Rec. zool. Surv. India, 79 : 521-530, 1982

INTRASPECIFIC GEOGRAPHICAL VARIATIONS IN THE INDIAN BUSH RAT, *GOLUNDA ELLIOTI* J. E. GRAY [RODENTIA : MURIDAE]

By

V. C. AGRAWAL AND S. CHAKRABORTY

Zoological Survey of India, Calcutta

(With 4 Text-figures)

The Indian Bush Rat, *Golunda ellioti*, was first described by J. E. Gray (1837) and was accommodated in a new genus *Golunda*, having an unusual dentition (upper incisors broad and prominently grooved, cusps of upper molars peculiarly enlarged and raised up, and third upper molar large and lacking the outer row of cusps). Subsequently, a number of species of the Bush Rat, namely, *Mus hirsutus* Elliot, 1839, *Mus myothrix* Hodgson, 1845, *Golunda coffaeus* Kelaart, 1850, *Golunda nuwara* Kelaart, 1850, and *Pelomys watsoni* Blanford, 1876, were described from the Indian subregion. Wroughton (1920) recognized only three species under the genus *Golunda*, namely, *ellioti*, *nuwara* and *watsoni* and synonymized *coffaeus* and *myothrix* with the nominate subspecies. Thomas (1923) maintained only one species, *G. ellioti*, under this genus and treated all others as its subspecies. In addition, he (loc. cit.) erected six new subspecies, namely, *bombax*, *coraginis*, *gujerati paupera*, *coenosa* and *limitarius* from different regions of India. But both Wroughton (1920) and Thomas (1923) did not mention any thing about the status of *Mus hirsutus*. Ellerman (1941) maintained all the above eleven subspecies and treated *hirsutus* as a synonym of the nominate one. Later, he (1947) stated that "all the named forms of this species are very similar to each other, and it becomes largely a matter of personal preference whether it is worth while dividing this species into subspecies at all", and provisionally maintained seven of them, synonymizing *coffaeus*, *bombax* and *coraginis* with the nominate subspecies and *limitarius* with *watsoni*. Ellerman (1963) retained all the seven subspecies recognized earlier by him with the remark that most of the colour characters mentioned by Thomas (1923) for subspecific differentiation are nothing but individual or seasonal variations, and apart from the subspecies *nuwara*, others retained are most doubtful and might well be placed in synonymy of the nominate form. Hence, it was felt necessary to study in detail the intraspecific variations in the Indian Bush Rats from different geographical areas. For this purpose, a good

number of specimens from different parts of India, Pakistan and Sri Lanka present in the Zoological Survey of India and the Bombay Natural History Society were studied. The data provided by Ellerman (1963) were also taken into consideration. The results of our study are summarized in this paper.

All measurements are in millimetres and have been taken after Ellerman (1963). The body and cranial measurements of about 250 specimens belonging to different populations were statistically analysed. The measurement of type-specimens, wherever available, have been taken into consideration. Population range diagrams (Text-figs. 1-4) for different external and cranial measurements have been prepared according to the methods of Dice and Leraas (1936) and Hubbs and Perlmutter (1942). The length of each ordinate represents the extremes of each set of measurements and a central crossbar the mean ; a narrow shaded rectangle represents a distance equal to one standard deviation from the mean on either side of the mean, while the broad rectangle represents a distance equal to twice the standard error of the mean on either side of the mean. The colours given with initial capital letters in the text are after Ridgway (1886).

Observation

Nature of fur : Body covered with thick fur ; its texture varies with age, altitude and season. Fur long and soft in winter specimens, while short, crisp and spiny in summer ones. Similarly, fur in juvenile specimens and in those of high altitude is softer than that of adults and of those belonging to plains, irrespective of the locality. Hair covering the tail generally short and coarse.

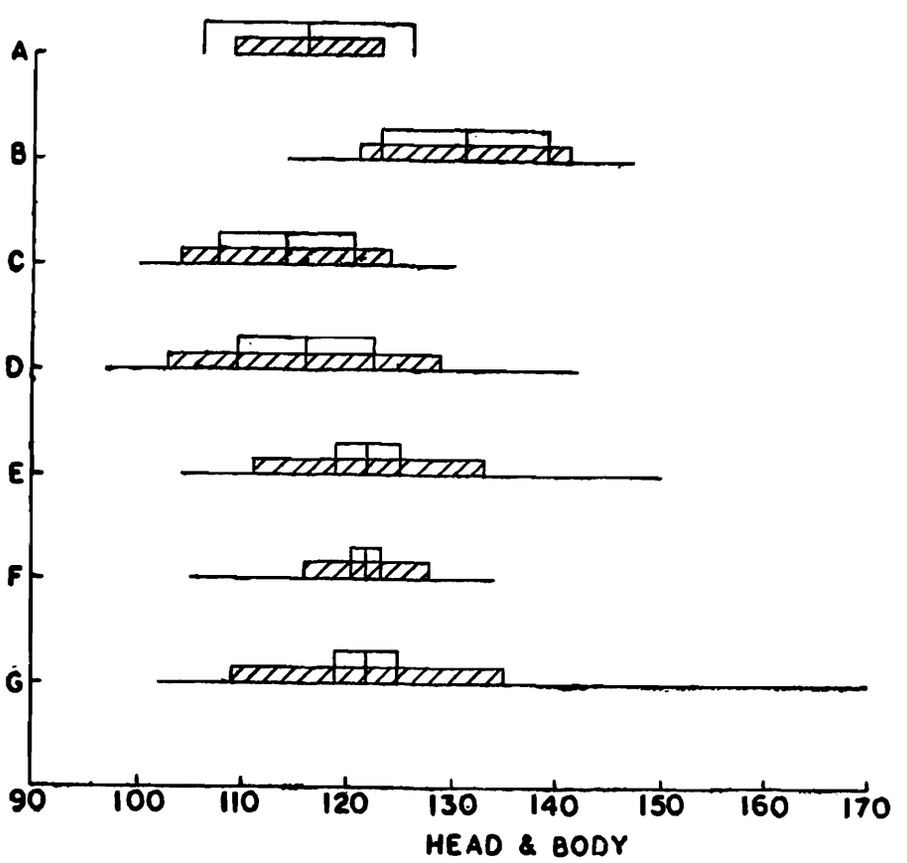
Colour : Dorsum ranging from greyish brown to black. Normally, hairs are of two types. One type of hair is slaty to Mouse Gray on the base, pale Ochraceous to pale yellow in the middle and Seal Brown at the tip. Another type of hair is slaty to Mouse Gray on the base and sandy to yellowish brown at the tip. It is the mixture of these yellow brown and Seal Brown-tipped hairs which give the dorsum a grizzled appearance and different shades of colour. In *nuwara* Seal Brown-tipped hairs dominate over sandy or yellowish brown ones, hence the mid-dorsum is blackish. In other populations, the pale yellow and Seal brown-tipped hairs are almost equally represented, hence the colour effect is light. However, there is a tendency of the dorsal colour being dark in populations of the humid north eastern India, and gradually becoming lighter in those of the relatively drier zone, *viz.* western India forming almost a cline.

Juvenile and subadult specimens are normally darker than the adults. Similarly, winter specimens are relatively darker than the summer ones. However, specimens in moulting phase appear blackish as their slaty underfur is exposed.

In many specimens, irrespective of sex, season and locality, small areas at the base of the ear, around the eyes and side of the nostrils are buff or brown in colour looking like a spot or ring. But these spots are variable and may or may not be present in all specimens of the same locality and season.

Venter : Ventral surface is white in *gujerati*. Hair may be white up to the base or the basal one-third may be gray and rest white (exceptions being two out of 42 specimens where ventral colour is greyish white). In *nuwara*, ventral colour is bluish grey. In populations other than *gujerati* and *nuwara*, hairs vary from grey to slaty for greater part of the basal region and the tip whitish, yellowish or brown, making the venter greyish in appearance, exceptions being six out of 124 specimens (two from Salt Range, one from Sind, two from Madhya Pradesh and one from Kumaon, Uttar Pradesh, all collected in summer) where the undersurface is almost white.

Colour of the hand and foot vary from dirty white to pale brown



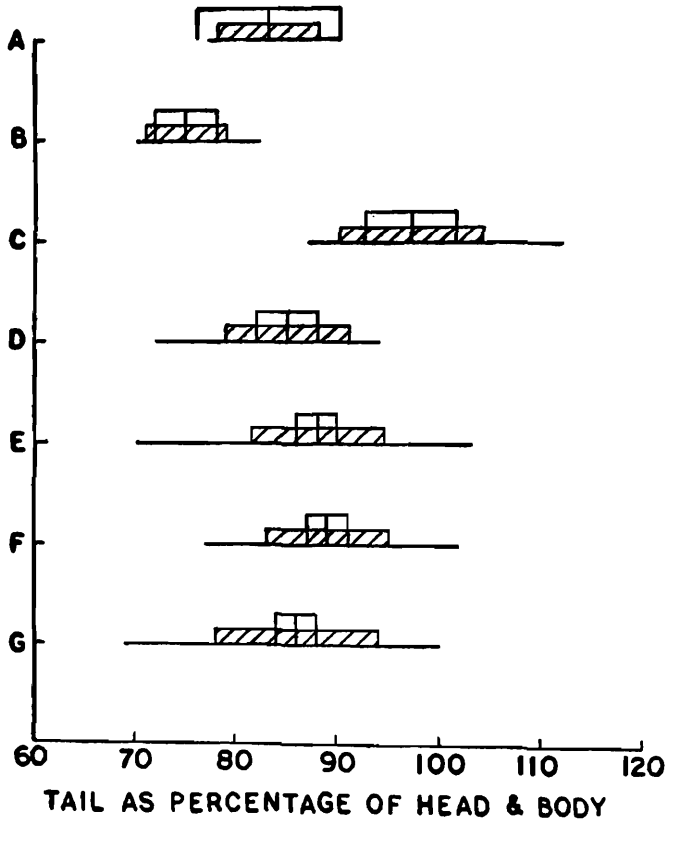
Text-fig. 1. Graphic comparison of head and body length (in mm) in seven populations of *Golunda ellioti* J. E. Gray. A, *paupera* ; B, *nuwara* ; C, *watsoni* ; D, *coenosa* ; E, *myothrix* ; F, *gujerati* ; G, *ellioti*.

or even darker, irrespective of the locality. But, in general, the hand tends to be lighter in colour than the foot.

Tail distinctly bicoloured, dark brown above and pale below.

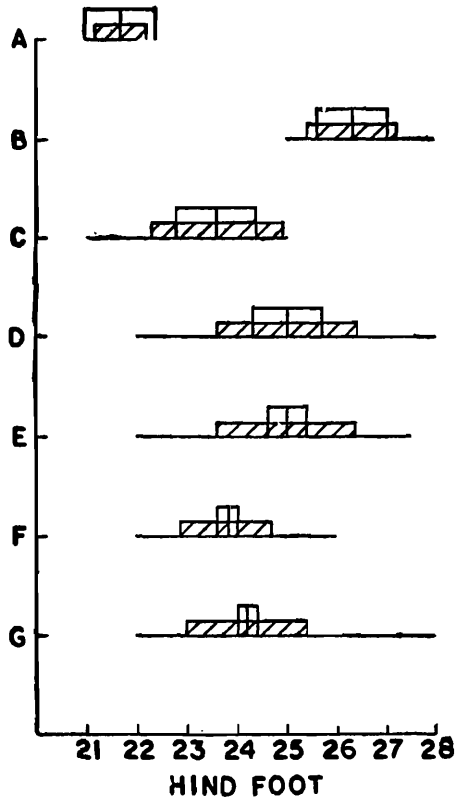
Size : Head and body length : Highly variable within the species, ranging from 97 to 170 mm. Although the population from Sind (*watsoni*) is, on an average, smaller than those of other areas, the difference is not significant (indicated by overlap of one standard deviation rectangle of comparable lines) (Text-fig. 1 & Table 1).

Tail-length : Length of tail, within the species, ranges from 84 to 131 mm and is generally smaller than the head and body. On an average, it is less than 100 mm in populations *coenosa*, *paupera* and *nuwara* and more than this in *ellioti*, *myothrix*, *watsoni* and *gujerati*. It is, on an average, greatest in *watsoni* and smallest in *nuwara*, both in absolute length as well as in relation to head and body. However, statistical analysis of the relative length of tail reveals that the populations from the range of *nuwara* are significantly smaller than those of *myothrix*, *watsoni*, *coenosa* and *gujerati*, whereas, of *watsoni* are significantly greater than those of *paupera* only (Text-fig. 2).



Text-fig. 2. Graphic comparison of length of tail as percentage of head and body length in seven populations of *Golunda ellioti* J. E. Gray.

Hindfoot : Length of hindfoot varies from 21 to 28 mm and is, on an average, greatest in specimens from the range of *nuwara* (26.3 mm) and smallest in those of *paupera* (21.7 mm). However, the former



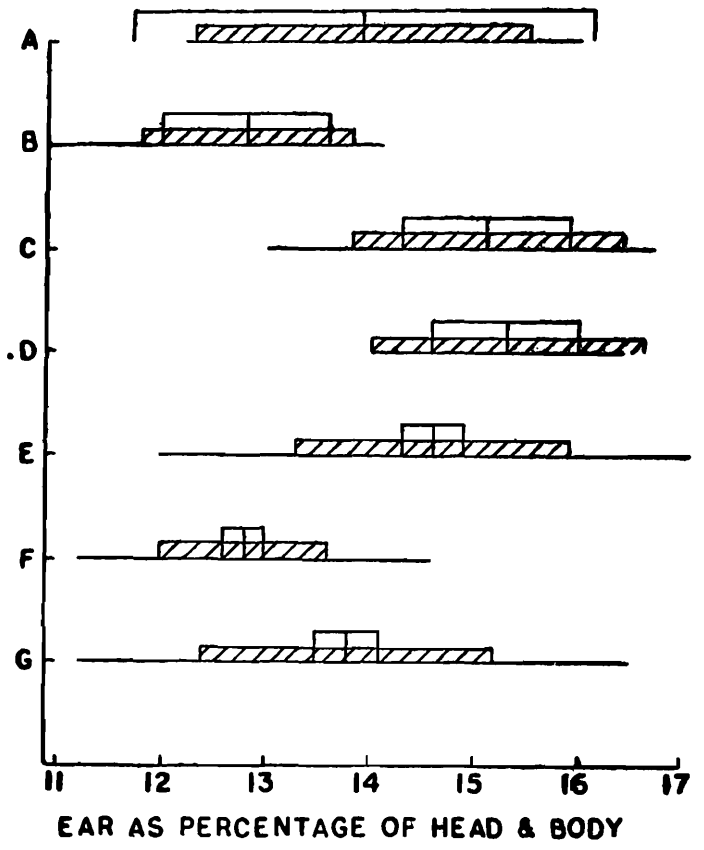
Text-fig. 3. Graphic comparision of length of hind foot (in mm) in seven populations of *Golunda ellioti* J. E. Gray.

population differs significantly from that of *ellioti*, *gujerati*, *paupera* and *watsoni*, whereas the latter differs from all except that of *watsoni*. (Text-fig 3).

Ear : Length of ear in relation to that of head and body is, on an average, greater in populations from the range of *watsoni*, *coenosa* and *myothrix* (more than 14.5% of head and body length) than those of *nuwara*, *paupera*, *ellioti* and *gujerati* (less than 14.5%). Although this difference between the two groups is of probable significance (indicated by nonoverlap of standard error rectangles of comparable lines), (Text-fig. 4) it does not hold good even at one standard deviation from the mean. Hence, it cannot be treated as a distinguishing character. However, *gujerati* may be differentiated from *watsoni* on this character.

Skull : The structure of skull has been dealt with in detail by Ellerman (1963). There is practically no variation in its structure at subspecific level except that in some specimens the zygomatic plate tends to be concave anteriorly.

Occipitonasal length varies from 28-35.2 mm. It is, on an average, longer in specimens from the ranges of *coenosa* and *watsoni* (more than



Text-fig. 4. Graphic comparison of length of ear as percentage of head and body length in seven populations of *Golunda ellioti* J. E. Gray.

32 mm) than those of others. Only one skull of *nuwara* available for examination has the upper molar toothrow 7.2 mm, which is longer than that in other populations.

Discussion

Thomas (1923) described a number of subspecies based on the body coloration and facial markings. Ellerman (1963) stated that "the various facemarkings, eyespots and noserings, and patch below ear, seem to be based on very little marked and individual characters rather than characters which have any importance for racial discrimination." Our observations support Ellerman's (1963) view.

There is no marked difference in the colour of dorsum in different populations of *Golunda ellioti* except in *nuwara* where it is definitely blackish. Ellerman (1963) differentiated the population from northern Uttar Pradesh and Himachal Pradesh (*myothrix*) from that of Bhutan Duars (*coenosa*), and the populations from Rajasthan and Gujarat (*gujerati*) from that of Western Ghats (*ellioti*) on the basis of lighter

TABLE 1. External measurements in different populations of *Golunda ellioti* J. E. Gray with Range, mean ± 2 standard error, sample size in parentheses.

Name of subspecies	Head & body	Length of tail	Tail as % of HB	Hindfoot	Hindfoot as % of HB	Ear as % of HB
G. e. ellioti	102-170	86-131	69-100	22-28	16.2-22.6	11.2-16.5
	122±2.8 (88)	104±2.5 (79)	86±2 (78)	24.2±0.25 (86)	20.1±0.35 (86)	13.8±0.3 (84)
G. e. paupera	106-123	95-98	77-90	21-22	17-20.7	12.2-16
	116±10 (3)	96±1.4 (3)	83±7 (3)	21.7±0.7 (3)	18.8±2 (3)	13.9±2.2 (3)
G. e. myothrix	104-150	86-129	70-103	22-27.5	17.2-23.8	12-17.1
	122±2.8 (62)	107±2.6 (55)	88±1.7 (55)	25±0.36 (61)	20.6±0.4 (61)	14.6±0.32 (61)
G. e. coenosa	97-142	84-112	72-94	22-28	18.3-25.8	14-16.4
	116±6.5 (16)	99±4.4 (13)	85±3.2 (13)	25±0.7 (15)	22±1.0 (15)	15.3±0.7 (15)
G. e. watsoni	100-130	92-122	87-112	21-25	19.2-23.5	13-16.7
	114±6.4 (10)	110±6.4 (10)	97±4.4 (10)	23.6±0.8 (10)	20.8±0.8 (10)	15.1±0.8 (10)
G. e. nuwara	115-147	89-119	70-82	25-28	17.7-22.6	10.9-14.1
	131±8 (7)	98±7 (7)	75±3.2 (7)	26.3±0.7 (7)	20.1±1.4 (7)	12.8±0.8 (7)
G. e. gujerati	105-134	94-126	77-102	22-26	17.5-21.9	11.2-14.6
	122±1.6 (55)	110±2.4 (45)	89±1.8 (45)	23.8±0.24 (55)	19.5±0.26 (55)	12.8±0.22 (52)

colour of the dorsum. Our study shows that although there is a tendency in the dorsal colour being lighter in specimens of the drier zone than those of the relatively humid areas, this difference is gradual and almost clinal. Hence, it cannot be treated as a differentiating character. However, the subspecies *gujerati* may be differentiated from other subspecies on the colour of its undersurface which is white as against drab grey or bluish grey.

The head and body length in different populations does not vary much. Ellerman (1963) differentiated *watsoni* from other populations (Table 1) by its relatively longer tail (more than 90% of head and body *vs.* less than 90%). But our analysis shows that this difference is not significant (indicated by overlap of one standard deviation rectangle of comparable lines), as such, it cannot be treated as a distinguishing character. However, the tail in *nuwara* is significantly smaller than in *watsoni*, *coenosa*, *myothrix* and *gujerati* (Text-fig. 2).

TABLE 2. Cranial measurements in different populations of *Golunda ellioti* J. E. Gray with Range, mean ± 2 standard error, sample size in parentheses.

	Occipitonasal length	Toothrow
G. e. ellioti	28.0-35.4 30.5±0.4 (49)	5.8-6.8 6.5±0.07 (49)
G. e. paupera	— — — —	— — — —
G. e. myothrix	28.9-34.3 31.1±0.46 (22)	6.0-6.9 6.4±0.08 (22)
G. e. coenosa	31.1-33.3 32.2±0.5 (8)	6.0-6.7 6.3±0.15 (8)
G. e. watsoni	31.8-35.2 32.9±1.1 (5)	6.3-6.7 6.5±1.4 (5)
G. e. nuwara	30 (1)	7.2 (1)
G. e. gujerati	28.5-33.5 31.0±0.36 (35)	5.8-6.7 6.3±0.01 (35)

Ellerman (1963) differentiated the subspecies *watsoni*, *myothrix* and *coenosa* from *paupera*, *nuwara*, *gujerati* and *ellioti* on the relative length of ear *viz* more than 14% of head and body as against less than 14% (Table 1). But as mentioned earlier, this difference is not significant, and, as such, cannot be treated as a distinguishing character.

Based on four specimens from Ambala (Haryana), Thomas (1923) described the subspecies *paupera*, and differentiated it from *gujerati* by

its smaller size and relatively shorter tail. Ellerman (1963) maintained it on the basis of its shorter hindfoot, ranging from 21 to 22 mm as against generally more than 22 mm in other subspecies. Our analysis shows that although there is significant difference between this population and others in absolute length of the hindfoot, there is no difference between them when its relative length is taken into consideration. Moreover, hindfoot as small as 21 or 22 mm is not an unusual feature in other populations too, and it appears to be simply a chance that all the three specimens of *paupera* examined by Ellerman (1963) have hindfoot 21 or 22 mm. Hence, it should not be taken as a distinguishing character.

Of the cranial features, the length of the upper toothrow is significantly long in *nuwara* (more than 7 mm. *vs.* less than 7 mm. in other populations) but nothing definite can be said as our observation is based on a single skull only (Table 2).

From the above discussion, it is clear that there is no difference amongst the populations *ellioti*, *myothrix*, *coenosa*, *paupera* and *watsoni*, and therefore, we would treat them as one, namely, *Golunda ellioti ellioti*, characterized by greyish brown dorsum and greyish undersurface, thus extending its range to whole of India (excepting Gujarat and southern Rajasthan), Pakistan (Sind and Punjab) and low lands of Sri Lanka (Central and parts of South and North Central Province up to an altitude of c 900 m). However, the subspecies *gujerati* and *nuwara* stand valid. The former can be separated on the basis of whitish undersurface combined with the tendency of having a longer tail and relatively shorter ear (Table 1) and the latter by its blackish dorsum, bluish gray venter and relatively shorter tail. The subspecies *gujerati* is restricted to southern Rajasthan and Gujarat and *nuwara* to the mountains of Central Province, Sri Lanka, above an altitude of c 1200m.

A key to the subspecies of *Golunda ellioti* as recognized by us is given below :—

1.	Undersurface of body white ...		*gujerati*
	Undersurface of body slaty grey or bluish grey	...	2
2.	Dorsum blackish ...		*nuwara*
	Dorsum speckled greyish brown ...		*ellioti*

ACKNOWLEDGEMENTS

The authors are thankful to the Director, Zoological Survey of India, for providing facilities and to Dr B. Biswas, Emeritus Scientist for going through the manuscript and criticism. We are also thankful

to the Honorary Secretary and the Curator of the Bombay Natural History Society for allowing us to study their collection.

References

Dice, H. H. and Leraas, H. J. 1936. A graphic method of comparing several sets of measurements. *Contr. Lab. Vertebr. Gen.*, **3** : 1-3.

Ellerman, J. R. 1941. *The Families and Genera of Living Rodents.* Vol. II, Muridae. London (*Brit. Mus. Nat. Hist.*).

Ellerman, J. R. 1947. A key to the Rodentia inhabiting India, Burma and Ceylon, based on collections in the British Museum. Part II. *J. Mammal.*, **28** : 357-387.

Ellerman, J. R. 1963. *The Fauna of India*, Mammalia, 3. Rodentia. Part II. Delhi (Govt. of India).

Gray, J. E. 1837. Description of some new or little known Mammalia, principally in the British Museum collection. *Charlesworth Mag. nat. Hist.*, **1** : 577-586.

Hubbs, C. L. and Perlmutter, A. 1942. Biometric comparisons of several samples with particular reference to racial investigations. *Am. Nat.*, **76** ; 582-592.

Ridgway, R. 1886. `Nomenclature of colors. Boston (Little Brown and Co.)

Thomas, O. 1923. Scientific Results from the Mammal Survey. No. XLII. The distribution and geographical races of the Golundi Bush Rats (*Golunda ellioti*) *J. Bombay nat. Hist. Soc.*, **29** : 373-376.

Wroughton, R. C. 1920. Summary of the Results from the Indian Mammal Survey of the Bombay Natural History Society. Part *V. J. Bombay nat. Hist. Soc.*, **26** : 955-967.