); Campo Grande (ZUFMS-REP 1732); Campo Grande, Jardim Autonomista (ZUFMS-REP 256); Chapadão do Sul, Campus da UFMS (ZUFMS-REP 2170); Sidrolândia, Estância Belém (ZUFMS-REP 101). Mato Grosso: Chapada dos Guimarães (MCP 13282).
Apostolepis lineata. Brazil, Mato Grosso: Chapada dos Guimarães (ANSP 11212, syntype).
Apostolepis nigrolineata. Brazil, Pará: Barcarena, arredores de Barcarena (MPEG 17292); Vila São Francisco, antiga sede de Barcarena (MPEG 16339); Benevides, Estrada da Belágua, Maguari (MPEG 21079); Canaã dos Carajás (MPEG 26453); Itaituba, A.P.A. do Tapajós, Mina do Tocantinzinho (MPEG 24569); Óbidos, ESEC Grão-Pará (MPEG 23737); Orixi-miná, Serra do Acarai (MPEG 23681); Santa Bárbara do Pará, Parque Ecológico do Gunma (MPEG 21330, MPEG 21333); Santarém, comunidade Tapari (MPEG 26512, MPEG 26553); Santo Antônio do Tauá (MPEG 3940); Viseu, Curupati (MPEG 10010, MPEG 10884, MPEG 10886, MPEG 10887, MPEG 13260); Viseu, km 220 da BR-316, antigo km 74 de Capanema (MPEG 3581, MPEG 8192, MPEG 10841, MPEG 10851); Viseu, Rio Gurupi, Colônia Nova, próximo do rio, BR-316 (MPEG 11487); Vitória do Xingu, U.H.E. de Belo Monte (MPEG 26189, MPEG 26190, MPEG 26503).

Apostolepis nigroterminata. Brazil, Acre: Km-80 da BR-317, Fazenda da Patroa, near Boca do Acre (UFAC 383), Campus Universitário da UFAC, Rio Branco (UFAC 504), Parque Zoobotânico da UFAC, Rio Branco (UFAC 397). Peru: Ayacucho, La Mar, in Sivia, Apurimac River, 760 m.a.s.l. (FMNH 39646); Loreto (MUSM 005); “Cayaria” (= Callaria, Departamento de Ucayali, Peru) (BMNH 1946.1.9.77, holotype).


Apostolepis striata. Brazil, Rondônia: Vilhena (CHUNB 12794, holotype).

Apostolepis tenuis. Bolivia, Santa Cruz: Buenavista (UMMZ 64436, holotype).

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Author Contributions: TL, CS and NRA conceived the project; FMS, TL, CS and NRA contributed to the acquisition of data of Apostolepis specimens, including those of the type series of A. kikoi; JSA and MBS analyzed the specimens of A. nigroterminata; FMS, CS and NRA wrote the paper, with contributions from OME-N and TL.

Competing Interests: The authors have declared that no competing interests exist.