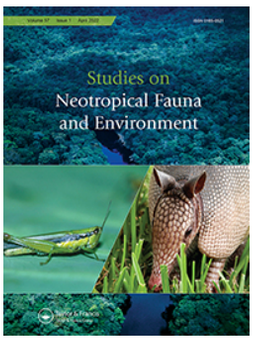

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ORIGINAL ARTICLE

The distribution of *Amphisbaena prunicolor* (Cope, 1885) in Paraguay and its diagnosis from *A. darwinii* Duméril & Bibron, 1839

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ABSTRACT

Amphisbaena prunciolor is known from very few Paraguayan reports in the southern department of Itapúa. Often confused with *A. darwinii* (including '*heterozonata*' and '*trachura*') and *A. albocingulata,* it is identified by the combination of a rounded head, checkerboard pattern on the ventral surface, presence of a postmalar scale row, and caudal annuli in the range 18–24. We reviewed southern Paraguayan specimens of *A. prunicolor* and *A. darwinii* and found that the most recently published specimen of *A. prunicolor* (IIBP-H 4460) in fact refers to *A. darwinii 'trachura'* but that the first report of the species in Paraguay is correctly identified and refers to a specimen with an autotomized tail. We include live images of an additional modern record of *A. prunicolor* from this same area and confirm that a specimen (USNM 253536) from the same locality identified in the literature as *A. darwinii 'trachura'* is in fact also *A. prunicolor*. Finally, we clarify and illustrate the diagnostic characters of *A. prunicolor* with respect to *A. darwinii* in Paraguay to reduce future confusion.

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Amphisbaena albocingulata; *Amphisbaena darwinii*; *Amphisbaena heterozonata*; *Amphisbaena trachura*

Introduction

The Amphisbaenidae of Paraguay are poorly known, and most species are represented by few specimens in collections (Montero & Terol 1999; Cacciali et al. 2016). Taxonomic issues with regard to species limits persist, and unclear species diagnoses based mainly on meristic characters (which often overlap) have caused widespread confusion in the literature (Vanzolini 2002). Particular confusion has surrounded the identity of Paraguayan specimens in the *Amphisbaena darwinii* (including *heterozonata* and *trachura*) complex and with regard to the distinction between *A. prunicolor* and *A. albocingulata* (Gans 1966). Important recent advances taking a more integrated approach have shed more light on these issues (Perez et al. 2012; Montero 2016). However, confusion still remains, confounded by the lack of experience that many researchers have with these species in life, itself a direct result of their fossorial habits.

Perez et al. (2012) clarified the diagnosis of *A. prunicolor* with respect to *A. albocingulata* but did not make clear the comparisons between both of these species with *A. darwinii*, another confusion species. That paper treated the three forms in the *A. darwinii* complex (*A. darwinii* Duméril & Bibron 1839, *A. heterozonata* (Burmeister, 1861), and *A. trachura* (Cope, 1885)) as distinct, diagnosable species (the latter two considered to be present in Paraguay), but a subsequent paper concluded that Paraguayan populations represent an intergrade between *A. heterozonata* and *A. trachura* (with some specimens not safely referable to either form) and recommended that these be considered conspecific with *A. darwinii* (Montero 2016). This echoed the earlier conclusions of Montero and Terol (1999) and Cacciali et al. (2016). The Paraguayan specimens of *A. darwinii* that we examined showed moderate tuberculation of the tail (tending toward *trachura*), with low caudal annuli counts (tending toward *heterozonata*). Similar specimens (with body annuli 194–202 and caudal annuli 15–17) captured in nearby Corrientes Province (Argentina) have been assigned to *A. trachura* (Ruiz-Garcia et al. 2016). However, we concur with Montero (2016) that, given the overlap in scale counts and variation in the extent of tail tuberculosity, such specimens cannot be confidently assigned to one taxa or the other, and so we treat both names as synonyms of *A. darwinii*. Thus, we clarify that our use of the term *A. darwinii* refers to this intergrade population and may not be directly comparable with the concept of *A. darwinii* referred to by Perez et al. (2012) but to a combination of A. *heterozonata* and *A. trachura* (tending toward the latter) as defined by those authors.

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In this paper, we review Paraguayan records (Figure 10) of the data-deficient *A. prunicolor* and provide clarification on how to distinguish this species from *A. darwinii* (*sensu* Montero 2016).

Methods

All claimed Paraguayan specimens and photographs of *A. prunicolor* were examined and compared with the diagnostic characters presented by Perez et al. (2012). Diagnostic characters were identified based on comparison with specimens of *A. darwinii*.

Results

The identity of IIBP-H 4460

Cabral et al. (2020) reported the rediscovery of the *A. prunicolor* in Paraguay based on a probable roadkill specimen IIBP-H 4460 (6 December 2017) found on a paved road near the Yacyretá Dam, Itapúa department (27°18'59.4"S 56°28'18.3"W). They identified the specimen as *A. prunicolor* noting that the characteristics defined by Perez et al. (2012) were 'all … present in the new collected specimen.' Meristic characters provided by the authors are shown in Table 1. Furthermore, they noted that the specimen differs from *A. albocingulata* by 'presenting a venter light checkerboard coloration pattern.'

In January 2020, we were able to reexamine this specimen and conclude that the specimen refers to *A. darwinii 'trachura.'* Our counts differed considerably from the published numbers given in Cabral et al. (2020) (Table 1). The body annuli counts for *A. prunicolor* and *A. darwinii* overlap and are thus non-diagnostic, but the caudal annuli counts are diagnostic, and the erroneous count by Cabral et al. (2020) (which included both the anal scale and the tail tip) was probably key to the misidentification. The corrected count lies outside the range of *A. prunicolor* and within the range of *A. darwinii* (Table 2) and so we conclude that it refers to that species.

Cabral et al. (2020) correctly eliminated *A. albocingulata* from consideration based on the characters provided by Perez et al. (2012), but they did not discuss the differentiation of their specimen from *A. darwinii*. We clarify here that the postmalar scale row which is present in *A. prunicolor* is not diagnostic for that species as it is also present in *A. darwinii*. Whilst the presence of this character does distinguish it from *A. albocingulata*, it is the absence of this character (as in *A. albocingulata*), and not the presence, that is the 'unusual state' in this group. We further note that the description of the head shape of *A. prunicolor* by Perez et al. (2012)

Table 1. Characteristics of examined specimens discussed in the main text.

	Amphisbaena prunicolor (Tirol)	*IIBP-H 4460* (Cabral et al. 2020)	*IIBP-H 4460 (our counts)*	*Examined specimens of A. darwinii (n = 3)*	*Amphisbaena prunicolor* (Vanzolini 2002)	*Amphisbaena darwinii trachura* (Vanzolini 2002)	*Amphisbaena darwinii heterozonata* (Vanzolini 2002)
Body annuli	194	197	202	197–205	180–206	168–208	190–207
Tail annuli	20	19	16	16–17	18–24	5 (?) –22	13–17
Dorsal segments at mid-body annulus	NA	14	16	15–19	10–16	14–21	14–19
Ventral segments at mid-body annulus	NA	17	19	18–20	14–19	17–23	15–22
Supralabials	3/3	3/3	3/3	3/3	NA	NA	NA
Infralabials	3/3	3/3	3/3	3/3	NA	NA	NA
Head shape	Rounded head	Rounded snout	Triangular head with rounded snout	Triangular head with rounded snout	NA	NA	NA
Precloacal pores	4	4	4	4	4	4	2–6
Postmalar row	Present	Present	Present	Present	NA	NA	NA
Ventral pattern	Checkerboard	'Light checkerboard'	Uniform pale	Uniform pale	NA	NA	NA

Table 2. Comparison of characters of diagnostic value in *Amphisbaena darwinii*, *A. prunicolor*, and *A. albocingulata* (Perez et al. 2012).

	(A) *darwinii*	(A) *prunicolor*	(A) *albocingulata*
Postmalar scale row	Present	Present	Absent
Ventral colouration	Uniformly pale, sometimes with slightly darker edges to annuli	Irregular checkerboard	Uniformly brown, paling toward midline
Dorsal colouration	Brownish	Purplish	Brownish
Body annuli	190–207	181–215	190–204
Tail annuli	13–17 '*heterozonata*' (autotomy 5–8), 15–22 '*trachura*' (autotomy 5–9)	18–24 (autotomy 6–9)	24–27 (autotomy 7–9)
Head shape	Triangular with rounded snout	Rounded	Rounded
Tail	Tuberculate, fattened	Slender, smooth	Slender, smooth

lacks clarity and is referred to alternately as a 'rounded head' and a 'rounded snout.' This subjective description may have misled the authors of Cabral et al. (2020). The head shape of *A. prunicolor* and *A. darwinii* is in fact quite different (Gans 1966) and that of the former may be more accurately described as a 'rounded head' and that of the latter as a 'rounded snout' (as stated for the specimen by Cabral et al. 2020).

We were unable to detect a 'checkerboard pattern' on the ventral side of IIBP-H 4460. We consider the ventral pattern exhibited by this specimen to be indistinguishable from that of 'southern *A. darwinii*' illustrated in Figure 5C-D of Perez et al. (2012). We also found the ventral coloration of IIBP-H 4460 to be indistinguishable from the other specimens of *A. darwinii* with which we were able to compare. Similarly, the uniformly brownish dorsal coloration was also consistent with specimens of *A. darwinii* and differs from the purplish coloration of *A. prunicolor* which is referenced in the species name. One additional character not mentioned by the authors is the presence of the 'fattened' tail, typical of Paraguayan specimens of *A. darwinii 'trachura,'* and unlike the slender 'smooth' tail of *A. prunicolor*. This character of *A. darwinii* can also be clearly seen in Figures 3 of Cabral et al. (2020).

Cabral et al. (2020) state that *A. prunicolor* was previously reported from open areas with anthropic intervention *fide* Entiauspe-Neto et al. (2016). However, we make two observations. First, Entiauspe-Neto et al. (2016) state in the main text that the species is found in 'humid and shaded habitats' (open areas are mentioned only in the table but cannot be described as 'shaded habitats'), and secondly, though the species is referred to *A. prunicolor* in the text, the illustrated specimen is referred to *A. trachura* in the figure legend. We assume that the former name is correct but are unable to confirm it from the figure in Entiauspe-Neto et al. (2016).

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Collected 3 km NE of Encarnación, Itapúa department, on 11 October 1984 by Isabela Gamarra, this specimen was identified as *A. prunicolor* by Montero and Terol (1999), representing the first record of the species for Paraguay. We examined images of this specimen during February 2021. The postmalar scale row is present, and the ventral side of the animal possesses the checkerboard pattern associated with *A. prunicolor*. There are 208 body annuli, and there are four preanal pores, all of these characters being consistent with *A. prunicolor*. The tail, however, consists of just seven annuli, but we consider this to be the result of autotomy (six to nine in this species according to Vanzolini (2002)). We concur with the identification of Montero and Terol (1999) that this is a specimen of *A. prunicolor*.

USNM 253536

Collected at Hotel Tirol, Itapúa department, on 9 October 1976 by Mercedes Foster, this specimen was identified as *Amphisbaena darwinii heterozonata*. We identify this specimen as *A. prunicolor* based on the characters of this species previously mentioned but note that the checkerboard pattern in this specimen is rather restricted and conspicuous only on the tail. This specimen has 187 body annuli, 4 preanal pores, and 20 tail annuli. It is thus the first specimen of *A. prunicolor* collected in Paraguay.

Figure 1. *Amphisbaena prunicolor*, Hotel El Tirol, Itapúa department, 13 November 2013 (Jean-Paul Brouard).

Figure 2. Same individual as Figure 1 head detail, showing rounded head shape (Jean-Paul Brouard).

Figure 3. Same individual as Figure 1 ventral side, showing presence of postmalar scale row and checkerboard ventral pattern (Jean-Paul Brouard).

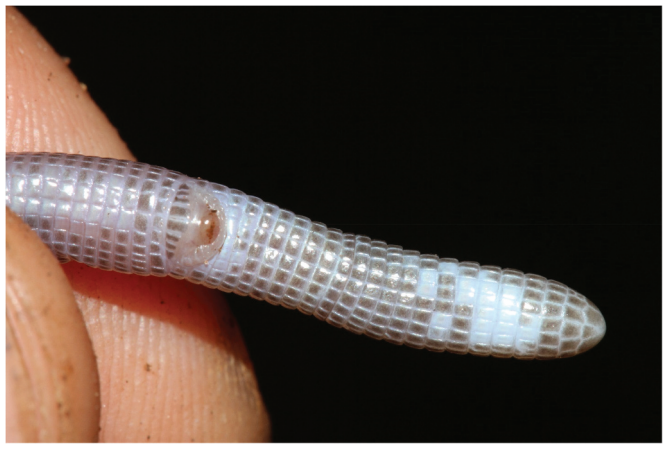

Figure 4. Same individual as Figure 1 tail and cloaca, showing four precloacal pores (Jean-Paul Brouard).

Figure 5. Dorsal head of *Amphisbaena darwinii* '*trachura*' CZPLT 1643 from Puerto Eliza, Ñeembucú department, showing triangular head shape with a rounded snout (George Hicks).

Figure 6. Ventral head of *Amphisbaena darwinii* '*trachura*' CZPLT 1643 from Puerto Eliza, Ñeembucú department, showing triangular head shape with a rounded snout (George Hicks).

Figure 7. Lateral head of *Amphisbaena darwinii* '*trachura*' CZPLT 1643 from Puerto Eliza, Ñeembucú department, showing triangular head shape with a rounded snout (George Hicks).

Figure 8. Dorsum of *Amphisbaena darwinii* '*trachura*' CZPLT 1643 from Puerto Eliza, Ñeembucú department (George Hicks).

Figure 9. Ventrum of *Amphisbaena darwinii* '*trachura*' CZPLT 1643 from Puerto Eliza, Ñeembucú department. Note the uniformly pale ventrum lacking the checkerboard pattern visible in Figure 3 and the thickened tail (George Hicks).

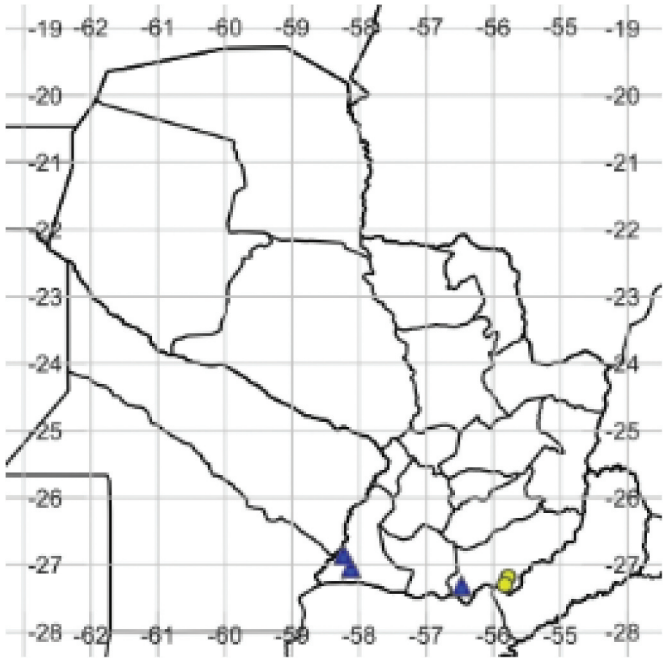

Figure 10. Map of Paraguay showing the collection localities of the specimens examined. *Amphisbaena prunicolor* (yellow circles); *Amphisbaena darwinii* (blue triangles).

New record of *A. prunicolor*

On 10 November 2013, an individual of this species was found under a log within the degraded Atlantic Forest at Hotel El Tirol, Itapúa department, by JPB. The specimen was not collected because of a lack of a collection permit, but annuli counts were taken (Table 1), and detailed photographs of characters of diagnostic importance were obtained (Figures 1–4). This specimen can be conclusively identified as *A. prunicolor* because of the checkerboard ventral coloration, the purplish dorsal coloration, the rounded head, the presence of four precloacal pores, presence of a postmalar scale row, and the annuli counts (Table 1).

Diagnosis of Paraguayan *A. prunicolor* and *A. darwinii*

These two species are only superficially similar but can be distinguished via a series of characters that are most easily assessed with reference to images (Figures 1–9). We suggest that a safe diagnosis between the two species should be made based on a combination of all of these characters (Table 2) and that, if necessary, further differentiation from *A. albocingulata* should be performed in reference to the characters provided by Perez et al. (2012). The postmalar scale row is present in both species (Figures 3 and 6). The ventral checkerboard coloration of *A. prunicolor* is distinctive and conspicuous (Figure 3) and not subjective. This character is not present in *A. darwinii* (Figure 9). Similarly, the dorsal coloration of the two species is also distinct, even in recently preserved specimens, with that of *A. prunicolor* distinctly purplish (or bluish) (Figure 1), while *A. darwinii* is uniformly brown (Figure 8). However, this difference is more subjective and should not be relied upon. Scale counts of the two species overlap almost entirely, and the only useful count for distinguishing the species is that of the tail annuli and then only when the tail is not autotomized or if the count is either low (<18) or high (>22) (Table 2). In direct comparison, the head shape of these two species is quite different, being notably rounded in *A. prunicolor* (Figure 2) and somewhat triangular with a rounded snout in *A. darwinii* (Figure 7). The tail of *A. darwinii* looks rather swollen and is tuberculate, making it look 'club-tailed' (more obviously so in '*trachura*-type' specimens and less obviously so in '*heterozonata*-type' specimens) (Figure 9). The tail of *A. prunicolor,* on the other hand, is slender and smooth (Figure 4). Thus, in combination with the head shape, both species present a totally different body shape at the extremities. However, we note that these conclusions are based on a small number of available specimens and that caution should be maintained until larger series are available.

Discussion

Confident identification of Amphisbaenids remains a difficult task, and recent literature continues to refine

the characters for identification. Based on the few specimens of *A. prunicolor* and *A. darwinii* available from Paraguay, there is an emerging tendency for the former to be associated with humid and forested environments in the Atlantic Forest zone (Itapúa department) and the latter with open, Humid Chaco and Mesopotamian grassland habitats mainly in the Paraguay River Basin (Ñeembucú and Central departments). We highlight that the specimen from Hotel Tirol, Itapúa department, (USNM 253536) identified as *A. darwinii* in Cacciali et al. (2016) is *A. prunicolor*, and thus, there is no evidence of sympatry between the two species in Paraguay. A second specimen identified as *A. darwinii* (MNHNP 11471) in Cacciali et al. (2016) and reported from the Atlantic Forest zone in Caaguazú department should also be reexamined to confirm the identification. We were unable to locate this specimen in the collection despite the help of the curators.

As a final comment, we note that the correct spelling of the species name is *A. darwinii* (Duméril & Bibron 1839: p.490) as per the original designation and not *A. darwini* as often appears in the literature.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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