Integrative overview of snake species from Londrina, state of Paraná, Brazil (Reptilia; Squamata)

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Abstract. The Municipality of Londrina is located in the northern region of the State of Paraná, and is inserted in the Atlantic Forest Biome, which is considered a biodiversity hotspot for world conservation. This biome suffers from the loss of natural areas mainly due to urbanization, agriculture and livestock farming. Therefore, it is imperative to improve the knowledge of species occurring in the region for their efficient conservation. Due to its large area and lack of herpetological studies, most of the northern region of the state of Paraná presents gaps in snake records. The present study aims to review the records of snake species for the municipality of Londrina based on the literature and specimens deposited in scientific collections. Thirty-two (32) snake species were reported, belonging to the families Anomalepididae (1), Boidae (1), Colubridae (4), Dipsadidae (18), Elapidae (2), Typhlopidae (1) and Viperidae (5). In addition, we present an artificial key to the identification of the reported species.

Keywords. Atlantic Forest, Biodiversity, Conservation, Serpentes

Introduction

The state of Paraná is inserted within the Atlantic Forest biome (IBGE, 2004), considered a hotspot for its high biological richness and deforestation, also being one of the 36 most relevant areas for biodiversity conservation worldwide (Myers et al., 2000; CEPF, 2019). This biome harbors over 8,000 endemic species of vascular plants, 323 amphibians, 94 reptiles, 148 birds and 48 mammals, being considered as one of the most diverse areas of the planet (Mittermeier et al., 2011). The Brazilian Atlantic Forest in the state of Paraná is divided into three ecoregions: Alto Paraná Atlantic forests, Araucaria moist forests and Serra do Mar coastal forests (Dinerstein et al, 2017). The Serra do Mar coastal forests present high humidity and are limited to the coast of the state; Araucaria moist forests are concentrated in the southern region and present lower temperatures with abundant presence of the arboreal species Araucaria angustifolia, known as the pine-of-Paraná; Alto Paraná Atlantic forest, where the municipality of Londrina is located, in the north-central region of the state, dominates the Seasonal Semideciduous forest, a seasonal and less developed forest, with lower humidity, specially during winter (DaSilva and Pinto-da-Rocha, 2011).

Few studies were conducted focusing on the reptile fauna of Paraná; among these, we highlight the squamate species list of Boettger (1905) and the list of specimens collected by André Mayer, compiled by Berníls and Moura-Leite (1990). Later, Morato (1995), in his unpublished dissertation, presented a study on the geographic distribution of the snakes from Araucaria Forest and adjacent vegetation formations, while Morato et al. (1995) provide a state list of threatened snake taxa. One year later, Moura-Leite et al. (1996) published new records of 22 species of reptiles in the state of Paraná.
Nine years later, Morato (2005) presented a monograph on the diversity, distribution and ecology of the snakes from the Atlantic Forest portion (Serra do Mar coastal forests) of Paraná.

Snake assemblage inventories in Paraná municipalities are still incipient, until now restricted to São José dos Pinhais (Oliveira and Oliveira, 2014), Mauá Hydroelectric Power Plant along Tibagi River (Souza-Filho and Oliveira, 2015), Pinhão (Souza-Filho et al., 2015), and Curitiba (Morato et al., 2017). In Londrina, Bernardeso and Machado (2002, 2006) sampled the herpetofauna from the Tibagi river basin. More recently, Shibatta et al. (2009) presented a checklist of the vertebrate fauna inhabiting the campus of the Universidade Estadual de Londrina (Londrina State University), with remarks on its herpetofauna within 12 species of snakes. The region of Londrina presents a large area of preserved forest at the Parque Estadual Mata dos Godoy (Godoy Forest State Park), with 656 ha (considering its continuous landscape of native phytophysionomies), an important refuge for local animals (Lopes and Anjos, 2006).

Aiming to promote a refinement of the geographic distribution and composition of the snake fauna in the state of Paraná, in this study we update the list of snakes of the municipality of Londrina, present new records for the area and discuss dubious occurrences previously mentioned in the literature. Additionally, we compare the snake taxocenosis of Londrina with that of other Atlantic Forest areas of Paraná.

Materials and methods

Study area.— The municipality of Londrina (23.29°S, 51.17°W) presents an area of 1,653.3 km² and mean elevation of 550 m above sea level, in the Atlantic Forest at the northern region of the state of Paraná (Fig. 1). In this area, the Atlantic Forest belongs to the Alto Paraná Atlantic Forest ecoregion (Dinerstein et al. 2017), and is characterized by its subtropical climate, a high annual temperature range (16–22 °C). In its southernmost portion, hoarfrosts are common during the winter (from June to August), notably in higher elevations (Di Bitetti et al., 2003). The precipitation in this ecoregion ranges from 1,000 to 2,200 mm per year, being generally lower in its northernmost region. Rains are not evenly distributed throughout the year, with drought periods up to five months, usually during the winter. The prevailing vegetation is Seasonal Semideciduous Forests (Di Bitetti et al., 2003).

During the colonization of the region, most of the native vegetation was deforested for logging activities, and later, for coffee plantations (IPARDES, 1993). The remaining mosaics of original vegetation, as small as they may be, employ an important role for biodiversity maintenance, hydrologic cycles and regional climate (Nepstad et al., 1996).

Sampling.— We compiled available literature on snakes recorded to the Municipality of Londrina. We also examined specimens housed in the Museu de Zoologia da Universidade Estadual de Londrina (MZUEL) and the voucher specimens in the Museu de História Natural Capão da Imbuia (MHNCI). Identifications follow Peters and Orejas-Miranda (1970), Dixon et al. (1993), and Costa et al. (2016). We follow the nomenclature adopted by Costa and Bérnils (2018) for taxon names.

Data analysis.— The composition of Londrina snake species was compared to other 12 Atlantic Forest localities in municipalities from the state of Paraná (Fig. 2): Tijucas do Sul, Guaratuba, Matinhos, Pontal do Paraná, Guaraqueçaba, Paranaguá, Antonina, Morretes, and Piraquara (Morato, 2005); São José dos Pinhais (Oliveira and Oliveira, 2014); Pinhão (Souza-Filho et al., 2015); and Curitiba (Morato et al., 2017).

With this data set, we generated a binary matrix concerning the presence/absence of 78 species.
We conducted the taxocenosis comparisons using the Jaccard similarity index (Jaccard, 1901) and Unweighted Pair Group Method with Arithmetic mean (UPGMA) (Sokal and Michener, 1958) as grouping method. The cophenetic correlation coefficient (Sokal and Rohlf, 1962) was calculated to indicate the degree of representability of the similarity matrix in the dendrogram, considering that values greater than or equal to 0.8 allow for dendrogram evaluation are adequate for the similarity matrix (Rohlf, 2000). The graphical result of the analysis allows the identification of groups formed by the evaluated localities, considering the similarities they present according to snake species composition. The multivariate analysis was performed using the R software (R Core Team 2014), using the vegan package (Oksanen et al., 2015).

Results

We examined the previous literature records from the region of Londrina (encompassing 30 species), the list of snake species recorded to Londrina at the MHNCI database (9 species), and 149 specimens housed in MZUEL (21 species; Appendix 1). Our study resulted in a total of 32 snakes species from 20 genera and seven families recorded to the municipality of Londrina (Fig. 3–4; Table 1), and we present an artificial dichotomic key to the identification of such species (Appendix 2).

The cluster analysis (cophenetic correlation coefficient = 0.8391), was employed based on 78 snakes species recorded in 13 localities and resulted in two clusters (Fig. 5):

Cluster 1 – Divided into two main subgroups: the first, composed by Paranaense Forest (municipality of Londrina), and the second, by the Araucaria Forest (municipalities of Curitiba, Pinhão, Piraquara, and Tijucas do Sul.)

Cluster 2 – This cluster presents only Serra do Mar localities (municipalities of Antonina, Guaraqueçaba, Guaratuba, Matinhos, Morretes, Paranaaguá, Pontal do Paraná, and São José dos Pinhais).

Discussion

Taxonomic considerations.— Since the previous samplings at Londrina, several noteworthy taxonomic changes have occurred. Zaher et al. (2009) presented a novel phylogenetic hypothesis, revalidating Dipsadidae Bonaparte, 1840 as a family for some taxa previously included in Colubridae Oppel, 1811; this proposal is followed herein.

_Dipsas indica_ Laurenti, 1768 suffered a taxonomic split, and the taxon previously cited as _Dipsas indica_ (Bernarde and Machado, 2002; Bernarde and Machado, 2006; Shibatta et al., 2009) should be treated as _Dipsas bucephala_ (Shaw, 1802) (Harvey, 2008; Harvey and Embert, 2008), a species that occurs in seasonal forests of the Paraná river basin. Forms of _Dipsas indica_ that occur in dense ombrophilous forests of the Atlantic Forest and coastal areas are now treated as _Dipsas indica indica_ Laurenti, 1768 and _Dipsas indica petersi_ Hoge and Romano-Hoge, 1975. This arrangement is, however, still uncertain, since _D. bucephala_ is still disputed as a junior synonym of the amazon form of _D. indica_, and the Paraná river basin populations could represent an unnamed taxon.

The genus _Liophis_ Wagler, 1930 presents poorly resolved interspecific relationships, as some authors consider it polyphyletic in its current form. Zaher et al. (2009) proposed the synonymization of the genus _Erythrolamprus_ Boie, 1826 under _Liophis_, and revalidating _Lygophis_ Fitzinger 1843. Curcio et al. (2009) contested these taxonomic actions, since
Erythromamus has priority over Liophis, while also commenting on poor sampling and lack of the type species of Liophis and Lygophis in the analyses. Grazziotin et al. (2012) suggest Liophis and Umbrivaga Roze, 1964 as junior synonyms of Erythromamus, while revalidating Lygophis.

Previous records of Micrurus frontalis (Duméril, Bibron and Duméril, 1854) are now referred to as Micrurus altirostris (Cope, 1860), based on Silva-Jr. and Sites (1999). The former taxon does not occur south of the Paranapanema river.

Dubious occurrence and misidentification.—Chironius flavolineatus (Jan, 1863) cited by Bernarde and Machado (2002) represents Chironius bicarinatus (Wied, 1820) based on the specimens deposited at the MZUEL. This assertion is supported by the diagnosis provided by Dixon et al. (1993), and the phytophysignomy of Londrina. The region lacks open areas, typically occupied by C. flavolineatus (Bailey, 1955; Dixon et al., 1993).

The sympatric occurrence of Thamnodynastes hypoconia (Cope, 1860) and T. strigatus (Günther, 1858) was confirmed based on specimens deposited at the MZUEL collection. Previously, only T. strigatus had been recorded to the area. Even though this is a new record, the occurrence of T. hypoconia is not unexpected, considering these two species present largely sympatric
distributions and are poorly diagnosed from each other. According to Franco et al. (2017), *T. hypoconia* presents keeled dorsal scales (absent in *T. strigatus*) and unblemished labial scales (strongly spotted in *T. strigatus*). An integrative taxonomic review of this species complex is in progress (V. C. Trevine, unpubl. data) and will provide detailed diagnoses for these taxa.

Figure 4. Voucher specimens of some of the snake species deposited at Museu de Zoologia da Universidade Estadual de Londrina (MZUEL): A) *Micrurus altirostris* (MZUEL 119); B) *Oxyrhopus petolarius* (MZUEL 1686); C) *Philodryas ofersii* (MZUEL 1291); D) *Dipsas mikani* (MZUEL 131); E) *Thamnodynastes hypoconia* (MZUEL 727); F) *Thamnodynastes strigatus* (MZUEL 700).
The occurrence of *Helicops modestus* Günther, 1861 (Table 1) is dubious because there is no other record of this species for the state of Paraná (Costa and Bénils, 2018). The species is typical of open areas like the Cerrado and the Caatinga and can be easily confused with *Helicops infrataeniatus* Jan, 1865 which is more common on the southern region of Brazil. Besides, there is record of *Helicops gomesi* Amaral, 1921 on the northwest portion of the state of Paraná (Renato Bérnils pers. comm.). Still, the group has a taxonomic instability with poor diagnoses to separate some species and we cannot confirm the correct identification because the specimen (MZUEL 572) was not found in the collection.

**Conservation and last considerations.**— The municipality of Londrina presents 14.2% of the snake fauna recorded to the Brazilian Atlantic Forest (219 spp.) (Moura et al., 2016) and 28% of the species recorded to the state of Paraná (114 spp.) (Costa and Bénils, 2018). At the state of Paraná, in the Brazilian Atlantic Forest biome, Moura et al. (2016) suggested with macroecological methods, four biogeographical subregions: BSR3 — included Serra do Mar; BSR4 — Lowlands in eastern portion of the Alto Paraná Forests; BSR5 — Western portion of the Alto Paraná Forests; and BSR6 with the Araucaria Moist Forests region. The city of Londrina is located within the BSR4, which shares some species with Cerrado areas. However, the majority of the snake species are exclusive from forests habitat (Table 1), as highlighted by the two clusters of the dendrogram (Fig. 5): one at western Serra do Mar between BSR4 and BSR 6 (municipalities of Pinhão, Curitiba, Tijucas do Sul, Piraquara, and Londrina) and other at eastern Serra do Mar in BSR 3 (municipalities of Paranaguá, Antonina, Morretes, Guaraqueçaba, Guaratuba, Portal do Paraná, Matinhos, and São José dos Pinhais). This cluster at western Serra do Mar highlights that the snakes fauna from Londrina is more similar to the former group than to the eastern portion, even though it is included within the BSR 4.

Londrina region presents only 2.8% of its original forest cover (Fig. 1) (IPARDES, 1993), which can result in local extinctions since the last records in MZUEL of some forests species as *Bothrops jararacussu* Lacerda, 1884 and *Clelia plumbea* (Wied, 1820) was more than two decades ago (MZUEL 1267 in 1998 and MZUEL 551 in 1995, respectively). It is noteworthy that coffee plantations, the initial deforesting reason in northern Paraná, triggered soil misuse and a reduction in species richness, leading to the establishment of abandoned open fields that will not be restored as forests, causing extinctions or population declines for the native fauna (Dean, 1996), and enabling the colonization by Cerrado species that occur in BSR4 and BSR5.

**Figure 5.** Dissimilarity dendrogram for composition of snake species between localities with inventories, using Jaccard similarity index and Unweighted Pair Group Method with Arithmetic mean (UPGMA) inferences.
### Table 1. Snakes recorded at the municipality of Londrina, state of Paraná, Brazil.

* = Species present in the MZUEL system, but whose voucher specimens were not found. ** = Species present in literature record but not vouchered at MZUEL. Habitat: Fo = Forest Areas; O = Open Areas; Def = Deforested Areas.

<table>
<thead>
<tr>
<th>Family</th>
<th>Species</th>
<th>Habitat</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boidae</td>
<td><strong>Eunectes marinus</strong> (Linnaeus, 1758)</td>
<td>Fo</td>
<td>Strimple, (1993); Bernarde and Machado (2002)</td>
</tr>
<tr>
<td>Colubridae</td>
<td><em>Chironius bicarinatus</em> (Wied, 1820)</td>
<td>Fo</td>
<td>Bernarde and Machado (2002, 2006); Marques et al. (2009); Shibatta et al. (2009)</td>
</tr>
<tr>
<td></td>
<td>Chironius laevicollis (Wied, 1824)</td>
<td>Fo</td>
<td>Marques and Puerto (1996); Bernarde and Machado (2002)</td>
</tr>
<tr>
<td></td>
<td><em>Mastigodryas bifossatus</em> (Raddi, 1820)</td>
<td>Fo, O</td>
<td>Bernarde and Machado (2002, 2006); Leite et al. (2007); Shibatta et al. (2009)</td>
</tr>
<tr>
<td></td>
<td><em>Spilotes pullatus</em> (Linnaeus, 1758)</td>
<td>Fo</td>
<td>Bernarde and Machado (2002, 2006); Marques et al. (2009)</td>
</tr>
<tr>
<td>Dipsadidae</td>
<td><em>Apostolepis dimidiata</em> (Jan, 1862)</td>
<td>O</td>
<td>Bernarde and Machado (2002); Marques et al. (2009)</td>
</tr>
<tr>
<td></td>
<td><strong>Atractus reticulatus</strong> (Boulenger, 1885)</td>
<td>Fo</td>
<td>Bernarde and Machado (2002); Marques et al. (2009)</td>
</tr>
<tr>
<td></td>
<td>Clelia plumbea (Wied, 1820)</td>
<td>Fo</td>
<td>Bernarde and Machado (2002, 2006); Marques et al. (2009)</td>
</tr>
<tr>
<td></td>
<td>Dipsas bucephala (Shaw, 1802)</td>
<td>Fo</td>
<td>Sazima and Haddad (1992); Bernarde and Machado (2002, 2006); Shibatta et al. (2009)</td>
</tr>
<tr>
<td></td>
<td>Dipsas mikanii (Schlegel, 1837)</td>
<td>Fo, O</td>
<td>Bernarde and Machado (2002, 2006); Marques et al. (2009); Shibatta et al. (2009)</td>
</tr>
<tr>
<td></td>
<td><strong>Erythrolamprus aesculapii</strong> (Linnaeus, 1766)</td>
<td>Fo, O</td>
<td>Bernarde and Machado (2002, 2006); Marques et al. (2009); Shibatta et al. (2009)</td>
</tr>
<tr>
<td></td>
<td>Erythrolamprus miliaris (Linnaeus, 1758)</td>
<td>Fo</td>
<td>Bernarde and Machado (2002, 2006); Marques et al. (2009); Shibatta et al. (2009)</td>
</tr>
<tr>
<td></td>
<td>Erythrolamprus poecilogyrus (Wied, 1824)</td>
<td>Fo, O</td>
<td>Bernarde and Machado (2002, 2006); Marques et al. (2009); Shibatta et al. (2009)</td>
</tr>
<tr>
<td></td>
<td><em>Helicops modestus</em> Günther, 1861</td>
<td>O</td>
<td>Marques et al. (2009); Shibatta et al. (2009)</td>
</tr>
<tr>
<td></td>
<td>Oxyrhopus guibei Hoge and Romano, 1978</td>
<td>Fo, O</td>
<td>Bernarde and Machado (2002, 2006); Marques et al. (2009); Shibatta et al. (2009)</td>
</tr>
<tr>
<td></td>
<td>Oxyrhopus petolarius (Linnaeus, 1758)</td>
<td>Fo</td>
<td>Bernarde and Machado (2002)</td>
</tr>
<tr>
<td></td>
<td>Philodryas oleresi (Liechtenstein, 1823)</td>
<td>Fo</td>
<td>Bernarde and Machado (2002, 2006); Marques et al. (2009); Shibatta et al. (2009)</td>
</tr>
<tr>
<td></td>
<td>Philodryas patagoniensis (Girard, 1858)</td>
<td>O</td>
<td>Bernarde and Machado (2002); Marques et al. (2009)</td>
</tr>
<tr>
<td></td>
<td>Thamnodynastes hypoconia (Cope, 1860)</td>
<td>Fo, O</td>
<td>This study; Marques et al. (2009)</td>
</tr>
<tr>
<td></td>
<td>Thamnodynastes strigatus (Günther, 1858)</td>
<td>Fo, O</td>
<td>Bernarde and Machado (2002, 2006); Marques et al. (2009); Shibatta et al. (2009)</td>
</tr>
<tr>
<td></td>
<td>Tomodon dorsatus Duméril, Bibron and Duméril, 1854</td>
<td>Fo</td>
<td>Bernarde and Machado (2002); Marques et al. (2009)</td>
</tr>
</tbody>
</table>
Although the state of Paraná was the pioneer in the preparation of lists of endangered species in Brazil, the most recent list made by the state was from the year 2004 and 13 species of reptiles were considered as threatened or with insufficient data (Mikich and Bérnil, 2004). Still, less than 20% of the species in the region were evaluated by the IUCN, and the remaining 80% lack any data concerning its conservation status. On the other hand, the Red Book of Endangered Species made by the Ministry of the Environment (MMA) in the year 2014 analyzed 732 species of reptiles that occur in Brazil and 11% of the species were considered at some level of threat, but none of the species listed in the state of Paraná and in the Red Books of Endangered Species occur in the region of Londrina. Also, about 90% of the sampling sites are located at the Serra do Mar, while there are still large sampling gaps at the northern and western portions of Paraná, at the Seasonal Forests of Paraná river. Further studies on composition species in the northern region of the state of Paraná are necessary since the sampling of snake species has been used as an important tool for conservationist decisions, as well as biogeographic studies regarding the distribution of Neotropical species (Guedes et al., 2017).

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References


Appendix 1. Voucher specimens analyzed in the Museu de Zoologia da Universidade Estadual de Londrina (MZUEL):

Colubridae: Chironius bicarinatus (MZUEL 36, 1224), Chironius laevicollis (MZUEL 158)

Dipsadidae: Clelia plumbea (MZUEL 11, 551), Dipsas bucephala (MZUEL 52, 183, 580, 621, 1225, 1239, 1315), Dipsas mikunii (MZUEL 9, 60, 63, 154, 155, 156, 157, 161, 169, 172, 182, 184, 185, 218, 276, 432, 499), Erythrolamprus miliaris (MZUEL 51, 426, 1238, 1257), Erythrolamprus poecilogyrus (MZUEL 10, 21, 29, 139, 509, 512, 562, 627, 1222), Helicops infractenatus (MZUEL 1006, 1007, 1008), Oxyrhopus guihei (MZUEL 148, 149, 227, 428, 431, 434, 496, 511, 695, 753, 1241, 1246, 1248, 1328), Oxyrhopus petolarius (MZUEL 28, 147, 150, 181, 1223, 1686), Philodryas olfersii (MZUEL 177, 493, 622, 688, 775, 1254, 1291), Philodryas patagoniensis (MZUEL 1003), Thamnodynastes hypoconia (MZUEL 138), Thamnodynastes striatus (MZUEL 124, 138, 492, 494, 495, 579, 599, 601, 616, 644, 645, 687, 698, 700, 769, 1001, 1002, 1228, 1234, 1236, 1244, 1245, 1234, 1262), Tomodon dorsatus (MZUEL 230); Elapidae: Micrurus alitostris (MZUEL 119, 1258), Micrurus corallinus (MZUEL 497, 508, 517, 625, 745, 774, 1235, 1247, 1803); Viperidae: Bothrops alternatus (MZUEL 49), Bothrops jararaca (MZUEL 1, 53, 55, 58, 59, 68, 238, 239, 491, 544, 548, 691, 767, 776, 1243, 1249, 1252, 1259, 1260), Bothrops jararacussu (MZUEL 73, 759, 1267) and Crotalus durissus (MZUEL 54, 67, 137, 178, 211, 490, 563, 564, 619, 697, 1005, 1226, 1251, 1253, 1578, 1687)
Appendix 2. Dichotomic key for the identification of snakes species from Londrina, Paraná, Brazil:

1)  – Ventral and dorsal scales equal in size
     – Ventral scales enlarged, significantly larger than dorsal scales
     2
     3

2)  – Dorsum brown with dark lines
     – Dorsum uniformly black
     Amerotyplops brongersmianus.
     Liotyplops beui.

3)  – Ventral scales do not extend laterally through the venter region
     – Ventral scales extend laterally through the venter region
     Eunectes murinus.
     4

4)  – Most of scales on the top of the head are small in size, loreal pit
     present, solenoglyphous dentition
     – Most of scales on the top of the head are large in size, loreal pit
       absent and no-solenoglyphous dentition
     5
     10

5)  – Presence of a rattle at the end of the tail
     – Absence of a rattle at the end of the tail
     Crotalus durissus.

6)  – Prelacunar scale fused with the second supralabial
     (Lacunolabial scale present)
     – Prelacunar scale separated from supralabials (Lacunolabial
       scale absent)
     7
     9

7)  – The area occupied by the spaces between the dorsal spots are
     1.5–2 times larger than the area of the spots
     – The area occupied by the spaces between the dorsal spots are
       equal in size with the area of the spots
     Bothrops jararaca.
     Bothrops jararacussu.

9)  – Colour pattern of the head with big brownish spot on the snout
     and two elongated white spots through the frontal region to
     the end of the jaw
     – Colour pattern of the head different from above; darkened
       supralabials with big white spots, dorsum with brown-
       brownish background
     Bothrops alternatus.
     Bothrops neuwiedi.

10) – Dorsal scales arranged in an even number of rows
     – Dorsal scales arranged in an odd number of rows
     11
     13

11) – Dorsal scales rows at midbody: 12 or fewer
     – Dorsal scales rows at midbody: 14 or 16
     Spilotes pullatus
     12

12) – Anal plate entire; darkened supralabial scales
     – Anal plate divided; light supralabial scales
     Chironius laevicollis.
     Chironius bicarinatus.

13) – Proteroglyphous dentition
     – Aglyphous or opystoglyphous dentition
     14
     15

14) – Dorsal colour pattern arranged in monads of black bands
     (sequence of black rings isolated along the body)
     – Dorsal colour pattern arranged in triads of black bands
       (sequence of three black rings along the body separated by
       red bands)
     Micrurus corallinus.
     Micrurus altirostris.

15) – Dorsal scales arranged in oblique rows
     – Dorsal scales arranged in regular longitudinal rows
     16
     17

16) – Loreal plate present; light oral palate
     – Loreal plate absent; black oral palate
     Xenodon merremi.
     Tomodon dorsatus.
Appendix 2. Continued.

17) – Internasal scales fused with prefrontals
    – Internasal scales not fused with prefrontals
    18 – A single internasal
    – A pair of internasals
    19 – Subcaudal scales keeled
    – Subcaudal scales not keeled
    20 – Without reduction on the number of dorsal scales rows
    – Number of dorsal scales rows reducing along the body
    21 – Dorsal scales rows 13/13/13
    – Dorsal scales rows 15/15/15
    22 – Cloacal plate entire
    – Cloacal plate divided
    23 – Circular pupil, dorsum uniformly reddish.
    – Vertically elliptic pupil; dorsum brownish with black spots
    24 – Body with coral snake colour pattern (with black diads along the body)
    – Colour pattern different from above
    25 – Aglyphous dentition
    – Opystoglyphous dentition
    26 – Dorsal scales rows at midbody: 17
    – Dorsal scales rows at midbody: 19
    27 – Body with coral snake colour pattern (with black triads along the body)
    – Colour pattern different from above
    28 – Circular pupil
    – Vertically elliptic pupil
    29 – Ventral scales immaculate; dorsum greenish
    – Ventral scales with dark borders; dorsum brownish with black spots
    30 – Striped dorsal pattern; cloacal plate divided
    – Dorsal pattern not striped; cloacal plate entire
    31 – Dorsal scales keeled
    – Dorsal scales not keeled
    32 – Supralabials 7; 3rd and 4th in contact with the eye
    – Supralabials 8; 4th and 5th in contact with the eye

\textit{Apostolepis dimidiata}.

\textit{Helicops infrataeniatus}.

\textit{Helicops modestus}.

\textit{Dipsas bucephala}.

\textit{Mastigodryas bifossatus}.

\textit{Atractus reticulatus}.

\textit{Dipsas mikanii}.

\textit{Erythrolamprus aesculapii}.

\textit{Oxyrhopus guibei}.

\textit{Philodryas olfersii}.

\textit{Philodryas patagoniensis}.

\textit{Thamnodynastes hypoconia}.

\textit{Thamnodynastes strigatus}.

\textit{Clelia plumbea}.

\textit{Oxyrhopus petolarius}.

\textit{Accepted by Pedro Pinna}