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Sexual dimorphism in *Trachylepis aurata transcaucasica* Chernov, 1926 (Reptilia: Scincidae) in the Zagros Mountains, western Iran

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Forty-nine preserved specimens (31 male and 18 female) of *Trachylepis aurata transcaucsasica* were examined with respect to metric and meristic features and dry skull anatomy to assess sexual dimorphism. Thirty-one morphological characters and 36 anatomical characters in dry skulls were examined. Subdigital lamellae under the forth toe, neck length, neck length/snout vent length, and six skull characters (skull length, condylobasal length, anterior rostrum width, eye width, and ratios of maxilla length to skull length and pterygoid length to skull length) were significantly different in males and females ($P < 0.05$). Other observed differences were in the base of the tail, which was thicker in males than in females, and in the structure of the anus. The sexes did not show dimorphism in color or pattern.

Key words: Skull, Morphology, Characters, Principal Component Analysis, Geographic variation.

INTRODUCTION

The genus *Trachylepis* Fitzinger, 1843 includes three 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 transcaucasica* Chernov, 1926 inhabiting northern to central parts of the Zagros Mountains (Anderson, 1999). Sexual Dimorphism (SD), defined as a phenotypic difference between males and females of a species, is a common phenomenon in animals including in reptiles (Andersson, 1994). Morphological differences between sexes include size and shape. Male and female lizards may differ with respect to coloration, body shape and ornamentation, and size. Generally, sexual dimorphism is defined at three levels. First, SD in size, which is based on two basic hypotheses: a) the intrasexual selection hypothesis, sexual selection for large males, and b) the fecundity advantage hypothesis, natural selection for large females (Thompson and Withers, 2005). Secondly, SD in ornamentation, which encompasses pholidosis, color and pattern characters (Cooper and Greenberg, 1992); and third, SD in body shape (Adriana et al., 2005).

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Geographic variation in morphology and skull characters analyzed statistically, as well as descriptive studies of skull characters, have been reported for *T. a. transcaucasica* (Faizi and Rastegar-Pouyani 2006, 2007; Rastegar-Pouyani and Faizi, 2007), but little information concerning SD in this taxon is available. In the current study, morphology and skull characters of four populations of *T. a. transcaucasica* in Iran were analyzed to investigate patterns of SD.

MATERIAL AND METHODS

Specimens were collected from 2003 to 2006 at localities in the Zagros mountain range, western Iran, and in West Azerbaijan, Kurdistan, Kermanshah, and Lorestan Provinces (Fig. 1). Specimens were preserved in 75% ethanol and deposited in the Razi University Zoological Museum (RUZM). Two sets of characters, including morphology as well as skull characters were evaluated (Table 1). Morphological studies were carried out using a stereomicroscope (Olympus, Model: SzX12, Japan) and measurements made with a digital caliper to the nearest 0.1 mm.

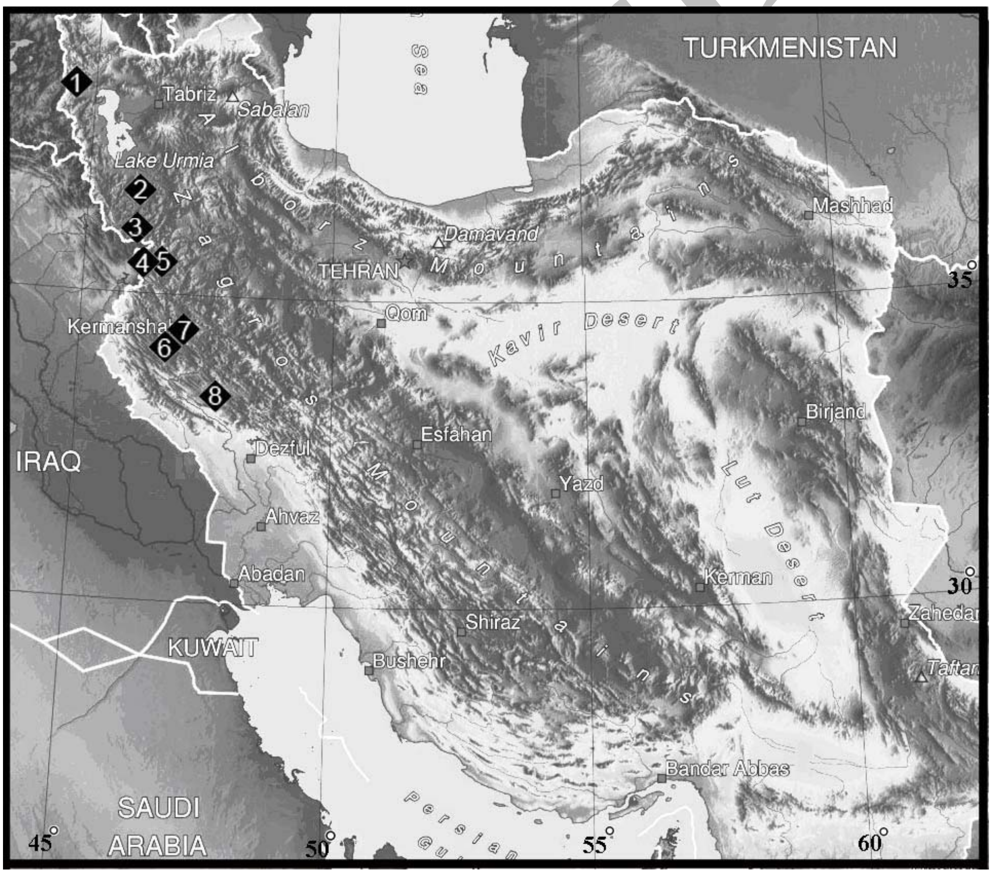

FIG. 1. Map of sampling localities for *Trachylepis aurata transcaucasica* specimens. West Azarbaijan Province: (1) Ghotur (38˚:35́ N, 45˚:02́ E); Kordestan Province: (2) Bukan (36˚:32́ N, 46˚:10́ E); (3) Baneh (35˚:58́ N, 45˚:55́ E); (4) Marivan (35˚:22́ N, 46˚:14́ E); (5) Sarvabad (35˚:17́ N, 46˚:21́ E); Kermanshah Province: (6) Esalm Abad-e-Gharb (34˚:05 N, 46˚:34 E´); (7) Kermanshah (34˚:17´ N, 47˚:04´ E); Lorestan Province: (8) Poldokhtar (33˚:08 N, 47˚:43 E´).

TABLE 1. External morphology and skull characters examined in 49 specimens of *Trachylepis aurata transcaucasica.*

Characters	
Morphological Characters	Skull Characters
SVL: Length of snout to vent	LS: Length of skull
TL: Length of tail	WS: width of Skull
LH: Length oh head	CBL: Condylobasal Length
WH: Wide of head	AWR: Anterior width of Rostrum
NED: Nostril-eye distance	IOW: Interorbital Width
NL: Neck length	LEY: Length of Eye
ORD: Orbit diameter	WEY: Width of Eye
SW: Snout wide	LM: Length of Maxilla
LFE: Length of femur	LPT: Length of Pterygoid
LL: Length of leg	LJL: Length of Lower Jaw
LA: Length of arm	LP: Length of Pterygoid
LFO: Length of forearm	CBL/LS
TRL: Trunk length	AWR/LS
WAN: Wide of anus suture	IOW/LS
SL4T: Subdigital lamellae under the forth toe	LEY/LS
SL4F: Subdigital lamellae under the forth finger	WEY/LS
NDS: Number of dorsal scales around body	LM/LS
VS: Number of ventral scales	LPT/LS
HL/SVL	LEY/WEY
TRL/SVL	
LFE/SVL	
LL/SVL	
WAN /SVL	
LFO/SVL	
NED/SVL	
NL/SVL	
ORD/SVL	
SW/SVL	
HW/HL	

The skulls were prepared according to a simple protocol and, along with the lower jaw, were labeled and photographed in lateral, dorsal, and ventral views, and the dimensions were measured using Photoshop CS software (Fig. 2). Because most skulls were small and not ossified to the extent of bird or mammal skulls, they were heated in water at low temperature to remove adhering flesh and brain tissue. Tissue inside the skull was removed mechanically and with a jet of water.

Skulls were then processed as follows:

1. Blood removing by 15% sodium chloride solution.
2. Removal of fat with benzene
3. Distaining with 7.5% sodium hypochlorite
4. Whitening of skulls with 15% hydrogen peroxide
5. Dehydration in 96% ethanol

Each stage took 24 h.

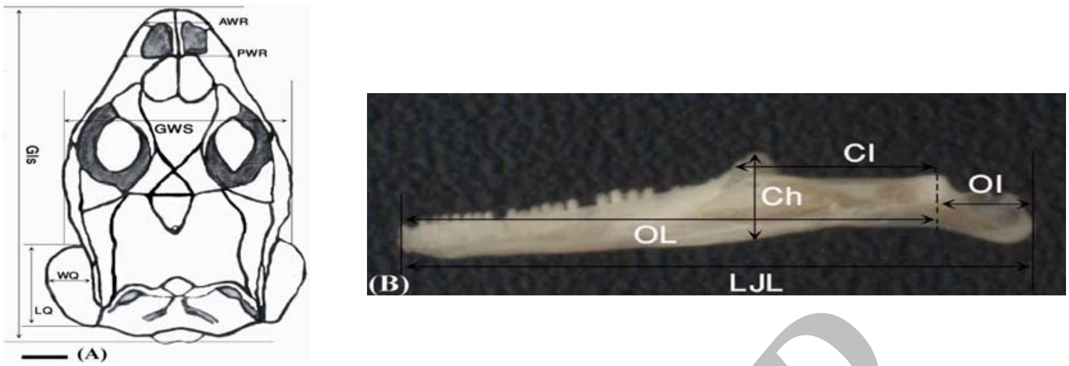

FIG.2.- Quantification of tooth and skull dimensions. (A). dorsal view of the skull of *Trachylepis aurata transcaucasica*. (gsl): Greatest length of skull was determined from the back of the parietal bone to the tip of the premaxilla. (Gws): Greatest width of skull measured just posterior to the orbits, at the level of the posterior process of the jugal. (LQ): Length of quadrate. (WQ): Width of quadrate from widest part of quadrate. (AWR): Anterior width of snout, from front of nostrils. (PWR): Posterior width of snout, from post of nostrils. (B). Lateral view on the lower jaw of *T. a. transcaucasica*. For description of characters, refer to Table (1).

All morphological variables were described by an independent sample t-test. The means of the two groups (male and female) were compared, and, sample size, maximum, minimum, means, F value, P value (at significance level of 0.05), and standard deviation of the mean were reported for each variable. Principal Component Analysis (PCA) was conducted to identify underlying variables, factors explaining the pattern of correlations within a set of observed variables. Factor analysis is often used in data reduction to identify a small number of factors that explain most of the variance observed in a much larger number of manifest variables. To avoid statistical problems when variables are not scaled uniformly (i.e. in different scales or units), we analyzed both sets of variables (metric and meristic characters) separately. Further, to investigate patterns of SD, metric characters of morphology and skull characters were analyzed separately.

RESULTS

UNI- AND MULTI-VARIATE ANALYSIS OF MORPHOLOGIC CHARACTERS

Initially, descriptive analyses and independent sample t-tests were carried out in four male and female populations of *T. a. transcaucasica* to obtain descriptive character parameters, including mean± SD, range, and significance levels in males and females (Table 2). This revealed significant differences in some metric, meristic, and character ratios between males and females.

Results for meristic characters showed significant differences, with females showing a greater number of subdigital lamellae under the fourth toe than males ($P \leq 0.05$**).** Results of metric characters also showed significant differences between sexes, with neck length and width of anus having higher values in males (Table 2 and Fig. 3). The means and standard errors for significant metric, meristic, and ratios of characters are shown in Fig. 3.

TABLE 2.- Descriptive analysis and independent T-test of morphological characters in male and female specimens of *Trachylepis aurata transcaucasica*.

Morphological Characters						
Characters	Mean± SD		Range		*F* Value	*P* Value
	Male (n=31)	Female (n=18)	Male	Female		
SVL	82.6±5.9	80.9±6.3	71.82-9414	71.23-96.58	0.8	0.4
TL	99.5±9.8	104.2±11.9	72.05-115	82.53-129	2.1	0.1
LH	14.5±1.4	14.3±0.9	9.77-16.40	12.56-15.79	0.3	0.6
WH	12.1±0.92	11.8±0.8	10.62-13.69	10.54-13.50	1.6	0.2
NED	4.3±0.5	4.1±0.5	3.29-5.69	3.53-5.21	0.6	0.4
NL	**13.4±1.4**	**12±1.4**	**10.54-16.30**	**9.78-14.87**	**10.6**	**0.002**
ORD	1.8±0.4	1.9±0.3	1-2.66	1.55-2.77	1.05	0.3
SW	2.8±0.3	2.7±0.4	2.35-3.62	1.98-3.56	1.2	0.3
LFE	9.5±1.02	9.2±0.9	8.02-11.92	7.49-11.30	1.6	0.2
LL	7.6±0.8	7.4±1.1	5.46-8.88	5.91-9.95	0.5	0.5
LA	6.7±1.0	6.5±0.9	4.84-9.23	5.02-9.06	0.8	0.5
LFO	5.9±0.9	5.7±0.9	4.10-8.56	4.20-8.49	0.8	0.4
TRL	39.3±4.1	40.1±4.9	33-50.20	34.05-51.56	0.8	0.4
WAN	4.2±1.3	3.6±0.8	2.43-6.40	2.30-5.68	0.4	0.06
SL4T	18.5±1.5	18.50±1.6	16-22	16-22	33.9	0.97
SL4F	**13.55±1.3**	**14.17±0.9**	**11-16**	**12-16**	**44.3**	**0.05**
NDS	24.55±1.6	23.67±1.5	21-28	21-26	3.54	0.06
VS	66.48±3.5	66.51±2.27	55-72	64-71	0.001	0.98
VR	11.94±1.05	11.95±1.2	10-14	10-14	0.002	0.96
HL/SVL	0.17±0.01	0.17±0.01	0.13-0.20	0.18-0.20	0.41	0.64
TRL/SVL	**0.47±0.03**	**0.49±0.03**	**0.42-0.54**	**0.42-0.56**	**1.70**	**0.06**
LFE/SVL	0.12±0.00	0.11±0.01	0.10-0.14	0.10-0.13	0.33	0.50
LL/SVL	0.09±0.00	0.09±0.00	0.07-0.12	0.07-0.11	0.00	0.77
WAN /SVL	**0.08±0.01**	**0.08±0.00**	**0.06-0.12**	**0.6-0.09**	**3.58**	**0.06**
LFO/SVL	0.07±0.00	0.07±0.01	0.05-0.09	0.05-0.10	0.11	0.57
NED/SVL	0.05±0.00	0.05±0.00	0.04-0.06	0.04-0.06	0.17	0.83
NL/SVL	**0.16±0.01**	**0.14±0.01**	**0.13-0.20**	**0.12-0.19**	**0.00**	**0.00**
ORD/SVL	0.02±0.00	0.02±0.00	0.01-0.03	0.02-0.03	0.00	0.14
SW/SVL	0.03±0.00	0.03±0.00	0.03-0.05	0.03-0.04	0.00	0.53
HW/HL	0.084±0.09	0.82±0.05	0.73-1.20	0.74-0.92	1.01	0.45

PRINCIPAL COMPONENT ANALYSIS OF MORPHOLOGIC CHARACTERISTICS

Results of PCA for meristic characters showed that the first two components jointly explained 59.4% of the total difference (Table 3). Of this, 34.9% was explained by PC1, with SLT and VS mainly responsible for the observed variation, and 24.4% was explained by PC2, in which VR and SQ had the highest values. Accordingly, the same PCA analysis applied for metric characters (Table 3). Ordination of PC1 against PC2 for metric, meristic, and ratios of characters in males and females of *T. a. transcaucasica* are given in Fig. 4. As is shown, data for males and females shows a distinct overlap.

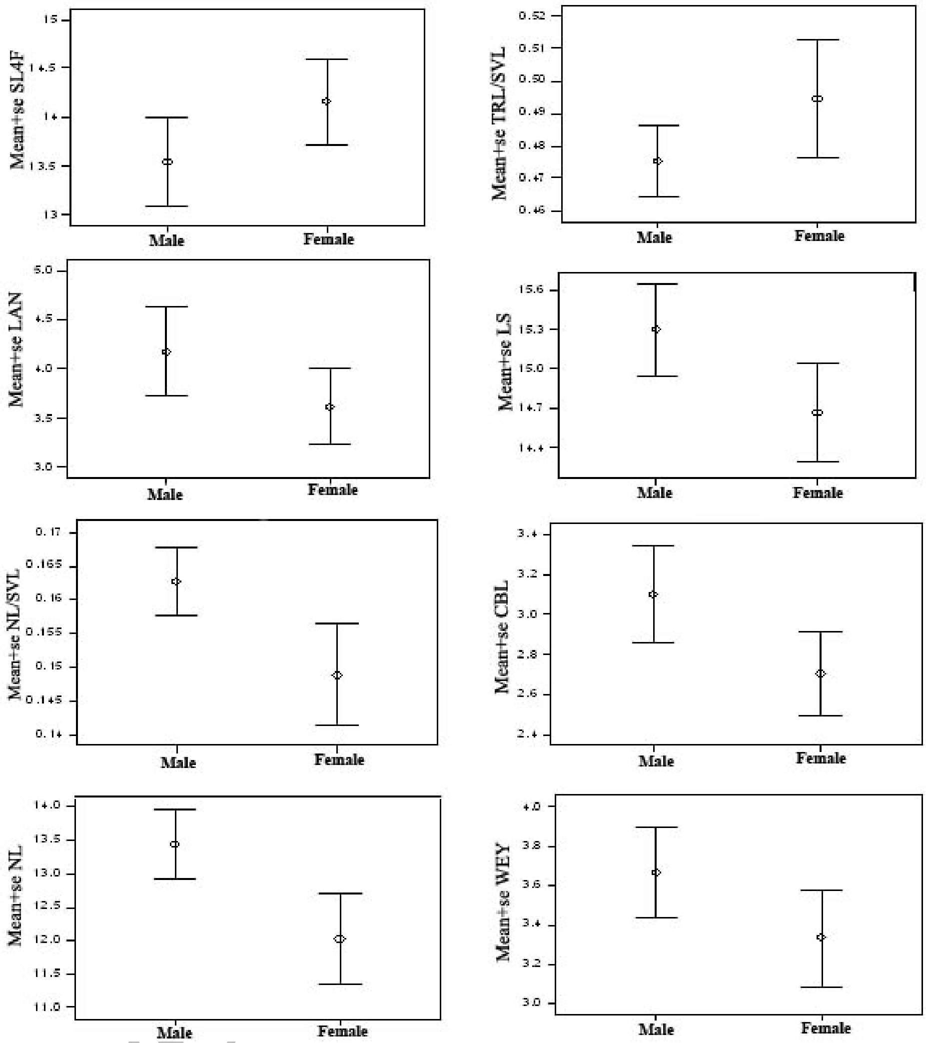

FIG. 3. Mean and standard error (bars) for significant ($P \leq 0.05$) external morphological and cranial characters of male and female of *Trachylepis aurata transcaucasica*. SL4F: Subdigital lamellae under the forth finger; TRL/SVL: Trunk Length/ Length of snout to vent; LAN: Length of anus suture; LS: Length of Skull; NL/SVL: Neck length/ Length of snout to vent; CBL: Condylobasal Length; NL: Neck Length.WEY: Width of Eye.

UNI- AND MULTI-VARIATE ANALYSIS OF SKULL CHARACTERS

Statistical analyses of skull characters showed significant differences between the two sexes of *T. a. transcaucasica* in GLS, CBL, WEY, AWR, LM/GLS and LPT/GLS ($P < 0.05$) (Table 4). Independent sample t-tests for some skull characters showed significant differences between the sexes: skull length ($P = 0.01$), condylobasal length ($P = 0.01$), anterior rostrum width ($P = 0.03$), and eye width ($P \leq 0.05$). For these characters, males exhibited greater values than did females (Table 4). Results of character ratios also showed significant differences in some characters, including maxilla length/skull length ($P = 0.04$) and pterygoid length/skull length ($P = 0.02$) (Table 4).

TABLE 3.- The eigenvalue, % variance, and cumulative % in the first two and four principal components for (A) meristic and (B) metric characters, respectively, in male and female specimens of *Trachylepis aurata transcaucasica.*

Meristic Characters			
Components	Initial Eigenvalue		
	Total	% of Variance	Cumulative %
1	1.75	34.99	34.99
2	1.22	24.44	59.44

Metric Characters			
Components	Initial Eigenvalue		
	Total	% of Variance	Cumulative %
1	4.58	32.75	32.75
2	2.07	14.84	47.60
3	1.38	9.89	57.50
4	1.08	7.73	65.23

TABLE 4.- Descriptive statistics and independent T- test in skull characters of male and female specimens of *Trachylepis aurata transcaucasica.*

Skull Characters						
Characters	Mean± SD		Range		*F* Value	*P* Value
	Male (n=31)	Female (n=18)	Male	Female		
GLS	**15.29±0.9**	**14.66±0.9**	**12.55-16.98**	**12.98-16.33**	**5.93**	**0.01**
GWS	8.03±0.5	7.77±0.5	6.59-8.88	6.58-9.30	2.86	0.09
CBL	**3.10±0.6**	**2.70±0.5**	**1.90-4.37**	**1.80-3.99**	**6.19**	**0.01**
AWR	**2.86±0.4**	**2.60±0.4**	**2.01-3.66**	**1.78-3.65**	**4.69**	**0.03**
IOW	1.93±0.3	1.79±0.3	1.25-2.30	1.32-2.36	3.44	0.06
LEY	4.93±0.5	4.70±0.6	3.95-5.84	3.42-5.65	2.53	0.11
WEY	**3.66±0.6**	**3.33±0.6**	**2.05-4.55**	**2.15-4.32**	**3.86**	**0.05**
LM	6.75±0.7	6.83±0.6	5.28-7.78	5.31-7.77	0.18	0.67
LPT	2.08±0.4	2.21±0.4	1.24-2.85	1.65-2.98	1.86	0.17
LJL	13.59±2.5	13.73±1	11.55-15.80	12.33-16.94	0.06	0.81
GWS/GLS	0.52±0.04	0.53±0.04	0.44-0.68	0.55-0.67	0.16	0.68
CBL/GLS	0.20±0.03	0.18±0.03	0.12-0.26	0.13-0.26	3.28	0.07
AWR/GLS	0.18±0.3	0.17±0.03	0.12-0.26	0.13-0.24	1.41	0.24
IOW/GLS	0.12±0.01	0.12±0.01	0.08-0.18	0.08-0.18	0.54	0.46
LEY/GLS	0.32±0.02	0.32±0.04	0.28-0.40	0.25-0.40	0.01	0.91
WEY/GLS	0.23±0.03	0.22±0.04	0.13-31	0.16-0.33	1.02	0.31
LM/GLS	**0.44±0.04**	**0.46±0.4**	**0.37-0.53**	**0.35-0.55**	**4.43**	**0.04**
LPT/GLS	**0.13±0.02**	**0.15±0.02**	**0.08-0.18**	**0.10-0.22**	**5.09**	**0.02**
LJL/GLS	0.89±0.16	0.94±0.09	0.10-1.08	0.76-1.16	1.69	0.19
LEY/WEY	1.38-0.25	1.45-0.28	0.94-2.22	1.02-2.25	0.91	0.34

PRINCIPAL COMPONENT ANALYSIS OF SKULL CHARACTERS

Results of PCA for skull characters show that the first four components jointly explain 64.32% of the total variation (Table 5). Of this, 27.59% was explained by PC1, in which LEY and CBL were mainly responsible for the observed variation; 14.73% was explained by PC2 with LM and IWR having highest impact; 11.77% was explained by PC3 with LPT and WEY mainly responsible for the observed variation; and 10.21% was explained by PC4 in which IOW and LJL showed highest variation. Ordination of PC1 against PC2 for skull characters in male and female *T. a. transcaucasica* is given in Fig. 4D. As is shown, there is no discernable pattern of SD. The means and standard error for significant skull characters are shown in Fig. 3.

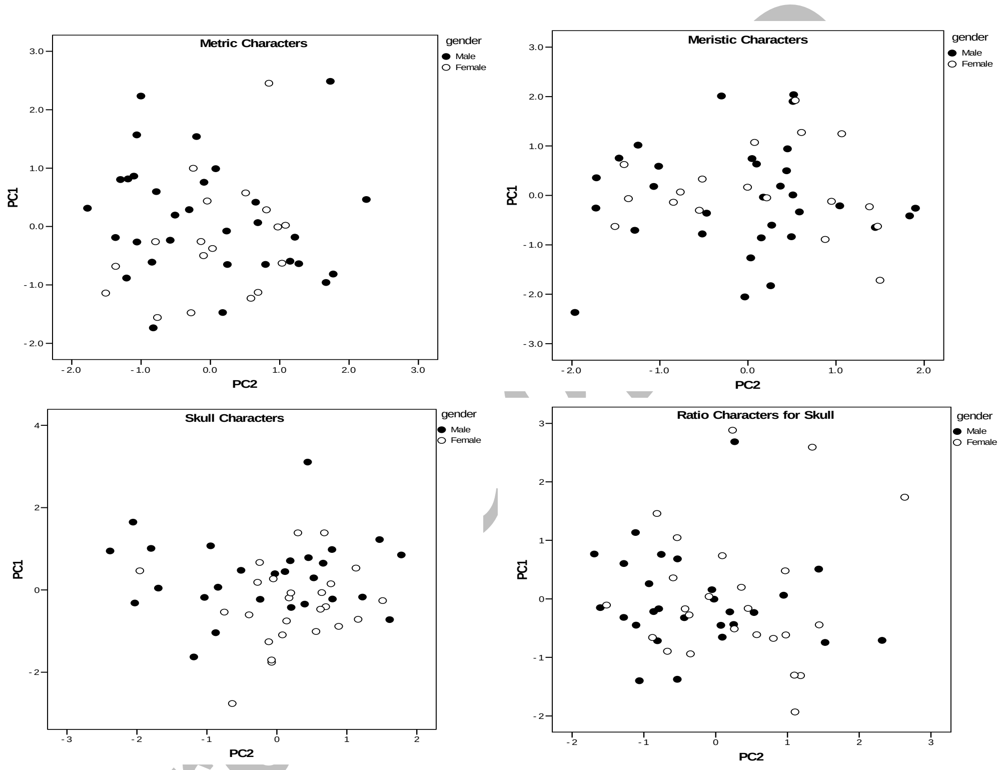

FIG. 4. Ordination of individual male and female *Trachylepis aurata transcaucasica* on the first two principal components (note the sexes do not show clear patterns of sexual dimorphism). ● = Male, ○= Female

TABLE 5.- The eigenvalue, % variance and % cumulative in the first four principal components for skull characters in male and female specimens of *Trachylepis aurata transcaucasica.*

Skull Characters			
Components	Initial Eigenvalue		
	Total	% Variance	Cumulative %
1	2.75	27.59	27.59
2	1.47	14.73	42.32
3	1.17	11.77	54.10
4	1.02	10.21	64.23

DISCUSSION

Species of lizards have been repeatedly used as models for SD studies (Fitch, 1981; Perry, 1996; Adriana et al., 2005; Antigoni et al., 2007; Chi-Yun et al., 2009). Lizard taxa show varying levels of SD related to evolutionary adaptations. For example, SD may have developed as a result of competition between sexes for a limited resource such as food, ecological factors such as food niche divergence (Schoener, 1967, 1968, 1982; Huey and Pianka, 1974; Lin and Ji, 2000), through male-male competition for mates (Trivers, 1976; Vitt and Cooper, 1985; Hews, 1990; Censky, 1997), or as a result of fecundity selection leading to larger body size in females (Griffith, 1990). Our results show that *Travhylepis aurata transcaucasica* show patterns of SD in morphology or in skull characters.

Males and females of this taxon are distinguishable by the thicker basal area of the tail in males (since copulatory organs are located at the tail base of males) as well as a difference in the structure of the anus detectable under magnification. Males have a suture with a small cavity at each end while the female possesses only a simple suture (personal observation). The remainder of the morphology, as well as skull characters, shows no obvious pattern of SD. For some character ratios **(**nl/SVL, Dhf/SVL, and ned/SVL**),** the difference between sexes was not discernable in raw measurements, and only in comparison of ratios of these characters could some minor differences be detected. Regardless of the scarcity of characters showing SD in *T. a. transcaucasica*, there were two important characters, the larger ratio of neck length to body size in males and the larger trunk to body size in females, which clearly indicated their evolutionary mechanisms. A longer neck in the male could be advantageous in copulation, and a larger trunk in females could be beneficial to fecundity. For the former, two evolutionary mechanisms have been proposed, intrasexual selection due to male combat (Trivers, 1976; Fitch, 1981; Stamps, 1983, 1993; Anderson and Vitt, 1990) and natural selection acting to reduce food competition between the sexes (Schoener, 1967, 1968; Stamps, 1977a; Preest, 1994).

Skull measurements suggest that the observed differences in characters may have evolved due to sex differences in condylobasal length. The ratio of maxilla length and pterygoid length to skull length in females is higher than in males, which may be explained by adaptation of females to consume larger prey items than males. This could have been favored by natural selection since females need more energy during reproduction.

Although we found evidence for SD in head size, both morphologically and by measuring dry skull size (length of skull), we found none for SD in distance between forelimbs and hind limbs. On the other hand, the ratio of trunk length to body size was significantly different in males and females, with females having greater trunk length to total body size ratio than males. Female lizards generally have a longer trunk, which provides an advantage for egg storage (Olsson et al., 2002).

In summary, based on the scenarios for the evolution of SD in lizards, including *T. a. transcaucasica*, differences in neck length, body length, distance from forelimbs to hind limbs (trunk length), skull length, and width and shape of anal region, represent a degree of SD in this lizard which can be attributed to intrasexual selection as well as the fecundity selection hypothesis.

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LITERATURE CITED

ABDOLI, A. 2000. The Inland Freshwater Fishes of Iran (In Farsi). *Iranian Museum of Nature and Wildlife*, Tehran, 378 pp.

ADRIANA, C. S., HELGA, C. W. AND GUARINO, R. C. 2005. Sexual dimorphism in the Neotropical lizard, *Tropidurus torquatus* (Squamata, Tropiduridae). *Amphibia-Reptilia* 26: 127–137.
ANDERSON, R. A., AND VITT, L. J. 1990. Sexual selection versus alternative causes of sexual dimorphism SDin teiid lizards. *Oecologia* 84: 145–157.

ANDERSSON, M. 1994. Sexual selection. Princeton University Press, Princeton, New Jersey, USA.

ANTIGONI, K., MIGUEL, CARRETERO, A., AND GUSTAVO A. L. 2007. Multivariate and geometric morphometrics in the analysis of sexual dimorphism variation in *Podarcis* lizards. *Journal of Morphology* 268: 152–165.

CENSKY, E. J. 1997. Female mate choice in the non-territorial lizard *Ameiva plei* (Teiidae). *Behav. Ecol. Sociobiol.* 40: 221–225.

CHI-YUN, K., YU-THE, L., AND YAO-SUNG, L. 2009. Sexual size and shape dimorphism in an agamid lizard*, Japalura swinhonis* (Squamata: Lacertilia: Agamidae). Zoological Studies 48: 351–361.

COOPER, W. E., AND GREENBERG, J. N. 1992. Reptilian coloration and behavior. In: Biology of the Reptilia: Hormones, Brain, and Behavior. Gans, C. Ed., Chicago, University of Chicago Press. p. 298-422

FAIZI, H. AND RASTEGAR-POUYANI, N. 2007. Further studies on the lizards cranial osteology, based on a comparative study of the skull in *Trachylepis aurata transcaucasica* and *Laudakia nupta* (Squamata: Sauria), *Russian Journal of Herpetology* 14(2): 107-116.

FAIZI, H., AND RASTEGAR-POUYANI, N. 2006. Intra- and-inter-specific geographic variation in the Iranian Scincid lizards of the genus *Trachylepis* Fitzinger 1843 (Sauria: Scincidae). *Iranian Journal of Animal Biosystematics* 2 (1): 1-11.

FITCH, H. S. 1981. Sexual size differences in reptiles. Misc. Publ. Mus. Nat. Hist. Univ. Kans. 70: 1–72.

GRIFFITH, H. 1990. Miniaturization and Elongation in *Eumeces* (Sauria: Scincidae). *Copeia* 1990: 751–758.

HEWS D. K. 1990. Examining hypotheses generated by field measures of sexual selection on male lizards, *Uta palmeri*. *Evolution* 44: 1956–1966.

HUEY, R. B., PIANKA, E. R., AND SCHOENE, T. W. 1983. Lizard ecology: studies of a model organism. Harvard University Press, Cambridge, Massachusetts, USA.

LIN, Z. H. AND X. JI. 2000. Foodhabits, sexual dimorphism and female reproduction in the skink (*Eumeces chinensis*) from a Lishui population in Zhejiang. *Acta Ecologica Sinica* 20(2): 304–310.

OLSSON M, SHINE, R., WAPSTRA, E, UJVARI, B., AND MADSEN, T. 2002. Sexual dimorphism in lizard body shape: the role of sexual selection and fecundity selection. *Evolution* 56: 1538-1542.

PERRY, G. 1996. The evolution of sexual dimorphism in the lizard *Anolis polylepis* (Iguania): evidence from intraspecific variation in foraging behavior and diet. *Canadian Journal of Zoology* 74: 1238–1245.

PREEST, M. R. 1994. Sexual size dimorphism and feeding energetics in *Anolis carolinensis*: Why do females take smaller prey than males? *Journal of Herpetology* 28: 292-298.

RASTEGAR-POUYANI, N., AND FAIZI H. 2007. Geographic variation in the skull morphology *Trachylepis aurata transcaucasica* Chernov, 1926 (Scincidae: Scincidae) in the Zagros Mountains, Western Iran. *Zoology in the Middle East* 42: 67-74.

SCHOENER T. W. 1967. The ecological significance of sexual dimorphism in size in the lizards of *Anolis conspersus*. *Science* 152: 474-477.

SCHOENER, T. W. 1968. The *Anolis* lizards of Bimini: resource partitioning in a complex fauna. *Ecology* 49: 704–726.

SCHOENER, T. W., SLADE, J. B., AND STINSON, C. H. 1982. Diet and sexual dimorphism in the very catholic lizard genus, *Leiocephalus* of the Bahamas. *Oecologia* 53: 160–169.

STAMPS, J. A. 1977. The relationship between resource competition, risk, and aggression in a tropical territorial lizard. *Ecology* 58: 349–358.

STAMPS, J. A. 1983. Sexual selection, sexual dimorphism and territoriality. Pp. 169–204 in E. R. Pianka and T. W. Schoener, eds. Lizard ecology: studies of a model organism. Harvard Univ. Press, Cambridge, MA.

STAMPS, J. A. 1993. Sexual size dimorphism in species with asymptotic growth after maturity. *Biol. J. Linn. Soc.* 50: 123-145.

THOMPSON, G., AND WITHERS, P. 2005. Size-free shape differences between male and female Western Australian dragon lizards (Agamidae). *Amphibia-Reptilia* 26: 55-63.

TRIVERS, R. 1976. Sexual selection and resource accruing abilities in *Anolis garmani*. *Evolution* 30: 253–269.

VITT, L. J. AND COOPER, W. E. 1985. The evolution of sexual dimorphism in the skink *Eumeces laticeps*: an example of sexual selection. *Canadian Journal of Zoology* 63: 995–1002.