



Morphological variation of *Philodryas patagoniensis* (Girard, 1858) (Serpentes, Dipsadidae) from Brazil, based on the study of pholidosis, coloration and morphometric features

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Abstract: The current study aimed to verify the relationship between the patterns of coloration, the morphometrical features and pholidosis of specimens of *Philodryas patagoniensis* from Brazil, with the sexual dimorphism of this species. We studied specimens of *P. patagoniensis* deposited in several herpetological collections from Brazil. A total of 355 specimens were analyzed, of these 145 were males (87 adults and 58 juveniles) and 210 were females (134 adults and 76 juveniles). Adult specimens exhibit sexual dimorphism in snout-vent length, tail length, head length, number of ventral shields, and number of subcaudal shields. The analysis of variance showed that the adult females are significantly longer than adult males, both at snout-vent length and tail length. Females have a greater number of ventral shields (138-210) than males (151-200). The specimens studied also exhibit two distinct patterns of coloration unrelated to geographical or sexual variations.

Keywords: Morphology, sexual variability, *Philodryadini*, Brazilian snakes.

Variação morfológica de *Philodryas patagoniensis* (Girard, 1858) (Serpentes, Dipsadidae) no Brasil, com base em estudos das características de foliose, coloração e morfometria

Resumo: O presente estudo objetivou verificar a relação entre os padrões de coloração, as características morfométricas e a foliose de espécimes de *Philodryas patagoniensis* existentes no Brasil, com o dimorfismo sexual dessa espécie. Foram estudados espécimes de *P. patagoniensis* depositados em várias coleções herpetológicas do Brasil. Um total de 355 espécimes foram analisados, destes 145 eram machos (87 adultos e 58 filhotes) e 210 fêmeas (134 adultos e 76 filhotes). Espécimes adultos apresentam dimorfismo sexual no comprimento rostro-cloacal, comprimento da cauda, comprimento da cabeça, número de escudos ventrais e número de escudos subcaudais. A análise de variância mostrou que fêmeas adultas são significativamente maiores que machos adultos, tanto no comprimento rostro-cloacal quanto no comprimento da cauda. Fêmeas possuem maior número de escudos ventrais (138-210) que machos (151-200). Os espécimes estudados apresentam dois padrões distintos de coloração não relacionadas a variações geográficas ou sexuais.

Palavra-chave: Morfologia, variabilidade sexual, *Philodryadini*, serpentes Brasileiras.

Introduction

External morphological features as pholidosis, measures of body regions and patterns of coloration of specimens are fundamental for taxonomic studies of snakes (Thomas 1976, Di-Bernardo & Lema 1990, López & Giraudo 2008). Pholidosis is the arrangement or pattern of scales and shields on the body surface of reptiles and is one of features for identification of snakes, and is a feature that may have variations within the same species (Dowling 1951a, b). The differences between the phenotypes such as foliose, morphology and physiology reflect the functional capacity of the specimen, which in turn are adaptive to different environments (Arnold 1983, Greene 1986, Coddington 1988, Emerson & Arnold 1989, Arnold 1994, Garland & Losos 1994).

Differences in behavior may influence evolutionary changes, for example, the occurrence of populations or species different from the usual habitat, possibly exhibiting different behaviors, which may lead to selection of phenotypes that maximize the effectiveness of these behaviors and the animal's relationship to its habitat (Mayr 1963).

Research on sexual dimorphism performed in several species of snakes of the families Colubridae and Dipsadidae demonstrate that the females have a highest snout-vent length compared to males (Solorzano & Cerdas 1989, Rivas & Burghardt 2001, Zug et al. 2001), and males have a highest tail length than females (King 1989, López & Giraudo 2008, Matias et al. 2011).

The Patagonia green racer, *Philodryas patagoniensis* (Girard, 1858) (Dipsadidae), occurs in Argentina, Bolivia, Brazil, Chile, Paraguay

and Uruguay (Thomas 1976, Peters et al. 1986, López & Giraudo 2008). This species was described by Girard (1858) as *Callirhinus patagoniensis*, based on two specimens collected in coastal region of Patagonia, Argentina. These two specimens were described as having mainly an olive-green coloration with black spots, 19 midbody rows of dorsal scales, divided cloacal and subcaudal shields, a divided nasal scale, a pair of loreal scales, two post-ocular scales, and one pre-ocular scale, with the third and fourth supralabial scales in contact with the orbit. This species was included into the genus *Philodryas* Wagler, 1830 by Hoge (1964), and redescribed by Thomas (1976).

The study of López & Giraudo (2008) with specimens of *P. patagoniensis* from Argentina is the only one that reveals significant differences in pholidosis of males and females of this species. Other studies with *P. patagoniensis* have addressed for ecological and natural history approaches (see Thomas 1976, Cei 1993, Achaval & Olmos 1997, Fowler & Salomão 1994a, b, 1995, Hartmann & Marques 2005, López & Giraudo 2008). Not only in specimens of *P. patagoniensis*, as in the whole tribe Philodryadini, from Brazil the studies with sexual dimorphism associated with pholidosis and morphometric features of this species are still scarce (Fowler & Salomão 1994a, b, 1995, Pontes 2007, López & Giraudo 2008, Zaher et al. 2008).

Therefore, the current study aimed to analyze the differences between sexual dimorphism and the patterns of coloration, the morphometrical features and pholidosis of *P. patagoniensis* from Brazil.

Material and methods

The current study was performed with specimens of *P. patagoniensis* from several localities in Brazil, and deposited in the following herpetological collections from Brazil: Museu de Zoologia João Moojen (MZUFV), from Universidade Federal de Viçosa, Viçosa; Fundação Ezequiel Dias (FUNED), Belo Horizonte; Museu de Ciências Naturais from Pontifícia Universidade Católica de Minas Gerais (MCNR), Belo Horizonte; Laboratório de Zoologia de Vertebrados from Universidade de Federal de Ouro Preto (LZV), Ouro Preto; Coleção Herpetológica da Universidade de Brasília (CHUNB), Brasília; Universidade Federal de Juiz de Fora (UFJF), Juiz de Fora; Centro Universitário de Lavras (UNILAVRAS), Lavras; Museu Nacional (MNRJ), Rio de Janeiro; and Museu de Zoologia da Universidade de São Paulo (MZUSP), São Paulo.

The specimens were analyzed between May 2011 and September 2012. A total of 355 specimens of *Philodryas patagoniensis* were analyzed, of which 145 were males (87 adult specimens and 58 juveniles) and 210 were females (134 adults and 76 juveniles) (see appendix). The specimens analyzed in the current study were identified according to morphological diagnostic features proposed by Girard (1858), and Thomas (1976).

The features of pholidosis analyzed or quantified are: number of dorsal scales (NDS), number of ventral shields (NVS), number of subcaudal shields (NSS), supra-labial scales (SLS), pre-ocular scales (PRS), post-ocular scales (POS), supra-ocular scales (SOS), nasal scale (NS), rostral scale (RS), loreal scale (LS), pre-frontal scales (PFS), parietal scales (PS), temporal scales (TS), infra-labial scales (ILS) and cloacal shields (CS), when possible was used the "first wider than long" system. The measurable features analyzed are: head length (HL), head width (WH), inter-ocular width (IOW), snout-vent length (SVL), tail length (TL), and total length (TBL). The measurements were made using analogical calliper and metric rule, according to Dowling (1951b), Thomas (1976), and Francini et al. (1990).

The sexual size dimorphism (SSD) was calculated according to the index adapted from Gibbons & Lovich (1990): $SSD = \text{mean SVL of the larger sex} / \text{mean SVL of the smaller sex}$, where negative values indicate that males are larger than females. Individuals missing all or part of the tail were not used in the analyses that employed SVL and TL values. Females with SVL < 670 mm and males with SVL < 525 mm were classified as juveniles, according to Pontes (2007).

The relationship of sex and/or sexual maturity with the NVS, NSS, SVL, and TL was determined by the Wilcoxon test. The same test was used to relate the HL with the sex of the specimens and to relate the NVS, NSS, SVL, TL, TBL, HL, WH and IOW to the patterns of coloration.

An analysis of covariance (ANCOVA) was used to relate the SVL to the TL; three models were tested: model 1 ($SVL = \beta_0 + \beta_1 \text{ Sex} + \beta_2 \text{ TL} + \beta_3 \text{ Sex:TL}$), model 2 ($SVL = \beta_0 + \beta_1 \text{ Sex} + \beta_2 \text{ TL}$) and model 3 ($SVL = \beta_0 + \beta_1 \text{ TL} + \beta_2 \text{ Sex:TL}$). The same tests were used to relate the SVL with the HL using the following models: model 1 ($SVL = \beta_0 + \beta_1 \text{ Sex} + \beta_2 \text{ HL} + \beta_3 \text{ Sex:HL}$), model 2 ($SVL = \beta_0 + \beta_1 \text{ Sex} + \beta_2 \text{ HL}$) and model 3 ($SVL = \beta_0 + \beta_1 \text{ HL} + \beta_2 \text{ Sex:HL}$). The proportions between TBL and TL, TBL and HL and NVS and NSS were tested by linear regression.

The data was tested for homogeneity of the variances by the Levene test before other statistical analyses. The significance level in all the tests was $\alpha = 0.05$. The statistical analyses were carried out with the R for Windows program.

To determine the sex, in all specimens analyzed was verified the absence or presence of hemipenis by eversion, or through a small median longitudinal section in the region of the first subcaudal shields according to Yuki (1994).

Results

In the current study the specimens analyzed exhibited an unmodified rostral-scale, two inter-nasal scales, two prefrontals, a single frontal scale, two parietals, a divided nasal scale, one loreal, one pre-ocular, two post-oculars, one supra-ocular, 1+2 temporals, 7 or 8 supralabials (with the third and fourth contacting the orbit), 9 or 10 infralabials, 19-19-15 dorsal scale rows with one apical pit, a divided cloacal shield, 138 to 210 ventral shield, and 40 to 123 divided subcaudal shields.

The juvenile and adult females have a higher NVS than males (Table 1; $W = 3179.5$, $p = 0.005$ for juveniles; $W = 10062$, $p < 0.001$ for adults). Adult females have a longer SVL than adult males (Table 1; $W = 10606.5$, $p < 0.001$) and the SVL of juvenile snakes does not differ between the sexes (Table 1; $W = 2390$, $p = 0.330$).

Males have a greater NSS than females, according to the analysis of covariance (Table 1; $W = 748$, $p = 0.001$ for juveniles; $W = 1923.5$, $p = 0.001$ for adults), however the adult females have a greater TL than males (Figure 1) (Table 1; $W = 6995$, $p = 0.007$). The TL of the juvenile specimens did not present a statistical difference between the sexes (Figure 1) (Table 1; $W = 1981.5$, $p = 0.381$).

The sexual size dimorphism (SSD) index in *P. patagoniensis* was positive in this study, confirming that females are larger than males (1.004).

The analysis of covariance between the TL and SVL of males and females ($R^2 = 0.7848$; $F = 638.3$) shows that the TL is influenced both by SVL and by sex, with a good approximation between the sexes based on the TL and SVL values (Figure 1).

The HL of the females ($n=208$) ranged between 11.3 to 44.2 mm, while for the males ($n=144$) it ranged between 7.7 to 33.1 mm. The HL of the females was significantly greater than HL of males ($W = 20925$, $p = 0.001$).

Three models were also tested in the analysis of covariance between the HL and SVL of males and females. Model 3 presented the highest significance ($R^2 = 0.8867$; $F = 2740$), with the following coefficients (Intercept: -280.7827 , $p < 0.001$; HL: 38.6754 , $p < 0.001$). Therefore, the head length is closely related to the snout-vent length of the specimens, however, there was no influence of sex in any of the models (Figure 1).

According to the R^2 value ($R^2 = 0.006$) found in the regression analysis, there was no correlation between the variables NVS, NSS, and TBL, indicating that these variables are not closely related.

The regression analysis also showed that the TL of these specimens corresponds to 24% ($R^2 = 0.840$) of the TBL. This means that the TL value

Table 1. Variation of morphometric and pholidosis characteristics measures separated by sex and age range in the specimens of the *Philodryas patagoniensis*.

Morphometric	Females				Males			
	N	Means (cm)	SD	Variation (cm)	N	Means (cm)	SD	Variation (cm)
Juveniles								
Ventral	75	185.21	12.69	147-207	58	177.53	7.82	155-194
Subcaudal	74	97.62	12.60	40-117	56	108.38	7.94	73-119
SVL	75	349.03	137.48	144-669	58	325.10	107.94	177-517
TL	75	129.35	71.06	57-439	58	128.60	51.26	66-241
Adults								
Ventral	134	188.28	8.65	138-210	86	178.06	6.7	157-196
Subcaudal	131	94.97	12.08	40-116	85	106.13	9.24	66-123
SVL	134	923.81	149.1	679-1345	86	688.38	97.2	539-1010
TL	134	298.43	56.24	90-429	86	285.84	42.43	181-396

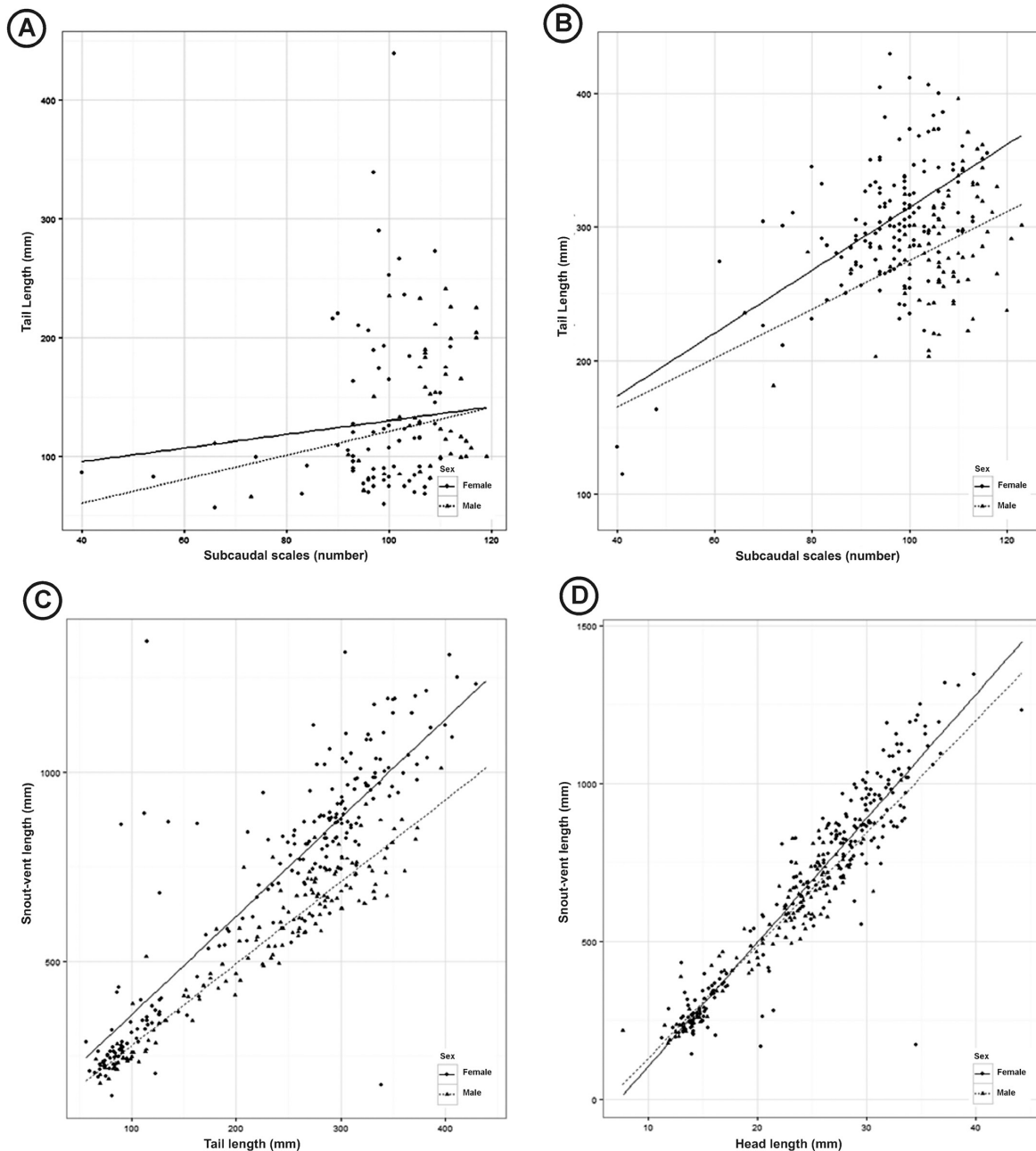


Figure 1. (A) Relation between the tail length and number of subcaudal shield of juveniles females and males. (B) Relation between the tail length and number of subcaudal shield of adults females and males. (C) Relation between the tail length and snout-vent length of females and males. (D) Relationship of the snout-vent length, head length and sex of the specimens.

can be predicted from the TBL value. The head length is corresponds to 1.8% ($R^2 = 0.903$) of the TBL. Thus it is possible to obtain any value of TBL or HL from the other pair.

We observed two patterns of coloration in the specimens studied herein: (1) dorsum dark brown, with black spots only on the posterior region of the scales, a clear and delineated black belly, and orange coloration on the head, and (2) uniform brown head and dorsum, light greenish-brown without black spots on the posterior portion of the dorsal scales, a light belly. These patterns (with or without spots) were used for comparisons of the all specimens studied herein (Figure 2) (Table 2).

The correlations of these two patterns of coloration between the NVS, NSS, TBL, SVL, TL, WH, HL, and IOW were performed according to the Wilcoxon test. We observed that only the NVS and NSS variables were not significant. Among the variables that showed significant results, only the variable IOW showed higher mean for the patterns of coloration 2. For all other variables, the mean was higher for the patterns of coloration 1 (Table 3).

Discussion

The wide range observed in the NVS and NSS in the specimens studied herein was also observed by Thomas (1976) and D'Agostini (1998) in other species of the genus *Philodryas*, such as *P. aestiva* (Duméril, Bibron & Duméril, 1854), *P. offersii* (Lichtenstein, 1823) and *P. viridissima* (Linnaeus, 1758). Thomas (1976) studied *P. patagoniensis* also found a large variation in the NVS and NSS (151 to 194 ventral shields and 68 to 120 subcaudal shields) than that observed in the current study.

The results obtained on the NSS and NVS of the adults of *P. patagoniensis* are in accordance with observed by López & Giraudó (2008) in the same species from Argentina. These authors observed that the adult males of *P. patagoniensis* have a higher NSS than the adult females, while the adult females have a higher NVS than the adult males. The higher body size and NVS in females of this species can be a reflective of the optimization of reproductive potential, since the females needs a higher body volume to produce a higher number of eggs or large size of eggs (Mebert 2011).

In the current study we observed a significant difference in the NSS between males and females (Table 1).

We observed that the adult females of *P. patagoniensis* have a largest body size that than adult males (Table 1). A similar pattern of females were reported in several other species of snakes (Solorzano & Cerdas 1989, Shine 1993, Rivas & Burghardt 2001, Gregory 2004, Pinto & Fernandes 2004, Matias et al. 2011, Mesquita et al. 2011, Henao-Duque & Ceballos 2013).

Several authors observed that the fertility is considered one of the main selective agents for the larger size of females for some species of snakes; however, the largest size of males in another species of snakes can be considered as a significant feature of males of species that possesses the behaviour of competition for territory and for females in reproductive period (Shine 1978, 1993, 1994, 2000, Zug et al. 2001, Matias et al. 2011, Henao-Duque & Ceballos 2013).

We found a high value of sexual size dimorphism index (SSD), which can possibly indicate the absence of territorial behaviour in *P. patagoniensis*, since the species of snakes that exhibiting the behaviour of territorial and reproductive dispute usually have $SSD < 0.05$ or with negative values of this index, according Shine (1978, 1994) and Oliveira (2008). The same applies to the species *P. agassizii* and *P. nattereri*, since they have $SSD > 0.05$ and there are no indications of territorial behavior (Marques et al. 2006, Mesquita et al. 2011).

Shine (1978) says that the late maturity in female snakes can represent a trade off in which the sexual maturity is delayed until their body size allows the production of sufficiently numerous and large eggs, and highest fertility. Sex differences in snake body size adjustments are considered that may lead to a higher success reproductive (Pizzatto et al. 2007). Therefore, the sexual dimorphism probably exists due to the benefits of larger body size of female so that, according to Pizzatto et al. (2007), the natural selection has favored females with larger body size. Studies of snakes have shown that on the average females are larger than males (approximately 15%) in species where males do not compete for mates, Shine (1994). The sexual dimorphism occurring in the SVL of *P. patagoniensis* indicates than the sexes reach maturity at different sizes; however, according to Fowler & Salomão (1995) it is known that growth is not a continuous process.

Table 2. Percentage of specimens from different Brazilian states according to the color pattern, sex and sexual maturity in the specimens of the *Philodryas patagoniensis*.

Localities	Female				Males			
	Juveniles		Adults		Juveniles		Adults	
	Pattern 1	Pattern 2	Pattern 1	Pattern 2	Pattern 1	Pattern 2	Pattern 1	Pattern 2
Bahia	0%	0%	2%	0%	0%	3%	10%	8%
Distrito Federal	20%	23%	10%	15%	16%	0%	0%	17%
Espírito Santo	0%	0%	4%	0%	0%	0%	0%	0%
Goiás	7%	0%	5%	9%	2%	18%	6%	8%
Maranhão	0%	0%	0%	0%	0%	0%	4%	0%
Mato Grosso	0%	0%	0%	0%	0%	0%	4%	0%
Mato Grosso do Sul	0%	0%	3%	0%	0%	0%	0%	0%
Minas Gerais	35%	38%	30%	30%	49%	29%	33%	34%
Pará	0%	0%	1%	0%	0%	0%	0%	0%
Paraíba	0%	0%	0%	3%	2%	13%	0%	0%
Paraná	0%	0%	1%	3%	2%	6%	0%	0%
Pernambuco	0%	0%	0%	0%	0%	6%	0%	0%
Rio de Janeiro	17%	15%	16%	9%	10%	3%	16%	8%
Rio Grande do Sul	2%	8%	5%	3%	4%	0%	0%	0%
Roraima	0%	0%	0%	0%	0%	0%	0%	0%
Santa Catarina	4%	0%	1%	0%	4%	0%	0%	1%
São Paulo	9%	8%	20%	9%	7%	23%	23%	17%
Sergipe	4%	0%	0%	6%	0%	3%	0%	0%
Tocantins	2%	8%	2%	13%	4%	6%	4%	0%

Morphological variation of *P. patagoniensis*



Figure 2. (A) Pattern of coloration 1 of specimen of *Philodryas patagoniensis* deposited in the Herpetological Collection of Universidade de Brasília (CHUNB), dorsal view. (CHUNB 3779, Brasília - DF). (B) Pattern of coloration 1 of specimen of *Philodryas patagoniensis* deposited in the Herpetological Collection of Universidade de Brasília (CHUNB), ventral view. (CHUNB 3779, Brasília - DF). (C) Pattern of coloration 2 of specimen of *Philodryas patagoniensis* deposited in the Herpetological Collection of Universidade de Brasília (CHUNB), dorsal view. (CHUNB 19337, Brasília - DF). (D) Pattern of coloration 2 of specimen of *Philodryas patagoniensis* deposited in the Herpetological Collection of Universidade de Brasília (CHUNB), ventral view. (CHUNB 19337, Brasília - DF). (E) Pattern of coloration 1 of specimen of *Philodryas patagoniensis* deposited in the Herpetological Collection of Museu de Zoologia João Moojen of Universidade Federal de Viçosa (MZUFV), dorsal view. (MZUFV 1369, Tocantins - MG). (F) Pattern of coloration 1 of specimen of *Philodryas patagoniensis* deposited in the Herpetological Collection of Museu de Zoologia João Moojen of Universidade Federal de Viçosa (MZUFV), ventral view. (MZUFV 1369, Tocantins - MG).

Table 3. Total number, means, standard deviation, variation and statistical results between the coloration patterns with variable: number of ventral and subcaudal shields (NVS and NSS), total length (TBL), snout-vent length (SVL), tail length (TL), head length (HL), head width (WH) and inter-ocular width (IOW) of *Philodryas patagoniensis*. Statistical significance represented by * in the table.

Scales	Patterns of coloration								Test Wilcoxon p-value
	Partens 1				Partens 2				
	N	Means (cm)	SD	Variation (cm)	N	Means (cm)	SD	Variation (cm)	
NVS	256	183.73	9.81	138-210	95	183.05	10.65	154-207	W = 12893.5, p < 0.385
NSS	251	100.25	11.45	40-123	93	102.12	11.95	41-120	W = 10205.5, p < 0.073
TBL	256	907.12	397.57	247-1713	95	807.21	284.64	225-1460	W = 14612, p < 0.004*
SVL	256	670.09	304.86	168-1317	95	587.38	219.36	144-1345.4	W = 14566, p < 0.004*
TL	256	237.03	103.03	60-439	95	219.83	78.35	57-360	W = 14251, p < 0.013*
HL	256	24.45	7.37	11-44.2	94	22.62	5.64	7.7-39.8	W = 14320, p < 0.006*
WH	256	10.03	3.59	3.3-29.6	95	9.5	3.44	4.4-32.8	W = 13854, p < 0.045*
IOW	256	7.98	2.41	2.2-21.1	95	8.24	7.79	3.1-81.3	W = 14000.5, p < 0.019*

According to Mesquita et al. (2010), in specimens of *Oxybelis aeneus* (Wagler in Spix, 1824) (Colubridae) from Brazil the growth rate declines after sexual maturity and therefore females reach maturity at a larger average size than males; although adult males with larger tails than adult females are most commonly pattern found in snakes, due to the presence of hemipenis and retractors muscles (Shine 1993). However, we observed that this pattern of tail sizes of males and females in *P. patagoniensis* (Table 1) not correspond with reported in most species of snakes. We can not find arguments that could support a hypothesis about females having a larger tail than males. Perhaps in the future, with the increase of studies on morphometric patterns in other species of neotropical snakes, not yet studied, could elucidate this fact. López & Giraud (2008) found out that there is difference in the count and size of the shields of females and adults males of *P. patagoniensis*. Females have more ventral shields and males have more subcaudal shields. Vanzolini & Brandão (1944, 1945) found the occurrence of that dimorphism in *Bothrops alternatus* Duméril, Bibron & Duméril, 1854, with the same pattern (females have a higher number of dorsal scales and ventral shields, and males have a higher number of subcaudal shields), however, as in the current study these authors also do not find a justification that would explain this fact.

Although sexual dimorphism in HL is related to dietary differences as suggested by Pough & Groves (1983), Forsman (1991), Shine (1986, 1991), Houston and Shine (1993), Forsman (1996), King (2002), Shetty

& Shine (2002), Nogueira et al. (2003), Aubret et al. (2004), Vincent et al. (2004), and López et al. (2013). The differences found in HL between males and females of *P. patagoniensis* are not related to diet (Hartmann & Marques 2005, López & Giraud 2008). This result is consistent with the observations of Mesquita et al. (2011) for the species *P. nattereri*, indicating that the sexual dimorphism observed is due to reproductive characteristics (Luiselli et al. 2002).

The sexual dimorphism can be observed in different ways in snakes (Rivas & Burghardt 2001). For several species the sexual dimorphism is related to volume and size of body (Shine 1993, 1994); the shape and size of head is another feature for diagnostic of sexual dimorphism (Camilleri & Shine 1990, Vincent et al. 2004); the size of visceral mass and glands also is a important feature for detection of sexual dimorphism (Kissner et al. 1998); but some authors affirms that the patterns of coloration rarely is related to sexual dimorphism (Shine 1993, Marques & Sazima 2003). In the current study we can affirm that not exist a significant difference in the pattern of coloration between males and females of *P. patagoniensis*.

The specimens that we examined from the state of Roraima have not been reported previously in the literature; therefore the current study provides data that expands geographic distribution of this species in Brazil (Figure 3).

We can affirm that the specimens of *P. patagoniensis* studied herein had a great variation in the folidosis. Sexual dimorphism in relation to

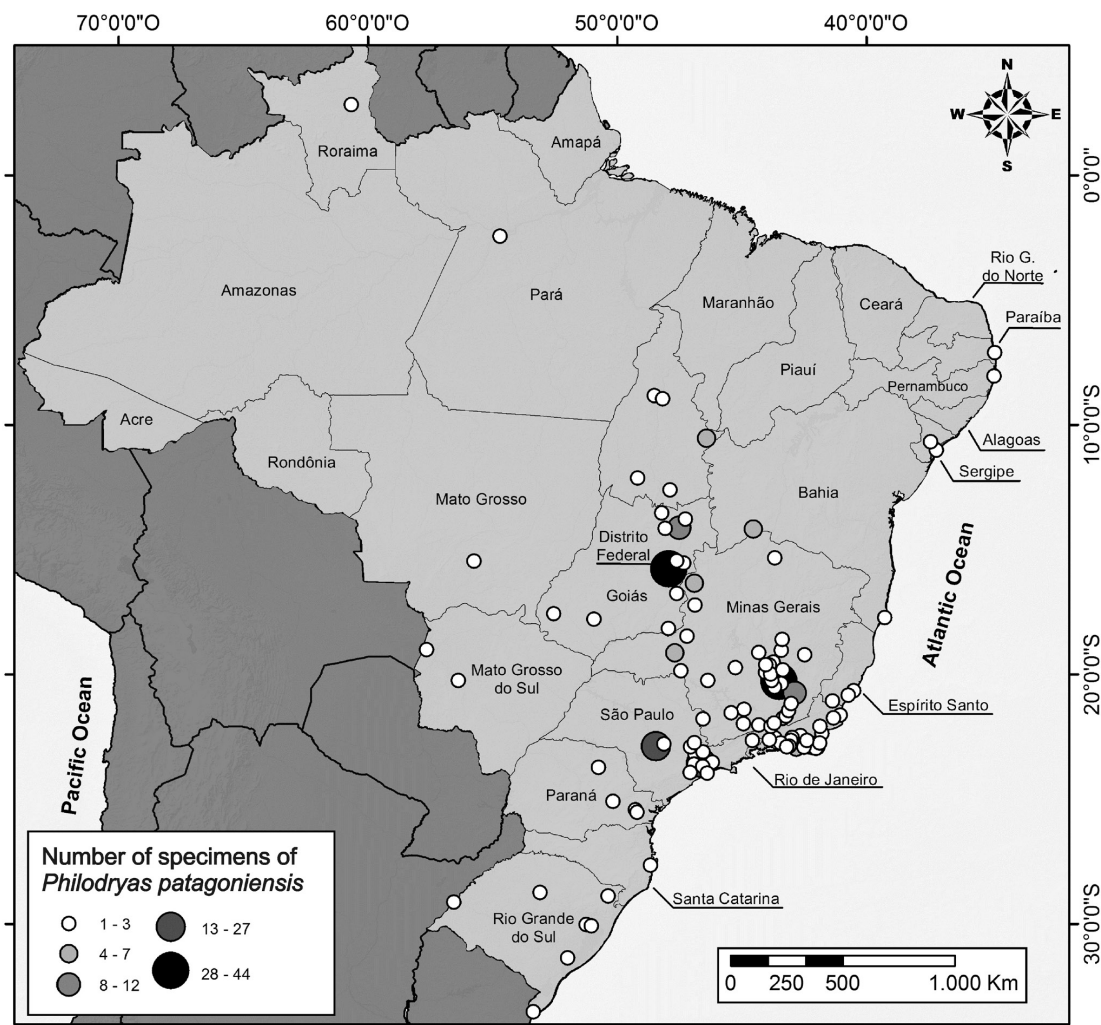


Figure 3. Distribution of studied specimens of *Philodryas patagoniensis* in 18 states of Brazil and the Federal District.

SVL, TL, NVS, NSS, and HL was observed. Adult females are larger than adult males in SVL and TL. However, in juveniles these differences do not occur. Females have a greater number of ventral shields than males, and males have a greater number of subcaudal shields. Also we can affirm that the specimens of *P. patagoniensis* studied have two distinct patterns of coloration, however without geographic and sexual specificity for these patterns.

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Appendix

Localities of collection of specimens analyzed, and respective codes of voucher specimens at the zoological collection of reference.

Bahia: Caravelas (MNRJ 9336), Cocos (CHUNB 51369; CHUNB 51370; CHUNB 51371; CHUNB 51372; CHUNB 51373), Sem procedência (MUZUSP 10082). Brasília: Brasília (CHUNB 139; CHUNB 3620; CHUNB 3640; CHUNB 3773; CHUNB 3774; CHUNB 3775; CHUNB 3776; CHUNB 3777; CHUNB 3778; CHUNB 3779; CHUNB 3781; CHUNB 3783; CHUNB 3784; CHUNB 3785; CHUNB 3787; CHUNB 3788; CHUNB 3789; CHUNB 3790; CHUNB 3837; CHUNB 14181; CHUNB 18473; CHUNB 19328; CHUNB 19330; CHUNB 19334; CHUNB 19337; CHUNB 19339; CHUNB 19340; CHUNB 19341; CHUNB 24445; CHUNB 24563; CHUNB 24596; CHUNB 25355; CHUNB 28948; CHUNB 30380; CHUNB 30843; CHUNB 40793; CHUNB 44139; CHUNB 49608; CHUNB 50788; CHUNB 56858; CHUNB 56862; CHUNB 56880; CHUNB 57464; CHUNB 65799). Espírito Santo: Guarapari (MNRJ 20045), Piúma (MCNR 2611). Goiás: Alto Paraíso de Goiás (MNRJ 9351; CHUNB 3751; CHUNB 19331; CHUNB 19342; CHUNB 59128; CHUNB 59129; CHUNB 59131; CHUNB 59132; CHUNB 59523), Catalão (MNRJ 7440), Cristalina (CHUNB 19335), Colinas do Sul (MNRJ 21197), Formosa (CHUNB 27640), Mineiros (CHUNB 18440; CHUNB 23729), Minaçu (CHUNB 3768), Planaltina de Goiás (CHUNB 19332), Rio Verde (CHUNB 50288), Teresinha de Goiás (MCNR 3187), Sem procedência (MUZUSP 1908; MUZUSP 15047; MUZUSP 17773). Mato Grosso: Chapada dos Guimarães (CHUNB 20421), Corumbá (MNRJ 20943; MNRJ 20994). Maranhão: Perdizes (MNRJ 11342). Mato Grosso do Sul: Miranda (FUNED 1942). Minas Gerais: Belo Horizonte (FUNED 973, MNRJ 4849), Bom Despacho (FUNED 195), Cachoeira Escuro (FUNED 2206), Caxambú (UFJF 17), Chácara (UFJF 875; UFJF 883), Conceição do Mato dentro (FUNED 1637; FUNED 1695), Contagem (MCNR 81), Cordisburgo (FUNED 198), Coromandel (MNRJ 8405; MNRJ 8406), Ingaí (UNILAVRAS 157; UNILAVRAS 216; UNILAVRAS 241), Irapé (MCNR 1707; MCNR 2913), Itabirito (LZV 94), Itaperuna (FUNED 1913), Jaboticatubas (MNRJ 8879), Jaíba (FUNED 1466), Juiz de Fora (UFJF78; UFJF79; UFJF500), Km 813, sentido Juiz de Fora, BR-040, RJ (MNRJ 19878), Lagoa Santa (MNRJ 1323), Liberdade (MNRJ 8408), Mariana (MUZUSP 15726; MUZUSP 15727; FUNED 1142), Mina do Serro (MCNR 3390), Nova Lima (LZV 177), Nova Ponte (FUNED 725; FUNED 772; FUNED 774; FUNED 775), Ouro Branco (LZV 285; LZV 493), Ouro Preto (LZV 16; LZV 17; LZV 18; LZV 36; LZV 61; LZV 62; LZV 69; LZV 93; LZV 148; LZV 161; LZV 162; LZV 172; LZV 250; LZV 262; LZV 273; LZV 286; LZV 287; LZV 293; LZV 294; LZV 327; LZV 357; LZV 358; LZV 391; LZV 424; LZV 442; LZV 443; LZV 454; LZV 455; LZV 481; LZV 596; LZV 654; LZV 666; LZV 670; LZV 671; LZV 736; LZV 773; LZV 787; LZV 807; LZV 886; LZV 902; LZV 989; MUZUSP 14096; MUZUSP 14212; MUZUSP 15149), Paracatu (MCNR 3158), Pedro Leopoldo (MCNR 95), Poços de Caldas (MNRJ 4511, MUZUSP 14072; MUZUSP 14093), Queimados, entre os municípios de Cabeira Grande - MG, Unai - MG, Cristalina - GO (MNRJ 10930), Rio novo (MNRJ 9584), Rio Preto (MCNR 4338), Sacramento (MZUFV 1077), Santa Bárbara do Monte Verde (MNRJ 7068), São Gonçalo do Rio abaixo (MNRJ 9047), São Roque de Minas (MZUFV 1755; MZUFV 1761; MZUFV 1826), São Simão (MNRJ 4919), Serra do Cipó (MCNR 3530), Tocantins (MZUFV 1369), Transição ente Paracatu e Pirapora (MCNR 3286), Unai (CHUNB 3618; CHUNB 24389; CHUNB 24477; CHUNB 29420), Varginha (MUZUSP 15155), Viçosa (MZUFV 62; MZUFV 155; MZUFV 336; MZUFV 719; MZUFV 1149; MZUFV 1203; MZUFV 1611; MZUFV 1615), Sem procedência (MUZUSP 15732; MUZUSP 17984; MUZUSP 17991; MUZUSP 18656). Pará: Santarém

(CHUNB 6665). Paraíba: João Pessoa (MUZUSP 8267; MUZUSP 8999; MNRJ 9717). Paraná: Curitiba (MUZUSP 3685; MUZUSP 3686), Ponta Grossa (MUZUSP 5787), São Jerônimo da Serra (MUZUSP 11520), São José dos Pinhais (MUZUSP 13868). Pernambuco: Sem procedência (MNRJ 620; MUZUSP 975). Rio de Janeiro: Arraial do Cabo (MNRJ 21774; MNRJ 21775; MNRJ 22924), Barra de São João (MNRJ 7684; MNRJ 8376), Búzios (MNRJ 10182), Cabo Frio (MUZUSP 4203; MUZUSP 5870; MUZUSP 10802; MNRJ 8401; MNRJ 8373), Cachoeira do Macacu (MNRJ 12350; MNRJ 12351; MNRJ 20923), Campos dos Goytacazes (MNRJ 16400; MNRJ 17765), Conceição de Macabu (MNRJ 16438), Guapimirim (MNRJ 14303), Iguaba (MNRJ 8403), Iguaba Grande (MNRJ 17340; MNRJ 17926; MNRJ 18128; MNRJ 18129; MNRJ 18130; MNRJ 18521), Macaé (MUZUSP 7486; MNRJ 15660; MNRJ 19240), Magé (MNRJ 16470), Maricá (MNRJ 4739; MNRJ 8402; MNRJ 13165; MNRJ 13166; MNRJ 14087), Nova Iguaçu (MNRJ 21776), Niterói (MNRJ 8359), Paulo Frantin (MNRJ 8377), Pirai (MNRJ 8375), São João da Barra (MNRJ 17436), Saquarema (MNRJ 7269; MNRJ 14122), Silva Jardim (MNRJ 19861), Sem procedência (MUZUSP 2338; MNRJ 3992). Rio Grande do Sul: Itaqui (MUZUSP 1385; MUZUSP 1852), Jaquirana (CHUNB 49965), Porto 15 de Novembro (MUZUSP 11604; MUZUSP 11605), São Lourenço (MUZUSP 248; MUZUSP 250), Taim (MUZUSP 7435), Tupaceretan (MUZUSP 2576), Viamão (MUZUSP 5745), Sem procedência (MUZUSP 270; MUZUSP 7335). Roraima: Boa Vista (CHUNB 6650). Santa Catarina: Palhoça (MNRJ 20169; MNRJ 20172; MNRJ 20173), Sem procedência (MUZUSP 5182; MUZUSP 9425; MUZUSP 9426). São Paulo: Anhembi (MNRJ 21753), Atibaia (MUZUSP 245), Botucatu (MUZUSP 2426; MUZUSP 2644; MUZUSP 2645; MUZUSP 3458; MNRJ 18545; MNRJ 18546; MNRJ 19336; MNRJ 20480; MNRJ 21131; MNRJ 21745; MNRJ 21748; MNRJ 21751; MNRJ 21908; MNRJ 21919; MNRJ 22079; MNRJ 22136; MNRJ 22140; MNRJ 22142; MNRJ 22143; MNRJ 22144; MNRJ 22147; MNRJ 22841; MNRJ 22903; MNRJ 22904; MNRJ 22905; MNRJ 22906; MNRJ 22907), Campinas (MUZUSP 244), Cotia (CHUNB 6124), Divisa do Campos dos Goytacazes - SP e Mimoso do Sul - ES (MNRJ 15817; MNRJ 15847), Jundiaí (MUZUSP 12810; MNRJ 17120), Juquitiba (MUZUSP 16495), Mogi das Cruzes (CHUNB 24490), Pedreira (CHUNB 6123), São Bernardo do Campo (MUZUSP 4024), São Vicente (MUZUSP 4572), Serra da Bocaina (MUZUSP 4103; MUZUSP 4649; MUZUSP 4911), Sem procedência (MUZUSP 239; MUZUSP 1689; MUZUSP 1955; MUZUSP 2640; MUZUSP 2860; MUZUSP 2861; MUZUSP 2979; MUZUSP 3457; MUZUSP 4068; MUZUSP 4069; MUZUSP 4605; MUZUSP 4651; MUZUSP 5519; MUZUSP 8531; MUZUSP 12355; MUZUSP 12832; MUZUSP 16529). Sergipe: Itabaiana (MUZUSP 15840), São Cristóvão (MUZUSP 15838; MUZUSP 15839), Sem procedência (MUZUSP 17454; MUZUSP 17455). Tocantins: Figueirópolis (CHUNB 62806), Guaraí (MUZUSP 1269), Mateiros (CHUNB 33800; CHUNB 41108, CHUNB 41109; CHUNB 41110; CHUNB 41111), Paraná (CHUNB 38287), Pedro Afonso (CHUNB 52431), Sem procedência (MUZUSP 14396; MUZUSP 14601; MUZUSP 15508; MUZUSP 15509; MUZUSP 15510; MUZUSP 15511).