

## Sexual dimorphism in *Trachylepis vittata* (Olivier, 1804) (Sauria: Scincidae) in the Zagros Mountains, western Iran

Nasrullah RASTEGAR-POUYANI<sup>1,2</sup>, Raziieh FATTAHI<sup>1\*</sup>

<sup>1</sup>Department of Biology, Faculty of Science, Razi University, Kermanshah, Iran

<sup>2</sup>Iranian Plateau Herpetology Research Group, Faculty of Science, Razi University, Kermanshah, Iran

Received: 07.11.2013

Accepted: 22.04.2014

Published Online: 02.01.2015

Printed: 30.01.2015

**Abstract:** We describe sexual dimorphism in coloration, size, and shape in 48 specimens (19 males and 29 females) of the bridled skink, *Trachylepis vittata* (Olivier, 1804), collected from western regions of the Iranian Plateau. For the analyses, we used 29 metric and 9 meristic characters. Our study showed the existence of slight sexual size dimorphism in body and head size between the sexes. Males had significantly smaller heads and narrower bodies than females. Furthermore, males and females were different in the structure of the cloaca. The possible scenarios behind sexual dimorphism in this lizard are discussed.

**Key words:** Bridled skink, Scincidae, sexual size dimorphism, sexual selection, Iranian Plateau

### 1. Introduction

Sexual dimorphism, defined as a phenotypic difference between males and females of a species, is a common phenomenon in animals, including reptiles (Aghili et al., 2010). The vast majority of comparative studies of sexual dimorphism have focused only on size dimorphism, with relatively few examining variation in shape (Selander, 1966; Andersson, 1994; Fairbairn, 1997). However, there is no reason to believe that shape dimorphism is any less important than size dimorphism (Butler and Losos, 2001).

Sexual size dimorphism (SSD) describes the situation in which the 2 sexes differ in measured values of morphometric characters (Aghili et al., 2010). Selection favoring intersexual differences in body shape might result from differences between the sexes in ecology (niche partitioning between the sexes), behavior (territorial or mate choice behavior), or reproduction (physiological or anatomical differences related to different reproductive costs or roles [Darwin, 1859, 1871]). Sex differences in ecology (food and/or habitat) associated with shape dimorphism are known from many reptiles (e.g., Schoener, 1967, 1968; Schoener and Gorman, 1968; Lister, 1970; Schoener et al., 1982; Hebrard and Madsen, 1984; Powell and Russell, 1984; Shine, 1991; Vitt et al., 1996). Behavior can influence dimorphism by the operation of sexual selection, which may result in exaggeration of body proportions in one sex, usually males (Butler and Losos,

2001). Anderson and Vitt (1990) suggest that the causes of sexual dimorphism in size could be related to several factors: competition between males, differential mortality between sexes due to differences in longevity, the larger amount of energy allocated by females for reproduction, or males being more active because they need to search for females and thus having a larger predation risk (Verrastro, 2004; Fathinia and Rastegar-Pouyani, 2011). Lizards in particular provide the opportunity for comparative studies and are a good model for studying the evolution of SSD, because this group presents remarkable variation in both direction and magnitude of SSD (Cox et al., 2003). Male and female lizards may differ in many traits, such as coloration, body shape, and size (Pinto et al., 2005; Ribeiro et al., 2010). Males are larger than females in the majority of lizards, although female-biased SSD is common and occurs in nearly every family. Male-biased SSD reaches extremes in which males average 50% longer than females in some polychrotid anoles (*Anolis*), tropidurids (*Tropidurus*), marine iguanas (*Amblyrhynchus*), and varanid monitor lizards (*Varanus*) (Fairbairn et al., 2007). By contrast, females exceed males by as much as 20% in some polychrotids (*Polychrus*), skinks (*Mabuya*), and pygopodids (*Aprasia*) (Fairbairn et al., 2007). In the majority of reptiles, the number of offspring in a clutch or litter increases with maternal body size, so selection for increased fecundity should favor larger female body size (Fairbairn et al., 2007).

\* Correspondence: raziye.fatahi@yahoo.com

The genus *Trachylepis* Fitzinger, 1843 includes 3 species in Iran: *Trachylepis vittata* (Olivier, 1804), distributed west of the Zagros Mountains; *T. septemtaeniata* (Reuss, 1834), found in southern regions of the Zagros Mountains; and *T. aurata* Chernov, 1926, inhabiting northern to central parts of the Zagros Mountains (Faizi, 2010). *Trachylepis vittata* is a rare species in the western Iranian Plateau, and there is little knowledge on the sexual dimorphism of this taxon in Iran. The aim of the present study is to investigate morphological peculiarities of *T. vittata* in Iran and to detect patterns of sexual dimorphism in this lizard.

**2. Materials and methods**

**2.1. Field study**

A total of 48 adult skinks (29 females and 19 males) were collected in different localities in the western region of the Iranian Plateau during March–August 2011 (Table 1). After examination, the specimens were released in similar habitats within the same region. Juveniles were clearly distinguished from adults based on their coloration pattern; they were not used for this study. Only fully adult specimens were used in this study (Figure 1). We measured 38 metric and meristic characters (see Table 2 for all abbreviations). The measurement of metric characters was performed using a digital caliper (0.01-mm precision). On the basis of temperatures measured during fieldwork, the individuals of this species were active in a temperature range of 17–40 °C in the spring. We found skinks in natural areas with vegetation such as *Carthamus tinctorius*, *Glycyrrhiza globra*, *Sinapis arvensis*, *Cynodon dactylon*, and *Alhagi maurorum*, but also among bean or wheat farms, fruit gardens, soft and moist soils, and borders of hedges and along the borders of small streams.

**2.2. Statistical analyses**

We used SPSS 16.0 and S-Plus 8.0 software for running all the analyses. For each character, sample size, maximum, minimum, mean, and standard error of the mean were calculated (Table 3). In the next step, we performed a principal component analysis (PCA) as an exploratory method to investigate between-sex variation of morphometric variables in the multivariate level. The



**Figure 1.** *Trachylepis vittata* from the city of Darreh Shahr, Ilam Province, western Iran.

existence of significant differences between the sexes for examined variables was then tested for by multivariate analysis of variance (MANOVA) with sex as a factor.

**3. Results**

Morphological measurements of 19 males and 29 females were entered into the analyses. Descriptive parameters of morphometric and meristic characters for males and females are presented in Table 3. Results of the PCA (Table 4) for metric, meristic, and character ratios showed that the first 3 components jointly explain 98.82% of the total variation. The first principal component (PC1) accounted for 94.08% of variation and was strongly and positively correlated with SVL and LHF. The second principal component accounted for another 3.66% of the total variation and was strongly and positively correlated with LHF and negatively with SVL; finally, PC3 accounted for 1.08% of the total variation and was strongly and positively correlated with LCL and FFL (Table 4). Results of the uni- and multivariate analyses were consistent with each other. Ordination of the first 2 principal components for morphological characters in males and females of *T. vittata* is presented in Figure 2. As shown, there is a relatively high degree of separation between males and females of *T. vittata*. Furthermore, the results of the MANOVA (morphological characters as dependent variables, sex as a factor) indicated effects of sex on HL, EED, LHF, and LCL for a given body size (Wilks' lambda = 0.177) (Table 5). These results indicate that sexual dimorphism in *T. vittata*

**Table 1.** Geographic details of the study localities for *Trachylepis vittata* in western Iran.

Locality	Geographical coordinates	Altitude, m
Kermanshah	34°18'N, 047°03'E	1437
Sarpol-e Zahab	34°23'N, 045°55'E	645
Darreh Shahr	33°09'N, 047°22'E	643
Poldokhtar	33°07'N, 47°43'E	688

**Table 2.** The morphometric and meristic characters examined in female and male specimens of *Trachylepis vittata*.

	Character	Definition
1	SVL	Length of snout to vent (from tip of snout to anterior edge of cloaca)
2	HL	Head length (from tip of snout to anterior edge of tympanum)
3	HW	Head width (at the widest point of head)
4	HH	Head height (from lower edge infralabial to tip of supraocular)
5	LFL	Length of forelimb
6	LHL	Length of hindlimb
7	LE	Length of eye (from anterior corner to posterior corner of eye)
8	NED	Nostril-eye distance (from anterior corner of eye to posterior edge of nostril)
9	EED	Eye-ear distance (from the posterior corner of eye to anterior edge of tympanum)
10	IORD	Interorbital distance (between anterior corner of orbit)
11	NL	Neck length (from the posterior edge of tympanum to anterior edge of shoulder)
12	ORD	Orbit diameter
13	SW	Snout width
14	LFE	Length of femur
15	LA	Length of arm
16	TD	Tympanum diameter (largest size)
17	TOL	Fourth toe length
18	FIL	Fourth finger length
19	MSOL	Maximum length of subocular
20	SEL	Length of snout to eye
21	LFO	Length of forearm
22	LHF	Length between hindlimb and forelimb
23	LCL	Length of cloaca
24	HHL	Length between hindlimbs
25	FFL	Length between forelimbs
26	SDLT	Subdigital lamellae under the fourth toe
27	SDLF	Subdigital lamellae under the fourth finger
28	NSL	Number of supralabials
29	NIL	Number of infralabials
30	NDS	Number of dorsal scales around body
31	NMC	Number of scales from mental to anterior edge of cloaca
32	NVS	Number of ventral scales (from gular to anterior edge of cloaca)
33	RVS	Row of ventral scales (in longitudinal rows)
34	NEE	Number of scales between posterior corner of eye to tip of ear
35	FIPL	Length frontal to interparietal (from anterior corner of frontal to posterior corner of interparietal)
36	IPW	Width of interparietal
37	PW	Parietal width
38	PL	Parietal length
39	LHFi	LHF/SVL
40	WHLH	WH/LH

**Table 3.** Descriptive statistics of morphological characters of males and females in *Trachylepis vittata*. SEM = Standard error of the mean; N = sample size.

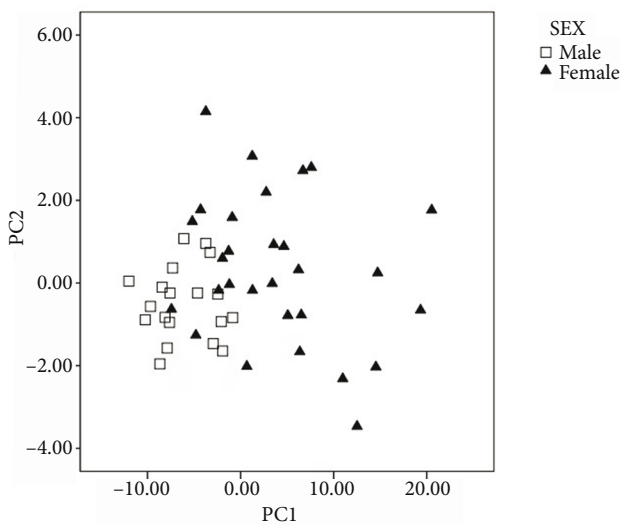
Characters	N		Mean		SEM		Maximum		Minimum	
	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂
SVL	29	19	77.83	70.25	1.16	0.62	90.72	74.90	69.13	65.13
HL	29	19	12.68	12.37	0.13	0.1	14.09	13.14	11.55	11.53
HW	29	19	8.2	7.98	0.13	0.1	9.47	8.77	6.52	7.38
HH	29	19	7.00	6.72	0.09	0.1	8.07	7.50	6.01	5.22
LFL	29	19	18.33	17.86	0.2	0.3	20.35	21.04	16.02	15.97
LHL	29	19	27.19	26.81	0.30	0.3	31.06	28.96	24.30	23.39
LE	29	19	3.22	3.25	0.05	0.08	3.74	4.27	2.64	2.73
NED	29	19	3.44	3.35	0.06	0.1	4.67	4.89	2.89	2.65
EED	29	19	4.37	4.37	0.06	0.06	5.31	4.86	3.94	4.00
IOR	29	19	5.71	5.57	0.05	0.06	6.44	6.01	5.16	5.08
NL	29	19	11.03	10.44	0.22	0.25	14.00	12.56	9.08	8.76
ORD	29	19	2.03	1.99	0.04	0.03	2.46	2.32	1.51	1.75
SW	29	19	4.23	4.06	0.05	0.06	4.84	4.73	3.83	3.68
LFE	29	19	8.35	8.42	0.18	0.23	10.39	9.61	6.87	6.57
LA	29	19	6.3	6.15	0.11	0.17	7.07	8.47	4.79	5.18
TD	29	19	1.51	1.5	0.04	0.04	1.93	1.89	1.07	1.21
TOL	29	19	7.54	7.74	0.13	0.2	9.40	9.33	5.99	6.52
FIL	29	19	4.47	4.5	0.05	0.07	5.01	5.05	3.90	4.05
MSOL	29	19	2.59	2.52	0.04	0.05	3.09	3.35	1.96	2.28
SEL	29	19	5.59	5.44	0.06	0.06	6.54	5.91	4.97	4.99
LFO	29	19	12.03	11.71	0.11	0.13	13.36	12.81	10.67	10.79
LHF	29	19	43.28	36.75	0.77	0.47	54.13	39.59	35.64	33.70
LCL	29	19	7.94	7.16	0.15	0.15	10.89	8.76	6.92	6.24
HHL	29	19	7.19	6.75	0.09	0.11	8.67	7.87	6.47	6.04
FFL	29	19	10.22	9.25	0.17	0.14	12.17	10.72	8.46	7.88
SDLT	29	19	16.48	16.63	0.17	0.17	18.00	18.00	13.00	15.00
SDLF	29	19	11.34	11.63	0.12	0.11	12.00	12.00	10.00	11.00
NSL	29	19	7.00	6.95	0.00	0.05	7.00	7.00	7.00	6.00
NIL	29	19	6.79	6.79	0.1	0.1	8.00	7.00	6.00	6.00
NDS	29	19	31.79	31.79	0.1	0.1	33.00	33.00	30.00	31.00
NMC	29	19	62.07	61.42	0.34	0.46	66.00	65.00	59.00	58.00
NVS	29	19	43.55	43.05	0.3	0.3	48.00	46.00	39.00	42.00
RVS	29	19	8.28	8.26	0.1	0.1	10.00	10.00	8.00	8.00
NEE	29	19	5.21	5.26	0.1	0.1	6.00	6.00	4.00	5.00
FIPL	29	19	7.98	7.69	0.07	0.07	8.96	8.32	7.19	7.15
IPW	29	19	1.99	1.92	0.03	0.04	2.31	2.37	1.75	1.69
PW	29	19	2.86	2.83	0.04	0.04	3.21	3.27	2.45	2.52
PL	29	19	4.00	3.83	0.05	0.04	4.36	4.23	3.46	3.52

**Table 4.** Factor loadings on the first 3 principal components of 9 morphological characters for males and females of *T. vittata*. The variables loading strongly on each principal component are marked with an asterisk; only significant variables are presented.

Characters	PC1	PC2	PC3
SVL	0.803*	-0.579*	-0.082
SW	0.011	0.025	0.083
LHF	0.586*	0.806*	-0.039
LCL	0.042	0.043	0.793*
HHL	0.035	-0.037	0.324
FFL	0.080	-0.065	0.490*
FIPL	0.031	-0.068	0.098
PL	0.018	-0.055	0.026
LHF/SVL	0.002	0.015	0.000
Eigenvalue	4.565	1.266	0.922
% of variance	94.08	3.66	1.08
Cumulative %	94.08	97.74	98.82

**Table 5.** Results of the multivariate analysis of variance (MANOVA) in *T. vittata* for effects of sex as a factor on the dependent variables, including metric and meristic characters. Only significant results are presented.

Factor	Dependent variable	df	Mean square	F	P-value
Sex	HL	1	0.811	4.800	0.034
	EED	1	0.363	5.215	0.027
	LHF	1	31.011	10.481	0.002
	LCL	1	2.936	5.265	0.026



**Figure 2.** Ordination of male and female specimens of *Trachylepis vittata* on the first 2 principal components. Note the relatively high degree of separation along PC1.

is restricted to several length measurements. All of them showed significantly greater values in females.

**4. Discussion**

Reproductive output is associated with morphological traits in lizards (Xu and Ji, 2006). Darwin (1871) proposed that natural selection should favor large female body size when female size is positively correlated with fecundity within a population, as appears to be the case for most lizards in which clutch size is variable (Cox et al., 2003). Becker and Paulissen (2012) showed that females of *Scincella lateralis* are larger (have larger SVL) than males. In lizards, the evolution of viviparity and reduced reproductive frequency are generally correlated with shifts toward female-biased SSD (Fairbairn et al., 2007). The most common hypothesis advanced to explain why female reptiles are larger is fecundity selection that favors larger body size in females to increase clutch size and/or clutch mass (Heideman et al., 2008). The only studies of which we

are aware that address this possibility present contradictory results. Johnson (1953) found no relationship between female SVL and either clutch size or egg length. However, Brooks (1963), working with a wider range of female SVLs, found a significant positive correlation between female SVL and clutch size (Becker and Paulissen, 2012). More recent studies have shown that differences in trunk and head dimensions between sexes can be present even in cases where SSD is not present—selection can work on individual body part differences rather than on body size as a whole (Schwartzkopf, 2005).

The present study confirms that in *T. vittata*, SVLs and trunks of females were larger than those of males. Additionally, males had narrower bodies than females. Due to the presence of ovoviviparity in *T. vittata*, females likely invest more energy in producing offspring than males, hence requiring a larger body size, which increases the offspring's chance of surviving. Therefore, fecundity selection in *T. vittata* females can produce a longer and wider trunk. Sexual differences in energy allocation for growth can result from divergence in reproductive investment between the sexes (Cox et al., 2003; Pinto et al., 2005; Ljubisavljević et al., 2008; Becker and Paulissen, 2012). The evolution of SSD in lizards is also associated with between-sex differences in reproductive success related to adult body size (Cooper and Vitt, 1989; Hews, 1990; Mouton and Van Wyk, 1993).

Our results for *T. vittata* show that the differences in head size that exist between males and females are likely responsible for differences in bite force. Sexual differences in head size in this species are attributable to distinct differences in prey size between the 2 sexes, in that females eat larger prey than males. Some characters such as the frontal to interparietal length, length of parietal, and snout width have greater values in females than in males. This suggests that females may be adapted to consume bigger prey items than males since females need more

energy during reproduction. However, in the absence of behavioral data on bite force or a detailed trophic study that deals with diet composition and prey size in both females and males of *T. vittata*, both reproductive investment and dietary differences as causes of head size sexual dimorphism remain hypothetical.

Sexual differences in head size are associated with sexual differences in bite force (Herrel et al., 2006). Lizards that are larger and that have wider and longer heads bite harder (Herrel et al., 2006). Thus, differences in diet may be the result of natural selection leading to reduced niche overlap between the sexes (Schoener, 1967). Intersexual niche separation, a strategy to minimize competition for resources between males and females, has been proposed as a cause of sexual dimorphism in size and body shape (Schoener, 1967).

*T. vittata* males have a thicker basal area of the tail than females, probably because copulating organs are located at their tail base. The structure of the cloaca is also different, which is noticeable under magnification: males have a smaller length of the cloacal aperture than females. However, in *T. vittata*, males and females did not show clear differences in coloration and color pattern.

In summary, our data show that males and females of *T. vittata* are slightly dimorphic in body and head size, and it seems likely that this is due to different growth patterns (as a proximate cause) and/or differences in intrasexual or natural selection forces between the sexes of this taxon. Adult females have larger bodies and longer heads than adult males. Female-biased SSD, which is influenced by fecundity selection and greater female investment in reproduction, exists in *T. vittata*.

### Acknowledgments

We would like to thank Rahmat Fattahi, Hasan Abbasi Seymareh, and Mohammad Reza Fattahi for their cooperation in collecting specimens.

### References

- Aghili H, Rastegar-Pouyani N, Rajabizadeh M, Kami HG, Kiabi BH (2010). Sexual dimorphism in *Laudakia erythrogastra* (Sauria: Agamidae) from Khorasan Razavi Province, Northeastern Iran. *Russ J Herpetol* 17: 51–58.
- Anderson RA, Vitt LJ (1990). Sexual selection versus alternative causes of sexual dimorphism in teiid lizards. *Oecologia* 84: 145–157.
- Andersson M (1994). *Sexual Selection*. Princeton, NJ, USA: Princeton University Press.
- Becker BM, Paulissen MA (2012). Sexual dimorphism in head size in the Little Brown Skink (*Scincella lateralis*). *Herp Con Bio* 7: 109–114.
- Brooks GR (1963). Population ecology of the ground skink, *Lygosoma laterale* (Say). PhD, University of Florida, Gainesville, FL, USA.
- Butler MA, Losos JB (2001). Multivariate sexual dimorphism, sexual selection, and adaptation in Greater Antillean *Anolis* lizards. *Ecol Monogr* 72: 541–559.
- Cooper WE, Vitt LJ (1989). Sexual dimorphism of head and body size in an iguanid lizard: paradoxical results. *Am Nat* 133: 729–735.
- Cox RM, Skelly SL, John-Alder HB (2003). A comparative test of adaptive hypotheses for sexual size dimorphism in lizards. *Evolution* 57: 1653–1669.

- Darwin C (1859). On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life. London: John Murray.
- Darwin CR (1871). The Descent of Man, and Selection in Relation to Sex. London: John Murray.
- Fairbairn DJ (1997). Allometry for sexual size dimorphism: pattern and process in the coevolution of body size in males and females. *Annu Rev Ecol Syst* 28: 659–687.
- Fairbairn DJ, Blanckenhorn WU, Székely T (2007). Sex, Size, and Gender Roles: Evolutionary Studies of Sexual Size Dimorphism. Oxford, UK: Oxford University Press.
- Faizi H, Rastegar-Pouyani N, Rajabizadeh M, Heydari N (2010). Sexual dimorphism in *Trachylepis aurata transcaucasica* Chernov, 1926 (Reptilia: Scincidae) in the Zagros Mountains, western Iran. *Iran J Anim Biosyst* 6: 25–35.
- Fathinia B, Rastegar-Pouyani N (2011). Sexual dimorphism in *Trapelus ruderatus ruderatus* (Sauria: Agamidae) with notes on the natural history. *Amphib Reptile Conserv* 5: 15–22.
- Hebrard JJ, Madsen T (1984). Dry season intersexual habitat partitioning by flap-necked chameleons (*Chamaeleo dilepis*) in Kenya. *Biotropica* 16: 69–72.
- Heideman NJL, Daniels SR, Mashinini PL, Mokone ME, Thibedi ML, Hendricks MGJ, Wilson BA, Douglas RM (2008). Sexual dimorphism in the African legless skink subfamily Acontiinae (Reptilia: Scincidae). *Afr Zool* 43: 192–201.
- Herrel A, McBrayer LD, Larson PM (2006). Functional basis for sexual differences in bite force in the lizard *Anolis carolinensis*. *Biol J Linn Soc* 91: 111–119.
- Hews DK (1990). Examining hypotheses generated by field measures of sexual selection on male lizards, *Uta palmeri*. *Evolution* 44: 1956–1966.
- Johnson RM (1953). A contribution on the life history of the lizard *Scincella laterale* (Say). *Tulane Stud Zool* 1: 11–27.
- Lister BC (1970). The nature of niche expansion in West Indian *Anolis* lizards I: Ecological consequences of reduced competition. *Evolution* 30: 659–676.
- Ljubisavljević K, Polović L, Ivanović A (2008). Sexual differences in size and shape of the Mosor rock lizard [*Dinarolacerta Mosorensis* (Kolombatović, 1886)] (Squamata: Lacertidae): a case study of the Lovćen mountain population (Montenegro). *Arch Biol Sci Belgrade* 60: 279–288.
- Mouton PFN, Van Wyk JH (1993). Sexual dimorphism in cordylid lizards: a case study of the Drakensberg crag lizard, *Pseudocordylus melanotus*. *Can J Zool* 71: 1715–1723.
- Pinto ACS, Wiederhecker HC, Colli GR (2005). Sexual dimorphism in the Neotropical lizard, *Tropidurus torquatus* (Squamata, Tropiduridae). *Amphibia-Reptilia* 26: 127–137.
- Powell GL, Russell AP (1984). The diet of the eastern short-horned lizard (*Phrynosoma douglasi brevirostre*) in Alberta and its relationship to sexual size dimorphism. *Can J Zoolog* 62: 428–440.
- Ribeiro LB, Kolodiuk MF, Freire EMX (2010). Ventral colored patches in *Tropidurus semitaeniatus* (Squamata, Tropiduridae): sexual dimorphism and association with reproductive cycle. *J Herpetol* 44: 177–182.
- Schoener TW (1967). The ecological significance of sexual dimorphism in size in the lizard *Anolis conspersus*. *Science* 155: 474–476.
- Schoener TW (1968). The *Anolis* lizards of Bimini: resource partitioning in a complex fauna. *Ecology* 49: 704–726.
- Schoener TW, Gorman GC (1968). Some niche differences in three Lesser Antillean lizards of the genus *Anolis*. *Ecology* 49: 819–830.
- Schoener TW, Slade JB, Stinson CH (1982). Diet and sexual dimorphism in the very catholic lizard genus, *Leiocephalus* of the Bahamas. *Oecologia* 53: 160–169.
- Schwartzkopf L (2005). Sexual dimorphism in body shape without sexual dimorphism in body size in water skinks (*Eulamprus quoyii*). *Herpetologica* 61: 116–123.
- Selander RK (1966). Sexual dimorphism and differential niche utilization in birds. *Condor* 68: 113–151.
- Shine R (1991). Intersexual dietary divergence and the evolution of sexual dimorphism in snakes. *Am Nat* 138: 103–122.
- Verrastro L (2004). Sexual dimorphism in *Liolaemus occipitalis* (Iguania, Tropiduridae). *Iheringia Sér Zool Porto Alegre* 94: 45–48.
- Vitt LJ, Zani PA, Caldwell JP (1996). Behavioural ecology of *Tropidurus hispidus* on isolated rock outcrops in Amazonia. *J Trop Ecol* 12: 81–101.
- Xu DD, Ji X (2006). Sexual dimorphism, female reproduction and egg incubation in the oriental leaf-toed gecko (*Hemidactylus bowringii*) from southern China. *Zoology* 110: 20–27.