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Morphological Variation in the Gerbils Inhabiting the Indian Desert

[With 7 Tables]

The paper deals with a comparison of external body parts and cranial measurements of two Gerbils, *Gerbillus gleadowi* Murray, 1886 and *G. nanus indus* (Thomas, 1920) collected from various localities in the Indian desert. Inter-population comparisons have been made. Male *G. gleadowi* are found to be larger than females in all the populations. *G. gleadowi* collected at Jhunjhunu, receiving highest amount of precipitation (430 mm) are largest in head and body size and those from Sind (91 mm) are smallest. However, the tail and ear lengths of gerbils from localities bear an inverse relationship with the aridity index. Various body parts take a midposition in gerbils collected from Bikaner (291 mm). The data presented suggests that body size of the same species decreases with the increasing aridity, whereas tail and ear lengths increase with the increasing aridity. The various external body parts and cranial measurements in male and female *G. n. indus* do not differ significantly. The tail, hind foot and ear lengths in the Sind specimens are significantly larger than those of the Rajasthan material.

I. INTRODUCTION

A comparison was made of external body parts and cranial measurements in two population of the Indian Gerbil, *Tatera indica indica* Hardwicke, 1807 inhabiting different types of habitats in the Indian desert (Rana *et al.*, 1970). This communication reports a similar study on the Hairy-footed Gerbil, *Gerbillus gleadowi* Murray, 1886 and the Little Indian Gerbil, *Gerbillus nanus indus* (Thomas, 1920)¹. These are the only species in the genus *Gerbillus* which are represented in the northwestern region of India. *G. nanus* is distributed from Sahara to India but the subspecies *indus* is endemic to the Sindo-Rajasthani desert. The species *G. gleadowi* is also restricted to the »Great Indian

¹ Ellerman (1961) considers the subspecies *indus* under the species *G. dasyurus* but we have followed Petter (1961) in placing it under *G. nanus*.

Desert«. Both the gerbils inhabit sandy habitat but *G. gleadowi* prefers sand dunes (Prakash *et al.*, 1971). It also inhabits the low rainfall arid region in the western parts of Jaisalmer district (Prakash & Rana, 1973) but *G. n. indus* does not inhabit this tract. In the sandy habitat of the Rajasthan desert, *G. n. indus* are not very common and form only 4.1 per cent of the rodent population whereas *G. gleadowi* is fairly abundant and constitute 16.6 per cent (Prakash *et al.*, 1971).

II. MATERIAL AND METHODS

The gerbils were snap trapped from natural pastures spread on hummocky sandy habitat in the desert biome of Rajasthan. As the number of *G. n. indus* collected from various localities (Bikaner, Jaisalmer, Jodhpur and Maulasar) was not enough, we have pooled the recorded data and compared with that from Sind (Pakistan) as evaluated by Ellerman (1961). Measurements of *G. gleadowi* are presented in respect of specimens collected at Bikaner (28°0' N, 73°—17'E) and Jhunjhunu (28°0' N, 75°—17'E) and their measurements are compared with those of Sind specimens (Ellerman, 1961). We had to keep the number of specimens in Bikaner and Jhunjhunu samples more or less equal to that of Sind for assuring a well distributed comparison. All methods and statistical treatments are according to our earlier paper (Rana *et al.*, 1970).

The following abbreviations are used in the text: *M* = male, *F* = female, *HB* = head and body, *T* = tail, *HF* = hind foot, *E* = ear, *SE* = standard error, $SDP = \text{sexual dimorphism percentage} = \frac{\text{Mean value of male}}{\text{Mean value of female}} - 1 (100)$, *N* = number of individuals, *t* = * = significant at 5 per cent level of probability, ** = significant at 1 per cent level of probability.

III. RESULTS AND DISCUSSION

A. *Gerbillus gleadowi* Murray, 1886

1. Differences between Sexes

In the Jhunjhunu sample all the standard body parts of male gerbils, except ear, are significantly larger ($P < .05$) than those of females (Table 1). In the Sind population also, males are larger in respect of all body measurements but the difference is significant ($P < .01$) in case of head and body length only. The Hairy-footed male gerbils at Bikaner are, on an average larger than their counterparts in respect of tail and hind foot length only and none of the characters between sexes differ significantly (Table 1). The *SDP* values also confirm these observations (Table 2). It is interesting that the sexual dimorphism is much more pronounced in respect of almost all body measurements (*SDP* range from -8 to -4) in the Jhunjhunu population as compared to those of Bikaner (*SDP* range from -4 to +1) and Sind populations (*SDP* range from -7 to -2, Table 2).

Table 1

Comparison of mean values (\pm SE) of external body parts (mm) of *Gerbillus gleadowi* from three population.

Body parts	Bikaner population		Jhunjhunu population		Sind population (Ellerman, 1961)	
	M (N=6)	F (N=8)	M (N=6)	F (N=3)	M (N=8)	F (N=6)
Head & body	85.50 \pm 1.54	86.20 \pm 2.00	90.16 \pm 1.50	83.00 \pm 3.12	83.00 \pm 2.03	77.33 \pm 0.95
Tail	128.00 \pm 1.25	127.00 \pm 5.00	130.00 \pm 2.77	121.66 \pm 6.00	133.25 \pm 2.60	131.60 \pm 0.25
Hind foot	27.50 \pm 0.22	26.58 \pm 0.21	28.66 \pm 0.60	26.66 \pm 1.66	27.00 \pm 0.75	26.50 \pm 0.45
Ear	11.37 \pm 0.65	11.50 \pm 0.29	10.50 \pm 0.20	10.16 \pm 1.00	12.37 \pm 1.28	12.00 \pm 0.23

Table 2

Comparison of sexual dimorphism percentage in external body parts and cranial characters for three populations of *Gerbillus gleadowi*.

Measurement	Bikaner (N=14)	Jhunjhunu (N=9)	Sind (N=14)
Head and body	0.00	-8.00	-7.00
Tail	-1.00	-7.00	-2.00
Hind foot	-4.00	-4.00	-2.00
Ear	+1.00	-7.00	-3.00
Occipitopremaxillar length	-4.00	0.00	
Condylbasal length	-4.00	-4.00	
Occipitonasal length	-2.00	-5.00	-2.00
Zygomatic width	0.00	-3.00	
Inter-orbital width	-8.00	-15.00	
Cranial width	-3.00	-5.00	
Occipital breadth	0.00	-3.00	
Mean depth of occiput	-4.00	-17.00	
Post molar length	-8.00	-5.00	
Auditory length	-2.00	-5.00	
Length of tympanic bulla	+2.00	-12.00	-2.00
Breadth of tympanic bulla	-2.00	-11.00	
Length of nasals	+4.00	+1.00	-1.00
Combined width of nasals	-9.00	+6.00	
Palatal length	-4.00	-4.00	-2.00
Length of diastema	-5.00	-5.00	
Length of interior palatine foramina	+4.00	-4.00	-3.00
Combined width of palatine foramina	-8.00	-10.00	
Length of upper molars	0.00	-9.00	-3.00
Length of lower molars	-6.00	-10.00	
Mandibular length	-2.00	-6.00	

Likewise, the skull of male gerbils are larger in respect of most of the measurements than those of female in all the three populations (Table 3). However, these differences reach level of significance in respect of the post-molar length in the gerbils of Bikaner ($P < .01$), and Cb. length ($P < .01$); occipitonasal length ($P < .05$), breadth of tympanic bulla ($P < .01$) and length of lower molars ($P < .01$) in the gerbils of the Jhunjhunu population (Table 3).

Table 3
Comparison of cranial characters (mm) of *Gerbillus gleadowi* of three populations.

Characters	Bikaner population		Jhunjhunu population		Sind population (Ellerman, 1961)	
	M (N=6)	F (N=8)	M (N=6)	F (N=8)	M (N=8)	F (N=6)
Occipitopremaxillar length	27.16±0.48	26.25±0.75	28.66±7.5	28.83±1.84		
Condylbasal length	26.60±0.48	25.56±0.75	28.75±0.58	27.66±0.80		
Occipitonasal length	28.00±0.29	27.62±0.35	30.25±0.58	28.83±0.70	28.71±0.33	28.22±0.30
Zygomastic width	12.25±0.41	12.31±0.30	13.75±0.54	13.33±0.46		
Interorbital width	6.25±0.30	5.81±0.25	6.25±0.30	5.33±0.60		
Cranial width	14.41±0.30	14.12±0.13	14.91±0.37	14.33±0.29		
Occipital breadth	12.83±0.41	12.87±0.41	13.50±0.35	13.16±0.33		
Mean depth of occiput	4.00±0.18	3.87±0.25	4.33±0.24	3.66±0.32		
Post molar length	12.50±0.18	11.50±0.32	12.66±0.50	12.00±0.16		
Auditory length	10.83±0.32	10.68±0.35	11.33±0.35	10.83±0.40		
Length of tympanic bulla	8.83±0.30	9.06±0.30	10.25±0.34	9.00±0.28	13.94±0.28	13.78±0.46
Breadth of tympanic bulla	5.66±0.32	5.56±0.33	5.91±0.20	5.33±0.19		
Length of nasals	10.73±0.34	11.18±0.39	11.33±0.37	11.50±0.33	10.70±0.16	10.62±0.28
Combined width of nasals	3.56±0.29	3.25±0.17	3.16±0.20	3.33±0.16		
Palatal length	12.00±0.29	11.62±0.30	12.08±0.50	11.66±0.50	13.94±0.30	13.78±0.46
Length of diastema	6.73±0.31	6.43±0.23	6.91±0.42	6.66±0.33		
Length of anterior palatine foramina	5.08±0.38	5.31±0.22	5.75±0.32	5.50±0.16	8.62±0.17	8.42±0.22
Combined width of anterior palatine foramina	3.50±0.18	3.25±0.20	3.33±0.34	3.00±0.0		
Length of upper molars	4.58±0.30	4.62±0.15	4.75±0.25	4.33±0.18	3.75±0.14	3.65±0.20
Length of lower molars	3.91±0.15	3.68±0.25	4.41±0.19	4.00±0.0		
Mandibular length	13.66±0.58	13.50±0.27	15.08±0.58	14.16±0.50		

It was observed that *SDP* within a population is of a greater magnitude in the Jhunjhunu sample (from -17 to +6) as compared to those of Bikaner (from -9 to +4) and Sind (-3 to -1) samples (Table 2).

2. Differences between the Three Populations

The body size of male gerbils in the Jhunjhunu population is larger than that of males of Bikaner ($P < .05$) and Sind ($P < .05$). Females of Jhunjhunu and Bikaner populations are also larger in body size than the females of Sind but significant difference ($P < .01$) occurred between females of Bikaner and Sind population only. Contrary to the smallest body size, the Sind gerbils possess longest tail. However, this difference reached a level of significance only between the females of Jhunjhunu and Bikaner populations. Little variation is found in the hind foot size of female gerbils in all the three population but that of males of Jhunjhunu and

Table 4

Relationship between body size (mm, average of both the sexes), aridity and annual average rainfall (mm) in *G. leadowi* from different populations.

Character	Sind	Bikaner	Jhunjhunu
Head and body	80.1	85.8	86.5
Tail	132.5	127.5	125.8
Hind foot	26.7	27.0	27.6
Ear	12.1	11.4	10.3
Aridity index	-94	-79	-73
Annual rainfall	91.4	291.3	430.5

Sind populations differed significantly ($P < .05$), the measurements from Sind population being less. Contrarily the ear of the Sind *G. leadowi* is longer than those of the other populations and the difference is significant in both the sexes of rodents from Jhunjhunu and Sind populations.

The comparison of the various body parts of the rodents from the three localities indicate that the *G. leadowi* inhabiting Sind are smallest in body size but possess longer tail and ear whereas, the gerbils inhabiting Jhunjhunu are largest in body size with smallest tail and ear, and the measurements of Bikaner population occupy a middle position (Table 4). If these figures are correlated to the xeric conditions existing in the three localities a trend in the evolutionary process is visualised.

Sind receive minimum rainfall and is the most arid out of the three localities, aridity index² being -94. Jhunjhunu receives about 430.5 mm

² Water deficiency as a percentage of water need (Krishnan, pers. comm.).

rainfall and is the most wet locality out of the three and Bikaner holds a mid position in respect of annual amount of precipitation and aridity index (Table 4). Bodenheimer (1957) has stated that the increase of desertic conditions runs parallel to smaller size of animals and quoted that the Arabian oryx is smaller than the *Oryx* species inhabiting the African savannah and *Gazella leptoceros* of the Central Sahara is smaller than the gazelles living on the fringes of the desert. This observation is well quantified by the data presented in Table 1 and summarised in Table 4. It is clear that head and body length decreases with an increase in the aridity index. This analogy is not, however, true for the tail and ear lengths since these parts are involved in locomotory and sensory adaptations to xeric environments. In more arid environment, as that of Sind, the gerbils are expected to have modifications in the hind extremity like true jumpers. To examine this aspect, we measured the tibio-fibular length of *G. leadowi* from two populations, one from Dhanana, only few kilometres away from Sind, which receives an annual precipitation of about 75 mm, and the other from Jhunjhunu. The tibio-fibular length of rodents from the former locality averages to 30.4 mm and 27.4 mm from the latter which is relatively less desertic. It is, therefore, indicated that *G. leadowi* inhabiting more xeric environment are superior in adaptation for jumping than those occurring in relatively wet locality. For jumping rodents the tail increases in importance, becoming a real »fifth leg« (Bodenheimer, 1957). Our data on tail length of *G. leadowi* agree with this conjecture and hence a longer tail in the rodents inhabiting drier parts (Sind) of the desert. The tail length increases with the decreasing aridity.

It is a well known observation that rodents, hedgehogs, hares, kit fox and fennec inhabiting various deserts possess large ears (Bodenheimer, 1957; Schmidt — Nielsen, 1964). The data on ear length of *G. leadowi* further points out that the ear length increases with an increase in aridity. The ear length in the gerbil population from Sind is maximum, whereas minimum at Jhunjhunu. Its role in sensory perception is discussed further in respect of the hypertrophy of tympanic bullae.

Most of the cranial measurements of male and female gerbils in the Jhunjhunu population are larger than those of the Bikaner population but significant differences occurred only in respect of condylobasal length, occipitonasal length, zygomatic width, lengths of tympanic bulla and lower molars in the males and the combined width of anterior palatine foramina and the length of lower molars in females. The measurements of skull, available for the Sind locality, show significant differences when compared with that of the Rajasthan populations. The palatal

length, length of anterior palatine foramina and length of tympanic bulla in the Sind gerbils in both the sexes are significantly longer than those of Jhunjhunu and Bikaner populations (Table 3), although there is not much difference in the total length of gerbil skulls of various populations. Unfortunately, Ellerman (1961) did not include the auditory length and breadth of tympanic bulla in the measurements given by him and, therefore, it is hard to fully discuss the phenomenon of hypertrophy of

Table 5

Comparison of the mean values (\pm SE) of external body parts (mm) of *Gerbillus nanus indus* from Rajasthan and Sind.

Body parts	Rajasthan population		Sind population	
	Males (N=5)	Females (N=10)	Males (N=7)	Females (N=7)
Head and body	67.20 \pm 2.48	66.70 \pm 1.79	70.57 \pm 2.20	75.00 \pm 1.62
Tail	86.75 \pm 3.81	87.80 \pm 2.43	111.00 \pm 4.06	118.28 \pm 5.06
Hind foot	18.00 \pm 1.27	18.50 \pm 0.91	20.21 \pm 0.39	20.28 \pm 0.26
Ear	9.33 \pm 0.41	9.05 \pm 0.49	11.14 \pm 1.29	10.85 \pm 0.43

Table 6

Comparison of sexual dimorphism percentage in external body parts and cranial parts of Rajasthan and Sind populations of *G. nanus indus*.

Characteres	Sind (N=14)	Rajasthan (N=15)
Head and body	+6.0	-1.0
Tail	+6.0	+1.0
Hind foot	0.0	+2.0
Ear	-3.0	-3.0
Occipito-premaxillar length		+2.0
Condylbasal length		0.0
Occipitonasal length		-1.0
Zygomatic width		-7.0
Inter-orbital width		0.0
Cranial width		-2.0
Occipital breadth		-4.0
Mean depth of occiput		-9.0
Post molar length		-5.0
Auditory length		+7.0
Length of tympanic bulla		+4.0
Breadth of tympanic bulla		+8.0
Length of nasals		+3.0
Combined width of nasals		+16.0
Palatal length		-3.0
Length of diastema		+1.0
Length of anterior palatine foramina		+15.0
Combined width of palatine foramina		-5.0
Length of upper molars		-2.0
Length of lower molars		0.0
Mandibular length		-4.0

tympanic bulla; yet it is clearly indicated that hypertrophy of this important structure for sensory perception in desert animals has a direct relationship with the aridity. Sind is comparatively more arid than Rajasthan and the Sind sample of gerbils possess a significantly longer ($P < 0.01$) tympanic bulla than that of Rajasthan sample. Why the palate in Sind gerbils is longer than the others is not clear, may be it is due to their having a significantly shorter tooth row (Table 3).

B. *Gerbillus nanus indus* (Thomas, 1920)

1. Differences between Sexes

No significant differences between sexes occur in respect of the standard body measurements of *G. n. indus* from Rajasthan and Sind populations.

Table 7

Comparison of cranial characters of *Gerbillus nanus indus* for Rajasthan and Sind populations. Averages and SE in mm are given.

Cranial characters	Rajasthan population		Sind population
	Males (N=5)	Females (N=4)	Males (N=3)
Occipito-premaxillar length	21.50±0.48	22.12±0.12	
Condylbasal length	20.70±0.53	20.87±0.74	
Occipitonasal length	22.70±0.43	22.66±1.19	25.33±0.24 (27.4)
Zygomatic width	10.90±0.36	10.16±0.94	
Inter-orbital width	4.50	4.50±0.45	
Cranial width	11.80±0.12	11.62±0.44	
Occipital breadth	10.90±0.18	10.50±0.40	
Mean depth of occiput	3.40±0.09	3.12±0.14	
Post molar length	10.20±0.25	9.75±0.43	
Auditory length	8.50±0.15	9.12±0.39	
Length of tympanic bulla	6.82±0.60	7.12±0.52	7.30±0.35 (7.9)
Breadth of tympanic bulla	4.50±0.22	4.87±0.25	
Length of nasals	8.50±0.38	8.83±0.67	9.10±0.24
Combined width of nasals	2.00	2.33±0.17	
Palatal length	9.50±0.20	9.25±0.47	12.40±0.21 (13.6)
Length of diastema	5.40±0.18	5.50±0.28	
Length of anterior palatine foramina	3.90±0.18	4.50±0.20	4.20±0.08
Combined width of palatine foramina	1.70±0.24	1.62±0.23	
Length of upper molars	3.80±0.24	3.75±0.43	3.23±0.10 (3.2)
Length of lower molars	3.50	3.50±0.35	
Mandibular length	11.40±0.48	11.00±1.83	

Figures in parentheses indicate the respective value for single female gerbil from Sind population.

ions (Table 5), although the Sind females are slightly larger than their counterparts in respect of head and body, and tail lengths (Table 6). The range of SDP values in respect of various body parts of the little gerbils of Rajasthan is very small, suggesting that the size of male and female animals is almost similar.

A comparison of various cranial characters of the two sexes (Table 7) show that the length of cranium and the occipital region, the palate and the mandible of male little gerbils is of larger size as compared to their counterparts, whereas the auditory region, nasals, anterior palatine foramina are larger in females. The differences are, however, not statistically different (Table 7).

2. Differences between the Two Populations

The little gerbils of Sind are larger in respect of all the standard body measurements and the differences are significant ($P < .01$) in respect of tail, hind foot and ear lengths in both the sexes (Table 1). These significant differences are logical in the light of discussion on the relationship of body size and varying aridity. Contrary to the thinking that the smaller size of mammals run parallel to the increase of aridity, the head and body length of little gerbils of Sind is more than those of Rajasthan and, therefore, the above conjecture is not well explained with regard to *G. n. indus*. A comparison of a large number of animals from more localities representing various aridity zones is very much desirable.

Among cranial characters, the occipitonasal and palatal lengths of male Sind gerbils are significantly ($P < .01$) longer than that of the Rajasthan sample. On an overall evaluation, other cranial measurements of the Sind sample are also slightly bigger than that of Rajasthan but the differences do not reach the level of significance.

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MORFOLOGICZNA ZMIENNOŚĆ PRZEDSTAWICIELI RODZAJU *GERBILLUS*
Z PUSTYNI INDYJSKIEJ

Streszczenie

Dokonano porównania wymiarów ciała i czaszki u dwóch gatunków gryzoni — *Gerbillus gleadowi* Murray, 1886 i *Gerbillus nanus indus* (Thomas, 1920) łowionych w różnych częściach pustyni indyjskiej (Pustynia Thar), co pozwoliło na dokonanie porównań pomiędzy populacjami. Samce *G. gleadowi* są większe niż samice tego gatunku (Tabela 2). *G. gleadowi* pochodzące z Jhunjhunu, gdzie ilość opadów (430 mm) jest największa wykazują najwyższe wskaźniki wielkości ciała, natomiast osobniki z Sind (91 mm opadów) są najmniejsze (Tabela 3, 4). Wskaźnik długości ogona i ucha wykazuje odwrotną zależność (Tabela 1). Populacja z Bikaner (291 mm opadów) zachowuje we wszystkich wartościach pozycję pośrednią. Przedstawione dane wskazują, że wielkość ciała ulega znizeniu przy zmniejszeniu ilości opadów. Długość ogona i ucha wykazuje zależność odwrotną (Tabela 4).

Natomiast większość wymiarów ciała i czaszki u *G. n. indus* z różnych populacji nie różni się w sposób istotny (Tabela 6, 7). Długość ogona, stopy i ucha jest jednak u osobników z populacji łowionej w Sind istotnie wyższa niż u przedstawicieli populacji z Rajasthan (Tabela 5).