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A Study of Intraspecies Variations of Indian Gerbil, *Tatera indica* Hardwicke, 1807 (Muridae, Rodentia) in Eastern Border of Iran

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Abstract: In this study, 93 specimens of adult Indian Gerbil (*Tatera indica*) were collected by live-trap from different localities of Eastern Border of Iran. Specimens were collected among 3 populations from Torbat-e-Jam, Sistan and Chabahar with North longitude 60°-61.5° and East latitude 25.50°-35.50°. At first, external and cranial characters were measured and then ratio of measured characters to head and body length were calculated. It showed that there are differences in characters of Indian gerbils in various latitudes while ratio of measured characters to head and body length were compared between these 3 populations. These differences are more obvious in Chabahar so that 16 from 23 characters are significantly higher than those in Torbat-e-Jam and Sistan and 3 characters are significantly lower than those from two other localities. Also, 4 characters have no significant difference in these populations. The result of MANCOVA showed that there are no significant differences between sexes. This study tries to shed some more light on the effect of climate changes and height on morphometric changes of Indian gerbil in Eastern border of Iran.

Key words: Indian Gerbil, *Tatera indica*, Eastern border of Iran, morphometric analysis, Taftan's mountains

INTRODUCTION

Indian Gerbil is a night-active animal. This animal often lives near farms beside human as social, but lives in its nest as individual (Corbet and Hill, 1991; Kam *et al.*, 1997; Vaughn *et al.*, 2000). Indian Gerbil is from those species that has penetrated to Iran very much. Its specimen type is reported from North of India (Wilson and Reeder, 1993; Wilson and Cole, 2000). Internationally, it is dispersed in Syria, Iraq, Kuwait, Afghanistan, Pakistan, India, Sri Lanka and South of Nepal (Alderton, 1996; Harrison and Bates, 1991; Prater, 1971; Roberts, 1977; Wilson and Reeder, 1993). It seems that height is one of the important living factors for this animal with regard to its dispersion. This species is more adaptable than other desert and wild rats (Goyal and Ghosh, 1993; Nowak and Paradiso, 1983; Prakash and Gosh, 1975; Roberts, 1977). Indian Gerbil is dispensed throughout South of Iran from sea level to 1370 m height (Douglas, 1967; Misonne, 1959) (Fig. 1a, b). Climates and diets are important factors that can affect on adaptations of Rodents in different habitats (Kerley and Whitford, 1994; Michaux *et al.*, 2006). There are some studies that report intraspecies variations of Indian Gerbil in different populations (Mumtaz, 1989; Rana *et al.*, 1970; Kumar and Khan, 1977). In this study, we investigated the effect of

climate changes and height on morphometric changes of Indian Gerbil in 3 habitats on Eastern Border of Iran. These habitats situated on same geographical longitude with various geographical latitudes and are some different by climatic and height changes.

MATERIALS AND METHODS

In this study 3 localities were considered for sampling on Eastern border of Iran. From April 2008 to August 2009, 3 or 4 zone was determined in each locality for trapping with the following specifications:

First locality was Torbat-e-Jam Township in Eastern longitude 60°46'-61°0' and Northern latitude 35°7'-35°47' with height 940-1649 m. Annual temperature of this locality is -13°C-+40°C and its average precipitation is 254 mm. Second locality is Sistan and Zabol Township in Eastern longitude 60°2'-61°21' and Northern latitude 30°15'-30°55' with height 480-1200 m. Annual temperature of this locality is -9.5°C-+49°C and its average precipitation is 63.2 mm. Third locality is Chabahar Township in Eastern longitude 60°23'-61°32' and Northern latitude 25°13'-25°29' with height 7-200 m. Annual temperature of this locality is +10°C-+34°C and its average precipitation is 180 mm (Khajeh and Darvish, 2002) (Fig. 2).

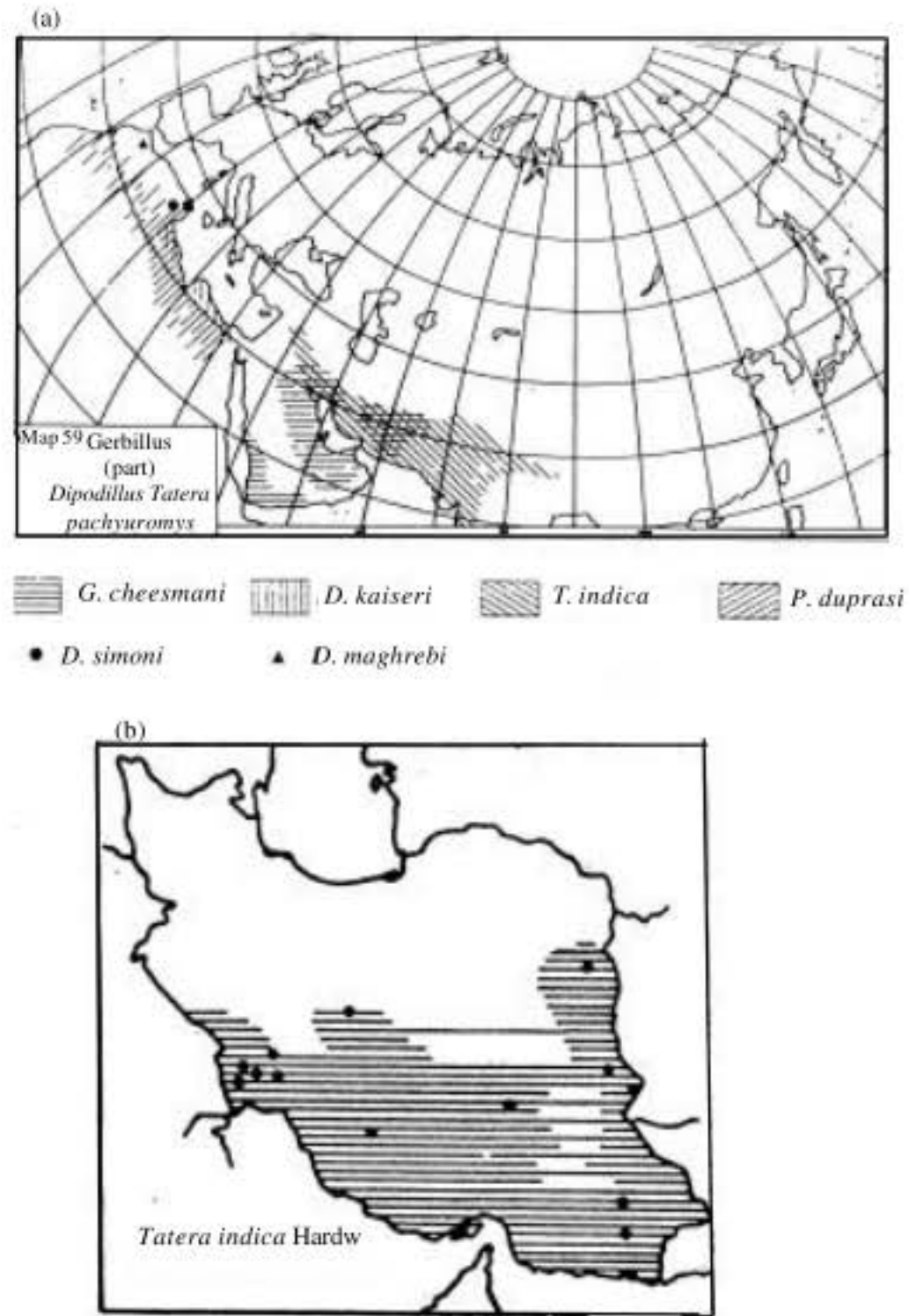


Fig. 1: (a, b) Map of *Tatera indica* distribution

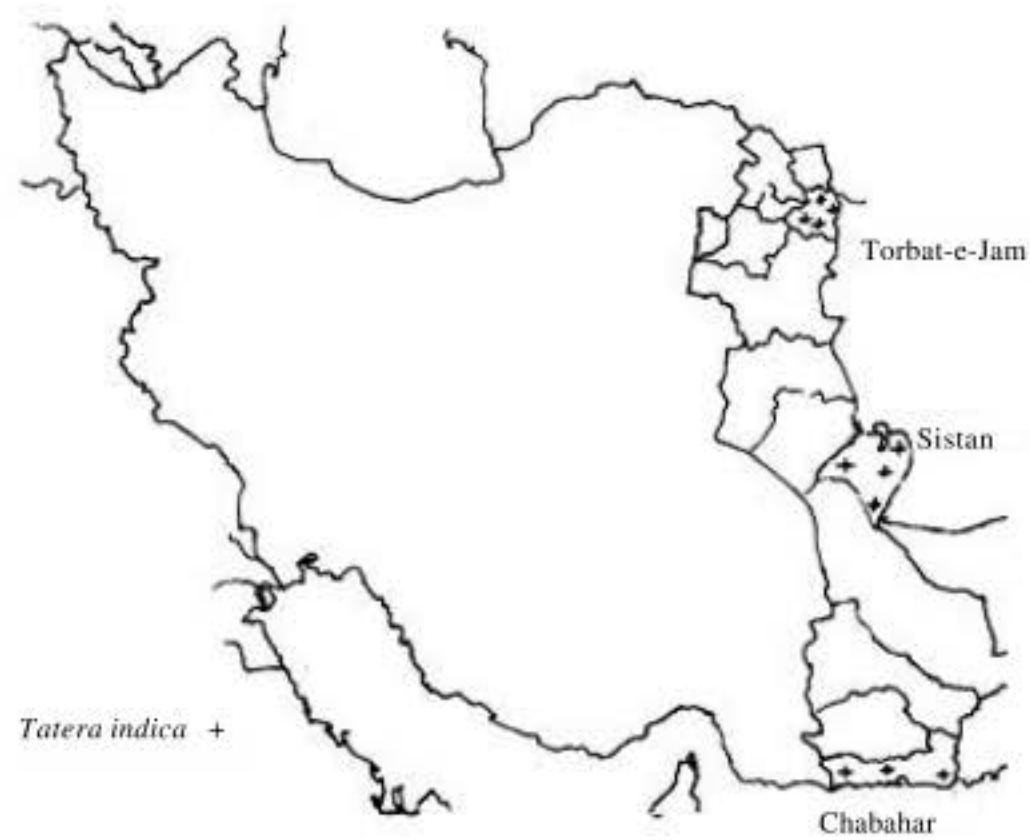


Fig. 2: Recorded localities of Indian Gerbil from Eastern border of Iran

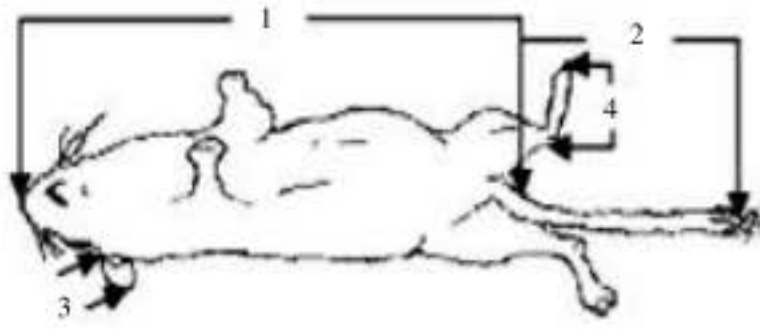


Fig. 3: Head, body and tale of *Tatera indica* (Ashrafzadeh *et al.*, 2007)

Sampling and study method: In each locality, farms and gardens near villages were considered for sampling. Sixty large Have-a-Heart traps with dimensions 65×18×18 cm and small Have-a-Heart traps with dimensions 45×13×13 cm were used for sampling (Ashrafzadeh *et al.*, 2008; Momenzadeh *et al.*, 2001). The traps were baited before sunset and were placed at animal's paths and then they were controlled the next day (Deblase and Martin, 1975; Cunningham and Moors, 1987; Cole, 2003). Often puffy snacks, dates, oil bread and potatoes were used for baits (Khajeh and Darvish, 2002).

Specimen identification: After sampling, hunted specimens were identified by valid keys and then adult specimens were separated by dental patterns (Etemad, 1978; Corbet, 1978; Harrison and Bates, 1991).

External characters are: (1) Body Length (BL), (2) Tail Length (TL), (3) Foot Length (FL), (4) Ear Length (EL), (5) Weight (W) (Ashrafzadeh *et al.*, 2007) (Fig. 3).

Cranial characters are: (1) Occipitonasal Length (OL), (2) Condilobasal Length (CL), (3) Zygomatic Width (ZW), (4) Least interorbital Width (LW), (5) Cranial Width (CW), (6) Length of Nasal (LN), (7) Length of Diastema (LD), (8) Length of anterior Palatine Foramina (LPF), (9) Length of Tympanic Bullae (LTB), (10) Width of Tympanic Bullae (WTB), (11) Upper Cheekteeth (UCH), (12) Lower Cheekteeth (LCH), (13) Height of Skull (HS), (14) Width of Rostrum (WR), (15) Length of Mandibule (LM), (16) Auditory Meatus Diameter (AMD), (17) Palatine Width (PW), (18) Diameter of Orbital (DO) (Ashrafzadeh *et al.*, 2007) (Fig. 4).

Up to 0.1 mm for external characters and up to 0.01 mm for cranial characters were measured by digital caliper with precision of 0.05 mm (Mirshamsi *et al.*, 2007). After measuring their external and cranial characters, data was analyzed using the SPSS software. In order to determine the differences between sexes, the data were tested with multivariate covariance analysis (MANCOVA) with CBL as covariate for cranial variables as covariate using GLM procedure of SPSS. In this procedure the effects of covariates with factor (sex) can

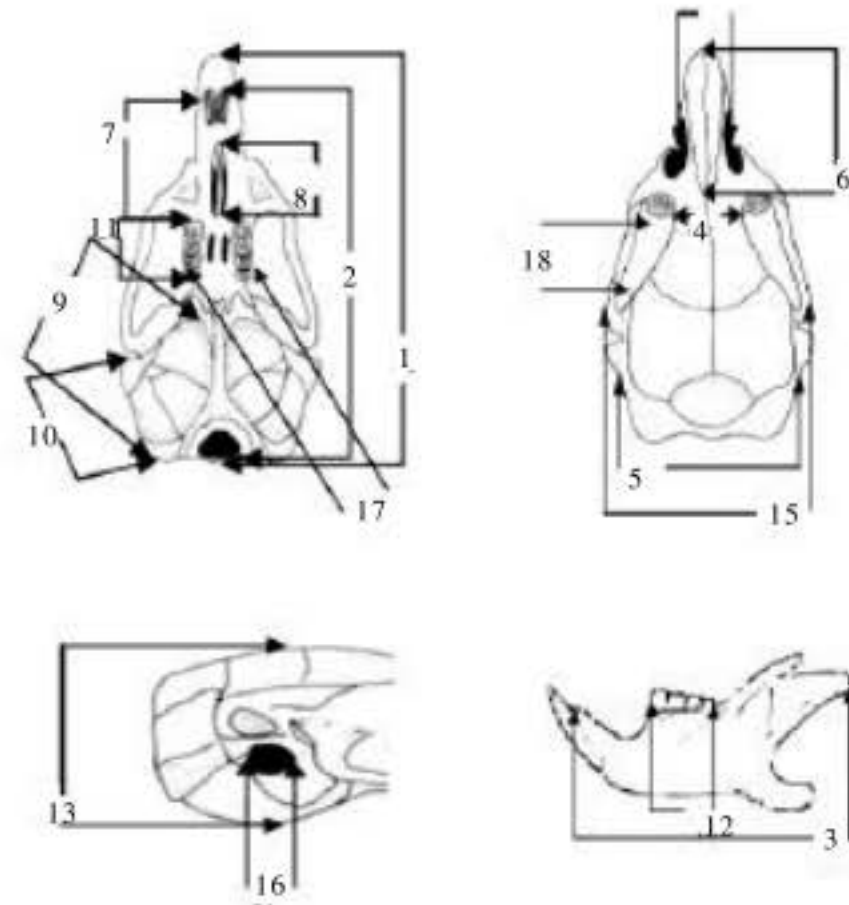


Fig. 4: Skull of *Tatera indica* (Ashrafzadeh *et al.*, 2007)

be included. The results of MANCOVA revealed that there are no significant differences between sexes (Wilk's lambda = 0.642; $p = 0.88$). Therefore, specimens of both sexes were combined in subsequent analysis. Significance was tested using one-way ANOVA followed by a Duncan test. Differences were considered significant when the p -value was <0.05 .

RESULTS AND DISCUSSION

In addition 93 specimens (Torbat-e-Jam: 41 S., Sistan: 28 S., Chabahar: 24 S.) were collected from Eastern border of Iran. In the first step, descriptive statistics were calculated for characters. These data show that in Chabahar population all averages of characters are greater from other populations in Torbat-e-Jam and Sistan (Table 1).

To obtain a scientific relation for measured characters and their comparison in different populations, ratio of size of all characters proportional to head and body was calculated, namely, size of each character was divided by head and body length. Descriptive statistics for these ratios are shown in Table 2.

Relationship of these characters was obtained by one-way ANOVA and Duncan Test. The results show that there are significant differences for morphometric characters between Chabahar population with Torbat-e-Jam and Sistan populations, but Torbat-e-Jam and Sistan populations are not significantly different in these characters. In regard to Table 1, it is indicated that average of all characters in Chabahar is greater than those two others. Also, the average body of population in

Table 1: Descriptive statistics for 23 characters (mm) of adult Indian Gerbils

Cha.	Torbat-e-Jam					Sistan					Chabahar				
	N	Mean	SD	Min.	Max.	N	Mean	SD	Min.	Max.	N	Mean	SD	Min.	Max.
HBL	41	166.6902	5.02582	160.50	177.50	28	167.2071	4.75043	160.60	175.10	24	170.3667	4.99458	161.70	178.50
TL	41	178.9659	5.02736	172.30	190.50	28	179.4679	4.63002	172.60	187.40	24	182.6625	4.96070	174.20	190.70
HFL	41	37.6561	0.14151	37.00	37.90	28	37.6929	0.09400	37.50	37.80	24	37.7417	0.08805	37.60	37.90
EL	41	24.4195	0.11878	24.20	24.60	28	24.4286	0.12430	24.20	24.60	24	25.8042	0.09991	25.60	26.00
W (g)	41	114.6683	10.66662	97.90	128.90	28	116.1214	9.83408	97.80	128.20	24	122.6708	6.31014	103.20	132.70
OL	41	45.0998	2.02676	42.44	48.87	28	45.2696	1.88639	42.45	48.24	24	46.5583	1.75680	42.98	49.22
CL	41	40.8795	1.15034	38.56	42.66	28	41.0439	1.06463	38.67	42.43	24	41.6833	0.83294	39.87	42.87
ZW	41	22.7846	0.42200	22.22	23.45	28	22.8989	0.53059	22.00	23.79	24	23.8092	0.43537	22.95	24.45
LW	41	6.9061	0.21071	6.68	7.35	28	6.9161	0.19540	6.69	7.29	24	7.0550	0.24213	6.72	7.56
CW	41	16.9656	0.16721	16.80	17.29	28	17.0364	0.30732	16.52	17.71	24	17.6792	0.59167	17.25	20.34
LN	41	19.4488	0.14224	19.27	19.71	28	19.4649	0.13915	19.27	19.68	24	19.5475	0.12691	19.31	19.72
LD	41	11.9534	0.16098	11.78	12.26	28	11.9696	0.15932	11.79	12.24	24	12.3229	0.22001	11.95	12.59
LPF	41	8.8471	0.15007	8.70	9.14	28	8.8543	0.14141	8.70	9.12	24	8.9500	0.15149	8.72	9.18
LTB	41	11.7395	0.50874	10.65	12.65	28	12.1054	0.42516	11.45	13.02	24	12.9817	0.19739	12.71	13.35
WTB	41	8.7895	0.17194	8.42	9.13	28	8.7618	0.14045	8.51	9.03	24	9.0971	0.14017	8.93	9.35
UCH	41	6.3549	0.14801	6.20	6.65	28	6.3654	0.14172	6.20	6.62	24	6.7608	0.15071	6.52	6.98
LCH	41	6.1578	0.10494	6.02	6.35	28	6.1682	0.09734	6.02	6.32	24	6.5350	0.09189	6.36	6.68
HS	41	16.5273	0.12915	16.37	16.76	28	16.5375	0.12189	16.37	16.74	24	17.8742	0.09117	17.71	18.05
WR	41	5.9468	0.11157	5.83	6.15	28	5.9568	0.10825	5.83	6.13	24	6.3767	0.34587	5.91	6.95
LM	41	21.0517	0.20158	20.78	21.39	28	21.0754	0.19394	20.79	21.35	24	21.7779	0.11572	21.53	21.98
AMD	41	2.9237	0.11774	2.75	3.15	28	2.9364	0.10979	2.75	3.13	24	3.0054	0.11045	2.81	3.18
DO	41	15.1205	0.40295	14.59	15.87	28	15.1511	0.36523	14.61	15.72	24	15.8075	0.33808	14.99	16.34
PW	41	7.5315	0.31595	7.16	8.22	28	7.5436	0.28640	7.16	8.04	24	7.7492	0.30699	7.24	8.24

Table 2: Descriptive statistics for ratio of measured characters to head and body length of adult Indian Gerbils

Ratios	Torbat-e-Jam			Sistan			Chabahar		
	N	Mean	SD	N	Mean	SD	N	Mean	SD
TL/HBL	41	1.0737	0.00311	28	1.0734	0.00358	24	1.0722	0.00345
HFL/HBL	41	0.2261	0.00620	28	0.2256	0.00583	24	0.2217	0.00600
EL/HBL	41	0.1466	0.00367	28	0.1462	0.00341	24	0.1516	0.00388
W (g)/HBL	41	0.6868	0.04671	28	0.6936	0.04264	24	0.7197	0.02091
OL/HBL	41	0.2704	0.00439	28	0.2706	0.00380	24	0.2732	0.00279
CL/HBL	41	0.2453	0.00210	28	0.2455	0.00176	24	0.2447	0.00271
ZW/HBL	41	0.1367	0.00218	28	0.1370	0.00212	24	0.1398	0.00221
LW/HBL	41	0.0414	0.00023	28	0.0414	0.00020	24	0.0414	0.00030
CW/HBL	41	0.1018	0.00209	28	0.1019	0.00178	24	0.1038	0.00442
LN/HBL	41	0.1168	0.00263	28	0.1165	0.00246	24	0.1148	0.00262
LD/HBL	41	0.0717	0.00120	28	0.0716	0.00110	24	0.0724	0.00117
LPF/HBL	41	0.0531	0.00073	28	0.0530	0.00069	24	0.0526	0.00067
LTB/HBL	41	0.0704	0.00283	28	0.0724	0.00140	24	0.0762	0.00127
WTB/HBL	41	0.0528	0.00088	28	0.0524	0.00096	24	0.0534	0.00085
UCH/HBL	41	0.0381	0.00030	28	0.0381	0.00026	24	0.0397	0.00034
LCH/HBL	41	0.0370	0.00049	28	0.0369	0.00047	24	0.0384	0.00059
HS/HBL	41	0.0992	0.00219	28	0.0990	0.00207	24	0.1050	0.00267
WR/HBL	41	0.0357	0.00042	28	0.0356	0.00037	24	0.0374	0.00145
LM/HBL	41	0.1264	0.00258	28	0.1261	0.00242	24	0.1279	0.00333
AMD/HBL	41	0.0175	0.00019	28	0.0176	0.00017	24	0.0176	0.00015
DO/HBL	41	0.0907	0.00051	28	0.0906	0.00048	24	0.0928	0.00167
PW/HBL	41	0.0452	0.00055	28	0.0451	0.00044	24	0.0455	0.00050

Chabahar is greater than that the two others. There is no significant difference for HBL between populations of Sistan and Torbat-e-Jam but there is significant difference in HBL between Chabahar population and two others. This shows that average body length increase toward Chabahar population (Fig. 5).

Due to body length of specimens has a direct effect on data, ratio of measured characters to head and body length were calculated to obtain scientific results (Table 2). In this step, ratio of characters to head and

body length were compared by one-way ANOVA and Duncan tests between 3 populations. The results show that there are no significant differences for LW/HBL, TL/HBL and CL/HBL ratios. For AMD/HBL ratio, Sistan and Chabahar settle in one group and Sistan and Torbat-e-Jam settle in another group. This ratio increases from Torbat-e-Jam toward Sistan and Chabahar. Also, there are significant differences between Chabahar population and two others in 19 ratios: W/HBL, UCH/HBL, WTB/HBL, LTB/HBL, LD/HBL, CW/HBL,

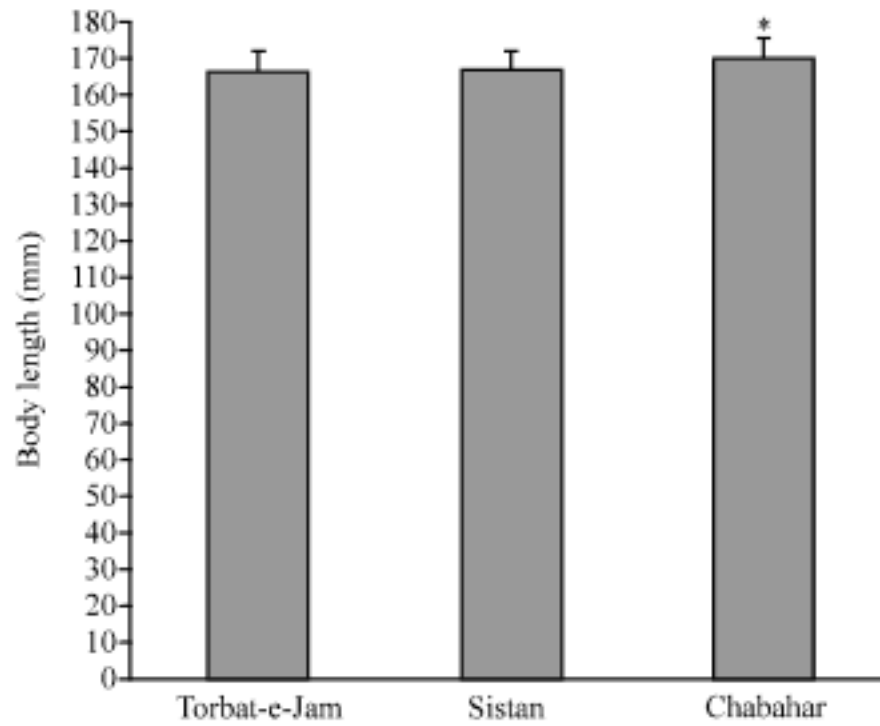


Fig. 5: Comparison of body length (mm) of Indian Gerbils in 3 populations analyzed by one-way ANOVA followed by a Duncan test. The average body of population in Chabahar is greater than the two others. There is no significant difference for HBL between populations of Sistan and Torbat-e-Jam but there is significant difference in HBL between Chabahar population and two others. This shows that average body length increase toward Chabahar population. Average plus standard deviation from three independent sets of experiments are expressed (* $p < 0.05$)

ZW/HBL, OL/HBL, EL/HBL, DO/HBL, PW/HBL, LM/HBL, WR/HBL, HS/HBL and LCH/HBL with decreasing trend toward Sistan and Torbat-e-Jam and ratios: LPF/HBL, LN/HBL and HFL/HBL with increasing trend toward Sistan and Torbat-e-Jam (Fig. 6, 7).

We expected to see equal ratios in division of size characters to head and body length between 3 populations, but it was not so and body of Indian Gerbils of Chabahar were rather larger than those of Sistan and Torbat-e-Jam specimens. Therefore, there are morphometric differences between these 3 populations.

In comparison with the results of Geno Biosphere Reserve in South of Iran (Ashrafzadeh *et al.*, 2007), these results show that bodies average of Chabahar specimens are greater, but populations of Torbat-e-Jam and Sistan are equal or smaller than Geno Biosphere Reserve. Meanwhile, these results compare with similar report (Yigit *et al.*, 2001) shows that specimens of Turkey are greater than hunted specimens from Iran for head and body length.

This study was done in Eastern border of Iran in an equal longitude but different latitudes. As it is apparent, latitude has a large effect on temperature and climate conditions, so that sun radiation angle increases and

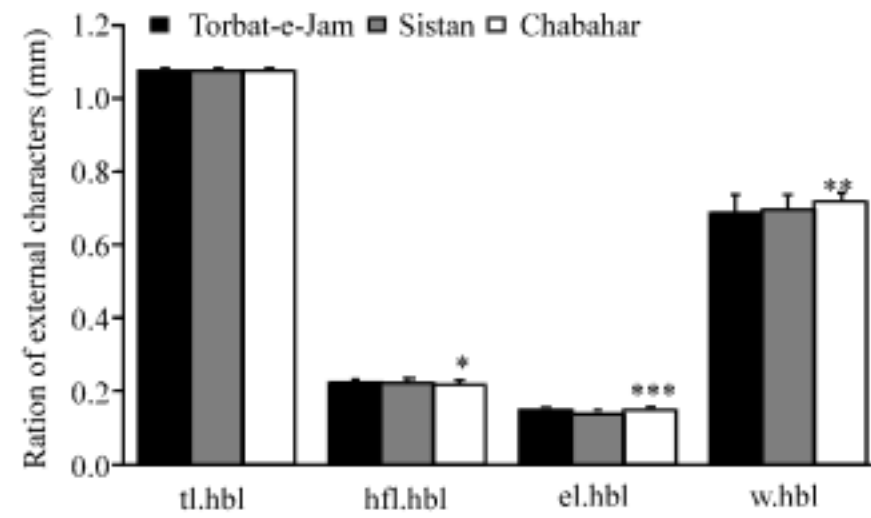


Fig. 6: Comparison of ratio of External characters (mm) of Indian Gerbils in 3 populations analyzed by one-way ANOVA followed by a Duncan test. There are significant differences between Chabahar population and two others in ratio of external characters. There is no significant difference for TL/HBL ratio but there are significant differences between Chabahar population and two others ratio of W/HBL and EL/HBL with decreasing trend toward Sistan and Torbat-e-Jam and ratio of HFL/HBL with increasing trend toward Sistan and Torbat-e-Jam. Average plus standard deviation from three independent sets of experiments are expressed (* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$)

temperature decreases by increment of latitude. When we go toward Sistan and Torbat-e-Jam from Chabahar, latitude will increase by 5 degrees. Higher temperature and inadequacy of surface water in Chabahar have produces dry climate, so plant density is low. Also, in Torbat-e-Jam, temperature decrement and plant diversity is higher than Sistan. Therefore, there are apparent differences in plant densities, climates and heights of these 3 localities, which is important for our discussion and conclusion.

While studying habitats of these 3 populations, we observed that there are flat plains between Torbat-e-Jam and Sistan, which is related to these two populations. So, there are more morphological and morphometric similarities between them. But, Chabahar has a characteristic that distinguishes it from the others. One of them is Taftan's mountains which are tall and long that separated Southern populations from Sistan and Torbat-e-Jam regions. From the other hand, special climate of Chabahar has opposed limitations for dispersal of animals, so that this place has weak plant density and low surface waters even if it is adjacent to sea. Rather, relative moisture is high so that some plants supply their required water from this moisture. Thus, there are apparent differences in morphometric characters of these localities. Many factors affect on this matter including

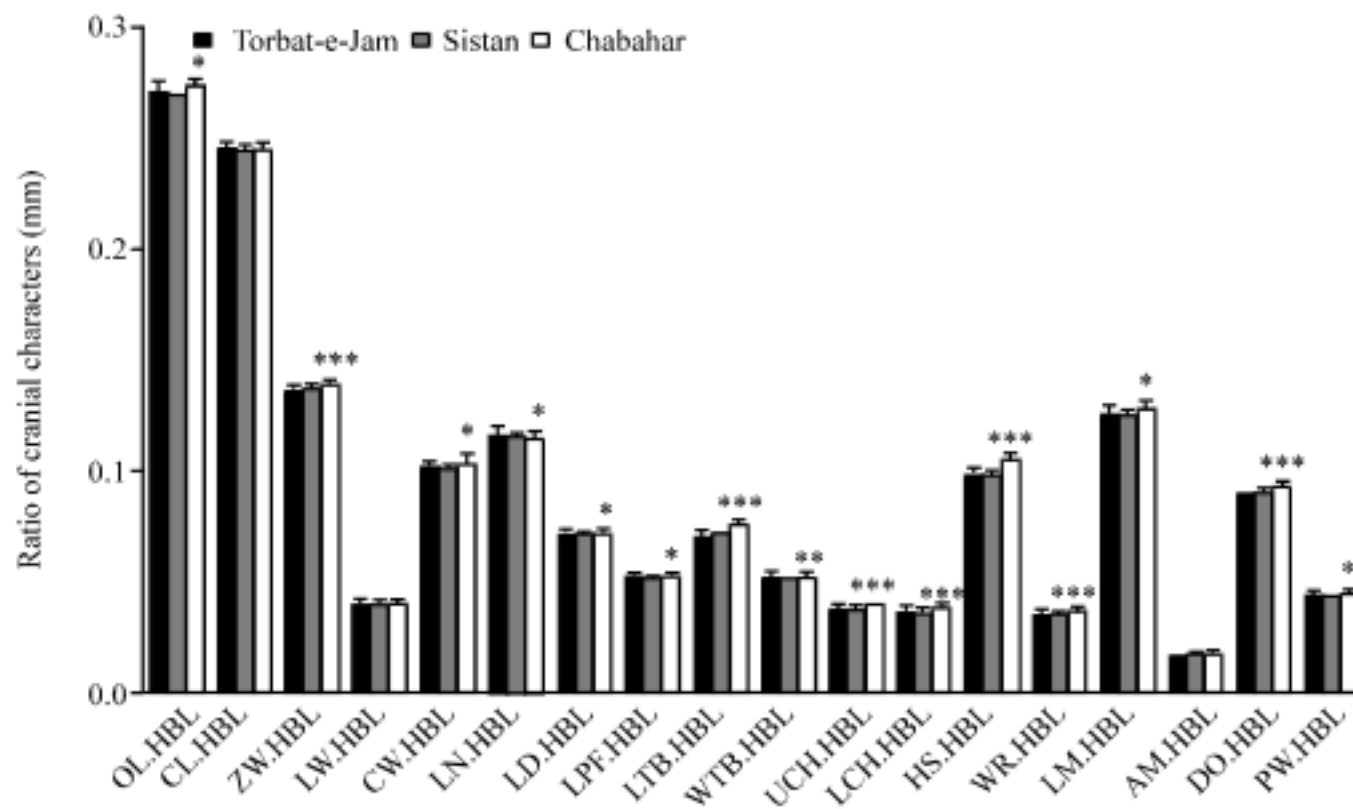


Fig. 7: Comparison of ration of cranial characters (mm) of Indian Gerbils in 3 populations analyzed by one-way ANOVA followed by a Duncan test. There are significant differences between Chabahar population and two others in ratio of cranial characters. There are no significant differences for LW/HBL and CL/HBL ratios but there are significant differences between Chabahar population and two others ratio of UCH/HBL, WTB/HBL, LTB/HBL, LD/HBL, CW/HBL, ZW/HBL, OL/HBL, DO/HBL, PW/HBL, LM/HBL, WR/HBL, HS/HBL and LCH/HBL with decreasing trend toward Sistan and Torbat-e-Jam and ratio of LPF/HBL, LN/HBL and HFL/HBL with increasing trend toward Sistan and Torbat-e-Jam. Average plus standard deviation from three independent sets of experiments are expressed (* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$)

different diets, various hunters and special climates (Kerley and Whitford, 1994; Michaux *et al.*, 2006; Mumtaz, 1989; Rana *et al.*, 1970; Shenbrot *et al.*, 1999; Kumar and Khan, 1977).

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