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Extraordinary claims require extraordinary evidence: on the taxonomic identity of *Phalotris cerradensis* Silveira, 2020

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Abstract: *Phalotris* Cope, 1862 is a fossorial dipsadid snake genus that encompasses 15 species, distributed mainly in open areas from Northeastern Brazil to Southern Argentina. Some of its species are known from small series, and there is little to no knowledge on their morphological variation and species delimitations. In this work, we analyze the taxonomic status of *Phalotris cerradensis* Silveira, 2020, a recently described species known from a single specimen, and provide evidence for its synonymy with *Phalotris concolor* Ferrarezzi, 1993.

Keywords: Elapomorphini - Neotropical - Synonym - Systematics.

INTRODUCTION

Phalotris Cope, 1862 is a speciose genus of Neotropical dipsadid snakes, with 15 small to medium sized species (< 1 m) that are widely distributed in open areas from Northeastern Brazil to Southern Argentina (Ferrarezzi, 1993; Costa & Bérnils, 2018). Together with the genera *Apostolepis* Cope, 1862, *Coronelaps* Lema & Deiques, 2010, *Elapomorphus* Wiegmann, 1843, they constitute the Elapomorphini Jan, 1862 tribe, a clade of approximately 50 cryptozoic and fossorial species (Ferrarezzi, 1993; Zaher, 1999; Zaher *et al.,* 2009; Grazziotin *et al.,* 2012; Entiauspe-Neto *et al.,* 2019). The Elapomorphini tribe can be diagnosed on the basis of a short dentigerous dentary teeth process, U-shaped fronto-parietal suture, two or less pterygoid palatine teeth, usually six or less supralabial scales, and an entire nasal plate (Ferrarezzi, 1993; Zaher, 1999; Zaher *et al.,* 2009). The morphological diagnosis of *Phalotris* is based on a single (fused) prefrontal scale, separated from two internasals (Ferrarezzi, 1993).

As in other Elapomorphini genera, *Phalotris* has been long subjected to taxonomic controversy. Some of its species are known based on a single or a small series of specimens (e.g. *Phalotris concolor* Ferrarezzi, 1994 [n = 4], *Phalotris multipunctatus* Ferrarezzi, 1994 [n = 4], *Phalotris nigrilatus* Ferrarezzi, 1993 [n = 15], *Phalotris normanscotti* Cabral & Cacciali, 2015 [n = 3]) even after long time periods since their description (Atkinson *et al.,* 2019; Cacciali *et al.,* 2020); others have had conflicting views among authors regarding their delimitations and validity (e.g. *Phalotris bilineatus* Duméril, Bibrón & Duméril, 1852; *Phalotris lemniscatus* Duméril, Bibrón & Duméril, 1852; *Phalotris reticulatus* Peters, 1860), with various interpretations (see Lema, 1979; Ferrarezzi, 1993).

Ferrarezzi (1994) described *Phalotris concolor* on the basis of an adult female specimen (IBSP 55018) from Cristália, Minas Gerais state, in the Cerrado of Southeastern Brazil. It was distinguished from its congeners by a suite of morphological characters, and said to be "distanced" from others due to a higher number of ventral scales. It remained known from its holotype (and subsequently, lost in the Instituto Butantan fire of 2010), until Moura *et al.* (2013) reported its rediscovery, based on two specimens from Brasilândia de Minas and Urucuia, both at Cerrado localities in Minas Gerais,

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Southeastern Brazil, while also providing a detailed redescription and an emended diagnosis. Freitas *et al.* (2016) reported its first record to Bahia, Northeastern Brazil, based on a specimen from the Cerrado of Cocos, close to the border with Minas Gerais.

Recently, Silveira (2020) described *Phalotris cerradensis*, on the basis of the same specimen reported by Freitas *et al.* (2016), a subadult male individual (CHUNB 51553) from Cocos, Bahia, Northeastern Brazil, providing only brief comments on its morphology and allocating it in the *Phalotris nasutus* species group, together with *P. concolor* Ferrarezzi, 1993; *P. labiomaculatus* Lema, 2002; *P. lativittatus* Ferrarezzi, 1994; *P. nasutus* Gomes, 1915; and *P. nigrilatus* Ferrarezzi, 1994. Silveira (2020) also states *P. cerradensis* is "phenotypically similar" to *P. concolor*. In this work, we reanalyze the holotype of *P. cerradensis*, and review its taxonomic status.

MATERIAL AND METHODS

We examined a total of 38 *Phalotris* specimens from the following collections: Coleção Herpetológica Universidade de Brasília (CHUNB), Coleção Herpetológica Universidade Federal do Rio Grande (CHFURG), Coleção Herpetológica Museu de Ciências e Tecnologia PUCRS (MCP), Fundacíon Miguel Lilo (FML), Museo Nacional de Historia Natural de Paraguay (MHNP), Museu de Zoologia João Moojen de Oliveira (MZUFV), Coleção Zoológica Universidade Federal de Santa Maria (ZUFSM). A list of the examined material is provided in Appendix. The geographic distribution of the *Phalotris nasutus* group was inferred based on records from Ferrarezzi (1994), Freitas *et al*. (2016), Nogueira *et al.* (2019), and Cacciali *et al*. (2020).

An emended diagnosis, as well as meristic and morphometric characters followed the nomenclature used by Entiauspe-Neto *et al.* (2020) for *Apostolepis*, as follows: head length, measured from the center of rostral to the corner of mouth; head width, measured at the corner of mouth; snout-vent length, ventrally measured from the center of rostral to the posterior margin of cloacal scale; tail length, measured from the posterior margin of cloacal scale to the terminal scale. Head and tail measurements were taken with a dial caliper to the nearest 0.01 mm; for others, a flexible ruler was used. Scale counts follow Dowling (1951). Sex was determined through a subcaudal incision.

RESULTS

Upon examination of the holotype of *P. cerradensis*, it becomes evident that the correct specimen number is in fact "CHUNB 51553", and not "CHUNB 52553", as stated in its description. According to Silveira (2020), the type specimen differs from its congeners by the following characters: a prominent rostral scale (projected), but with a rounded apex; presence of contact between the rostral and the prefrontal, which separates the pair of internasals, prefrontal with a more pronounced angle (evident) on its anterior edge; 1+1 temporals, fifth labial (supralabial) separated from the parietal for its anterior temporal; the number of ventral scales relatively high (202 in a male); the number of subcaudal scales also relatively high (36 pairs in a male); dorsum with uniform coloration, yellow in preservative and reddish-orange in life (with a vestigial dark vertebral stripe); venter with clear (sic) immaculate coloration, cream in preservative, with black blotches on chinshields; a pronounced and narrow anterior nuchal white collar, one to two wide dorsal at vertebral and paravertebral rows (smaller than its black nuchal collar); a pronounced and wide black nuchal collar, three to five wide dorsals at vertebral and paravertebral rows (Silveira, 2020: 54).

Furthermore, Silveira (2020) provides a comparison of *P. cerradensis* with *P. concolor* (characters in parentheses), distinguishing it from the latter by the presence of black dorsal and lateral head surfaces, with white supralabial blotches (versus darker color of dorsal surface of the head, pale or cream supralabial surfaces); white nuchal collar that is narrower than black nuchal collar (versus white nuchal collar broader than black nuchal collar).

Both characters, head coloration and nuchal collar size, are also regarded as highly polymorphic in Elapomorphini species (see Entiauspe-Neto *et al.,* 2020). There is only minor difference in the extent of nuchal collars over dorsal scale rows in *P. cerradensis* (white nuchal collar 1-2 scales wide, black nuchal collar 3-5 scales wide) and *P. concolor* (white nuchal collar 2-3 scales wide, black nuchal collar 1-3 scales wide).

The holotype of *Phalotris cerradensis* shares several similarities with the known specimens of *P. concolor* (Figs 1, 2): (1) rostral projected in lateral view, rounded in dorsal view; (2) temporals 1+1, fifth supralabial separated from parietal by anterior temporal; (3) a high number of ventrals in males (202 in the male *P. cerradensis*, 212 in the male *P. concolor*); (4) a high number of subcaudals in males (36 pairs in the male *P. cerradensis*, 34 in the male *P. concolor*); (5) orange or red dorsal coloration in life; (6) immaculate cream venter.

Both type localities (Cristália and Cocos) are situated within the Cerrado biome, and *Phalotris concolor* has been recorded close to *P. cerradensis* (Fig. 3). The only remaining difference is in coloration characters that are generally highly variable in these snakes. It should also be noted that *P. concolor* is known from fewer than 5 individuals, and these differences likely constitute the extremes of morphological variation for these characters (Table 1). Considering the lack of specific diagnostic characters and a significant overlap in morphology, we propose that *P. cerradensis* should be considered as a junior synonym of *P. concolor*. *Phalotris concolor* can be diagnosed based on (1) 15-15-15 dorsal scales; (2)

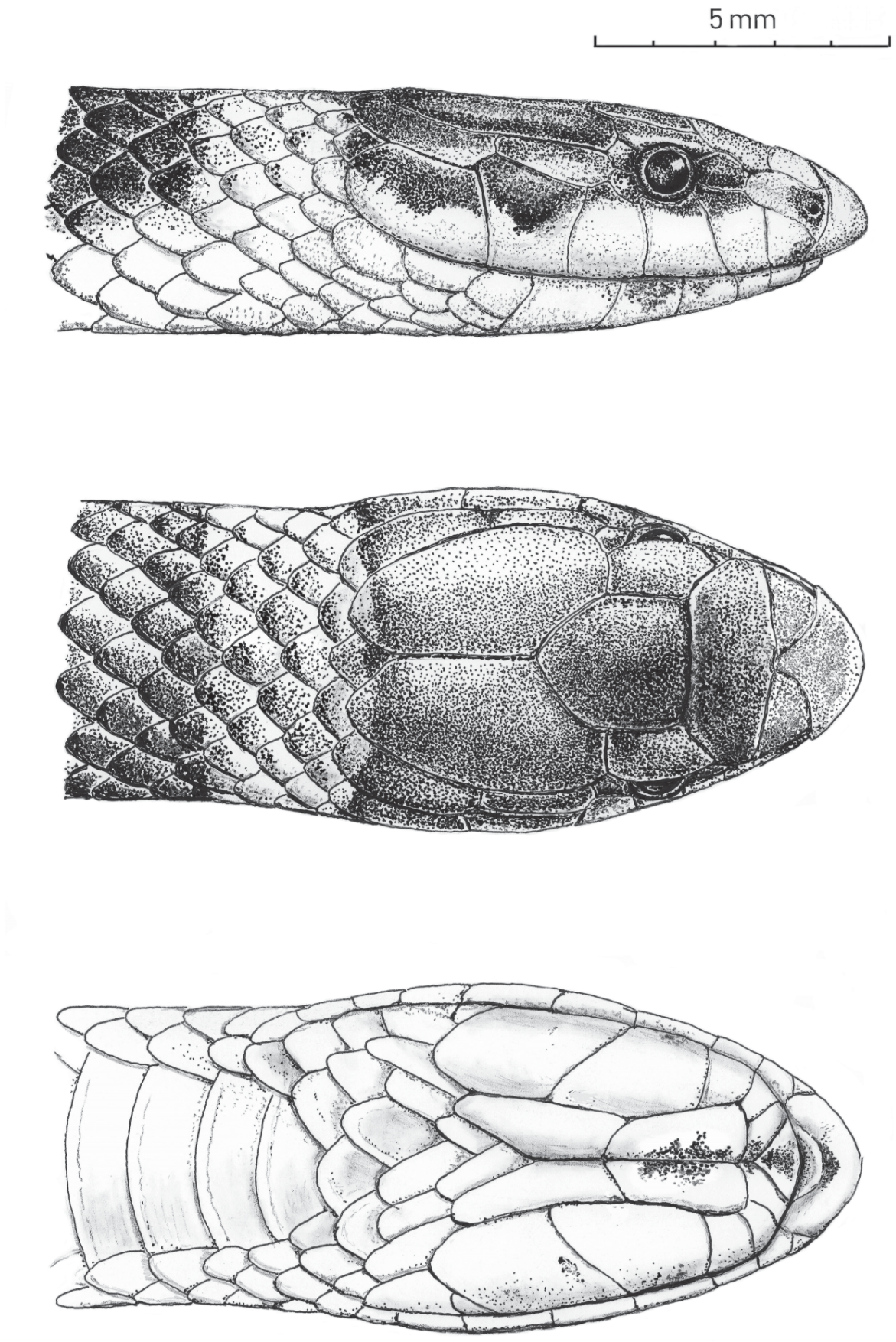

Fig. 1. Scalation of *Phalotris concolor* (MZUFV 1870).

Fig. 2. Morphological variation of *Phalotris concolor*. Top: Juvenile male (CHUNB 51553, former holotype of *P. cerradensis*); Middle: Adult male (MZUFV 1890); Bottom: Adult female (MZUFV 1870).

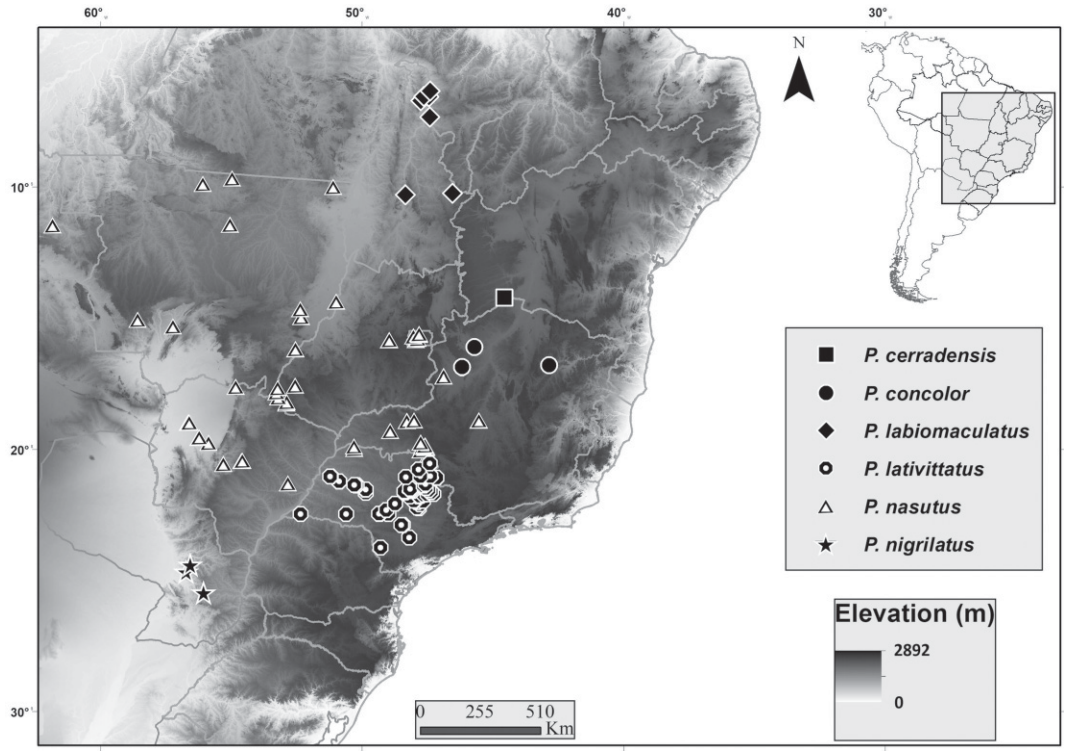

Fig. 3. Geographic distribution of the *Phalotris nasutus* species group.

Table 1. Morphological variation of *Phalotris concolor*. Measurements are given in mm. Data from [1]Ferrarezzi (1994); [2]Moura *et al.* (2013).

Characters	IBSP 55018 (holotype of *P. concolor*)[1]	CHUNB 51553 (holotype of *P. cerradensis*)	MZUFV 1870[2]	MZUFV 1890[2]
Age, sex	Adult female	Juvenile male	Adult female	Adult male
Head length	15	8.4	8.8	14.2
Head width	8	4.6	5.2	7.3
Tail length	43	19.1	23	60
Total length	550	203	322	582
Snout-vent length	507	184	299	522
Ventrals	224	202	220	212
Subcaudals	29	36	28	34
Supralabials	6, 2-3 in contact with orbit	6, 2-3 in contact with orbit	6, 2-3 in contact with orbit	6, 2-3 in contact with orbit
Infralabials	7, 1-4 in contact with anterior chinshields	7, 1-4 in contact with anterior chinshields	7, 1-4 in contact with anterior chinshields	7, 1-4 in contact with anterior chinshields
Temporals	1+1	1+1	1+1	1+1
Dorsal pattern	Uniformly red	Uniformly reddish orange	Uniformly orange	Uniformly reddish orange
Ventral color	Uniformly cream	Uniformly cream	Uniformly cream	Uniformly cream
White nuchal collar width	2-3 dorsal scale rows wide	1-2 dorsal scale rows wide	3 scale rows wide	2-3 dorsal scale rows wide
Black nuchal collar width	1-2 dorsal scale rows wide	3-5 dorsal scale rows wide	1-2 dorsal scale rows wide	1-2 dorsal scale rows wide

preocular present, contacting nasal; (3) loreal absent; (4) temporals 1+1 (rarely 1+1+1); (5) supralabials six, 2nd-3rd in contact with orbit; (6) infralabials seven, 1st-4th in contact with anterior chinshields; (7) ventrals 202-224 (220-224 in females, 202-212 in males); (8) subcaudals 28-36 (28-29 in females, 34-36 in males); (9) dorsal pattern uniformly red or orange, vertebral stripe, if present, vestigial; (10) ventral pattern uniformly cream, head and gular region white, diffuse black pigmentation on infralabials, chinshield, gulars, and symphisal; (11) white nuchal collar covering 1-3 rows, black nuchal collar covering 1-5 rows; (12) supralabial blotch large or medium, covering four to six supralabials; (13) SVL 184-522 mm, TL 23-60 mm.

DISCUSSION

The number of *Phalotris* species is herein reduced to 14. Recent rediscoveries (e.g. *P. nigrilatus*, Cacciali *et al.,* 2007, 2020; *P. concolor,* Moura *et al.,* 2013; *Phalotris multipunctatus,* Atkinson *et al.,* 2018) have highlighted that these secretive snakes may go undetected for long periods, even in historically well-sampled areas. More than that, these findings particularly call attention to the slight variations in meristic, morphometric and color pattern characters, even in specimens collected in the same locality. Not by chance, *P. lemniscatus*, the congener whose morphology has been most extensively studied (> 300 specimens), is the species that exhibits chromatic variations the most, with at least 8 recognizable patterns and some intermediate specimens between them (Noronha, 2012). If we consider the putatively diagnostic characteristics between *P. cerradensis* and *P. concolor* (head coloration and nuchal collar size) in the light of the variation of *P. lemniscatus*, it is possible to notice that both are very fragile. While the head color can vary from black to light brown in *P. lemniscatus*, the nuchal collar size is widely variable and may even be absent in many specimens (Noronha, 2012; this study). In addition, the same pattern variation in the nuchal collar has already been pointed out for more than one species of the genus *Apostolepis*, which suggests that this characteristic is highly variable not only in *Phalotris*, but possibly in Elapomorphini as a whole (Ferrarezzi *et al.,* 2005; Entiauspe-Neto *et al.,* 2020).

The most surprising feature in Silveira's (2020) paper, however, is that it contemplates exactly the combination of two factors that have generated numerous taxonomic problems in Elapomorphini throughout history: poor diagnoses based on a single specimen. This practice is obviously not exclusive to this group of snakes, and its potential negative consequences have been reported by different authors (e.g. Cruz-da-Silva *et al.,* 2018; Palacios-Aguilar & García-Vázquez, 2020). However, possibly due to the difficulty in obtaining large series of specimens, together with the high chromatic variability, this practice has become frequent in Elapomorphini (Lema, 2004a, b; Lema & Renner, 2011). This problem was addressed indirectly by Ferrarezzi *et al.* (2005), but Entiauspe-Neto *et al.* (2019) clearly exposed this point of view through direct association between single-based descriptions and subsequent synonymizations, and warned: "*We urge our fellow authors not to commit taxonomic malpractice and to carefully generate, rethink and analyze their data,* ***providing compelling evidence for their claims***" (our bold). Currently, the snake's systematics has evolved in order to increasingly combine sources of evidence to support taxonomic decisions (e.g. cranial osteology, muscular, glandular and hemipenial morphology, and different molecular frameworks) and minimize nomenclatural instabilities. We argue that, while many of these sources of evidence do not yet exist in the scientific literature for much of the species of Elapomorphini, this should not be seen as a reason to continue a tortuous cycle of rudimentary descriptions. On the contrary, it should be seen as an excellent opportunity to put into practice a more robust taxonomy and really provide useful information regarding the diversity and evolutionary relationships of this elusive neotropical snake lineage.

Phalotris concolor is a poorly known species, known from four specimens, and restricted to the Cerrado open areas of the Espinhaço Range, a narrow mountain formation between the states of Minas Gerais and Bahia. There is no available information on its populational trends or conservation, and very little is known about its natural history. We suggest that further fieldwork on the Espinhaço Range should uncover new specimens, and help enrich the knowledge on the variation of this elusive species.

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APPENDIX

Material examined: 38 specimens. *Phalotris concolor* (*n*=3): CHUNB 51553, holotype of *P. cerradensis*, Brazil, Bahia, Cocos. – MZUFV 1870, Brazil, Minas Gerais, Brasilândia de Minas. – MZUFV 1890, Brazil, Minas Gerais, Urucuia.

Phalotris nigrilatus (n=2): FML 0709, holotype of *P. nigrilatus,* Paraguay, San Pedro, Carumbé. – MHNP 12577 Paraguay, San Pedro, Colonia Friesland.

Phalotris labiomaculatus (n = 1): MCP 10693, holotype of *P. labiomaculatus,* Brazil, Maranhão, Porto Franco.

Phalotris lemniscatus (n = 30): ZUFSM 0736, Brazil, Rio Grande Do Sul, Caçapava do Sul. – ZUFSM 1351, Brazil, Rio Grande Do Sul, Cacequi. – MCP 14323, CHFURG 1251, 1501, Brazil, Rio Grande Do Sul, Campus da FURG, Rio Grande. –

CHFURG 766, Brazil, Rio Grande Do Sul, Cassino, Rio Grande. – CHFURG 4905, 4906, 4912, 4913, 4914, Brazil, Rio Grande Do Sul, Corredor da Barra, Rio Grande. – CHFURG 1413, 1483, 1724, Brazil, Rio Grande Do Sul, ESEC Taim. – ZUFSM 2676, Rio Grande Do Sul, Júlio de Castilhos. – CHFURG 843, Brazil, Rio Grande Do Sul, Parque São Pedro, Rio Grande. – CHFURG 934, 1110-1120, Brazil, Rio Grande Do Sul, Rio Grande. – ZUFSM 2772, Brazil, Rio Grande Do Sul, Quaraí. – CHFURG 696, Brazil, Rio Grande Do Sul, São Lourenço. – ZUFSM 2773, Brazil, Rio Grande Do Sul, Santiago.

Phalotris matogrossensis (n=1): MCP 12801, holotype of *P. matogrossensis,* Brazil, Mato Grosso, Cuiabá.

Phalotris nasutus (n = 1): MCP 15322, Brazil, Mato Grosso: U.H.E. Manso, Chapada dos Guimarães.