# COLOR VARIATION IN *APOSTOLEPIS ASSIMILIS* (SERPENTES: COLUBRIDAE: DIPSADINAE: ELAPOMORPHINI)

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## ABSTRACT

*Apostolepis assimilis*, a member the *assimilis* group, inhabits the Cerrado biome in Brazil. It is the most frequent species of Elapomorphini in the region. The examination of a large sample allowed us to observe color variation in the species. Most differences were found in the head, neck, nucho-cervical collars, and supralabial blotch. The shape of the latter varies a lot, from long to short, polygonal to rounded, but mostly in the aspect of the triangular supralabial blotch. Invariable color characters are the blackish lower side of the head, the dimension of the background color, and the tail, which has a fully black blotch and a spine at the tip that is used for defense. Some rare abnormalities were found.

**Keywords**. Collars; supralabial blotch; anomalies; Cerrado; Central Brazil.

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## INTRODUCTION

*Apostolepis assimilis* (Reinhardt 1861) is the most frequent species of Elapomorphini found in the Cerrado of Central Brazil. There are many publications on the species, but none mentions color variation. We examined a large sample from Instituto Butantan, which allowed us to record color variation and thus contribute to the knowledge of the taxonomy of the species, particularly in regards to variable characters that have been used to synonymize/separate species (Ferrarezzi *et al*., 2005; Costa & Bérnils, 2015). The species of the *assimilis* group, for the most part, inhabit the Cerrado. Only one species inhabits the Caatinga. In areas where Cerrado and Caatinga overlap, the species of the group are sympatric. The major color variation in *A. assimilis* was observed in the head and neck blotches, suggesting polymorphism. Three species, *A. assimilis, Apostolepis sanctaeritae* Werner 1924, and *Apostolepis tertulianobei* Lema 2004, have white snout; the other species have red snout. The observed variation does not depend on age and sex. *Apostolepis freitasi* Lema 2004 is a valid species, and *Apostolepis parassimilis* Lema & Renner 2012 was synonymized with *A. tertulianobeui* (Costa & Bérnils, 2015). One citation of *A. assimilis* for the Caatinga (Amaral, 1930) is a mis-determination of *Apostolepis cearensis* Gomes 1915.

## MATERIAL AND METHODS

Abbreviations for Pholidosis: AC, anterior chin-shield; CC, chin-shields; CL, cloacal; DO, dorsal; FR, frontal; GU, gular; IL, infralabial; IN, internasal; ME, mental; NA, nasal; OC, occipital; PA, parietal; PC, posterior chin-shield; PF, prefrontal; PR, preocular; PS, postocular; RO, rostral; SC, subcaudal; SL, supralabial; SO, supraocular; TE, terminal; TP, posterior temporal; VE, ventral.

Brazilian States: DF, Distrito Federal; MG, Minas Gerais; MS, Mato Grosso do Sul; MT, Mato Grosso; PR, Paraná; RJ, Rio de Janeiro; RS, Rio Grande do Sul; SC, Santa Catarina; SP, São Paulo.

Institutions acronyms: CHAFB, Arlindo Figueiredo Beda, Aquidauana, MS, moved to MZUSP, and MCP; CHUNB, Universidade Nacional de Brasília, DF; DZSP, Departamento de Zoologia da Secretaria de Agricultura, SP, moved to MZUSP; FUNED, Fundação Ezequiel Dias, Belo Horizonte, MG; IBSP, Instituto Butantan, SP; IBUFRJ, Instituto de Biologia, Universidade Federal do Rio de Janeiro, RJ; LPH, Linha de Pesquisa em Herpetologia, Pontifícia Universidade Católica do Rio Grande do Sul, Porto Alegre, RS, moved to MCP; MCN, Museu de Ciências Naturais da Fundação Zoobotânica do Rio Grande do Sul, Porto Alegre, RS; MCP, Museu de Ciências e Tecnologia, PUCRS, Porto Alegre, RS; MHNCI, Museu de História Natural de Capão da Imbuia, Curitiba, PR; MMKM, Museo Manoel Kenpff Mercato, Santa Cruz, Bolívia; MNRJ, Museu Nacional do Rio de Janeiro, RJ; MZUSP, Museu de Zoologia, Universidade de São Paulo, São Paulo; NMW, Natürlisches Museum, Wien; Áustria; UFMT, Universidade Federal de Mato Grosso, Cuiabá, MT; UMMZ, Museum of Zoology, University of Michigan, Ann Arbor, Michigan, USA; ZMK, Zoologisk Museum, Copenhagen, Denmark.

## RESULTS AND DISCUSSIONS

The holotype (ZMK.63206) of *A. assimilis* was illustrated by Jan and Sordelli (1865). Its coloration differs from the most frequent phenotype (Fig. 1). Most examined specimens were from the IBSP (See Appendix). We noted the presence of two basic phenotypes regarding the SL blotch: (1) supralabial elongate, large, triangular or quadrangular, rarely curled or short, and (2) mainly curled and vertical (Fig. 2). Anomalies, some of them very strange and singular, were also observed: (a) Specimens IBSP.9154 and 15723 (Figs. 2.11, 2.12) have the black collar in the shape of an oval longitudinal blotch, isolated from the pileon by a long white collar, which extends under the black blotch, posteriorly the neck becoming fully white; this morph resembles *Apostolepis ammodites* Ferrarezzi, Barbo & Albuquerque 2005, and suggests that it is a hybrid. (b) Newborns have the supralabial blotch continuous with RO, and lack the black oblique band on eyes. (c) NMW.13808 (Figs. 2.5-2.7) presents the TE modified as a true spine, the snout very long, with apparent horns on the posterior portion of the head, and extroversion of the quadrate-jaws articulation (probably the result of trauma); this specimen is similar to other specimens that belong to *Xenodon merremii* (Wagler 1824), observed by Lema (1962). (d) There is a strange anomaly observed in the IBSP collection (Laboratory of Alphonse R. Hoge), a juvenile with a black collar transformed into a pair of wings: the black collar is turned upward and elongated, having narrow sides, along the vertebral DO rows (Fig. 3); we do not know where it was housed. (e) IBSP.9154, a large adult from Goiás, has the head wide and the snout conic and projected; PA with rounded sides, forming a concave angle between them; PF contacting the second SL on both sides, isolating RO from PR, which extends to the dorsal surface, forming a suture between them, similarly to IN; PT present. We had not seen anomalies d and e before, even though we have examined many Elapomorphini from all species.

### Generalized color variation

*Snout*: white in all examined specimens, as the collar (never yellow), extending to the large PF, with white frontal blotch unique to the species, which may correspond to a display coloration. *Pileon*: large, black, not reaching PF, only the posterior margin of FR, and posterior half of SO; extending, or not, along the suture between FR. Black band on eyes, from SO to first and second SL, hiding eyes, which have black iris, most likely as a protection, as it occurs in several snakes (e.g. *Boa constrictor* Linnaeus 1758). *Lower side of head*: usually blackish, but may be light, with less black blotches, never fully white. Posterior margin of the pileon extending to the gular region, forming sideburns. Band crossing the eye reaches IL. Largest IL with black inner margin, forming black longitudinal band. In the holotype, median zone of ventral head shadowed. Supralabial blotches reaching outer sides of IL, varying in size. The figures formed by the different blotches vs. white may be very complex, and it is difficult to describe them. Sometimes, there are specimens with an almost fully black lower head. *Supralabial blotch*: Very variable, the most variable mark of the species. Usually, it is triangular (Fig. 2); it may, however, be rectangular or trapezoidal, short or long; oval, with protrusion, side or sides wavy, sometimes very small. *Black nape collar*: Posterior

margin of pileon straight, wavy or irregular, but usually wavy; extends to the gular region, forming sideburns, with projections on both margins. *White collar*: Very variable, narrow to very long, straight or oblique, and margins wavy; usually three dorsal scales long. In some rare anomalous specimens, black collar restricted to vertebral and paravertebral zones; white collar extended under it, reaching posterior margin of oval black collar, similar to *A. ammodites* (Figs. 14, 15). *Gular region*: Usually marbled dark white, varying from completely white to bearing small black blotches. Blotches at the margin of the pileon are usually broken, but when not, it is fully black. *Black collar*: This is the most variable blotch, one or two vertebral DO rows; on the sides, two to five DO rows, usually three; with margins straight or wavy, irregular, or oblique. The most frequent pattern is three long DO, with margins straight; a variation of this pattern does not extend to the paraventral side. *Tail black blotch*: Most specimens have it very long, about 12 DO, counting on vertebral line, with TE fully black. The holotype is anomalous in this respect, since it has a short blotch, which is a rare feature. Usually it is fully black, with TE also black. Rarely, TE white below. *Temporal plate*: This species presents PT, a plesiomorphy, which contrasts with a number of derived characters (Ferrarezzi, 1993a).

**Rare chromatic anomaly.** The IBSP.49208 (from Osasco, SP, ♂) has 5/5 GU rows in oblique direction, irregularly disposed from the PC until nuchal collar margins, and after with three oblique PV, asymmetrical, until the last VE (241), and the CL preceded by median azygous; a large dark elongate blotch on the trunk sides bends to ventral side: the dark parts are composed by dense minute black dots, except in the distal periphery; the ventral-side blotch at right, in the 16th VE; afterwords it reaches the VE 19th to 49th, forming a lateral darkish blotch at left extending in the right side as another darkish blotch from 50th to 59th VE. In both sides there is a very large blotch from 42nd to 59th VE, at level of first DO row. In the left side the blotch begins narrow and gradually inclines upwards, reaching the first and second DO rows, at the level of the 42nd VE; following it reaches the third DO row (43rd VE); to fourth DO row (44th VE); to fifth DO row (45th VE); to sixth DO row (46th VE); until the seventh DO row (47en VE); and decreases after it. Parallel to this chromatic anomaly occurs DO with a reticulate pattern of black dots in the vertebral and pleural zones, until the upper margin of the third DO row; the second and first DO rows are not reticulate. (Fig. 11).

## CONCLUSIONS

The variation observed in *A. assimilis* suggests that the species has been established in the Cerrado for a long time, went through a lot of genetic recombinations, and possibly formed geographical races according to the different aspects of the Cerrado, e.g., neighboring Caatinga, neighboring Amazon Forest, and so on. Comparing this species with other components of the *assimilis* group, it presents many putative plesiomorphies, such as a round, slightly projecting snout, compared with the snout of *A. ammodites* and *A. cearensis*, which are strongly projected. *Apostolepis assimilis* presents many similarities with *A. sanctaeritae* and *A .tertulianobeui.*

*Apostolepis tertulianobeui* Lema 2004, was considered by Ferrarezzi et al. (2005) as the same *A. assimilis.* He mentioned that the phenotype he found was the latter species

(Ferrarezzi, 1993). We did not found this phenotype despite having studied a large sample (See Annex). The differences between the two species are many, which makes the synonym unaceptable. *Apostolepis tertulianobeui* vs. *A. assimilis*: snout projected (vs. not projected), snout pointed (vs. rounded), tail stocky with round tip (vs. tail slightly slender with conic tip), tail blotch only dorsal (vs. complete, including the terminal). Ferrarezzi et al. (2005) stated that he did not see the holotype of *A. tertulianobeui.*

Another species, *Apostolepis parassimilis* Lema & Renner 2012, was synonymyzed with *A. tertulianobeui* (Costa & Bérnils, 2015), and the differences may suggest that the holotype of the former is an immature of the latter. However, this hypothesis needs investigation based on more specimens of different sexes and ages.

A good illustration of *Apostolepis assimilis* was first given by Fonseca (1949), then it was copied by Amaral (1977). This image, however, has an error: the snout is colored in yellow, when in specimens it is white, at least in the innumerable live specimens observed by us, documented in a lot of photographs and publications. As far as we know, there is no yellow color on the skin of this species.

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**APPENDIX**

Specimens examined of *Apostolepis assimilis.* Abbreviations: w/l, without locality.

BRAZIL: w/l (IBSP.43960). **Bahia:** w/l (MNRJ.6524, paratype of *A. parassimilis*); Barreiras (UMMZ.108810, UMMZ.108811). Brumado (IBSP.33685). Tanque do Aragão (MNRJ.8523). **Distrito Federal:** Brasília (CHUNB.1418, CHUNB.23781; IBSP.49363), Rancho Fundo Farm (IBSP.28734). **Goiás:** Águas Lindas de Goiás (CHUNB.13810). Aragarças (MNRJ.21). Cana Brava (IBSP.9154). Catalão (MNRJ.7446). Ilha do Bananal: Santa Isabel (IBSP.12324, IB. 13324). Planaltina (CHUNB.34). Mato Grosso: Chapada dos Guimarães: (IBUFRJ w/n/), Buriti (IBSP.5346), Cachoeira das Andorinhas (UFMT.2085). Cuiabá (MNRJ.2031). **Mato Grosso do Sul**: Alta Floresta (IBSP.46659). Amambaí: São Pedro Farm (IBSP.41163). Campo Grande (CHAFB.213, CHAFB.423, CHAFB.424, CHAFB.591, CHAFB.670, CHAFB.671, CHAFB.675, CHAFB.676, CHAFB.680, CHAFB.681, CHAFB.688A, CHAFB.688B, CHAFB.689; MCP.2490, 2491; MZUSP.10155), Santa Fé (MHNCI.6719). **Minas Gerais:** Cassilândia (MHNCI.748). Caxambu (IBSP.816). Entre Rios de Minas (FUNED.691). Ibirité (FUNED.603). Itajubá (IBSP.9407). Itatiaiuçu (FUNED.510). Lambari (DZSP.113, 114). Moeda (FUNED.2). Mooca (DZSP.115). Nova Lima (FUNED.550). Ouro Fino (IBSP.34306). Passa Quatro (IBSP.3274). Poços de Caldas (IBSP.49374). Pouso Alegre: Sítio dos Bastos (IBSP.44597). Serra do Cipó (MZUSP.7595). São Bento do Sapucaí to São José dos Campos Highway (IBSP.40417). Serra do Espinhaço: Capão dos Porcos Farm (MNMK.63206, holotype). Uberlândia (LPH.52, LPH.53, LPH.54, LPH.55, LPH.56; MHNCI.355; IB.888; MHNCI.904; MCP.1754, MCP.1755; MZUSP.3841, MZSUP.3845; MCP.4372; MHNCI.6388; MCNRS.8535a, holotype of *A. parassimilis;* MCP.8782 to MCP.8796), Santa Monica (MCP.4084, MCP.4174). Vespasiano (FUNED.4). **Santa Catarina**: Florianopolis: Ilha de Santa Catarina (BGSS.5344, IBGSS.5345, IBGSS.5346). Tubarão (MHNCI.4495, MHNCI.4496, MHNCI.4497, MHNCI.4498, MHNCI.4499). **São Paulo**: Avaré (IBSP.22895). Barueri (IBSP.23206, IBSP.23523, IBSP.29176, IBSP.30283, IBSP.49354), Boa Vista (IBSP.44540, IBSP.44542), Jardim Belval (IBSP.44436), Jardim Muteng (IBSP.44650). Bauru (MHNCI.4790). Cabriúva (MCTP.7305; IB.26565). Caieiras (IBSP.40320). Cajamar (IBSP.30408). Campo Largo (IBSP.4498). Campo Limpo (IBSP.6532, IBSP.7654, IBSP.9463, IBSP.24610). Campos do Jordão (IBSP.26796). Cerrado (IBSP.5256). Conceição dos Ouros (IBSP.33206). Cotia (MCP.7303; IBSP.24588, IBSP.28597). Ibiúna (IBSP.32672). Ilha do Marimbondo (IBSP.4008). Itapevi (IBSP.23525, IBSP.30436, IBSP.32074, IBSP.32076, IBSP.49043). Itatiba (IBSP.5703). Itu (IBSP.4180; MHNCI.6969), Pau d'Alho Farm (IBSP.6606). Jales (IBSP.4162). Jandira (IBSP.31694, IBSP.40451), Vila Ouro Verde (IBSP.40493). Jarinu (IBSP.30019, IBSP.30022). Jundiaí (DZSP.109; IBSP.16688). Osasco (MCP.64, MCP.110, MCP.112, MCP.4825; CHUNB.6141; MCP.6868, MCP.6871; IBSP.23889, IBSP.40482, IBSP.49208), Jardim Bonanza (IBSP.41068), Jardim Três Montanhas, Via Anhanguera Km.18 (IBSP.40480), Munhoz Júnior (IBSP.31767). Piraçununga (IBSP.2761). Pinhal (IBSP.32441). Poá (IBSP.7515). Santana do Parnaíba (IBSP.31432). Santo Amaro (IBSP.1636). São Bernardo (DZSP.116). São João da Boa Vista (IBSP.6926). São Paulo: (MCP.109), Avenida (IBSP.318), Bosque da Saudade (IBSP.8945), Brooklin Novo (IBSP.22221), Butantan (IBSP.8040, IBSP.9711, IBSP.27598, IBSP.27959, IBSP.28932, IBSP.32427, IBSP.32491, IBSP.32516, IBSP.32650, IBSP.32804), Caixa d'Água (IBSP.6659), Horto Oswaldo Cruz (IBSP.30586), Ipiranga (DZSP.105, DZSP.106, DZSP.110, DZSP.117, DZSP.118, DZSP.119; IBSP.6401), Mayrink (IBSP.41065, IBSP.44480, IBSP.49429), Morumbi (IBSP.30153, IBSP.32490), Pinheiros (IBSP.6558, IBSP.9871), São Paulo (MCP.6867,

IBSP.8449, IBSP.10358, IBSP.17817), Campus da USP (IBSP.21993), Vila Jardim (IBSP.49375). São Roque: (MCP.7302, MCP.7304; IBSP.24548, IBSP.27309, IBSP.28604, IBSP.32563), Chácara Maurer (IBSP.44543, IBSP.44593). Sorocaba (MHNCI.6970; MCP.7301). Várzea (IBSP.15760).

**Figure 1.1**

**Figure 1.2**

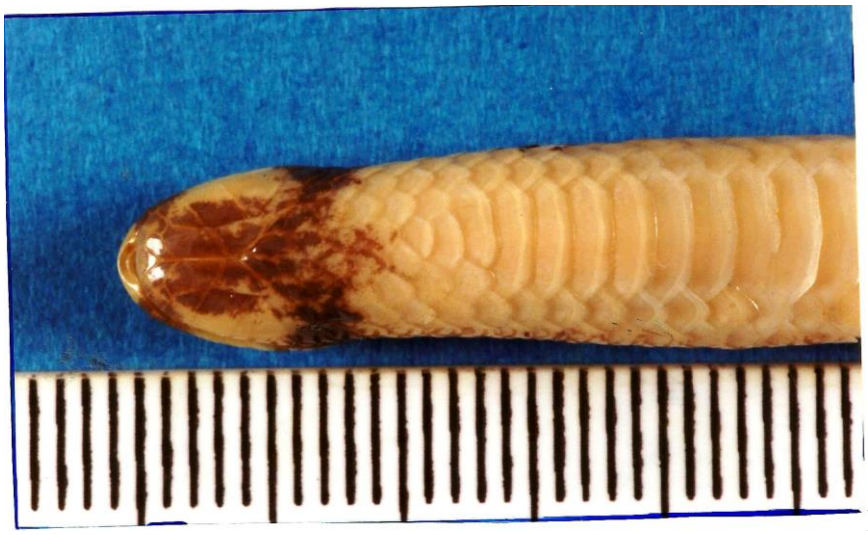


**Figure 1.3**

Figure 1: Specimen (FUNED.0002) presenting the usual pattern: 1.1. Lateral; 1.2. Dorsal, 1.3. Ventral.

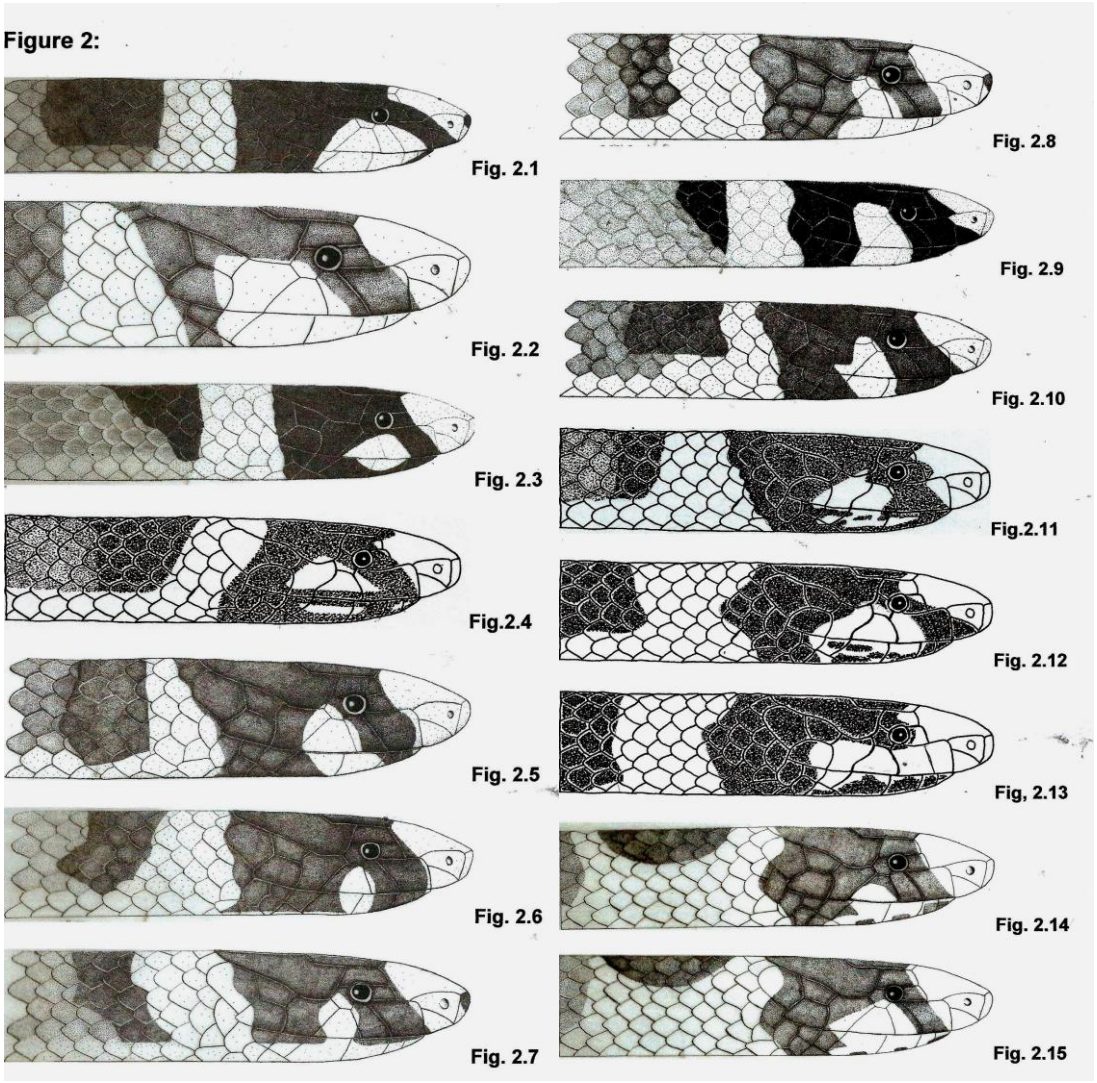



Figure 2: Head and neck color variation in *Apostolepis assimilis*; abbreviations: BC, black collar; NC, nuchal collar; SB, supralabial blotch; WB, white blotch: 2.1: SB and BC long (IBSP.6659); 2.2: SB trapezoidal (IBSP.12945); 2.3: SB and BC reduced (DZSP.116); 2.4: SB and BC usual (IBSP.41065, 49354, 49374, 49375, 49666); 2.5: SB reduced as Turkish door and WC narrow (IBSP.24598); 2.6: SB very reduced, as Turkish door; BC narrow and oblique to posterior portion; 2.7: SB as Turkish door; BC very narrow and oblique to frontal portion; 2.8: SB rounded, oblique to posterior portion, BC very narrow (IBSP. 26565); 2.9: SB rounded, oblique to posterior portion, BC minute; 2.10: SB rounded, BC rectangular, WC narrow; 2.11: SB small and rounded, BC very reduced (IBSP.9154); 2.12: SB rounded and large, BC usual, NC prominent; 2.13: SL joined with RO blotch; 2.14-2.15: BC oval, dorsal: WC continuous; may be an anomalous *Apostolepis ammodites*; (2.14: IBSP.9154, giant specimen from Goiás; 2.15:IBSP.15723)

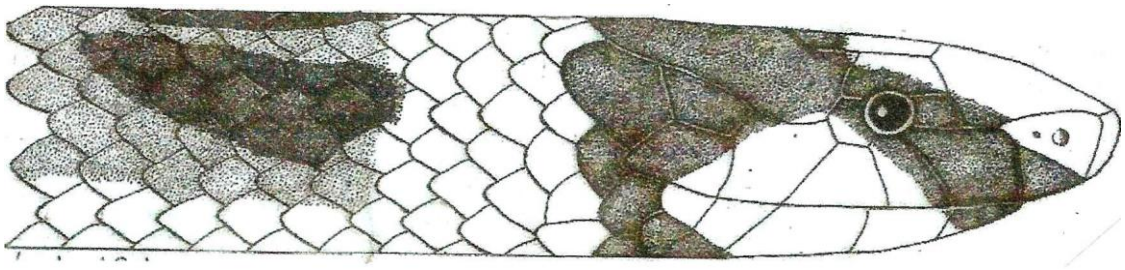


Figure 3: Juvenile with strange anomaly: instead of the black collar there is a pair of blotches as wings (Exposition Instituto Pinheiros, S. Paulo).

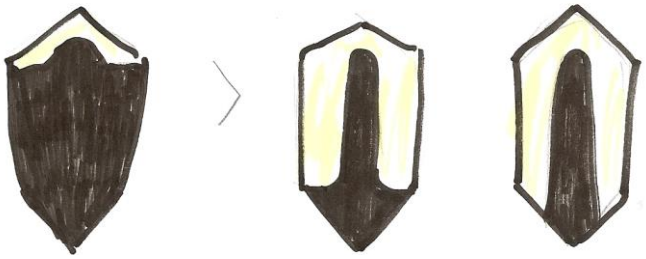


Figure 4: Color variation of the frontal shield.

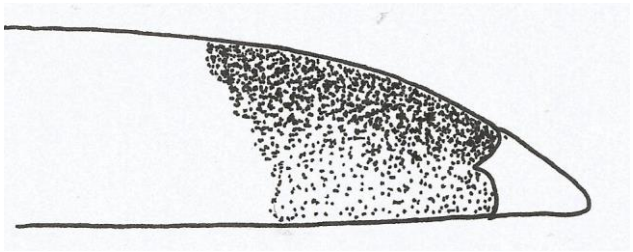
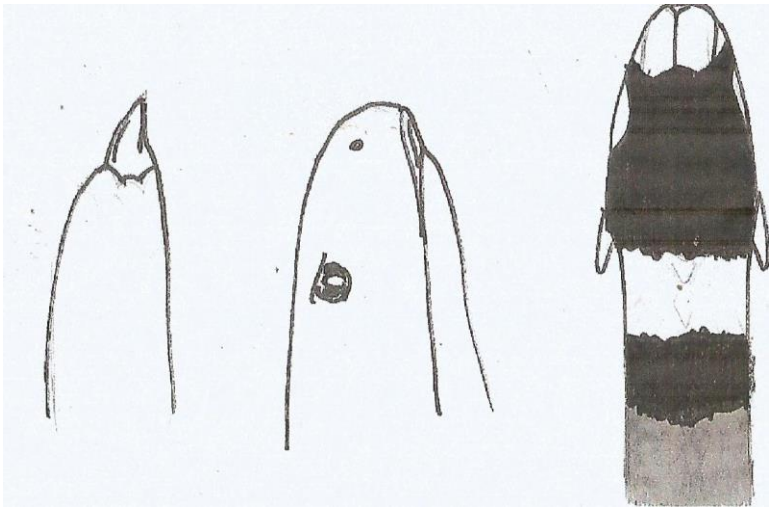


Figure 5: Specimen (DZSP.116) showing the usual aspect of the tail tip.



Figures 6-8: Specimen (NMW.13808), with anomalies as presence of spine on the tail tip, projecting snout, and traumatic outer projection of the jaws.

Figure 9: Schematic aspect of lower side of head of the IBSP.49374, showing low degree of melanin, a very scarce account.

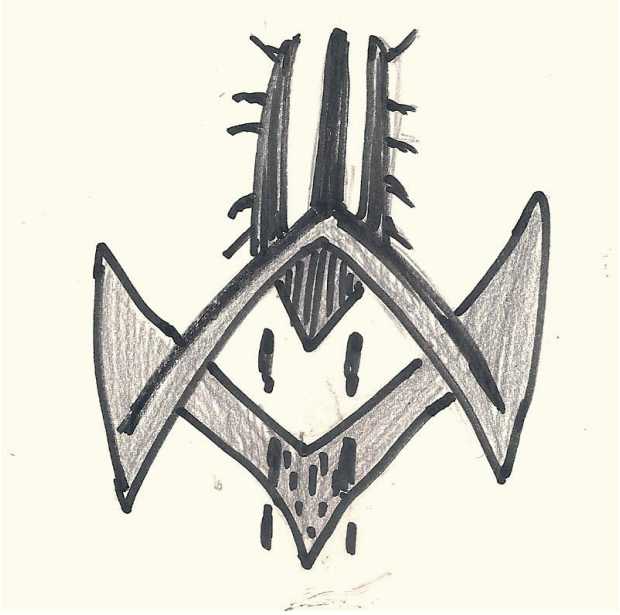


Figure 10: Figure usually occurring on ventral side of the head (schematic generalization); compare with Fig.1.3.


Figure 11: Schematic drawings of very rare achromatic anomaly in the specimen IBSP.49208, from Osasco, São Paulo.