Rec. zool. Surv. India : **104** (Part 1–2) : 85-90, 2005

ON TAXONOMIC STATUS OF *BANDICOTA BENGALENSIS LORDI* (WROUGHTON) AND *BANDICOTA MAXIMA* (PRADHAN *ET. AL.*) : (SUBFAMILY : MURINAE; FAMILY : MURIDAE; ORDER : RODENTIA)

M. S. PRADHAN, AJOY KUMAR MONDAL* AND A. M. BHAGWAT**
Zoological Survey of India, WRS, Rawet Rd., PCNTDA, Pune-411 044, India

INTRODUCTION

Agrawal (2000) recorded certain remarks on the taxonomic status of *Bandicota bengalensis lordi* (Wroughton) and *B. maxima* (Pradhan *et. al.*) in the revisionary studies on Indian Murids and Hystricids. While reporting them, he has completely ignored the results obtained from the biochemical studies of these populations. Though merger of *B. bengalensis lordi* in *B. bengalensis bengalensis* has been supported by Agrawal (2000), he has totally neglected the variant populations occurring in the natural population. Probably very few taxonomists are aware of the observations made by Fergusson (1980) that allelic heterozygosity at any genomic site even in a single specimen, irrespective of age and sex, is a concrete proof of occurrence of polymorphism in the gene pool of the naturally occurring population under study.

RESULTS AND DISCUSSION

It is now established fact that proteins like hemoglobins, eye lens proteins, keratins, certain enzymes like esterases, *etc.* are stable proteins and they are often used worldwide as chemotaxonomic parameters for solving taxonomic problems (Dessauer and Fox, 1964, Selander and Young, 1969, Wright, 1974, Fergusson, 1980 and Gavin *et. al.*, 1999). Eye lens proteins and Keratins (hair proteins) are considered to be extremely stable and can be used for resolving taxonomic problems even at the family level (Fergusson, 1980). Even though aware of these results, Pradhan (1979) remarked that merger of *B. bengalensis lordi* in *B. bengalensis bengalensis* could be more practical irrespective of the differences in the Hindfoot measurements and occurrence of Haemoglobin

* *Zoological Survey of India, M-Block, New Alipore, Kolkata-700 053, India*
** *C. B. Patel Research Centre, Vile Parle (West), Mumbai-400 053*

polymorphism in the natural populations. However, he further stated that *B. bengalensis lordi* could not be merged in *B. bengalensis bengalensis* by just overlooking the significant differences. But for these prominent differences, he was also in favour of merger, of the two subspecies.

All the morphological measurements reported in Pradhan (1979) and Pradhan *et. al.* (1989, 1993) were taken meticulously by following Roonwal and Agrawal (1962). Even if, there is an element of error in taking Hindfoot measurements, as stated by Agrawal (2000), the level of difference can not be to the extent of 8–11 mm (Table 1). Hence, in light of these observations, the authors are, now, confident that two distinctly separate populations exist in the region. They are of the opinion that revisionary taxonomic studies of freshly collected *B. bengalensis lordi* and *B. bengalensis bengalensis* populations be carried out with the help of the morphological and osteological studies alongwith the studies based on modern parameters like biochemical, karyological and hair impression pattern studies. The systematic position of these populations can also be resolved by testing these observations on the scales of genetic distances and evolutionary separations (Nei, 1972 and Sneath and Sokol, 1973).

Taxonomic studies of *Bandicota maxima* populations were based on these lines only. All the available parameters were tested meticulously on Genetic and Evolutionary scales (Pradhan, 1989). On the basis of data on Genetic I values and UPGMA method of cluster analysis of Nei (1972) and Sneath and Sokol (1973), it became crystal clear that this population is distinctly separate from *B. indica* and deserves *species novum* status. In all probabilities and possibilities, *B. maxima* cannot be synonymised in *B. indica*. Agrawal (2000) overlooked the results based on the biochem-taxonomical studies reported earlier by Pradhan *et. al.* (1989, 1993). These studies are being widely used in systematics even today (Peppers and Bradley, 2000).

Table 1. : Measurements (In mm) of some key characters of three *Bandicota bengalensis* subspecies.

	Bandicota bengalensis bengalensis	*Bandicota bengalensis kok*	*Bandicota bengalensis lordi*
Head and Body Length	132–237 179 ± 21	130–225 165 ± 24	221–261 241 ± 20
Hindfoot Length	29–39 33.7 ± 2.0	27–39 33.5 ± 2.0	41–48 44.5 ± 2.0
Occipitonasal Length	33.3–45.5 39.1 ± 2.6	33.8–45.4 39.2 ± 2.2	43.5–47.9 45.7 ± 2.0
Molar tooth-row Length	5.9–8.0 7 15 ± 0.4	6.3–8.5 7.25 ± 0.4	6.3–7.9 7.65 ± 1.15

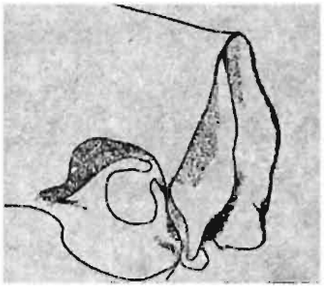
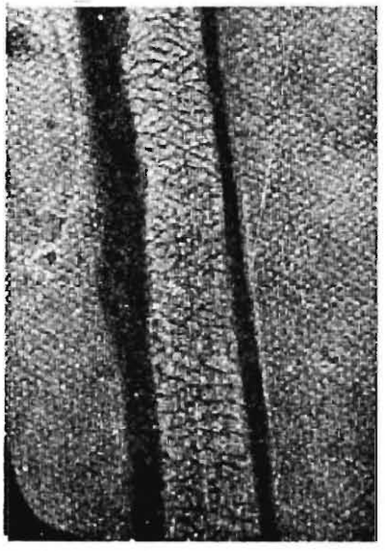
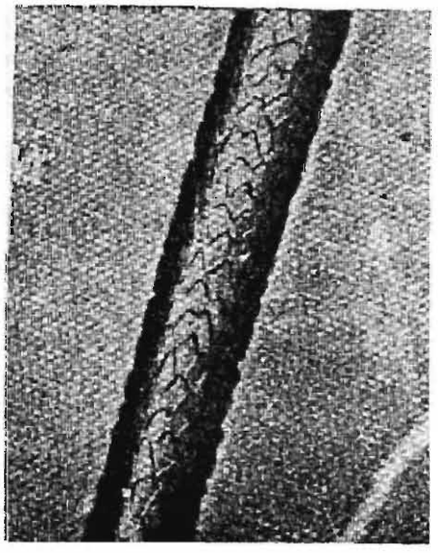
In case of other character like difference in occipitionasal length, which is one of the key characters and not the only character (Pradhan, 1993), it has been observed that occipitonasal length was always equal to or more than and never less than condylobasal length in the juvenile, subadult and adult specimens of *B maxima* populations studied from different regions (Table 2). The measurements of these specimens were taken as per Roonwal and Agrawal (1962). Osteomorphological measurements reported in Pradhan *et. al.* (1989, 1993) were noted from the freshly collected specimens as well as those registered in Zoological Survey of India and Bombay Natural History Society's collections. Localities of these specimens include Mumbai, Pune, Goa, Kolkata, Pondicherry, some areas of Western Ghats and North India. While noting down the osteological measurements, it was observed that ridges in the flattened occiput region were distinctly pronounced and prominent in *B. indica* specimens of different sex and age groups. However, in *B. maxima* populations the occiput region was clearly inflated and swollen and the ridges were not as sharp, prominent and pronounced as those were in *B. indica* (Table 2). This difference could be noticed even in the juvenile and subadult specimens.

Differences in the hair impression patterns of dorsal guard hairs are distinct (Table 2) and have been used as an additional key character. It is, now, universally accepted fact that basal part of the mammalian guard hair shows definite and uniform hair impression patterns irrespective of sex, age and locality groups (Ryder, 1973 and Koegh, 1985). Similar techniques have been widely used in identification of carnivore species in wildlife studies by Chakraborty *et. al.* (1996) and De *et. al.* (1998). Thus the prominent differences seen in the hair impression patterns (Mozaic pattern in *B. indica* and Chevron in *B. maxima*) can not be overruled so easily.

Finally, on the basis of consolidation of the results derived from all the parameters (including use of Genetic Identity, UPGMA dendrogram and phylogenetic tree studies), Pradhan *et. al.* (1989 and 1993) came to the ultimate conclusion that there exists a third population under Genus *Bandicota, which* cannot be merged in *B. indica* with the help of any circumstantial evidence. Hence, the population has rightly been separated as a new species and named as *B. maxima* on the basis of possession of the combination of key characters like occipitonasal length equal to or more than condylobasal length, inflated occiput region and mozaic hair impression pattern (Table 2). We strongly feel and conclude that *B. maxima* is a valid species which does exist in the natural population and there is no ground for its "tentative" inclusion in *B. indica* as has been done by Agrawal (2000).

Agrawal (2000) in the revisionary studies of Indian Murids merged two subspecies (*pallidior* and *singuri*) of *Millardia meltada* to nominate subspecies *meltada.* Here he has deviated from the basic definition of subspecies given in Mayr (1969). According to Mayr (1969) the subspecies is "a geographically defined aggregate of local populations which differs taxonomically from other such subdivisions of the species."

Table 2. : Distinct differences in some of the key characters of *Bandicota indica* and *B. maxima.*

	Bandicota indica	*Bandicota maxima*
Occipitonasal Length (In mm.)	48.5–61.2 54.6 ± 4.0	58.5–68.1 62.6 ± 2.71
Condylobasal Length (In mm.)	48.8–63.4 56.1 ± 5.0	57.2–67.9 61.62 ± 2.96
Shape of Occiput Region	FLATTENED 	INFLATED 
Cuticular Hair Impression Pattern (Lower Magnification)	MOZAIC 	CHEVRON 

Ellerman (1961) recognized two subspecies of *Millardia meltada* namely : *Millardia meltada meltada* and *Millardia meltada pallidior* from India. Latter subspecies differs from the former in having more pallid grey dorsum and whitish venter. He has recognized two geographical areas for these two subspecies. Further he has mentioned that the colour difference of these two subspecies is an average and not absolute. What Agrawal (2000) found in Rewa, Gwalior and Darbhanga collections was nothing but mixed characters of *pallidior* and *meltada* due to mixing (interbreeding) of the two subspecies in the demarcated fringes of the two populations.

In case of *Millardia meltada singuri* described by Mandal and Ghosh (1981) the specimens of this subspecies were collected from Singur, Dist. Hugli, West Bengal in 1978 and 1980. They are more darker than *Millardia meltada meltada*. Even after 21–23 years of collection there is no sign of foxing in the coloration of these specimens which have been deposited in the National Zoological Collection of Zoological Survey of India in Kolkata. Over and above, these specimens have been collected from an entirely new geographical area. Thus, we find three subspecies in case of *Millardia meltada* in India *viz.* : *M. m. meltada, M. m. pallidior* and *M. m. singuri* which are present as geographically defined populations, although we came across with some mixing of *meltada* and *pallidior* populations living on borders.

ACKNOWLEDGEMENTS

The authors are thankful to the Director, Zoological Survey of India, Kolkata, and Officer-in-Charge, ZSI, WRS, Pune, for providing the necessary facilities.

REFERENCES

Agrawal, V. C. 2000. Taxonomic studies on Indian Muridae and Hystricidae (Mammalia : Rodentia). *Rec. zool. Surv. India*, Occ. Pap. No. 180 : 1-177 + 6 plates.

Chakraborty, R., De, J. K. and Chakraborty, S. 1996. Identification of dorsal guard hairs of Indian species of the genus *Panthera* Oken (Carnivora : Felidae). *Mammalia*, **60**(3) : 473-480.

De, J. K., Chakraborty, S. and Chakraborty, R. 1998. Identification of dorsal guard hairs of five Indian species of Mongoose, *Herpestes* Illiger (Mammalia : Carnivora). *Mammalia*, **62**(2) : 285-295.

Dessauer, H. C. and Fox, W. 1964. Electrophoresis in taxonomic studies illustrated by analyses of blood proteins. In : *Taxonomic Biochemistry and Serology* Ed. C. H. Leone, New York : pp. 625-647.

Fergusson, A. 1980. Ed. *Biochemical systematic and Evolution* Publ : Blackie, London. pp : 1-194.

Gavin, T. A., Sherman, P. W., Yensen, E. and May, B. 1999. Population genetic structure of the northern Idaho ground squirrel (*Spermophilus brunneus brunnens*). *Journal of Mammology*. **80**(1) : 156-168.

Keogh, H. J. 1985. A photographic reference system based on the cuticular scale patterns and groove of the hair of 44 species of Southern African Cricetidae and Muridae. *S. Afr. J. Wildl. Res.* **15**(4) : 109-159.

Mandal, A. K. and Ghosh, S. 1981. A new subspecies of the Metad *Millardia meltada* (Gray, 1837) (Rodentia : Muridae) from West Bengal. *Bull. zool. Surv. India*, **4**(2) : 235-238.

Nei, M. 1972. Genetic distance between populations. *Amer. Nat.*, **106** : 283-291.

Peppers, L. L. and Bradely, R. D. 2000. Cryptic species in *Sigmodon hispidus* : Evidence from DNA sequences. *Journal of Mammology*, : **81**(2) : 332-343.

Pradhan, M. S. 1979. Application of some biochemical methods in bandicoot taxonomy. *J. Bombay nat. Hist. Soc.*, **76**(1) : 59-65.

Pradhan, M. S., Ajoy Kumar Mondal and Agrawal, V. C. 1989. Proposal of an additional species in the Genus *Bandicota* (Gray) (Order : Rodentia : Family : Muridae, Subfamily : Murinae) from India. *Mammalia,* **53**(3) : 369-376.

Pradhan, M. S., Mondal, A. K., Bhagwat, A. M. and Agrawal, V. C. 1993. Taxonomic studies of Indian bandicoot rats (Rodentia : Muridae : Murinae) with description of a new species. *Rec. zool. Surv. India*, **93**(1-2) : 175-200.

Roonwal, M. L. and Agrawal, V. C. 1962. The measurements of rodents (Mammalia), particularly skull for taxonomic purposes. *Rec. Ind. Mus.*, **60**(1 & 2) : 81-93.

Ryder, M. 1973. *Hair* : Studies in Biology series No. 41. Pub : Edward Arnold, Pub. Edward Arnold, Pub. in U.K. by The Camelot Press Ltd., Southampton, pp : 1-60.

Selander, R. K. and Yang, S. Y 1969. Protein polymorphism and genetic heterozygasity in a wild population of the house mouse (*Mus musculus). Genetics* Princeton : 653-667.

Sneath, P. H. A. and Sokal, R. P. 1973. *Numerical Taxonomy*. W. H. Freeman & Co., San Fracisco. pp. 1-573.

Wright, C. A. 1974. *Biochemical and Immunological Taxonomy of Animals*. Academy Press, New York.