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Sexual dimorphism of the Yassujian lizard, *Apathya yassujica (*Nilson et al. 2003)(Sauria: Lacertidae) from Iran

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Abstract: Sexual size dimorphism in the Iranian endemic Yassujian lizard, *Apathya yassujica* (Nilson et al., 2003), was previously undocumented. In this study 23 male and 19 female adult specimens of *A. yassujica* were collected from Kohguiluyeh va Boyer Ahmad and Fars Provinces in southwestern regions of the Iranian Plateau. Univariate and multivariate analyses performed on morphometric data showed that males are larger than females, and except for number of scales from collar to anal plate and that all other sexual differences were male-biased. We also further the previous range of *A. yassujica* with records from different regions of Fars province, southwestern Iran.

Key words. Lacertidae, *Apathya yassujica*, sexual dimorphism, Zagros Mountains, Iran, range extension.

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Introduction. The genus *Apathya* (Méhely 1907) is distributed in southeastern Turkey, northern Iraq, and western Iran (Arnold et al. 2007). This genus includes two species *Apathya cappadocica* (Werner 1902) with five subspecies, *A. c. cappadocica* (Werner 1902), *A. c. muhtari* (Eiselt 1979), *A. c. schmidtleroroum* (Eiselt 1979), *A. c. urmiana* (Lantz and Suchow 1934), *A. c. wolteri* (Bird 1936), and *A. yassujica* (Nilson et. al. 2003) which is endemic to Iran. The sexual dimorphism of *A. yassujica* has not been previously been documented.

Sexual dimorphism (SD), defined as a phenotypic difference between males and females of a species and sexual dimorphism in body size, which is the result of a variety of selective forces, and also is a common phenomenon affecting on the body size or other morpho-logical characteristics, which has been reported in numerous lizard species (Darwin 1871, Andersson 1994, Braña 1996, Kratochvíl and Frynta 2002, Olsson et al., 2002). Sexual size dimorphism (SSD) is a fundamental and widespread biological phenomenon in which individuals of one sex are characteristically larger than those of the opposite sex for a given population or species (Cox et al., 2003). Sexual dimorphism in animals affects three different characteristics, behavior, size and shape (Selander 1972). In the current research, sexual size dimorphism in *A. yassujica* collected from southwestern Iran is investigated and discussed. In addition, three new localities for this species are reported.

Methods. Based on extensive field work performed in summer 2012 and 2013, we examined 42 adult specimens of *A. yassujica*. The specimens were collected by noose or hand in rocky slopes and vertical rock sides of Nil Mountain, Pir-e-Zal (30° 50' N 50° 44' E, 980-3415 m above sea level (a.s.l.)), and Dashteroom area (30° 30' N, 51° 31' E, 2200 m a.s.l.) type locality in Kohguiluyeh va Boyer Ahmad Province (20 males and 17 females), Margoon waterfall (30° 29' N 51° 53' E, 2200 m a.s.l.) and Tizab valley (30° 17' N 51° 56' E, 2245 m a.s.l.) in Fars (3 males and 2 females) Province (Fig. 1). Four of the specimens (two males and two females) were dissected in order to determine their sex. The all the collected specimens were deposited in Razi University Zoological Museum (RUZM).

The specimens were initially examined basing on 26 morphological characteristics. The characters used in this study are as follows: length of snout to vent (SVL); tail length (TL); length mental to collar (LMC); head width (HW); head height (HH); snout length (SL); eye-ear distance (EED); parietal width (PW); parietal length (PL); hindlimb length (HLL); forelimb length (FLL); maximum width of base tail (WBT); anal plate length (APL); number of scales from collar to anal plate (SCA); number of scales between posterior corner of eye to tip of ear (NEE); number of scales around midbody (SAM); number of scales around fifth caudal whorl (SAFC); distance collar to cloac (DCC); distance between forelimb and hindlimb (DFH); distance between femoral pore (DBFP); number of scales between mental to collar (SMC); number of supralabial (SLs); number of infralabial (IFs); number of femoral pore (NFP); number of ring tail **(**NRT**);** number of collar scales (NCS).

Morphometric measurements were taken by digital calipers model Shoka Gulf to the nearest 0.01 mm, and for meristic characters a stereo microscope was used.

Statistical analyses. We used the Statistical Package for the Social Sciences (SPSS) version 19 for statistical analyses. Adult specimens were initially examined for 16 morphometric and 10 meristic characters. Calculation of coefficient of variation for each character and carrying out a preliminary Analysis of Variance (ANOVA) revealed that most characters did not contribute to discrimination. Also uninformative characters were discarded (three morphometric, six meristic) and 13 morphometric and four informative meristic characters were selected for intersexual comparison analysis. Moreover, the morphometric characters, means, standard error of the mean, minimum, and maximum were calculated. The values for the morphometric and meristic characters as well as the direction of differences and the significant characters ($P \leq 0.05$) were measured.

We performed a principal component analysis (PCA) as an exploratory method to investigate between-sex variation of morphometric variables in the multivariate level, as several morphological parameters were significantly correlated with snout to vent length (SVL).

Results. Differences in the value of metric and meristic variables are disclosed between the sexes using the One-way ANOVA. Males have higher values for 16 characters (13 morphometric, three meristic) than those of females. Females have higher value just in SCA. The mean values for metric and meristic characters ($P \leq 0.05$) are presented in Tables (1) and (2), and all the variables are male biased.

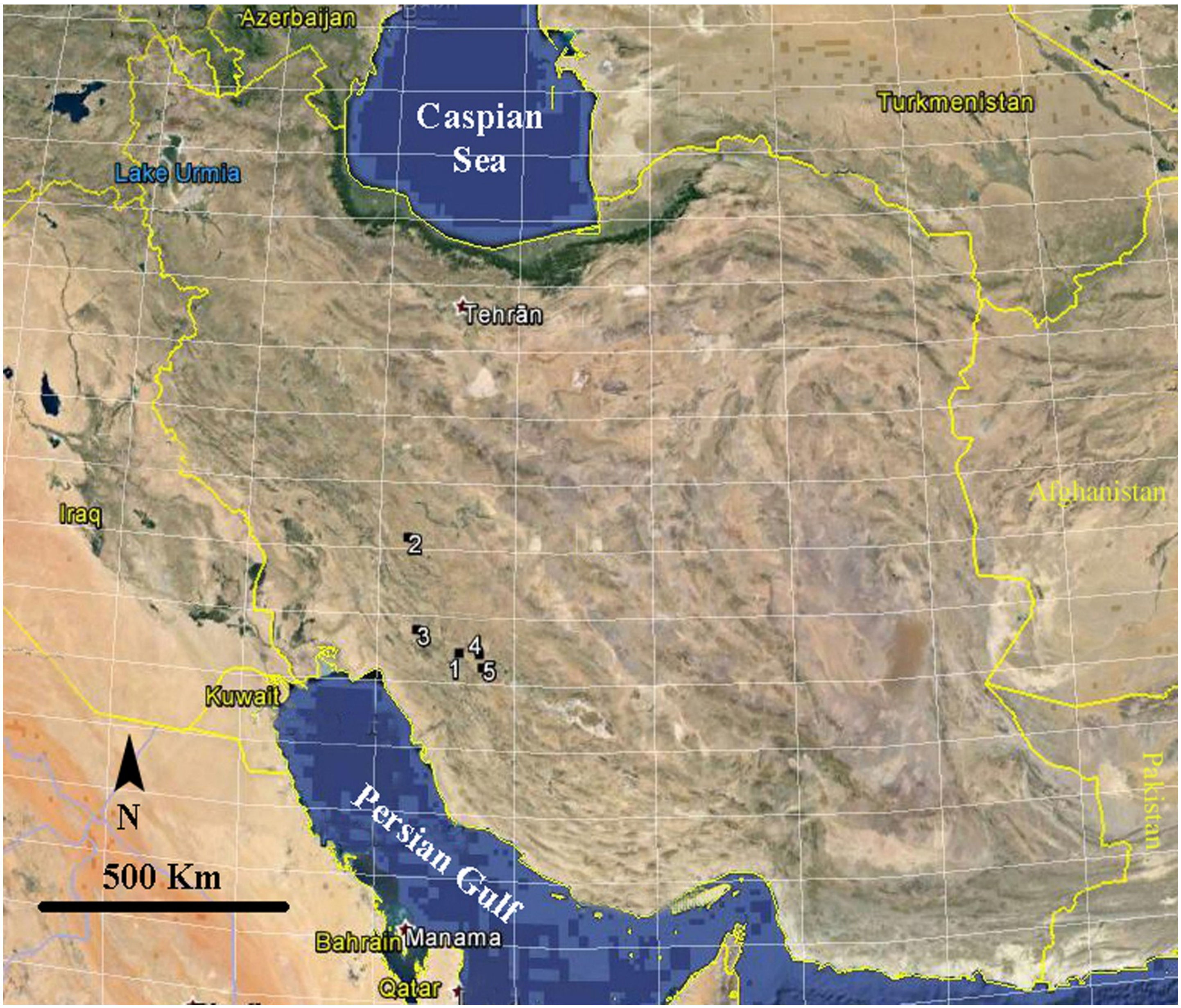

Figure 1. Distribution map of the newly found specimens. 1: Type locality 30 km SW of Yasuj (Kohgiluyeh and Boyer-Ahmad Province). 2: Rajabizadeh et al (2010) have recorded Pire Ghar, south of Farsan city (Chaharmahal va Bakhtiari Province). Newly found localities in: 3: Nil Mountain, Pir-e-Zal (30° 50' N, 50° 44' E) (Kohgiluyeh and Boyer-Ahmad Province), 4: Margoon waterfall (30° 29' N, 51° 53' E) and 5: Tizab valley (30° 17' N, 51° 56' E, 2245 m a.s.l.) in Fars Province.

Figure 2. A. Dorsal view of male (left) (RUZM-27) and female (right) (RUZM-9) of *Apathya yassujica*; **B.** Presence of swellings in the male of *A. yassujica* at base of the tail which accommodate hemipenes (27) and their absence in female (9); **C.** *Apathya yassujica* in life, **D.** Habitat of *A. yassujica*, Nil Mountain, Pir-e-Zal (30º50'N, 50º44'E) of Kohkiluyeh va Boyer Ahmad Province, southwestern Iran (980 – 3415 m elevation).

The ANOVA showed statistical difference in SVL between the two sexes (59.23 ± 0.62 and 55.68 ± 0.76 mm for males and females, respectively, F = 13.19, P = 0.00), and in TL (120.43 ± 2.72 and 96.78 ± 2.90 mm for males and females, respectively, F = 35.06, P = 0.00) but revealed slight significant differences in head width (9.40 ± 0.14 and 7.99 ± 0.13 mm for males and females, respectively, F = 52.10, *P* = 0.00) and greater differences in five morphometric indices for head (LMC, HH, SL, EED, PW, PL), limbs (HLL, FLL) and base tail (WBT, APL) (Table 1). These results indicate that males have longer head, limbs, and tail base which are relative to their body comparison with females. Results of the ANOVA test of scalation (meristic) characters implied SCA in females paucity to differenced, but males in three meristic characters indices for body scales (NEE, SAM, SAFC) a few more than of females (Table 2).

The ANOVA revealed more slight significant differences in DCC, DFH, and DBFP, SMC, SLs, IFs, NFP, NRT, and NCS between the sexes ($P \geq 0.05$) (Table 3).

For comparison of sexes at the multivariate level, the PCA was employed. All the morphological variables were standardized to obtain an unbiased statistical analysis. The results of the Principal Component Analysis (PCA) for morphometric characters show that the first three axes collectively represent 76.08% of the total variation (Table 4). Of these, 61.749% is explained by the PC1, with SVL, TL, LMC, HW, HH, SL, EED, PW, PL, HLL, FLL, WBT, APL, SCA, and SAFC mainly responsible for the observed variation, and 8.07% is explained by the PC2, in which the NEE has the highest value, and 6.26% is explained by the PC2, in which the NEE has the highest value, and 6.26% is explained by the PC3, in which the SAM has the most important role. This analysis shows that the PC1 is chiefly responsible for separation of males and females of *A. yassujica* (Table 4; Fig. 3).

Table 1. Results of the one way ANOVA test in measured of morphometric characters in males and females of *Apathya yassujica*. SEM: Standard. Error Mean, D of d: Direction of difference, Min: Minimum; Max: Maximum. all measurements in millimeter (mm).

SEX		*SVL*	*TL*	*LMC*	*HW*	*HH*	*SL*	*EED*	*PW*	*PL*	*HLL*	*FLL*	*WBT*	*APL*
♂ (n = 23)	**Mean**	59.23	120.43	14.53	9.40	3.97	2.33	5.48	2.21	4.53	35.19	22.18	6.85	5.89
	SEM	0.62	2.72	0.16	0.14	0.06	0.03	0.07	0.02	0.05	0.38	0.24	0.12	0.07
	Min	52.23	97.20	13.25	7.91	3.41	2.00	4.76	1.89	3.94	30.17	18.60	5.34	5.22
	Max	62.72	138.75	16.16	10.25	4.45	2.63	6.31	2.50	5.03	37.52	23.87	7.77	6.58
♀ (n= 19)	**Mean**	55.68	96.78	12.87	7.99	3.35	2.08	4.58	1.98	3.74	30.59	19.42	5.81	4.98
	SEM	0.76	2.90	0.32	0.13	0.10	0.04	0.10	0.02	0.07	0.56	0.36	0.12	.09
	Min	50.37	72.37	11.06	7.23	2.77	1.84	3.84	1.76	3.23	25.00	15.98	5.27	4.37
	Max	60.62	127.37	17.41	9.49	4.44	2.37	5.59	2.26	4.62	36.49	22.38	7.14	5.65
D. of d.		**M>F**	**M>F**	**M>F**	**M>F**	**M>F**	**M>F**	**M>F**	**M>F**	**M>F**	**M>F**	**M>F**	**M>F**	**M>F**
***F*-value**		13.19	35.06	22.88	52.10	27.61	22.54	54.67	32.20	83.19	48.24	41.90	34.04	59.87
***P*-value**		**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Table 2. Results of the one way ANOVA test showed significant in measured of scalation (meristic) characters in males and females of *Apathya yassujica*. SEM: Standard. Error Mean; D of d: Direction of difference; Min: Minimum; Max: Maximum.

Sex		**SCA**	**NEE**	**SAM**	**SAFC**
♂ (n = 23)	**Mean**	37.42	12.84	52.52	27.00
	SEM	0.13	0.15	0.33	0.40
	Min	37.00	11.00	50.00	23.00
	Max	40.00	14.00	58.00	32.00
♀ (n= 19)	**Mean**	38.93	12.12	50.93	23.50
	SEM	0.28	0.19	0.42	0.50
	Min	37.00	11.00	48.00	21.00
	Max	41.00	14.00	54.00	27.00
D. of d.		**F>M**	**M>F**	**M>F**	**M>F**
***F*-value**		16.72	7.79	9.21	28.41
***P*-value**		**0.00**	**0.00**	**0.00**	**0.00**

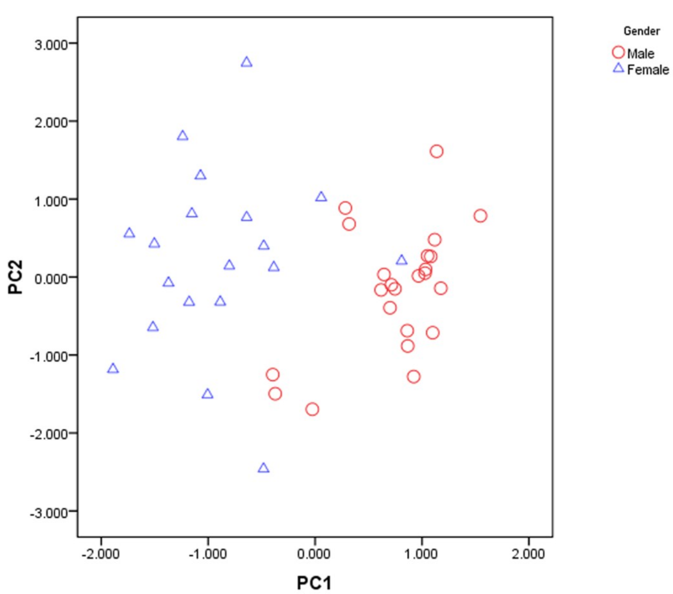

Figure 3. Ordination of the individual males and females of *Apathya yassujica* (Nilson et al. 2003) on the first two principal components. Note the relative separation of males and females in the PC1.

Generally males have more blue spots on each side of body (4 - 7) than in females (one spot only), and in males the throat in males is yellowish. Our results indicated that sexual dimorphism in body size (i.e. SVL, TL) and head width for both sexes of *A. yassujica* are clear with males being larger than females.

Conclusion. Comparative studies of sexual dimorphism (SD) should generally encompass body size as a potential determinant (Fairbairn et al. 2007), and reproductive output is associated with morphological traits in reptiles (Luo et al. 2012). Proximate (affecting the ontogeny of growth) causation and ultimate (i.e. evolutionary) causes are responsible for sexual dimorphism (Frayer and Wolpoff 1985). Sexual dimorphism between sexes is explained by three reasons sexual, fecundity, and natural selection (Olsson et al. 2002, Cox et al. 2003, Kaliontzopoulou et al. 2007).

According to the Rensch's rule (Rensch 1950) females of various animal clades tend to be larger than males in small species, whereas males are larger than females in large species. Also Rensch's rule states that sexual size dimorphism characteristically increases with size when males are the larger sex and decreases with size when females are the larger sex (Abouheif and Fairbairn 1997, Chang and Oh 2012, Colwell 2000, Fairbairn et al. 2007, Karamiani et al. 2013).

Males of the Yassujian lizard *Apathya yassujica* showed longer SVL, TL, LMC, SCA, SAM, and SAFC than conspecific females. It is universal that male lacertid lizards have a larger relative head size than females (Huang 1998, Ji et al. 1998, Molina-Borja et al. 1998, Chang and Oh 2012). Males display exaggerated body parts related to rivalry success or territory advertisement in lineages exhibiting male-male aggression or territoriality, respectively (Kratochvíl and Frynta 2002). Therefore, success in combat usually correlates with body size (Olsson 1992, Zucker and Murray 1996). Males with larger head may produce greater bite force and a stronger grip (Herrel et al. 1999) as weaponry during combat (Lappin and Husak 2005).

Dominant males obtain better position in male-male competitions (Andersson 1994). Consequently, males can occupy a more spacious and better space for greater reproductive success. This explains why females tend to prefer larger size males (Cox et al. 2003, Chang and Oh 2012).

Table 3. Results of the one way ANOVA test showed no significant in measured of morphometric (**bold**) and meristic (no bold) characters in males and females of *Apathya yassujica*. SEM: Standard. Error Mean, D of d: Direction of difference, Min: Minimum; Max: Maximum.

SEX		***DCC***	***DFH***	***DBFP***	*SMC*	*SLs*	*IFs*	*NFP*	*NRT*	*NCS*
♂ (n = 23)	**Mean**	38.48	27.50	2.47	28.73	9.04	7.34	22.43	103.00	8.78
	SEM	0.62	0.39	0.06	0.26	0.04	0.16	0.26	2.53	0.14
	Min	30.06	22.48	1.81	27.00	9.00	6.00	20.00	79.00	8.00
	Max	41.81	30.10	3.15	32.00	10.00	10.00	25.00	122.00	10.00
♀ (n= 19)	**Mean**	37.49	27.21	2.56	28.05	8.95	7.37	21.79	97.53	8.84
	SEM	0.52	0.38	0.08	0.32	0.05	0.11	0.21	1.66	0.25
	Min	33.89	24.53	1.93	25.00	8.00	7.00	20.00	86.00	7.00
	Max	41.84	30.75	3.36	30.00	9.00	8.00	23.00	111.00	11.00
D. of d.		M>F	M>F	F>M	M>F	M>F	F>M	M>F	M>F	F>M
***F*-value**		1.42	0.27	0.73	2.83	2.02	0.01	3.41	3.04	0.04
***P*-value**		0.24	0.61	0.40	0.10	0.16	0.92	0.07	0.90	0.83

Table 4. Loadings from a principal component analysis of metric and meristic characters *Apathya yassujica* Variables loading strongly on each principal component are shown in bold.

Variables	**PC1**	**PC2**	**PC3**
SVL	**0.817**	0.430	-0.040
TL	**0.798**	0.073	-0.145
LMC	**0.695**	0.186	0.210
HW	**0.927**	0.142	-0.018
HH	**0.758**	0.095	-0.079
SL	**0.791**	0.015	-0.270
EED	**0.898**	0.132	0.121
PW	**0.764**	-0.160	0.133
PL	**0.934**	-0.085	0.130
HLL	**0.930**	0.084	0.039
FLL	**0.909**	0.129	-0.091
WBT	**0.900**	0.104	-0.119
APL	**0.867**	-0.250	0.013
SCA	**-0.572**	0.486	0.463
NEE	0.397	**-0.758**	-0.161
SAM	0.367	-0.399	**0.746**
SAFC	**0.717**	-0.027	0.218
Eigenvalues	10.497	1.373	1.064
% of Variance	61.749	8.074	6.260
Cumulative %	61.749	69.824	76.083

The phenomenon of male(s) combat suggests sexual selection for larger male size, hence can predict a phylogenetic correlation between male-biased SSD and male aggressive behavior, as an evolutionary association between male-biased HSD and male–male combats (Kratochvíl and Frynta 2002). Adult males having larger heads than females that is a widespread pattern in some lizards, including in male-biased SSD species, *Eumeces chinensis*, Lin and Ji 2000; *Lacerta oxycephala*, Verwaijen et al. 2002; *Gallotia caesaris*, Molina-Borja et al. 2010; *Laudakia erythrogastra*, Aghili et al. 2010; *Takydromus wolteri*, Luo et al. 2012). Large male heads have been related to the advantages of a larger gape and more robust jaws in combat with rival males or in retaining a grip on females during mating (Luo et al. 2012). It seems that larger heads *Apathya yassujica* males are correlated with their mating success because males must hold on the female's abdomen in order to mate successfully.

The TL was generally found in SSD of lacertid lizards (Chang and Oh 2012). It was also the case with our species, *A. yassujica*, in which males showed a tail growth rate higher than that of females, which is partly related with fecundity selection acting on females (Zhang et al. 2005). The longer tails in males could be due to physiological differences between sexes as males need additional tail space to accommodate hemipenes (Arnold 1986). As in our study, in males maximum width of base tail (WBT), anal plate length (APL), and number of scales around fifth caudal whorl (SAFC) is larger than of females, which there might be ecological causes driving longer tails in males (Fig. 2 A-B; Luo et al. 2012).

Males actively search for mates that may increase the rate of exposure to predators in the wild (Arnold 1986). Thus, having a longer tail is to benefit for male *A. yassujica*, tail color is blue in sunshine, gleaming green in shadow, and irregular tremor (Fig. 2 C). Specimens of *A. yassujica* were found in natural habitat with dominant cover of shrubs, bushes such as wild fig, *Ficus carica*, Hawthorn, *Cratagus pontica*, wild pistachio, *Pistacia atlantica*, almond, *Amygdalus arabica* (Fig. 2 C-D).

The length of forelimbs (HLL) and hind-limbs (FLL) in males of *A. yassujica* were longer than females. The relatively longer limbs of males afford them greater running speed than females; it is presumed greater success at outrunning predators may offset higher predation pressure (Nkosi et al. 2004). Longer limbs may be increased stride length and stride rate increased (Avery et al. 1987). Males of *A. yassujica* are required agility to avoid predators, as male should distribute more energy in forelimbs and hind-limbs, hence, may be larger SVL and lengthy limbs (HLL, FLL) is an ultimate cause which is selected in males because this feature enhances sexual selection.

Therefore, according to our findings, the best fit for explanation of the occurrence of sexual size dimorphism in *Apathya yassujica* (Nilson et al. 2003) may be sexual selection in action in which combat among males is in favor of larger males. Females have higher value in SCA (number of scales from collar to anal plate) than males which is probably related to carrying eggs in females.

We define the currently known distribution of *A. yassujica* as Kohguiluyeh Va Boyer Ahmad (type locality), Chaharmahal and Bakhtiari (Rajabizadeh et al. 2010) and Fars (new localities) Provinces.

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Literature cited.

Abouheif E, Fairbairn DJ. 1997. A comparative analysis of allometry for sexual size dimorphism: Colwell, R. K. 2000. Rensch's rule crosses the line: convergent allometry of sexual size dimorphism in hummingbirds and flower mites. *The American Naturalist* 156(5): 495-510.

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. 1871. *The Descent of Man, and Selection in Relation to Sex*. Appleton, New York.

Fairbairn DJ, Blanckenhorn WU, Székely T. 2007. *Sex, Size, and Gender Roles Evolutionary Studies of Sexual Size Dimorphism*. Oxford University Press, New York.

Fathinia B, Rastegar-Pouyani N, Mohamadi H. 2011. Sexual dimorphism in *Carinatogecko heteropholis* (Minton, Anderson, and Anderson, 1970) (Sauria: Gekkonidae) from Ilam Province, western Iran. *Amphibian and Reptile Conservation* 5(1): 47-53.

Frayer DW, Wolpoff MH. 1985. sexual dimorphism**.** *Annual Review of Anthropology* 14: 429-73.

Herrel A, Spithoven L, Van Damme R, De Vree F. 1999. Sexual dimorphism of head size in *Gallotia galloti*: testing the niche divergence hypothesis by functional analyses. *Functional Ecology* 13: 289-297.

Frayer DW, Wolpoff MH. 1985. sexual dimorphism**.** *Annual Review of Anthropology* 14: 429-73.

Herrel A, Spithoven L, Van Damme R, De Vree F. 1999. Sexual dimorphism of head size in *Gallotia galloti*: testing the niche divergence hypothesis by functional analyses. *Functional Ecology* 13: 289-297.

Huang WS. 1998. Sexual size dimorphism and microhabitat use of two sympatric lizards, *Sphenomorphus taiwanensis* and *Takydromus hsuehshanensis*, from the central highlands of Taiwan. *Zoological Studies-Taipei* 37: 302-308.

Ji X, Zhou WH, Zhang XD, Gu HQ. 1998. Sexual dimorphism and reproduction in the grass lizard *Takydromus septentrionalis*. *Russian Journal of Herpetology* 5(1): 44–48.

Karamiani R, Rastegar-Pouyani N, Fattahi R, Fathinia B. 2013. Sexual dimorphism in leaf-toed gecko *Asaccus elisae* (Werner, 1895) (Sauria: Gekkonidae) from western Iran. *Hamadryad* 36(2): 157-161.

Kratochvíl L, Frynta D. 2002. Body-size effect on egg size in eublepharid geckos (Squamata: Eublepharidae), lizards with invariant clutch size: negative allometry for egg size in ectotherms is not universal. *Biological Journal of the Linnean Society* 88(4): 527-532.

Lappin AK, Husak JF. 2005. Weapon performance, not size, determines mating success and potential reproductive output in the collared lizard (*Crotaphytus collaris*). *The American Naturalist* 166(3): 426-436.

Lin Z, Ji X. 2000. Food habits, sexual dimorphism and female reproduction of the skink (*Eumeces chinensis*) from a Lishui population in Zhejiang. *Acta Ecologica Sinica* 20(2): 304-310

Luo L, Wu Y, Zhang Z, Xu X. 2012. Sexual size dimorphism and female reproduction in the white-striped grass lizard *Takydromus wolteri***.** *Current Zoology* 58(2): 236-243.

Molina-Borja M, Padron-Fumero M, Alfonso-Martin T. 1998. Morphological and behavioural traits affecting the intensity and outcome of male contestes in *Gallotia galloti galloti* (family Lacertidae). *Ethology* 104(4): 314-322.

Molina-Borja M, Rodríguez-Domínguez MA, González-Ortega C, Bohoŕquez-Alonso ML. 2010. Sexual size and shape dimorphism variation in Caesar's Lizard (*Gallotia caesaris*, Lacertidae) from different habitats. *Journal of Herpetology* 44(1): 1-12.

Nkosi WT, Heideman NJL, Van Wyk JH. 2004. Reproduction and sexual size dimorphism in the lacertid lizard *Pedioplanis burchelli* (Sauria: Lacertidae) in South Africa. *Journal of Herpetology* 38(4): 473-480.

Nilson G, Rastegar-Pouyani N, Rastegar-Pouyani, Andrén C. 2003. Lacertas of South and Central Zagros Mountains, Iarn, with description of two new taxa. Russian Journal of Herpetology 10 (1): 11-24.

Olsson M. 1992. Contest success in relation to size and residency in male sand lizards, *Lacerta agilis*. *Animal Behaviour* 44: 386-388.

Olsson M, Shine R, Wapstra E, Ujvari B, Madsen T. 2002. Sexual dimorphism in lizard body shape: the roles of sexual selection and fecundity selection. *Evolution* 56(7): 1538-1542.

Rajabizadeh M, Rastegar-Pouyani N, Khosravani A, Barani-Beiranvand H, Faizi H, Oraei H. 2010. New records of lacertid genera, *Iranolacerta* and *Apathya* (Sauria: Lacertidae) in Iran. *Iranian Journal of Animal Biosystematics* 6(2): 21-32.

Selander RK. 1972. *Sexual selection and dimorphism in birds*, pp. 180-230 in B. Campbell (ed.), Sexual Selection and the Descent of Man. Heinemann Educational Books, London.

Verwaijen D, Van Damme R, Herrel A. 2002. Relationships between head size, bite force, prey handling efficiency and diet in two sympatric lacertid lizards. *Functional Ecology* 16(6): 842-850.

Zhang XD, Ji X, Luo LG, Gao JF, Zhang L. 2005. Sexual dimorphism and female reproduction in the Qinghai toad-headed lizard *Phrynocephalus vlangalii*. *Acta Ecologica Sinica* 51(6): 1006-1012.

Zucker N, Murray L. 1996. Determinants of dominance in the tree lizard *Urosaurus ornatus*: the relative importance of mass, previous experience and coloration. *Ethology* 102(6): 812-825.

Authors Biographies

Rasoul Karamaini earned his B.Sc. and M.Sc. from Lorestan and Razi universities, respectively. His M.Sc. research focused on systematics of the Family Eublepharidae in Iran with special reference to *Eublepharis angramainyu*. He also investigated skull comparison of several genera of reptiles and amphibians. Currently, he is a Ph.D. student at Razi University, Kermanshah, western Iran under advisement of Prof. Nasrullah Rastegar-Pouyani and Dr. Eskandar Rastegar-Pouyani. His PhD research involves ecology, phylogeography, molecular systematics, and population genetics of the snake-eyed skink *Ablepharus* in Iran. His research interests include taxonomy, behavior, ecology, conservation and phylogeography of amphibians and reptiles.

Sarallah Dabid earned his B.Sc. in Animal Biology from the Shiraz University of Fars province, Iran, and his M.Sc. in Animal Biosystematics from Razi University, Kermanshah, Iran in 2013, where he studied systematics and distribution of the genus *Apathya* with special reference to *Apathya yasujica* from Kohguiluyeh Va Boyer Ahmad Province under the supervision of Prof. Nasrullah Rastegar-Pouyani. His research interests include taxonomy, ecology, biology and conservation of amphibians and reptiles.

Nasrullah Rastegar-Pouyanai received his Ph.D. in 1999 working the on taxonomy and biogeography of Iranian Plateau agamids, specifically *Trapelus*. Since 1996, he has described numerous new taxa of lizards (mainly geckonids, agamids, and lacertids) from the Iranian Plateau. His research interests include taxonomy and biogeography of the herpetofuana of the Iranian Plateau, and in general the Middle East and Central Asia. Nasrullah is currently Head of the Department of Biology, Faculty of Science, Razi University, and co-manages the Conservation Breeding Program for two species of Critically Endangered newts in Iran, the Kurdistan newt (*Neurergus microspilotus*) and the Loristan newt (*N. kaiseri*).