

The snakes of Bahia State, northeastern Brazil: species richness, composition and biogeographical notes

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Abstract. Nearly 150 years after the first systematic study on the snakes of Bahia, Brazil, this paper aims to fill still existing gaps in knowledge by characterizing the richness, composition and habitat use of the snakes in this state. Based on bibliographic records and visits to scientific collections, a total of 129 snake species distributed over nine families are recorded. The ombrophilous forest, caatinga vegetation, and restingas are relatively well sampled and present the highest richness of snakes, whereas data from savannas, semi-deciduous, and deciduous seasonal forests is scarce and renders them poorly known. Endemic species, generalists, and new biogeographical records for the state are presented. An identification key to the snakes of the region is also provided.

Key words: Squamata, Serpentes, species richness, habitat use, biogeography, diversity.

Introduction

Brazil is an extremely diverse country in biological terms and possesses one of the most diverse continental biota, comprising 13% of all the world's biodiversity (LEWINSOHN & PRADO 2005). It has one of the greatest numbers of reptiles on the planet (RODRIGUES 2005), especially snakes, which account for 371 species in 10 families (BÉRNILS 2010). Despite that, the degree of knowledge on these animals varies a lot, depending on the taxon, region and biome (SABINO & PRADO 2003a).

Some studies point out that information about systematics, ecology, and biogeography of these animals in northeastern Brazil is rather scarce, not to say insufficient, due to incomplete geographic sampling and deficient coverage of biomes and ecosystems (MMA 2002, SABINO & PRADO 2003b, RODRIGUES 2003, RECORDER & NOGUEIRA 2007).

Considering this scenario, Bahia seems to be in a fortunate position because the state's snake fauna has been studied since the 19th century, when many naturalists received, collected, and described numerous species, making the region a type locality for various taxa, such as *Taeniophallus occipitalis* (JAN, 1863), *Liophis almadensis* (WAGLER, 1824), *Xenodon merremii* (WAGLER, 1824), *Bothrops leucurus* (WAGLER, 1824), *Xenopholis scalaris* (WUCHERER, 1861), *Atractus guentheri* (WUCHERER, 1861), *Phimophis guerini* (DUMÉRIL, BIBRON & DUMÉRIL, 1854), *Bothrops lutzi* (LACERDA, 1884), *Oxyrhopus formosus* (WIED, 1820),

Xenodon rhabdocephalus (WIED, 1824), and *Bothriopsis bilineata* (WIED, 1825).

Nearly 150 years after the first systematic study on snakes of the state of Bahia conducted by OTTO WUCHERER (1861a, 1861b; see LIRA-DA-SILVA 2009a), this paper aims to fill still existing gaps by characterizing the richness and composition of snakes within the political boundaries of the state. Information on possible endemism and habitat use by each species are also provided, being key factors to better understand the evolution of the group. Since several changes in the scenery of Brazilian herpetology, especially after the description of unknown species, taxonomic rearrangements and locality records have occurred, we provide an updated key to the genera of snakes of Bahia state.

Material and methods

The state of Bahia covers an area of approximately 565,000 km², accounting for 6.64% of the Brazilian territory. It is located in the coastal zone of the northeast, between the latitudes of 8° and 18° south, and the longitudes of 37° and 45° west. It borders the states of Sergipe, Alagoas, Pernambuco, and Piauí to the north, Minas Gerais, Goiás, and Tocantins to the west, and Espírito Santo to the south (SEI 2009).

Its climate ranges from humid to arid/semiarid, and has annual temperatures between 14.5 and 33.7°C. Altitude

tudes in the area vary from sea level to 2033 m in the 'Pico do Barbado', and the demographic density is 23.79 inhabitants per square kilometre with an estimated population of 13,500,000 inhabitants (SEI 2007). Bahia State possesses a rich vegetal cover, comprising the Atlantic rainforest, Caatinga and Savanna dominions (AB'SABER 1977, 2003), and their respective phytophysiognomies: savanna, caatinga, ombrophilous forest, semi-deciduous seasonal forest, deciduous seasonal forest, and restingas (IBGE 1992).

Our list of snake species is based on literature records and/or specimens housed in the following scientific collections: Museu de Zoologia of Universidade Federal da Bahia (MZUFBA), Museu Paraense Emílio Goeldi (MPEG), Museum of the Comissão Executiva do Plano da Lavoura Cacaueira (CEPLAC), Coleção Herpetológica "Alphonse Richard Hoge", Instituto Butantan (IB), Coleção Herpetológica of the Universidade Nacional de Brasília (CHUNB), Coleção Herpetológica of Universidade Estadual de Feira de Santana (MZUEFS), Coleção de Répteis of the Museu Nacional of Universidade Federal do Rio de Janeiro (MNRJ), Coleção de Répteis of the Museu Professor Mello Leitão (MBML), Coleção de Répteis of the Universidade de São Paulo (MZUSP), and The Natural History Museum of London (BMNH).

Species richness was established as the total number of species found in a certain location. Habitat use is based on the recognition of the phytophysiognomy according to SEI (2007) in which a snake was collected. We also use the following references to complement habitat use data: SILVA JR. (1993, 1997), MARQUES et al. (2001, 2006), HAMDAN & LIRA-DA-SILVA (2008), FREITAS et al. (2007), and ARGÔLO (1999a). Doubtful data were not included in the analyses. The taxonomic nomenclature follows BÉRNILS (2010) with exceptions being commented on in our discussion. The classification of snakes is restricted to specific level and exceptions are commented on. Our identification key is primarily dichotomous, however, trichotomies are presented in some cases. Besides autapomorphies, we used any other meristic or qualitative morphological trait, that would facilitate the taxa determination if and when required.

Results

The species richness found in the state of Bahia was 129 snake species, distributed over nine families (Tab. 1). From these, we recognized seven species that have not yet been described or are in the process of description for the state. Here, they are represented only at generic level, and vouchers of the new state records are cited in the appendix.

Species richness and composition in different types of sampled phytophysiognomies are different from one another. Record analyses showed the ombrophilous forest as the richest one ($n = 76$ species), followed by the caatinga ($n = 45$), restinga ($n = 35$), savanna ($n = 33$), semi-deciduous seasonal forest ($n = 30$), and deciduous seasonal forest ($n = 11$).

The taxa *Apostolepis* sp. 5, *Taeniophallus* sp. 1, *Sibynomorphus* sp. 1, *Micrurus* sp.1, *Philodryas agassizii*, and *Tantilla marcovani* are new records for the state. Our data also indicate *Chironius bicarinatus*, *Chironius foveatus*, *Chironius laevicollis*, *Dipsas sazimai*, *Coronelaps lepidus*, *Elapomorphus wuchereri*, *Caaeteboia amarali*, *Oxyrhopus formosus*, *Siphlophis leucocephalus*, *Siphlophis pulcher*, *Tropidodryas serra*, *Xenopholis scalaris*, *Bothriopsis bilineata*, *Bothrops pirajai*, *Lachesis muta*, *Micrurus corallinus*, *Micrurus* sp.1, *Epicrates cenchria*, and *Liotyphlops trefauti* as inhabiting exclusively areas of ombrophilous forests in the state of Bahia. *Apostolepis arenarius*, *Apostolepis gaboi*, *Taeniophallus* sp.1, *Phimophis chui*, *Phimophis scriptorcibatus*, *Tantilla marcovani*, *Thamnodynastes almae*, *Typhlops amoipira*, and *Typhlops yonenagae* would be restricted to the caatinga, and *Apostolepis flavotorquata*, *Philodryas agassizii*, *Bothropoides lutzi*, *Bothrops moojeni*, *Micrurus brasiliensis*, *Siagonodon brasiliensis*, and *Epicrates crassus* are savanna-dwellers. *Sibynomorphus* sp.1, *Tropidodryas striaticeps*, *Bothropoides jararaca*, and *Bothropoides neuwiedi* were found only in areas of high altitude, mainly associated with the semi-deciduous seasonal forest and other floristic elements like cerrado and rupestrian fields. Deciduous forests and restingas do not hold a characteristic snake fauna, and the species recorded from there were also found in other types of vegetation. In contrast to the former species, *Liophis poecilogyrus*, *Oxyrhopus trigeminus*, and *Xenodon merremii* are widely distributed, inhabiting all phytophysiognomies studied. So far, eight species are known to be endemic to Bahia State.

Discussion

Our data have substantially increased the known snake species richness as compared to the first systematized study of the snakes in Bahia by WUCHERER (1861a, 1861b, 1861c) who, at the time, knew of 31 species. The fact that numerous naturalists and researchers have been collecting snake here for more than a century, as well as the good representation of species in the consulted museums add up to a relatively good knowledge of the snakes in this state.

The lack of current and complete regional lists for the other states of Brazil makes it difficult to make appropriate comparisons, but we can at least quite safely state that the snake species richness is greater in Bahia than in the states of Acre and Rio de Janeiro (SILVA 2006, ROCHA et al. 2004) and comprises about 35% of the national snake fauna.

Certainly, the large territorial extent combined with its complex vegetation patterns and the history of biodiversity make Bahia the home of the third richest snake fauna of the country, second only to São Paulo and Minas Gerais (ZAHER et al. 2011, BÉRNILS et al. 2009).

Species richness proved to be variable for different types of environments found in the state. Usually, over time, different areas have been occupied by different clades and, in turn, different clades have different potentials for diversi-

fication (WEBB et al. 2002). Thus, by adding the facts that areas have different sizes and particular histories of occupation, and the different snake lineages and populations have different abilities to occupy particular niches (GHISELIN 1987), each phytophysiognomy in the state today has its unique richness and composition.

An elevated species richness found particularly in the areas of ombrophilous forest, for instance, has been the norm for several regions of Brazil (e.g., CONDEZ et al. 2009, CUNHA & NASCIMENTO 1993). In general, historic stability of this environment is a determining factor for high species richness (GRAHAM et al. 2006).

Despite of the large area of cerrado in Bahia, the representation of snakes is less than 25% of the total number of species reported from the entire savanna (142 species) (COLLI et al. 2002, PAVAN & DIXO 2003, SILVA et al. 2005), indicating an urgent necessity of increasing collecting efforts.

The knowledge of the ophidiofauna in the Caatinga of Bahia seems to be better, and its species richness corresponds to more than 80% of the total number of species listed for all the Caatinga biomes in the country ($n = 52$) (RODRIGUES 2003).

The absence of an exclusive restinga snake fauna has already been noted, and this is probably due to its rather short history of formation that has afforded it little time for speciation (VANZOLINI & AB'SABER 1968, DIAS 2006).

The particularities of the snake fauna from some areas of altitude in seasonal forests of the state were presented by ARGÔLO (1999e) and could be due to historic events of formation of this type of vegetation that allowed an unique faunal composition, particularly in the Planalto de Conquista (e.g., ARGÔLO 2001a, 2001b). It also encompasses elements of the Caatinga and forests, as observed in the Chapada Diamantina (e.g., ARGÔLO & FREITAS 2002, HAMDAN & LIRA-DA-SILVA 2007, HAMDAN et al. 2007, FREITAS et al. 2010), usually with elements of rupestrian fields and savanna. As we pointed out for the savannas and ROCHA & SLUYS (2007) for the restingas, the very few papers published highlight that the snake faunas of semi-deciduous seasonal forests and in particular deciduous forests are scarcely studied.

Characterizing endemic species is crucial for understanding taxa and geographical evolution. However, it can be somewhat a difficult task because well-supported geographical and ecological information is missing. This is exactly the case for many parts of Brazil, particularly in the areas adjoining the state of Bahia. Exhaustively studied regions, such as the municipalities of Santo Inácio and Barra on the opposite banks of the São Francisco River, are exceptions and show that the pairs of vicariant species are truly endemic and would have a particular history associated with the differentiation of the river drainage over time (see RODRIGUES 1991a, b, RODRIGUES 1993). However, the confirmation of endemism and the mechanisms of speciation associated with other species, such as *Bothrops pirajai* and *Atractus guentheri*, remain unclear even though their geographical ranges are relatively well studied (ARGÔLO 2004b).

Biogeographical notes and taxonomic comments

Tantilla marcovani from the municipality of Santo Inácio is a new record for the state of Bahia, expanding its known range by ca. 456 km N from Pico do Jabre, municipality of Maturéia, Paraíba State, the sole locality from which it was previously known (LEMA 2004).

Philodryas agassizii from the municipality of Caetité is the first record from northeastern Brazil, state of Bahia. It was previously known from northeastern Argentina and Uruguay and from Brazil from the states of São Paulo, Goiás, Brasília, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Paraná, Rio Grande do Sul and Santa Catarina (PETERS & OREJAS-MIRANDA 1970, KIEFER 1998, GIRAUDO 1999, NOGUEIRA 2001, GUIZONI-JR. et al. 2009, MARQUES et al. 2006).

The analysis of 24 specimens of *Thamnodynastes almae* from MZUFBA revealed meristic and morphological characteristics not previously reported, making them disagree with the original definition of the species (FRANCO & FERREIRA 2002).

The specimens examined present ventral and subcaudal counts ranging from 145–161 and 56–70, respectively, snout–vent lengths of 217–700 mm, head lengths of 12.64 to 29.87 mm, and tail lengths of 50–170 mm. Cloacal plate entire ($n = 3$) or divided ($n = 21$), and ventral side of the head with dark blotches varying in shape in all juvenile and some adult specimens. Besides Bahia and Ceará (FRANCO & FERREIRA 2002, JOVENTINO et al. 2009), we here also record for the first time its occurrence in the state of Alagoas, i.e., in the municipality of Piranhas. The new information outlines a necessity for complementing the diagnosis of this species, which is already underway.

The taxa *Leptophis ahaetulla liocercus*, *Dipsas indica petersi*, *D. i. indica* and *Micrurus lemniscatus carvalhoi* are here maintained at subspecies level even though their elevation to full species is imminent (see ALBUQUERQUE 2008, ARGÔLO 2004b, SILVA JR. 1999, 2001). All snakes with occurrences restricted to the ombrophilous forest have previously been portrayed in the literature as typical of forest habitats (CUNHA & NASCIMENTO 1993, LEMA et al. 2002, ARGÔLO 2004b, ARGÔLO & MOURA-LEITE 2007). Here we call attention to *Chironius bicarinatus*, which was found only in areas of ombrophilous forest, although literature suggests its occurrence in more open areas, too (DIXON et al. 1993, CARVALHO & SILVA 1994). *Xenodon merremii* showed to be a generalist species, although it is commonly regarded as an open-area species (VANZOLINI et al. 1980, VITT & VANGILDER 1983, MONTINGELLI & MOURA-LEITE 1996).

In contrast, the seemingly extensive plasticity in habitat use by *Liophis poecilogyrus* may in fact be due to two *sensu stricto* species still being known as a unique taxon: *L. p. schotti* (= *L. schotti*) and *L. p. poecilogyrus* (= *L. poecilogyrus*) with apparently allopatric distribution (FERNANDES 2006). The presence of *Philodryas nattereri*, a species typical of drier and more open environments (VANZOLINI et al. 1980), in areas regarded as ombrophilous forest may reflect

the continuous destruction that the Atlantic rainforest has been suffering along the Bahian coast and, as it is apparently an able colonizer, it seems to follow the expansion of open environments.

Apostolepis sp. 5 is described under the same denomination in FERRAREZZI (1993). This species belongs to the “*nigrolineata*” group (THALES DE LEMA unpubl. data) and is distinguished from the three other species of the group by having the nasal shield separated from the preocular, the absence of a light nuchal collar, and the presence of dark spots along the mid-ventral face of the tail (H. FERRAREZZI pers. comm.). The specimen examined has 15-15-15 dorsal rows, 141 (+ n) ventrals, 50 subcaudals (which is a very high count compared to *A. cearensis* that occurs in syntopy and has 25–28 subcaudals), and the cloacal scute divided.

Taeniophallus sp.1 is a member of the *T. occipitalis* group that is currently being described (A. SANTOS JR. unpubl. data).

Sibynomorphus sp.1 has 15-15-15 dorsal rows, a slightly enlarged vertebral row of scales, 170 ventrals, 64 subcaudals, 7 supralabials (the 3rd and 4th of which in contact with the orbit), 8 infralabials, an entire cloacal scute, 1 + 2 oculars, 1 + 2 temporals, and the loreal contacts the orbit directly. It was found in a high altitude area and is possibly an undescribed species. The species *S. mikanii* has previously been recorded from Bahia by ARGÔLO (1999e) and we confirm its presence in the state by the three specimens reported here (see appendix).

Still without any convincing explanation, our records show no syntopy for the widely distributed species in the state, *Oxyrhopus trigeminus*, and its counterpart *O. guibei* with a smaller range. More detailed ecological studies, contextualised in a historical biogeographical perspective are necessary to understand this phenomenon.

Liophis taeniogaster was the name used for both the population inhabiting the northern portion of the state and the population in the south, the latter of which may be referred to as *L. aff. taeniogaster*.

There is an apparent increase in the relative abundance of *L. almadensis* populations along the Bahian coast. Numbers of records are low for the south coast due to disjunctions in its distribution (ARGÔLO 2004b) and increase towards the north coast, where it is relatively common, especially in the metropolitan area of Salvador City.

Micrurus sp. 1 is a Bahian species without a name as yet that is currently under description (N. J. SILVA JR. pers. comm.). For further biological and geographical information on the Viperidae and Elapidae in northeastern Brazil, see LIRA-DA-SILVA (2009b) and LIRA-DA-SILVA et al. (1994, 2009).

The family Boidae is underrepresented in the literature, but we can highlight the widespread distribution of *Boa constrictor* in all types of vegetation, and the presence of *Corallus hortulanus* predominantly in areas of caatinga, which is a relict and unusual record, but also in other regions of the country (RODRIGUES 2003).

The Scolecophidia is undersampled, not only in the state of Bahia, but also throughout the rest of the country, and

statements about any aspect other than biological ones would be hasty.

ARGÔLO (2004b) presented the first and so far only record of the family Tropidophiidae for the state. This family consists of two neotropical genera, and the *Tropidophis* sp. 1 record, currently under description, will provide valuable information on the evolution and niching of a group that is considered a relict sister-group of the Caenophidia (ZAHER et al. 2009, OGUIURA et al. 2009).

According to WHITMORE & PRANCE (1987), WILEY (1988) and GASTON (2000), the “where?”, “why?”, “how?” and “since when?” organisms are distributed today are the most basic and important questions to answer for understanding how species change over time. Along with other researchers, we provided a contribution in answering the first of these questions, but comprehensive inventories that could close various gaps in the state inventory are still missing. They would facilitate accurate phylogeographic, taxonomic, and ecological studies to better understand the evolution of the group. The provided checklist is also a first step towards compiling a regional list of endangered species, not existent for the state of Bahia yet.

Species that likely occur in the state of Bahia, but are not properly documented and could increase the known richness of its snake fauna are *Apostolepis assimilis*, *Atractus reticulatus*, *Liophis meridionalis* and *Rachidelus brazili*. Vouchers exist in scientific collections, but are still awaiting confirmation of their taxonomic identities. As far as *Corallus caninus* is concerned, the species was reported for the first and last time by WUCHERER (1861a).

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Key to the genera of snakes from Bahia state, Brazil

Names in parentheses indicate a previous taxonomy

1. Ventral and dorsal scales equal or almost equal in size 67
Not so 2
2. Loreal region with deep pit 69
Loreal region without deep pit 3
3. Robust snakes; remnants of a pelvis are commonly seen externally as cloacal spurs; most of scales on the top of the head are small in size 71
Not so 4
4. A single internasal *Helicops*
A pair of internasals 5
5. Only one pair of chin shields *Atractus*
Not so 6
6. Vertebral row disproportionally enlarged 7
Vertebral and paravertebral rows subequal 11
7. Dorsal scale rows at midbody 17 or more 8
Dorsal scale rows at midbody 15 or fewer 10
8. Dorsal scale rows 25 or more *Rhachidelus*
Dorsal scale rows 19 or fewer 9
9. Dorsal scale rows without reduction, brownish *Imantodes*
Dorsal scale rows with reduction, reddish ... *Siphlophis*
10. Anal plate divided *Uromacerina*
Anal plate entire *Dipsas*
11. Loreal scale absent; sometimes prefrontal and supralabial scales in the loreal region 12
Loreal scale present 21
12. Dorsal scale rows 21 or more *Tropidophis*
Dorsal scale rows fewer than 21 13
13. Rostral modified 14
Rostral normal 15
14. Dorsum and belly with green longitudinal stripes; supralabials < 8 *Philodryas* (*Xenoxybelis*)
Dorsum and belly without stripes; Supralabials ≥ 8 *Oxybelis*
15. Body with coral snake ringed pattern in red, black and white, complete ventrally; proteroglyphous *Micrurus*
Body without coral snake ringed pattern 16

16. Internasal scales fused with prefrontal; tip of the tail dark *Apostolepis*
Internasal scales normal 17
17. Top of the head half black, half pale
..... *Coronelaps (Elapomorphus)*
Top of the head uniform 18
18. Subcaudal scales more than 100 *Leptophis*
Subcaudal scales fewer than 100 19
19. With nuchal collar or band across back of head *Tantilla*
Not so 20
20. Dorsum with more than one dark longitudinal stripe; without pre/postocular stripe or ocellate blotches *Elapomorphus*
Dorsum without distinct longitudinal stripe; with pre/postocular stripe and ocellate blotches *Caateboia*
21. Dorsal scales in oblique rows 22
Dorsal scale rows normal 24
22. Subcaudal scales more than 100 *Pseustes*
Subcaudal scales fewer than 85 23
23. Generally 8 supralabials *Xenodon*
Generally 7 supralabials *Xenodon (Waglerophis)*
24. Dorsals in an odd number of rows 25
Dorsals in an even number of rows 26
25. Dorsal scales rows at midbody 12 or fewer .. *Chironius*
Dorsal scales rows at midbody 14 or more *Spilotes*
26. Dorsal scale rows without reduction 27
Dorsal scale rows with reduction 38
27. Dorsal scale rows 15 or fewer 28
Dorsal scale rows 17 or more 35
28. Dorsal scale rows 13-13-13 29
Dorsal scale rows 15-15-15 30
29. Anal plate entire *Dipsas*
Anal plate divided *Pseudablades*
30. Anal plate entire 31
Anal plate divided 32
31. Preocular scales absent and the loreal entering orbit; generally two supralabials also in contact with orbit *Sibynomorphus*
Preocular scales present; generally three supralabials in contact with orbit *Drymoluber*
32. Body with 'coral snake pattern' *Erythrolamprus*
Not so 33
33. Subcaudal scales more than 85 *Mastigodryas*
Subcaudal scales fewer than 85 34
34. Dorsum without longitudinal stripes or ocellate blotches; belly with no longitudinal stripes *Liophis*
Dorsum with longitudinal stripes or ocellate blotches; belly with longitudinal stripes .. *Taeniophallus*
35. Prefrontal fused into a single scale; dorsum blotched all over *Xenopholis*
Prefrontal scales normal; if dorsal blotches are present, they are concentrated in the anterior region 36
36. Anal plate entire *Drymoluber*
Anal plate divided 37
37. Lateral and ventral anterior regions of the body not yellow; vertebral stripe generally present; tip of the scales in the vertebral row darker than on the neighbouring scales; subcaudals 55-82 *Taeniophallus*
Lateral and ventral anterior regions of the body yellow; vertebral stripe generally absent; subcaudals 82-108 *Echinanthera*
38. Dorsal scale rows 13-13-11 *Dipsas*
Dorsal scales rows at midbody 15 or more 39
39. Dorsal scales rows at midbody 15, keeled, apical pits present *Leptophis*
Dorsal scales rows at midbody 15, smooth 40
Dorsal scales rows at midbody more than 15 42
40. Rostral modified; body with coral snake pattern *Simophis*
Rostral normal; body without coral snake pattern 41
41. Anal plate entire *Sibynomorphus*
Anal plate divided *Taeniophallus*
42. Dorsal scale rows 17 43
Dorsal scale rows more than 17 50
43. Rostral modified 44
Rostral normal 45
44. Dorsum and belly with green longitudinal stripes; supralabials < 8 *Philodryas (Xenoxybelis)*
Dorsum and belly without stripes; supralabials ≥ 8 *Oxybelis*
45. Longitudinal lines/blotches extending over entire belly; well-marked or ill-defined; opisthophous *Thamnodynastes*
Longitudinal belly lines, if present, restricted to the posterior region; aglyphous 46
46. Belly with chequered pattern of red/yellow and black or occasionally with black marks on lateral edges of ventrals *Liophis*
Not so 47

47. Anal plate entire *Drymarchon*
Anal plate divided 48
48. Subcaudal scales ≥ 85 *Mastigodryas*
Subcaudal scales < 85 49
49. Vertebral line from the neck to the tail present;
paraventral line from the neck to anal region
present; supralabials distinctly paler than the
top of the head *Psomophis*
Dorsum variably patterned; if vertebral line is
present, never a paraventral line from the neck
to the anal region *Liophis*
50. Dorsal scale rows more than 19 51
Dorsal scale rows 19 55
51. Greenish, bluish in preserved specimens *Philodryas*
Another colour except green 52
52. Most subcaudals entire *Tropidophis*
Most subcaudals divided 53
53. Dorsum without well-marked blotches 54
Not so; long postocular stripe, generally
connecting with the dorsal region; dorsum
with square blotches *Tropidodryas*
Not so; a short postocular stripe, generally not
connecting with the dorsal region; dorsum with
rounded blotches *Leptodeira*
54. Blackish; if another colour, nuchal collar always
present; dorsal scale rows ≥ 25 *Rhachidelus*
Brownish; nuchal collar absent; dorsal scale
rows < 25 *Philodryas*
55. Most subcaudal scales entire; rostral not or little
modified *Pseudoboa*
Most subcaudal scales entire; rostral substan-
tially modified *Phimophis*
Most subcaudal scales divided 56
56. Belly with longitudinal lines/blotches, well-
marked or ill-defined *Thamnodynastes*
Belly without longitudinal lines/blotches 57
57. Anal plate divided 58
Anal plate entire 61
58. Rostral modified *Lystrophis*
Rostral normal 59
59. Dorsum uniform brownish or orange with dark
round spots all over, fused in some cases; post-
ocular stripe always present; never with a 'coral
snake pattern' *Leptodeira*
Dorsum variable, but if uniform brownish
with dark round spots all over, the postocular
stripe is absent 60
60. Opisthoglyphous; long tail with more than 85 sub-
caudals *Philodryas*
Aglyphous; short tail with fewer than 85 sub-
caudals *Liophis*
61. Dorsum and belly greenish, bluish in preserved
specimens *Philodryas*
Not so 62
62. Dorsum uniform black/brown without blotches
in adults, or if another colour, nuchal collar
always present; sometimes ill-defined all over
or no blotches; only the 3rd and 4th but not
the 5th supralabial entering orbit; rostral little
or substantially modified 63
Dorsum with blotches or rings all over, or if
uniform; the 5th supralabial entering orbit;
rostral normal 66
63. Fewer than 195 ventrals; rostral little modified
..... *Phimophis*
More than 195 ventral 64
64. Rostral substantially modified, upturned into a
sharp point *Phimophis*
Rostral little modified 65
65. Dorsum uniform dark and belly uniform yellow
or white in adults, in some case with dark
pigmentation only on the outer lateral tips
of the scales; juveniles with nuchal collar;
loreal generally missing or reduced in com-
parison with postnasal *Clelia*
Dorsum uniform dark and belly gradually
becoming darker towards the tail where dark
pigmentation covers entire scales; juveniles with
nuchal collar; loreal not normally reduced in
comparison with the postnasal *Boiruna*
66. Body round; head not distinctly broader than
neck; generally two supralabials in contact
with orbit; tail short; top of the head
monochrome *Oxyrhopus*
Body compressed; head distinctly broader than
neck; generally three supralabials in contact
with orbit; tail long; top of the head
spotted *Siphlophis*
67. Ventrals and dorsals almost equal in size; body
scale rows 14 *Epictia* / *Siagonodon* / *Tricheilostoma*
Ventrals and dorsals almost equal in size; body
scale rows > 14 68
68. Prefrontals present, separated by the contact
between rostral and frontal *Liotyphlops*
Prefrontals absent; posterior nasal scale en-
larged contacting frontal; preocular and
anterior nasal scales separated *Typhlops*

69. Tip of tail without rattle 70
 Tip of tail with rattle *Caudisona*
70. All dorsal scales uniformly keeled; tip of tail
 without bone spine and non-prehensile
 *Bothrops / Bothropoides*
 All dorsal scales uniformly keeled; tip of tail
 without bone spine and prehensile; ground
 colour green *Bothriopsis*
 Scales in middorsal rows with knobby keels; tip
 of tail with bone spine; ground colour yellow .. *Lachesis*
71. Scales on top of the head and snout the same
 size; supralabial sensory pits absent 72
 Scales on top of the head and snout different in
 size; supralabial sensory pits present 73
72. Top of the head uniformly brown, without
 median stripes *Eunectes*
 Top of the head not uniform with a median
 longitudinal dark stripe *Boa*
73. Supralabial scales entering orbit; tail not
 prehensile *Epicrates*
 Supralabial scales not entering orbit; tail pre-
 hensile *Corallus*

Appendix

Voucher numbers of new snakes records from the state of Bahia housed in the Coleção de Répteis of Museu de Zoologia from Universidade Federal da Bahia (MZUFBA).

Dipsadidae: *Apostolepis* sp. 5: Brasil: Bahia: Poções: 1808, 1810, 1814. *Philodryas agassizii*: Brasil: Bahia: Caetité: 2.043. *Sibynomorphus* sp. 1: Brasil: Bahia: Lençóis: 800. *Taeniophallus* sp. 1: Brasil: Bahia: Poções: 1.849. *Tantilla marcovani*: Brasil: Bahia: Santo Inácio: 1.769. *Thamnodynastes almae*: Brasil: Alagoas: Piranhas: 847, 1.128. Elapidae: *Micrurus* sp. 1: Brasil: Bahia: Paulo Afonso: 99, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178. Brasil: Alagoas: Piranhas: 1.160, 1.162, 1.163, 1.164.



Figure 1. Snakes from Bahia. A. *Epictia borapeliotes*; B. *Typhlops brongersmianus*; C. *Boa constrictor*; D. *Corallus hortulanus*; E. *Epicrates assisi*; F. *Epicrates cenchria*; G. *Epicrates crassus*; H. *Eunectes murinus*. Photos: G. PUERTO (D), M. A. FREITAS (E, G, D), D. LOEBMANN (H).



Figure 2. Snakes from Bahia. I. *Chironius carinatus*; J. *Chironius fuscus*; K. *Chironius flavolineatus* (central state pattern); L. *Chironius flavolineatus*; M. *Leptophis ahaetulla*; N. *Oxybelis aeneus*; O. *Pseustes sulphureus*; P. *Spilotes pullatus*. Photos: T. FILADELFO (I), M. A. FREITAS (K), D. LOEBMANN (M), C. SAMPAIO (O) G. PUERTO (P).



Figure 3. Snakes from Bahia. Q. *Apostolepis cearensis*; R. *Boiruna sertaneja*; S. *Dipsas indica*; T. *Dipsas sazimai*; U. *Echinanthera melanostigma*; V. *Erythrolamprus aesculapii*; W. *Liophis miliaris*; X. *Liophis poecilogyrus*. Photos: M. A. FREITAS (R), T. FILADELFO (S, T), O. A. V. MARQUES (U).



Figure 4. Snakes from Bahia. Y. *Liophis reginae*; Z. *Liophis taeniogaster*; AA. *Oxyrhopus rhombifer*; AB. *Oxyrhopus trigeminus*; AC. *Philodryas patagoniensis*; AD. *Pseudoboa nigra*; AE. *Sibynomorphus mikanii*; AF. *Sibynomorphus neuwiedi*. Photos: D. LOEBMANN (Y), A. CAMACHO (AD).



Figure 5. Snakes from Bahia. AG. *Taeniophallus affinis*; AH. *Taeniophallus occipitalis*; AI. *Thamnodynastes pallidus*; AJ. *Thamnodynastes* sp. 2; AK. *Siphlophis compressus*; AL. *Siphlophis leucocephalus*; AM. *Xenodon newwiedii*; AN. *Xenodon rhabdocephalus*. Photos: D. LOEBMANN (AG), M. A. FREITAS (AK, AL).



Figure 6. Snakes from Bahia. AO. *Bothriopsis bilineata*; AP *Bothropoides erythromelas*; AQ *Bothropoides jararaca*; AR. *Bothrops leucurus*; AS. *Bothrops pirajai*; AT. *Caudisona durissa*; AU. *Lachesis muta*; AV. *Micrurus corallinus*. Photos: G. PUERTO (AU), R. J. SAWAYA (AV).

Table 1. Richness and composition of snake species recorded for the State of Bahia and their main physiognomy types of occurrence. Endemic species are marked with an (*) and species with no habitat use data with an (**). OF = Ombrophilous Forest; Ca = Caatinga; Re = Restinga; Sa= Savanna; SDSF = Semi-Deciduous Seasonal Forest; DSF = Deciduous Seasonal Forest.

Taxon	Habitat use						Previous record
Family/Species	OF	Ca	Re	Sa	SDSF	DSF	
Anomalepididae							
<i>Liotyphlops trefauti</i> (FREIRE, CARAMASCHI & ARGÔLO, 2007)	X						ARGÔLO (2004b)
Leptotyphlopidae							
<i>Epictia borapeliotes</i> (VANZOLINI, 1996)		X		X			VANZOLINI (1996)
<i>Siagonodon brasiliensis</i> (LAURENT, 1949)				X			LAURENT (1949)
<i>Tricheilostoma salgueiroi</i> (AMARAL, 1955)	X		X				ARGÔLO (2004b)
Typhlopidae							
<i>Typhlops amoipira</i> (RODRIGUES & JUNCÁ, 2002)		X					RODRIGUES & JUNCÁ (2002)
<i>Typhlops brongersmianus</i> (VANZOLINI, 1976)	X		X		X		VANZOLINI (1976)
<i>Typhlops yonenagae</i> * (RODRIGUES, 1991)		X					RODRIGUES (1991a)
Tropidophiidae							
<i>Tropidophis</i> sp. 1***							ARGÔLO (2004b)
Boidae							
<i>Boa constrictor</i> (LINNAEUS, 1758)	X	X	X	X	X		WUCHERER (1861a)
<i>Corallus hortulanus</i> (LINNAEUS, 1758)	X	X					REUSS (1834)
<i>Epicrates assisi</i> (MACHADO, 1945)		X		X	X	X	VANZOLINI et al. (1980)
<i>Epicrates cenchria</i> (LINNAEUS, 1758)	X						GÜNTHER (1861)
<i>Epicrates crassus</i> (COPE, 1862)				X			AMARAL (1954)
<i>Eunectes murinus</i> (LINNAEUS, 1758)	X		X		X		WUCHERER (1861a)
Viperidae							
<i>Bothriopsis bilineata</i> (WIED, 1825)	X						WUCHERER (1861a)
<i>Bothropoides erythromelas</i> (AMARAL, 1923)		X	X				AMARAL (1923)
<i>Bothropoides jararaca</i> (WIED, 1824)					X		AMARAL (1977)
<i>Bothropoides lutzi</i> (MIRANDA-RIBEIRO, 1915)				X			MIRANDA-RIBEIRO (1915)
<i>Bothropoides neuwiedi</i> (WAGLER, 1824)					X		WAGLER (1824)
<i>Bothrops jararacussu</i> (LACERDA, 1884)					X		CAMPBELL & LAMAR (1989)
<i>Bothrops leucurus</i> (WAGLER, 1824)	X		X		X		WUCHERER (1861a)
<i>Bothrops moojeni</i> (HOGE, 1966)				X			HOOGMOED & GRUBER (1983)
<i>Bothrops pirajai</i> * (AMARAL, 1923)	X						AMARAL (1923)
<i>Caudisona durissa</i> (LINNAEUS, 1758)		X	X	X	X	X	WAGLER (1824)
<i>Lachesis muta</i> (LINNAEUS, 1766)	X						WUCHERER (1861b)
Elapidae							
<i>Micrurus brasiliensis</i> (ROZE, 1967)				X			ROZE (1967)
<i>Micrurus corallinus</i> (MERREM, 1820)	X						GÜNTHER (1861)
<i>Micrurus ibiboboca</i> (MERREM, 1820)	X		X				CAMPBELL & LAMAR (1989)
<i>Micrurus lemniscatus carvalhoi</i> (ROZE, 1967)	X		X				GÜNTHER (1861)
<i>Micrurus</i> sp. 1		X			X	X	new record
Colubridae							
<i>Chironius bicarinatus</i> (WIED, 1820)	X						DIXON (1993)
<i>Chironius carinatus</i> (LINNAEUS, 1758)	X						WUCHERER (1861b)
<i>Chironius exoletus</i> (LINNAEUS, 1758)	X	X	X				DIXON (1993)
<i>Chironius flavolineatus</i> (BOETTGER, 1885)	X		X				DIXON (1993)
<i>Chironius foveatus</i> (BAILEY, 1955)	X						BAILEY (1955)
<i>Chironius fuscus</i> (LINNAEUS, 1758)	X		X				WUCHERER (1861b)
<i>Chironius laevicollis</i> (WIED, 1824)	X						MARQUES & PUERTO (1996)
<i>Chironius quadricarinatus</i> (BOIE, 1827)	X			X			ARGÔLO (1998b)

The snakes of northeastern Brazil

Taxon Family/Species	Habitat use						Previous record
	OF	Ca	Re	Sa	SDSF	DSF	
<i>Drymarchon corais</i> (BOIE, 1827)	X	X	X				WUCHERER (1861b)
<i>Drymoluber brazili</i> (GOMES, 1918)				X	X		ARGÔLO (2004a)
<i>Drymoluber dichrous</i> (PETERS, 1863)	X						AMARAL (1977)
<i>Leptophis ahaetulla liocercus</i> (WIED, 1824)	X		X				WUCHERER (1861a)
<i>Leptophis</i> sp.1		X		X	X		VANZOLINI (1980)
<i>Mastigodryas bifossatus</i> (RADDI, 1820)	X	X		X	X		AMARAL (1977)
<i>Oxybelis aeneus</i> (WAGLER, 1824)	X	X	X	X			WUCHERER (1861b)
<i>Pseustes sulphureus</i> (WAGLER, 1824)	X						WUCHERER (1861b)
<i>Simophis rhinostoma</i> ** (SCHLEGEL, 1837)							ARGÔLO (1998c)
<i>Spilotes pullatus</i> (LINNAEUS, 1758)	X	X	X		X		WUCHERER (1861b)
<i>Tantilla marcovani</i> (LEMA, 2004)		X					new record
<i>Tantilla melanocephala</i> (LINNAEUS, 1758)	X		X	X			MONTANELLI et al. (1997)
Dipsadidae							
<i>Apostolepis ammodites</i> (FERRAREZZI, BARBO & ALBUQUERQUE, 2005)				X			FERRAREZZI et al. (2005)
<i>Apostolepis arenaria</i> * (RODRIGUES, 1992)		X					RODRIGUES (1992)
<i>Apostolepis cearensis</i> (GOMES, 1915)	X	X					ZAMPROGNO et al. (1998)
<i>Apostolepis flavotorquata</i> (DUMÉRIL, BIBRON & DUMÉRIL, 1854)				X			LEMA & RENNER 2005
<i>Apostolepis gaboi</i> * (RODRIGUES, 1992)		X					RODRIGUES (1992)
<i>Apostolepis</i> sp. 5**							new record
<i>Atractus guentheri</i> * (WUCHERER, 1861)	X						WUCHERER (1861a)
<i>Atractus potschi</i> (FERNANDES, 1995)	X	X					LIMA et al. (2000)
<i>Bairuna sertaneja</i> (ZAHER, 1996)		X					ZAHER (1996)
<i>Caaeteboia Amarali</i> (WETTSTEIN, 1930)	X						WETTSTEIN (1930)
<i>Clelia plumbea</i> (WIED, 1820)	X						ZAHER (1996)
<i>Coronelaps lepidus</i> (REINHARDT, 1861)	X						BOULENGER (1896)
<i>Dipsas albifrons</i> (SAUVAGE, 1884)	X						ARGÔLO (2004b)
<i>Dipsas catesbyi</i> (SENTZEN, 1796)	X						GÜNTHER (1861)
<i>Dipsas indica indica</i> (BOETTGER, 1802)	X						ARGÔLO & ALVES (2003)
<i>Dipsas indica Petersi</i> (HOGE & ROMANO, 1975)	X						ALVES & ARGÔLO (1998)
<i>Dipsas sazimai</i> (FERNANDES, MARQUES & ARGÔLO, 2010)	X						FERNANDES et al. (2010)
<i>Dipsas variegata</i> (DUMÉRIL, BIBRON & DUMÉRIL, 1854)	X						PETERS (1960)
<i>Echinanthera cephalostriata</i> ** (DI-BERNARDO, 1996)							ARGÔLO & DE JESUS (2008)
<i>Echinanthera melanostigma</i> (WAGLER, 1824)							WAGLER (1824)
<i>Elapomorphus Wuchereri</i> (GÜNTHER, 1861)	X						GÜNTHER (1861)
<i>Erythrolamprus aesculapii</i> (LINNAEUS, 1766)	X						WUCHERER (1861a)
<i>Helicops angulatus</i> (LINNAEUS, 1758)	X		X				WAGLER (1824)
<i>Helicops leopardinus</i> (SCHLEGEL, 1837)	X	X	X		X		DUMÉRIL et al. (1854)
<i>Helicops modestus</i> (GÜNTHER, 1861)		X					FREITAS & SILVA (2011)
<i>Imantodes cenchoa</i> (LINNAEUS, 1758)	X						MARQUES (1996)
<i>Leptodeira annulata</i> (LINNAEUS, 1758)	X	X		X	X	X	GÜNTHER (1861)
<i>Liophis almadensis</i> (WAGLER, 1824)	X	X	X		X		WAGLER (1824)
<i>Liophis dilepis</i> (COPE, 1862)		X					FREITAS (2003)
<i>Liophis maryellenae</i> (DIXON, 1985)				X	X		DIXON (1985)
<i>Liophis miliaris</i> (LINNAEUS, 1758)	X			X			WIED (1821)
<i>Liophis mossoroensis</i> (HOGE & LIMA-VERDE, 1972)		X					DIXON (1983)
<i>Liophis poecilogyrus</i> (WIED, 1825)	X	X	X	X	X	X	WAGLER (1824)
<i>Liophis reginae</i> (LINNAEUS, 1758)	X		X				WUCHERER (1861b)
<i>Liophis taeniogaster</i> (JAN, 1863)	X	X	X		X		DIXON (1983)
<i>Liophis typhlus</i> (LINNAEUS, 1758)	X						OUTEIRAL et al. (1995)
<i>Liophis viridis</i> (GÜNTHER, 1862)		X	X				JAN (1863)

Taxon Family/Species	Habitat use						Previous record
	OF	Ca	Re	Sa	SDSF	DSF	
<i>Oxyrhopus clathratus</i> ** (DUMÉRIL, BIBRON & DUMÉRIL, 1854)							ARGÔLO (2001b)
<i>Oxyrhopus formosus</i> (WIED, 1820)	X						WIED (1820)
<i>Oxyrhopus guibei</i> (HOGE & ROMANO, 1978)	X						ZAHER & CARAMASCHI (1992)
<i>Oxyrhopus petola</i> (LINNAEUS, 1758)	X	X	X				REUSS (1834)
<i>Oxyrhopus rhombifer</i> (DUMÉRIL, BIBRON & DUMÉRIL, 1854)		X		X			ARGÔLO & FREITAS (2000)
<i>Oxyrhopus trigeminus</i> (DUMÉRIL, BIBRON & DUMÉRIL, 1854)	X	X	X	X	X	X	DUMÉRIL et al. (1854)
<i>Philodryas aestiva</i> (DUMÉRIL, BIBRON & DUMÉRIL, 1854)				X			ARGÔLO & FREITAS (2002)
<i>Philodryas agassizii</i> (JAN, 1863)				X			new record
<i>Philodryas argenteus</i> ** (DAUDIN, 1803)							WUCHERER (1861b)
<i>Philodryas nattereri</i> (STEINDACHNER, 1870)	X	X	X	X	X		BRAZIL et al. (1992)
<i>Philodryas olfersii</i> (LICHTENSTEIN, 1823)	X	X	X	X			WIED (1824)
<i>Philodryas patagoniensis</i> (GIRARD, 1858)	X		X		X		BRAZIL et al. (1992)
<i>Philodryas viridissima</i> (LINNAEUS, 1758)	X						WUCHERER (1861b)
<i>Phimophis chui</i> (RODRIGUES, 1993)		X					RODRIGUES (1993)
<i>Phimophis guerini</i> (DUMÉRIL, BIBRON & DUMÉRIL, 1854)		X	X	X			DUMÉRIL et al. (1854)
<i>Phimophis iglesiasii</i> (GOMES, 1915)		X		X			GOMES (1915)
<i>Phimophis scriptorciatus</i> * (RODRIGUES, 1993)		X					RODRIGUES (1993)
<i>Pseudoboa nigra</i> (DUMÉRIL, BIBRON & DUMÉRIL, 1854)	X	X	X		X		DUMÉRIL, BIBRON & DUMÉRIL (1854)
<i>Psomophis joberti</i> (SAUVAGE, 1884)				X		X	MYERS & CADLE (1994)
<i>Sibynomorphus mikanii</i> (SCHLEGEL, 1837)	X			X			ARGÔLO (2002a)
<i>Sibynomorphus neuwiedi</i> (IHERING, 1911)	X		X				PETERS (1960)
<i>Sibynomorphus</i> sp. 1*					X		new record
<i>Siphlophis compressus</i> (DAUDIN, 1803)	X		X				ARGÔLO (2004b)
<i>Siphlophis leucocephalus</i> (GÜNTHER, 1863)	X						GÜNTHER (1863)
<i>Siphlophis pulcher</i> (RADDI, 1820)	X						ARGÔLO (2004b)
<i>Taeniophallus affinis</i> ** (GÜNTHER, 1858)							ARGÔLO (1998a)
<i>Taeniophallus occipitalis</i> (JAN, 1863)	X		X				JAN (1863)
<i>Taeniophallus</i> sp. 1		X					new record
<i>Thamnodynastes almae</i> (FRANCO & FERREIRA, 2002)		X					FRANCO & FERREIRA (2002)
<i>Thamnodynastes hypoconia</i> ** (COPE, 1860)							FRANCO & FERREIRA (2002)
<i>Thamnodynastes nattereri</i> (MIKAN, 1828)	X						GÜNTHER (1861)
<i>Thamnodynastes pallidus</i> (LINNAEUS, 1758)	X				X		WAGLER (1824)
<i>Thamnodynastes sertanejo</i> (BAILEY, THOMAS & SILVA-JR., 2005)		X				X	BAILEY, THOMAS & SILVA (2005)
<i>Thamnodynastes</i> sp. 2		X		X	X	X	FRANCO & FERREIRA (2002)
<i>Tropidodryas serra</i> (SCHLEGEL, 1837)	X						ARGÔLO (1999b)
<i>Tropidodryas striaticeps</i> (COPE, 1869)					X		ARGÔLO (1999c)
<i>Uromacerina ricardinii</i> (PERACCA, 1897)	X						ARGÔLO (2001a)
<i>Xenodon merremii</i> (WAGLER, 1824)	X	X	X	X	X	X	WAGLER (1824)
<i>Xenodon nattereri</i> ** (STEINDACHNER, 1867)							ARGÔLO (2002b)
<i>Xenodon neuwiedii</i> ** (GÜNTHER, 1863)							ARGÔLO (1999d)
<i>Xenodon rhabdocephalus</i> (WIED, 1824)	X				X		WIED (1824)
<i>Xenopholis scalaris</i> (WUCHERER, 1861)	X						WUCHERER (1861c)