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Distribution of the Large-Scaled Rock Agama, *Laudakia nupta* (De FiLippi, 1843) in Iran and its Sexual Dimorphism (Squamata: Agamidae).

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ABSTRACT

The distribution range of *Laudakia nupta* (De Filippi, 1843) was revised based on new records from southeastern, southern, central, north eastern and eastern Iran. We recognized main distribution range of this species is regions above mentioned. To explore patterns of sexual dimorphism in the Large-Scaled Rock Agama, *Laudakia nupta* De Filippi, 1843, we examined 13 morphometric and four meristic traits in 59 adult specimens, including 31 males and 20 females of *Laudakia nupta nupta* De Filippi, 1843, further to four males and four females of *Laudakia nupta fusca* Blanford, 1876. To determine degree of sexual dimorphism between the two sexes in each subspecies, we used univariate and multivariate analyses. Analyses of the morphometric traits showed that the head size (head length, head width and head height) was significantly different between males and females of *Laudakia nupta nupta,* while univariate analysis revealed no significant differences in characters between the two sexes in *Laudakia nupta fusca.* Furthermore, in each taxon, males have more pronounced coloration or ornamentation and more developed callous scales on mid-ventral and pre-anal regions than those of females. Meristic traits, on the other hand, showed no significant differences between the two sexes.

Keywords: *Laudakia nupta*, metric and meristic traits, Sexual selection, Lizard, Iranian Plateau, Sexual dimorphism.

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INTRODUCTION

The Agamidae, a monophyletic family of lizards (Honda et al., 2000), with 54 genera and more than 330 contemporary species are distributed throughout the old world (Rastegar-Pouyani & Nilson, 2002). One of the Agamidae's genera, *Laudakia* Gray, 1845, is distributed through highlands and mountainous regions of central and south Asia (Rastegar-Pouyani & Nilson, 2002). One of the twenty or so species of *Laudakia*, the Large-Scaled Rock Agama, *Laudakia nupta* (De Filippi, 1843), is believed to have two subspecies *L. nupta nupta* and *L. nupta fusca*. *L. nupta nupta* is distributed in northeastern and eastern regions of Iraq towards Iran, Afghanistan and Pakistan (Anderson, 1999; Rastegar-Pouyani & Nilson, 2002). *L. nupta fusca,* on the other hand, is mainly distributed through southeastern regions of the Iranian Plateau (Rastegar-Pouyani & Nilson, 2002).

Sexual dimorphism, defined as morphological differences between males and females of the same species, is common and widespread among reptile species (Andersson, 1994; Berry & Shine, 1980; Fitch, 1981; Gibbons & Lovich, 1990; Schoener, 1977; Shine, 1991; Stamps, 1983). Both natural selection and sexual selection can influence the form of dimorphism in secondary sexual traits (Andersson, 1994; Endler, 1983), and evolutionary interactions between natural selection and sexual selection, usually believe to generate morphological variations and differences in coloration and/or ornamentation between the two sexes. Also comparative studies have shown strong relationships between sexual dimorphism in coloration, or ornamentation, and other indices of sexual selection, e.g. mating system (Dunn, Whittingham, & Pitcher, 2001; Figuerola & Green, 2000; Owens & Hartley, 1998).

Sexual selection and ecological factors have been proposed as two main mechanisms generating phenotypic variations between sexes (Shine, 1989). Sexual selection is a form of directional selection on specific characteristics, e.g. large head size, that can increases reproductive success in certain species (Lappin & Swinney, 1999). In some taxa, including lizards, ecological factors have been linked to intersexual dietary partitioning (Rand, 1967; Schooner, 1967; Stamps, 1977).

As a part of a relatively large scale study on biology and distribution of *L. nupta,* in this paper we present the results on its distribution range as well as the patterns of its sexual dimorphism.

MATERIAL AND METHODS

Our unpublished molecular data confirmed some populations in northwestern, western and southwestern Iran which attributed to *Laudakia nupta* for many years, belong to new entities (*Laudakia* sp.) so these samples was excluded in this study.Fifty nine specimens of *Laudakia nupta* were either hand collected from 41 localities in Iran (Figure 1 and Table 1) during spring and summer 2011, or borrowed from museums (see Appendix 1), in order to describe distribution range of the species and to examine the intersexual differences in morphometric and meristic characteristics were used. Those specimens included 51 specimens of *L. nupta nupta,* 31 males and 20 females, and further eight specimens of *L. nupta fusca*, four males and four females. Thirteen morphometric and four meristic characters (Table 2) were examined and consequently analyzed to illustrate the patterns of sexual dimorphism between the two sexes.

Table 1: Specimens used in this study and their localities, elevations, and coordinates.

Taxa	Province	Locality	Latitude	Longitude	Elevation(m)
Laudakia nupta fusca	Sistan and Baluchistan	Bazman	27° 50' N	60° 12' N	943
	Kerman	Sirjan	29° 23' N	55° 47' N	1748
		Bazenjan	29° 16' N	56° 42' N	2420
		Joopar	30° 04' N	57° 09' N	1870
		Delfard	29° 00' N	57° 35' N	2068
		Between Jiroft to Kerman	29° 05' N	57° 32' N	2822
		Between Baft to Sirjan	29° 28' N	56° 12' N	2462
	South Khorasan	Ferdows	33° 59' N	58° 11' N	1199
Laudakia nupta nupta	Kohkyloyeh and Boyerahmad	Aliabad	30° 37' N	50° 30' N	1461
		Kheirabad	30° 28' N	50° 30' N	515
		Soq	30° 52' N	50° 27' N	873
		Gheyam	30° 56' N	50° 16' N	683
		Gusheh	30° 57' N	50° 46' N	2465
		Near Soq	30° 50' N	50° 30' N	851
		Khowli	31° 01' N	50° 08' N	1498
		Abshirin	30° 17' N	50° 32' N	2448
		Sarchenar	30° 54' N	51° 03' N	2061
		Amirabad	30° 49' N	51° 29' N	2392
		Lendeh	30° 52´ N	51º26´ N	858
		Sisakht	30° 52´N	51° 26´ N	2324
	Hormozgan	Kohich	27° 12' N	54° 12' N	446
		Geno	27° 23' N	56° 10' N	1087
		Lemazan	27° 05' N	54° 50' N	655
	Yazd	Herat	30° 20' N	53° 54' N	1966
	Qom	Langrood	34° 30'	50° 56' N	935

			N		
	Isfahan	Khonab	33^o 52' N	51^o 21' N	1525
		Dare	33^o 53' N	51^o 20' N	1520
		Near Dare	33^o 52' N	51^o 18' N	1716
		Henjen	33^o 36' N	51^o 42' N	1682
		Fin	34^o 18' N	51^o 46' N	1415
	Bushehr	Naiband	27^o 21' N	52^o 37' N	15
		Ahrom	28^o 48' N	51^o 23' N	249
		Kuh-e Bang	29^o 45' N	50^o 20' N	71
	Fars	Noorabad	30^o 00' N	51^o 33' N	1061
		Perspolis	29^o 56' N	52^o 53' N	1632
		Konartakhteh	29^o 32' N	51^o 23' N	490
		Bamoo	29^o 41' N	52^o 38' N	2037
		Arsanjan	29^o 58' N	52^o 55' N	1651
		Bavanat	30^o 18' N	53^o 54' N	2065
		Firozabad	28^o 51' N	52^o 36' N	2191
	Semnan	Khartooran	35^o 39' N	56^o 34' N	2119

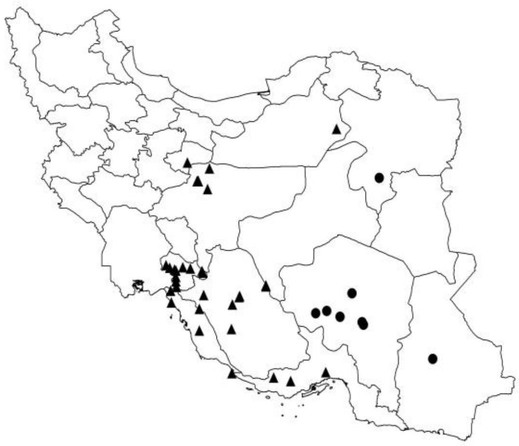

Figure 1: Sampling localities and places where *L. nupta nupta* (▲) and *L. nupta fusca* (●) are recovered in this study.

Table 2. List of the morphometric and meristic characteristics examined in the present study.

Characteristics	Characteristics Acronym	Characteristics definition
Snout-Vent Length	SVL	Distance between tip of the snout to anterior edge of cloaca
Tail Length	TL	Distance between posterior edge of the cloaca and tip of the tail
Head Length	HL	Distance between tip of the snout and posterior edge of tympanum
Head Width	HW	The width of the widest part of the head
Head Height	HH	Distance between the top of the head and the lower jaw
Snout-Nostril Length	SN	Distance between nostril and snout
Nostril-Nostril Length	NN	Distance between the two nostrils
Scales Around Mid Body	SQ	Number of scales in a single row around the widest part of the body
Anus-Gular Fold Scales	AGFS	Number of ventral scales in a single row from posterior edge of the gular fold to the vent
Fifth Caudal Whorl Scales	FCWS	Scales around the fifth caudal whorl just behind the vent
Length Of Fore Limb	FLL	From top of the shoulder joint to the tip of the 4th finger
Length Of Hind Limb	HLL	From hip joint to the tip of the 4th finger
Gular Fold-Vent Length	GFV	Distance between anterior edge of the gular fold to the vent
Maximum Trunk Width	MTrW	Length of the widest part of the trunk
Maximum Tail Width	MTaW	Length of the widest part of the tail base
Body Mass	BM	Body weight

Measurements of the traits performed to the nearest 0.1 millimeter using vernier calipers, whenever necessary. Scales on the different parts of body are counted using stereomicroscope. Descriptive statistics were used to explore the means, standard errors and ranges of selected characteristics. We used independent samples T-test and Principal Components Analysis (PCA) to analyze patterns of sexual dimorphism at univariat and multivariate levels, respectively. All statistical analyses were run by the SPSS (version 21) statistical package. The significance levels for all statistical tests were set at $p<0.05$.

RESULTS

In this study specimens of *Laudakia nupta nupta* were collected from the southern, southwestern, central and north eastern Iran. Specimens were found in rocky mountainous habitats from 15m above sea level (Figure 2), in Naiband (Bushahr; 27^{o} 21' N 52^{o} 37'E), up to 2891m, in Firoozabad (Fars; 28^{o} 51' N 52^{o} 36' E).Four male and four female specimens of *Laudakia nupta fusca* were collected from south eastern, southern and eastern parts of Iran. Specimens were found in rocky mountainous habitats from 943m above sea level (Figure 3) in Bazman (Baluchistan; 27º 23´N 60º 12´E), up to 2822m on the road between Jiroft to Kerman (29º 5´N 57º 32´E). new range extension of this species was recorded from South Khorasan province (Ferdos, 34 05 06.1 N, 58 05 04.0 E) that near 400 km far from its known distribution range in Baluchistan.

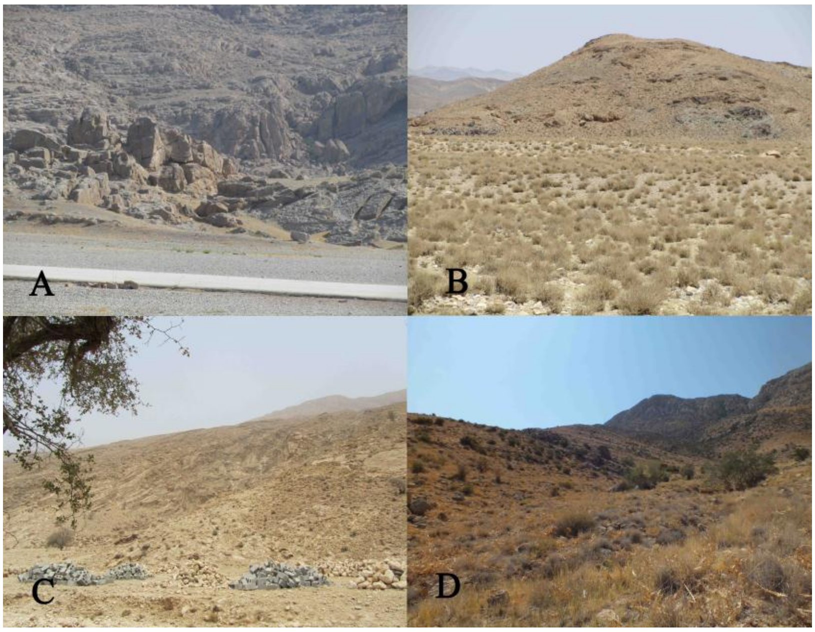

Figure 2: Typical habitats of *Laudakia nupta nupta,* where specimens were caught, Perspolis (A), Heart (B), Bastak (C), and Bamoo (D).

Figure 3: Typical habitats of *Laudakia nupta fusca*, where specimens were caught, Bazman (A), Joopar (B), Ferdows (C), and Delfard (D).

Statistical analyses

Univariate analysis

Descriptive analyses were performed for males and females separately (Table 3). The analyses showed that males had higher average in all meristic characters including scales around mid-body (SQ), large vertebral scales (LVS), number of ventral scales in a single row from posterior edge of gular fold to vent (AGFS), scales around fifth caudal whorl just behind the vent (FCWS). Descriptive analyses revealed that most of the metric characters including snout-vent length (SVL), tail length (TL), head length (HL), head width (HW), head height

(HH), snout-nostril length (SN), nostril-nostril distance (NN), length of forelimb (FLL), length of hind limb (HLL), maximum trunk width (MTrW), and maximum tail width (MTaW) had higher averages in males than in females.

Table 3. Descriptive analyses of morphometric and meristic characteristics of *Laudakia nupta nupta*, including minimum (min), maximum (max), mean and standard error (SE), as well as the T-test based on intersexual comparison of those characters. All measurements are in millimeter except body mass is in gram. t: Statistics of t-test, df: Degrees of freedom, *p*: p-value, *: Significant character.

Characteristics	Males (n=31)			Females (n=20)			t	df	*p*
	min	max	mean±SE	min	max	mean±SE			
SVL	75.18	160.94	127.99±4.31	87.58	144.90	123.74±3.71	0.692	49	0.492
TL	111.36	281.94	203.86±9.65	130.05	265.49	192.55±1.58	0.753	36	0.456
HL	26.43	45.72	36.49±0.90	25.83	40.80	33.78±0.75	2.317	48.862	0.025*
HW	20.31	38.22	29.33±0.80	21.03	32.90	25.91±0.67	3.007	49	0.004*
HH	11.90	25.10	19.37±0.57	13.99	23.95	17.24±0.55	2.549	49	0.014*
SN	3.74	7.55	5.68±0.16	4.01	7.09	5.42±0.21	1.011	49	0.317
NN	5.24	8.79	7.43±0.18	5.68	8.22	6.98±0.17	1.733	49	0.089
FLL	58.12	93.31	75.72±2.31	63.28	85.38	72.95±1.82	0.924	30	0.363
GFV	55.63	104.67	81.26±4.13	54.82	100.22	83.49±3.44	- 0.409	30	0.686
BM	26.10	156.41	84.57±8.22	35.41	148.20	77.18±7.84	0.646	30	0.523
SQ	86	114	101.06±1.39	81	113	100.75±2.43	0.121	49	0.904
AGFS	81	107	93.65±1.42	78	107	91.30±1.85	1.017	49	0.314
HLL	78.70	130.10	106.07±3.13	87.07	114.98	104.80±2.33	0.318	30	0.753
MTrW	28.02	50.18	42.45±1.74	28.42	46.95	40.47±1.70	0.812	29	0.423
MTaW	11.96	27.17	19.73±0.94	13.92	21.76	19.03±0.67	0.605	29	0.550
LVS	17	22	18.71±0.28	16	22	18.30±0.34	0.934	49	0.355
FCWS	18	22	20.61±0.24	16	22	20.05±0.36	1.372	49	0.176

The T-test showed significant differences in head dimensions (head length, head width, and head height) between the two sexes at the level of 95% ($p<0.05$) (Table 3).

Multivariate analyses

The results of the PCA for *Laudakia nupta nupta* concur with the results of the t-test, variables loading the highest for PC1 are HH, HL, HW, BM and MTaW and PC1 accounts for 42.84% of the variance. GFV and SVL load the highest on PC2; While PC2 explains 18.27% of the variance. SN loads higher on PC3, LVS loads higher on PC4 and AGFS loads higher on PC5. PC3 accounted for 9.71% of the variance, PC4 accounted for 6.31% of the variance and PC5 accounted for 6.02% of the variance. The first five components accounted for 83.15% of the total variance (Table 4). The results of the PCA, as a scatter plot, are shown in (Figure 4).

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Table 4: Results of PCA, principal component loadings and the percent variance accounted for by each principal component are provided for *Laudakia nupta nupta*.

Variable	PC1	PC2	PC3	PC4	PC5
Zscore (SVL)	0.259	0.923	0.115	0.021	-0.004
Zscore (TL)	-0.193	-0.031	0.097	-0.872	-0.088
Zscore (HL)	0.884	0.339	0.161	-0.057	0.045
Zscore (HW)	0.856	0.255	-0.051	-0.182	0.003
Zscore (HH)	0.932	-0.001	0.271	0.036	0.071
Zscore (SN)	0.453	0.189	0.783	-0.066	-0.107
Zscore (NN)	0.579	0.243	0.687	0.005	0.053
Zscore (FLL)	0.160	0.586	0.295	-0.164	-0.472
Zscore (HLL)	0.434	0.339	-0.114	-0.413	-0.573
Zscore (GFV)	0.155	0.958	0.057	0.089	-0.061
Zscore (MTrW)	0.779	0.005	0.521	0.104	0.164
Zscore (MTaW)	0.833	0.121	0.416	0.135	0.027
Zscore (BM)	0.842	0.108	0.233	0.228	-0.148
Zscore (SQ)	0.054	-0.523	0.530	0.254	0.287
Zscore (LVS)	-0.098	-0.029	0.273	0.702	-0.146
Zscore (AGFS)	0.175	-0.053	0.133	-0.144	0.839
Zscore (FCWS)	0.297	0.062	0.653	0.374	0.242
Percent variability	42.84	18.27	9.71	6.31	6.02
Cumulative percentage	42.84	61.12	70.82	77.13	83.15

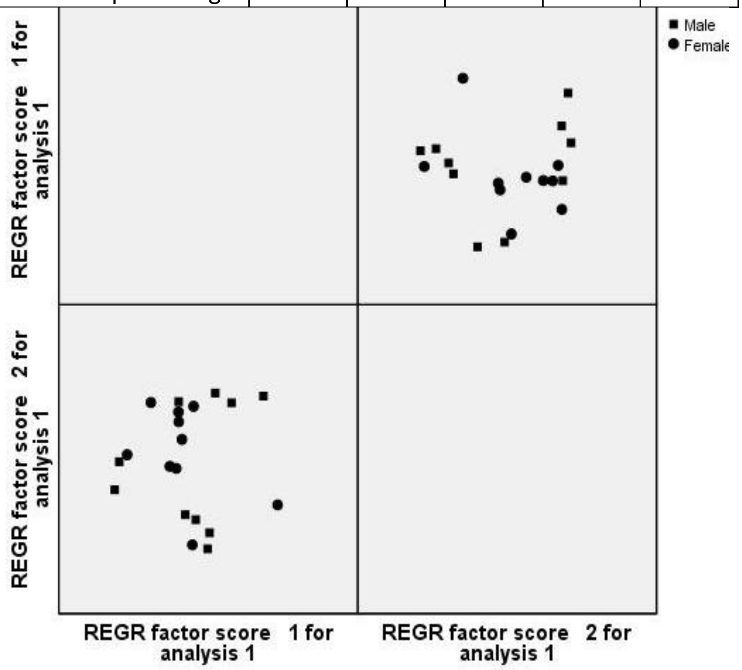

Figure 4: The scatter plot resulted from the PCA examining sexual dimorphism in *Laudakia nupta nupta*.

Descriptive statistics analyses were performed to calculate the means, standard errors, and ranges for examined characteristics of *L. nupta fusca*. The T- test did not reveal any significant difference in examines characteristics between the two sexes (Table 5). The PCA was performed on metric and meristic variables of *L. nupta fusca (*Figure 5) and yielded three components. PC1 explained 68.17% of the variance and variables loading highest for PC1 were MTaW, MTrW, HL, HW, SVL, BM, NN, GFV and HH. PC2 explains 16.74% of the variance and variables loading highest for PC2 were SQ, AGFS and FCWS. Finally, PC3 accounted for 9.38% of the variance and the variable loading highest for PC3 was LVS. All together, PC1, PC2 and PC3 explained for 94.30% 0f the variance (Table 6).

Table 5: Descriptive analyses of morphometric and meristic characteristics of *Laudakia nupta fusca*, including minimum (min), maximum (max), mean and standard error (SE), as well as the T-test based on intersexual comparison of those characters. All measurements are in millimeter except body mass is in gram. t: Statistics of t-test, df: Degrees of freedom, p: p-value, *: Significant character.

characters	Males (n=4)			Females (n=4)			t	df	P
	min	**max**	**mean±SE**	**min**	**max**	**mean±SE**			
SVL	96.85	163.68	137.37±14.28	111.42	116.67	113.82±1.08	1.644	6	0.151
TL	213.76	220.67	218.19±2.22	223.82	237.71	230.75±4.01	-2.740	4	0.52
HL	25.05	44.40	36.18±4.08	29.61	33.43	31.20±0.81	1.198	6	0.276
HW	18.57	35.06	28.72±3.60	22.88	26.41	24.15±0.79	1.238	6	0.262
HH	12.34	22.15	18.33±2.10	15.11	18.22	16.67±0.70	0.751	6	0.481
SN	2.63	6.80	5.34±0.93	4.22	5.41	4.81±0.25	0.553	6	0.600
NN	5.16	8.64	7.21±0.79	6.13	6.55	6.43±0.11	0.985	6	0.363
FLL	62.82	82.05	75.58±4.51	64.59	76.14	69.97±2.40	1.136	6	0.299
GFV	71.80	11.29	93.61±8.13	74.68	84.76	75.68±2.15	1.768	6	0.128
BM	25.10	192.60	106.77±34.48	43.80	52.10	49.14±1.93	1.669	6	0.146
SQ	95	100	97.75±1.11	91	103	97±2.45	0.279	6	0.790
AGFS	84	94	90.75±2.29	85	99	90±3.19	0.191	6	0.855
HLL	89.02	132.23	111.70±8.85	94.93	107.94	102.21±3.21	0.999	6	0.356
MTrW	30.53	54.17	43.60±4.89	32.98	35.60	34.29±0.59	1.889	6	0.108
MTaW	11.85	25.89	20.51±3.11	15.24	18.36	16.92±0.64	1.132	6	0.301
LVS	17	20	18.25±0.63	17	20	18±0.71	0.264	6	0.801
FCWS	20	22	21±0.58	19	22	20.50±0.65	0.577	6	0.585

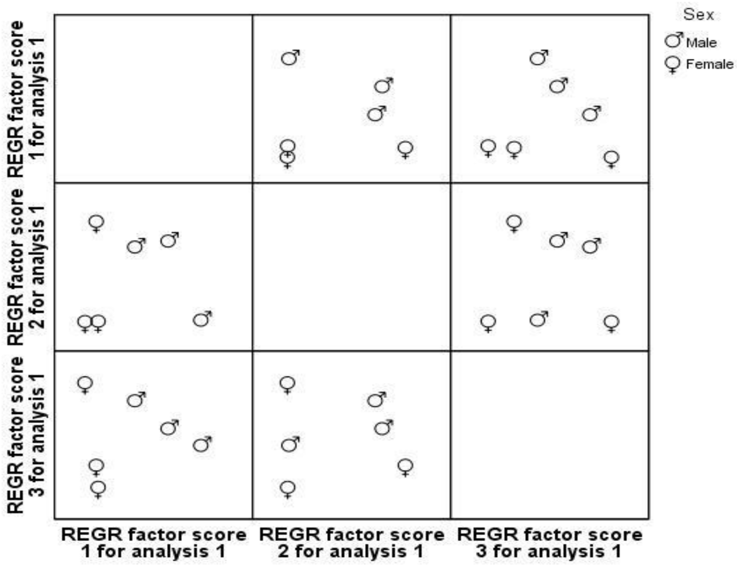

Figure 5: The scatter plot resulted from the PCA examining sexual dimorphism in *Laudakia nupta fusca*.

Table 6: Results of PCA, principal component loadings and the percent variance accounted for by each principal component provided for *Laudakia nupta fusca*.

Variable	PC1	PC2	PC3
Zscore (SVL)	0.974	-0.011	0.198
Zscore (TL)	-0.679	-0.260	-0.639
Zscore (HL)	0.982	-0.174	-0.019
Zscore (HW)	0.980	-0.116	0.000
Zscore (HH)	0.907	0.166	0.166
Zscore (SN)	0.803	0.136	0.485
Zscore (NN)	0.951	-0.154	0.059
Zscore (FLL)	0.763	0.103	0.575
Zscore (HLL)	0.857	-0.486	0.121
Zscore (GFV)	0.930	-0.102	0.325
Zscore (MTrW)	0.983	0.037	0.074
Zscore (MTaW)	0.990	-0.069	-0.001
Zscore (BM)	0.968	-0.192	0.058
Zscore (SQ)	-0.212	0.911	-0.140
Zscore (LVS)	-0.050	-0.115	0.953
Zscore (AGFS)	-0.333	0.906	0.185
Zscore (FCWS)	0.339	0.839	-0.006
Percent variability	68.174	16.743	9.388
Cumulative percent	68.174	84.918	94.305

In *L. nupta nupta* adult males have dark blue chin, throat and chest with numerous scattered light yellow scales. Furthermore they have larger spiny scales around tympanum and more developed callous scales on mid-ventral and pre-anal regions than the females (Figure 6). Adult males of *L. nupta fusca* have spiny scales around the tympanum and sides of the neck. Furthermore, in males the scales on the tail base were larger than those of the females. In males, the body proper has callouse scales on mid-ventral and pre-anal regions, yellow scales are scattered on blue ground coloration in gular region, and the proximal part of tail shows cream rings, the characteristics not observed in females (Figure 7).

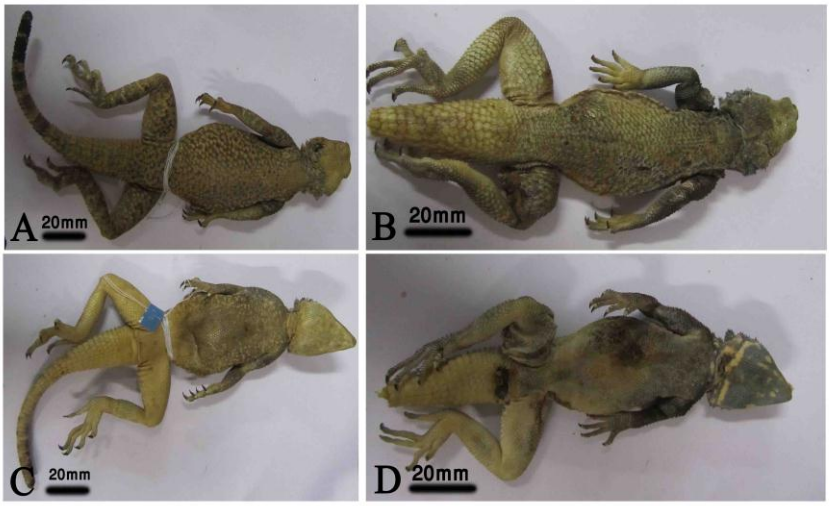

Figure 6: *Laudakia nupta nupta*. (A) Male, dorsal view; (B) female dorsal view; (C) Male and (D) female, ventral views.

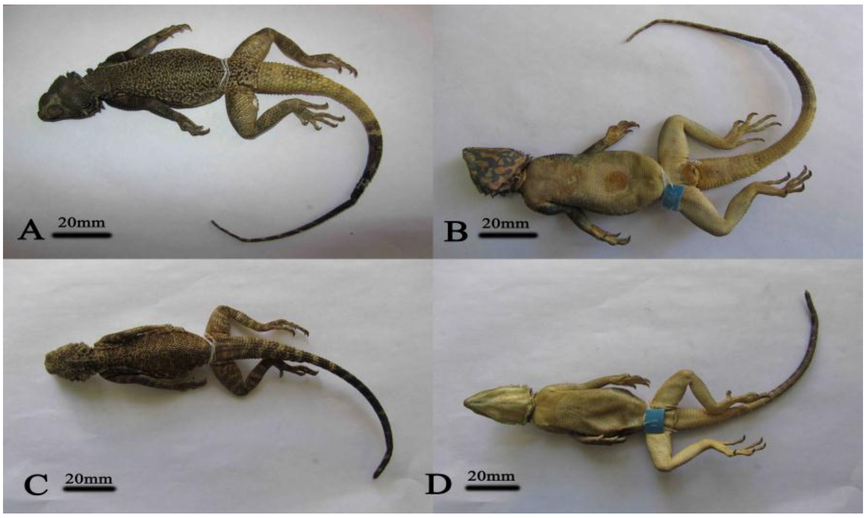

Figure 7: ***Laudakia nupta fusca*****. Male: (A) dorsal and (B) ventral views; Female: (C) dorsal and (D) ventral views**

DISCUSSION

According to Ananjeva & Peters (1990), Ananjeva, Peters, & Rzepakovskii (1981), Ananjeva & Tuniev (1994), Baig (1992), Baig, Kh. J., Wagner, P., Natalia, B., Anajeva, B., & Bohme, W. (2012), Greer (1989), and Peters (1971) proposed center of origin for the *Laudakia* is Pamir knot, which comprises Pamir, Karakoram, Himalaya, and Hindukush, providing an ideal place for speciation and dispersal to all directions.

During Tertiary huge mountain ranges, e.g. Hindukush, formed and *Laudakia* was one of the products of this surface changes. Later on, *Laudakia nupta* independently evolved around the Pamir and distributed toward the south, reaching Makran coasts and consequently invading southern mountain ranges of Iran, though which it extended its range up to the western regions of Iraq (Greer, 1989).

Previous studies have recorded *L. nupta nupta* from southern, southwestern, north-central and northwestern of Iran (Anderson, 1966, 1999; Cheatsazan, Rabani, Mahjoorzad, & Kami, 2008; Mahjoorazad, Cheatsazan, Kami, & Rabani, 2005; Rastegar-Pouyani & Nilson, 2002; Tuck, 1979). While Rastegar-Pouyani & Nilson (2002) have reported *L. nupta nupta* from northwestern provinces of Kermanshah and Kurdestan, molecular data (unpublished results) indicate that the Kermanshah and Kurdestan populations consist a separate clade. Based on the same unpublished results, Hormozgan and Bushehr provinces (Southern part of Iran) are also part of the *L. nupta nupta* domain. Consequently, in Iran the distribution range of *L. nupta nupta* covers southern, southwestern, central and north eastern parts of Iran.

According to Anderson (1999) the distribution range of *L. nupta fusca* is not known. Mahjoorazad et al. (2005) reported its occurrence from Baluchistan, Hormozgan and Bushehr regions. We believe that material reported on that study might have in fact been *L. nupta nupta,* being mistaken for *L. nupta fusca.* Hence, based results reported by Anderson (1986), Greer (1989), and Rastegar-Pouyani and Nilson (2002), as well as results presented in this work, we firmly believe that *L. nupta fusca* is distribted from south eastern part of

Iran, in Baluchistan, toward Kerman, to the northwest, and to the North covering southern parts of Khorasan provinces.

Distribution patterns of *L. nupta* populations may have been shaped, or at least have been affected, by the formation of the Makran and Zagros mountain systems in Iran during and after Tertiary (Greer, 1989), by global climatic fluctuations during Quaternary (Rastegar-Pouyani and Nilson 2009), and finally by intraspecific competition (Mayer ????) and long presence of competitors. Those competitors in case of *L. nupta* in Iran are believe to be *Paralaudakia microlepis* (distributed on the inner mountains), *P. caucasia* (North and north-western), *P. erythrogastra* (North and North-east) and *Laudakia* sp. (west).

Sexual dimorphism manifests in many different ways in different animal groups. In many vertebrates, for example, males have longer and wider head than the females, resulting from intrasexual (male to male) competition (Bonduriansky & Row, 2003; Cooper & Vitt, 1989; Kratochvil & Frynta, 2002; Okada & Miyatake, 2004; Shine, 1978; Vitt, 1983; Vitt & Cooper, 1985).

In lizards, too, sexual dimorphism in both body and head sizes are resulted from intrasexual selection (Anderson & Vitt 1990; Kratochvil & Frynta, 2002; Vitt & Cooper, 1985). According to Beutler (1981), Blanc & Carpenter (1969), Brattstrom (1971), Carpenter (1978), Harris (1963), Orlova (1981), Schleich (1979), Schmidt, (1966), and Smith (1935) males of agamid lizards have territorial behavior, Carothers (1989); Cooper & Vitt (1989) reported that males with large head are better in formation and keeping prime territories. In squamates males have longer and wider head than females (Anderson, 1994; Cox, Skelly, & John-Alder, 2003; Olsson, Shine, Wapstra, Ujvari, & Madsen, 2002). Cox et al. (2003) and Olsson et al. (2002) suggested that larger body and head facilitate food partitioning in lizards, while Herrel, Van Damme, & De Vree (1996) proposed these characteristics enable lizards to consume larger and relatively harder preys.

Comparing sexual dimorphisms in *Laudakia nupta nupta* and *L. nupta fusca* with that in other congeners in Iran shows that in *L. caucasia* males have larger bodies and limbs, more pointed and more voluminous heads and usually more developed callous scales on the mid-ventral and pre-anal regions, but no meristic traits differed significantly between the two sexes in *L. caucasia* (Cheatsazan, Kami, Kiabi, & Rabani, 2006). In *L. erythrogastra* males bear more pronounced ornamentation than females have, males are darker in coloration than the females, and finally males have longer heads and limbs than the females (Aghili, Rastegar-Pouyani, Rajabizadeh, Kami, & Kiabi, 2010).

It seems that the pattern of sexual dimorphism in *Laudakia microlepis* is similar to *Laudakia caucasia* (Rastegar-Pouyani & Nilson, 2002).

Heidari, Cheatsazan, Kami, & Shafiei (2010) were able to recognized *Laudakia melanura lirata* based on fourteen metric and nine meristic charecteristics. They also realized that males had larger bodies and limbs and usually more developed callous scales on the mid-ventral and pre-anal regions, but no meristic characteristics was significantly different between the two sexes in *L. melanura lirata*. However, there were differences in the positioning of the orbits, nostrils and tympanums between the two sexes.

In *L. nupta nupta* significant differences were observed in head dimensions (HL, HW, and HH), but in *L. nupta fusca* no significant difference was evident in those characteristics. That might have been resulted from the low specimen numbers of *L. nupta fusca* in the present study. Despite our intense efforts to recover enough specimens, we failed to gather enough *L. nupta fusca,* which, according to Cheatsazan et al. (2008), is a very rare lizard. In *L. nupta fusca* best results were found, the first three principal components accounted for 94.38% of total variance while in *L. nupta nupta* the first five components accounted for only 83.15% of total variance, hence as obvious from Figures (4 and 5), in *L. nupta fusca* and *L. nupta nupta* sexes are separated from each other.

In *L. nupta nupta* our results, including univariate and multivariate analyses, showed that head dimensions (HL, HW, and HH) are larger in males than those in females. Head size differences may be resulted from interaction between natural and sexual selection that can generate phenotypic variation (Andersson, 1982; Endler, 1983, 2000; Land & Kirkpatrick, 1988; Price, 1998). Consequently, larger head in males of *L. nupta nupta* may be advantageous in intra sexual competition such as male-male combat for investment and maintenance their territories for obtaining successful mating partners and enhancing their reproductive successes. Larger head may also help them to consume larger and harder preys.

Differences in coloration between two sexes of the two subspecies may enhance males chance to be selected by females, hence, increasing their reproductive success.

Finally we concluded natural and sexual selection combined generate sexual dimorphism while different phenotype between two sexes resulted from this phenomenon.

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