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TAXONOMIC STUDIES OF INDIAN BANDICOOT RATS (RODENTIA : MURIDAE : MURINAE) WITH DESCRIPTION OF A NEW SPECIES

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Zoological Survey of India.

INTRODUCTION

Gray (1842) separated the bandicoot rats from the house rats under the genus *Nesokia*. Thomas (1907), however, divided them into three genera, *Nesokia*, *Gunomys* and *Bandicota*. Later, Wroughton (1908, 1919) maintained 6 species (*gigantea*, *malabarica*, *elliotana*, *indica*, *nemorivaga* and *savilei*) under the genus *Bandicota*, 7 species (*bengalensis*, *gracilis*, *wardi*, *varius*, *lordi*, *sindicus* and *kok*) under *Gunomys* and 4 species (*indica*, *huttoni*, *griffithi* and *beaba*) under *Nesokia* from the Indian subregion. Subsequently, Ellerman (1947, 1961) retained the genus *Nesokia* for the highly specialised bandicoot rats from Palaearctic and North-west India, *Bandicota* for the more generalised Indo-Malayan forms, and synonymised *Gunomys* with *Bandicota*. Further, based on the body colour and morphological characters, Ellerman (loc. cit.) maintained a single species *indica* under the genus *Nesokia* and two species, namely, *indica* and *bengalensis* under *Bandicota*. While doing so, he merged all the large-sized bandicoot rats with *indica* except *nemorivaga* and *savilei* which were given subspecific ranks under it. Tiwari *et al.* (1971), however, stressed the need of retaining *malabarica* from the Western Ghats as a separate subspecies of *B. indica*. Later, Pradhan *et. al.* (1989), with the help of biochemical analysis found polymorphic populations in the species *Bandicota indica* which created confusion as to the status of different species synonymised with it. Hence, it was decided to undertake the study of large bandicoot rats afresh, covering all possible aspects like osteo-morphological, biochemical and hair sculpture studies.

The present work is based on the data collected for the following research projects :—

1. Ecological and taxonomic studies of the rats (subfamily Murinae) from Pune and adjacent areas.

2. Chaemotaxonomic studies of the commensal rodents and shrews from Bombay-Pune region.

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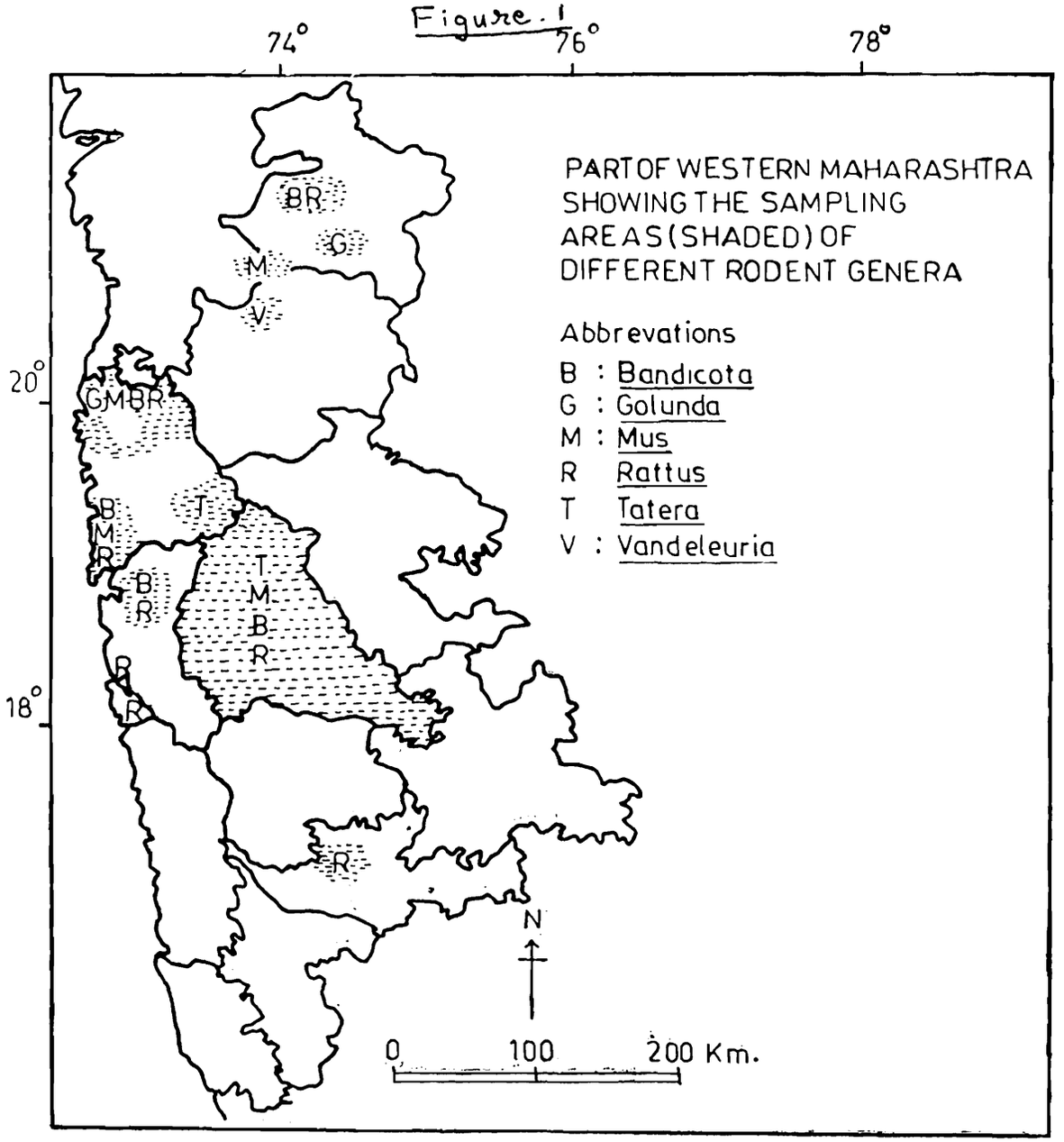
3. Chaemotaxonomy of rodents from Pune district.
4. Ecological and taxonomic studies of rodents in and around Calcutta.

Areas Surveyed and Duration

Initially, the sampling was restricted to the metropolis of Calcutta, Bombay and Pune. Later, it was extended to the western parts of Maharashtra. The sampling

Figure. 1



areas have been shown in Figure 1. The rodent collection in the sampling areas was made during the extensive surveys carried out over a period of four years from 1982 to 1986.

MATERIAL AND METHODS

More than 100 bandicoot specimens along with their skulls were studied in detail for the present work. The material, in addition to the freshly collected specimens, included the specimens present at the Bombay Natural History Society, Bombay, Zoological Survey of India, Calcutta, and the Western Regional Station of the Zoological Survey of India, Pune. The freshly collected specimens have been deposited at the Western Regional Station, Pune.

For osteomorphological studies, all measurements were taken after Roonwal and Agrawal (1966). The freshly collected material as well as the already identified specimens (*vide* Ellerman 1961) were reidentified with the help of keys provided with by Wroughton (1919) and then compared. For comparison of data only adult specimens were taken into consideration. The significance or student 't' test was applied to every character showing statistically significant differences ($P = 0.05$) in the average measurements.

For biochemical studies, haemoglobins were separated according to method described by Wright (1974). The samples of haemoglobin and plasma protein were resolved in individual patterns using polyacrylamide gel electrophoresis (PAGE) after Davis and Ornstein (1961), Whitaker (1967), and Gordan (1980). PAGE separation was carried out under carefully controlled factors like gel concentration (7.5%), pH of stacking (8.3) and running (9.5) gels, buffer system (Tris-glycine, pH 8.3), voltage current (4 watt per tube) temperature ($4°C \pm 1°C$), the time of run, etc. The dye, bromophenol blue, mixed with sample before loading on the gel columns in the neutral glass tubes, served as a marker. To identify various specific proteins, gels were stained after Gordon (1980) for plasma proteins, Brewer and Sing (1970) for Lactate dehydrogenase (LDH) and non-specific esterases, and Ornstein (1967) for haemoglobin (Hb) fractions. The eye lenses were extracted according to Smith (1971), with certain modifications (Pradhan and Bhagwat 1990). After PAGE separation, the eye lens proteins were stained by the method of Gordon (1980). Consolidated protein profiles were prepared by analysing each sample in several replicates and averaging the electrophoretic mobilities with reference to marker (Rm values) for individual specimen. The final Rm values, obtained for individuals, were clubbed together to obtain characteristic profiles for the three populations of *Bandicota* under investigation.

For the analysis of hair structure, hair samples were collected from the region posterior to the neck on the dorsal surface. Five specimens each of *Bandicota* spp. under study were selected for the present work. For light microscopic study, the hair smaples were first washed in warm water and then transferred to detergent solution (Teepol, 1 % v/v). After this treatment, hair were repeatedly washed with warm distilled water and transferred to 1 : 1 mixture of ether and alcohol as suggested

by Dreyer (1966). After shaking this mixture, hair were once again washed with distilled water and dried in clean watch glasses. For routine study impressions of of hair sculptures were obtained on gelatin or polyvinyl acetate (Brunner and Coman, 1974) and photographed using Olympus microphotography attachment at x 200.

Observation & Discussion

Osteo-morphological Study

The external and skull-measurement of the large-sized bandicoot rats (Tables 1 & 2) show that out of about 100 specimens examined from the distributional range of *indica*, *malabarica* and *nemorivaga*, 15 have the occipitonasal length more than the condylobasal length. The reverse is true in the rest. Not only that, these specimens are, on average, larger in size. When the average measurements (with standard deviations) of these specimens were plotted on a graph against the average measurements of *indica*, *malabarica* and *nemorivaga* (Figs. 2, 3, 4 & 5) for comparative study, distinct differences were noticed in the lengths of occipitonasal, condylobasal, palate and diastema and width of zygomatic arches. All these differences were found to be statistically significant ($P = 0{\cdot}05$). Although the measurements of these specimens come quite close to those of *B. indica malasbarica*, yet these differ in the length of occipitonasal, condylobasal and palate, and width of zygoma. Moreover, the longer occipitonasal, wider zygomatic arches and inflated occiput (Fig. 6 & 7) give a somewhat triangular shape to the head of these large-sized rats (Fig. 8).

From the above study it is clear that *Bandicota i. malabarica* not only differs from the other two populations, *viz.*, *B. indica indica* and *B. indica nemorivaga* in the length of nasals, diastema and palate, but is also allopatric in distribulion. Hence, it is treated as a separate subspecies of *Bandicota indica* (Bechstein). Our view finds support from the earlier work of Tiwari *et al.* (1971) who maintained *malabarica* as a separate subspecies of *Bandicota indica.*

As mentioned above, the large-sized bandicoot rat, *Bandicota* sp. differs from *Bandicota indica* (all three subspecies) in the occipitonasal length being more than condylobasal length, and in the width of zygomatic arches and length of mandibles (Tables 1-3). Although these bandicoot rats (*Bandicota* sp.) come very close to *Bandicota indica malabarica*, yet cannot be placed as a subspecies of *Bandicota indica* due to its India-wide distribution. Hence, it deserves a specific rank.

Biochemical Study

The consolidated population profiles for five specific proteins of three bandicoot populations in question are represented in Figs. 9 & 10. The data on protein

separation was used to calculate Genetic Identity (I) at the specific locii (Nei, 1972).

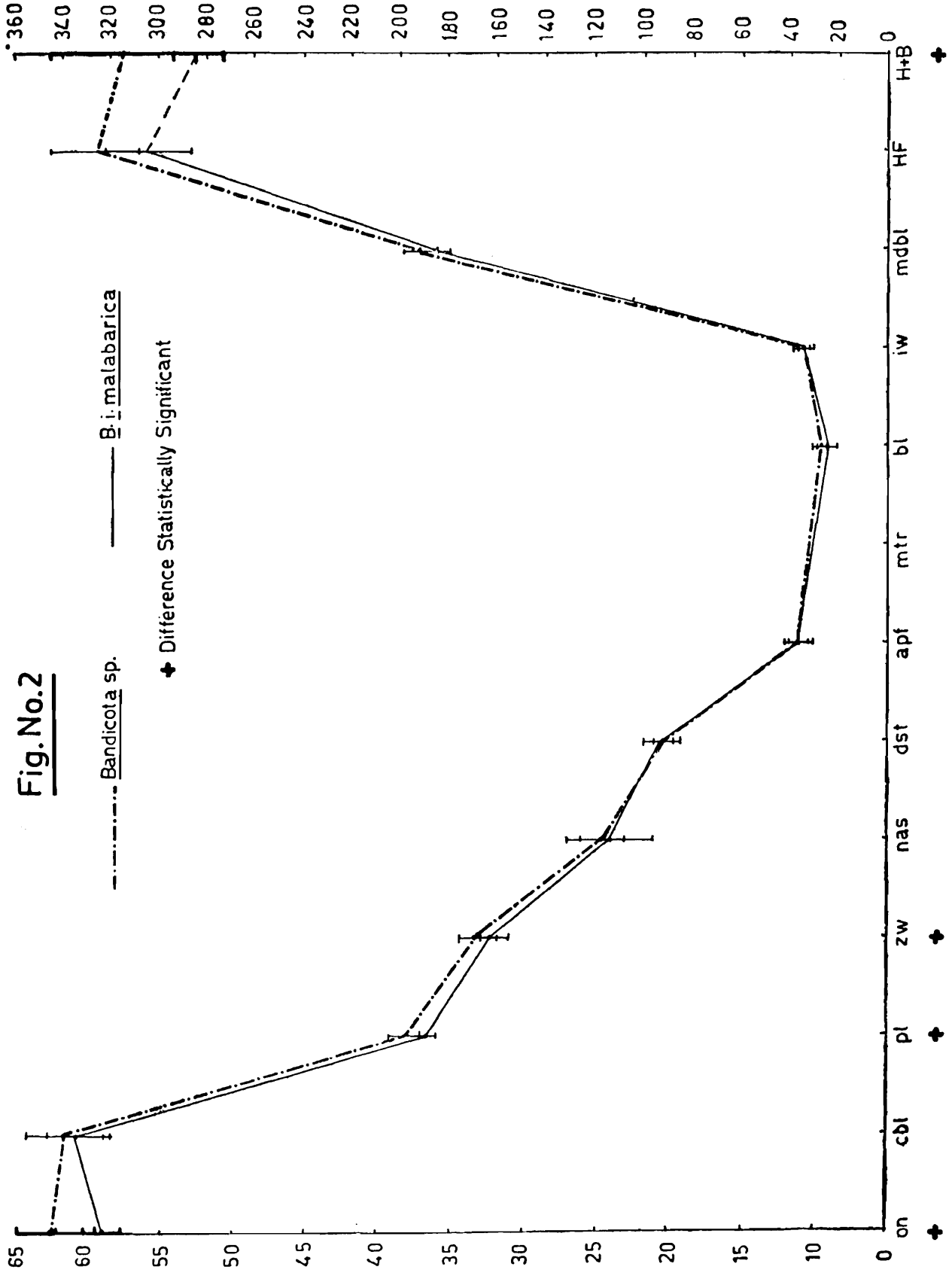


Fig.No.2

Table 4 represents the I values for individual proteins as well as mean I (I) for all

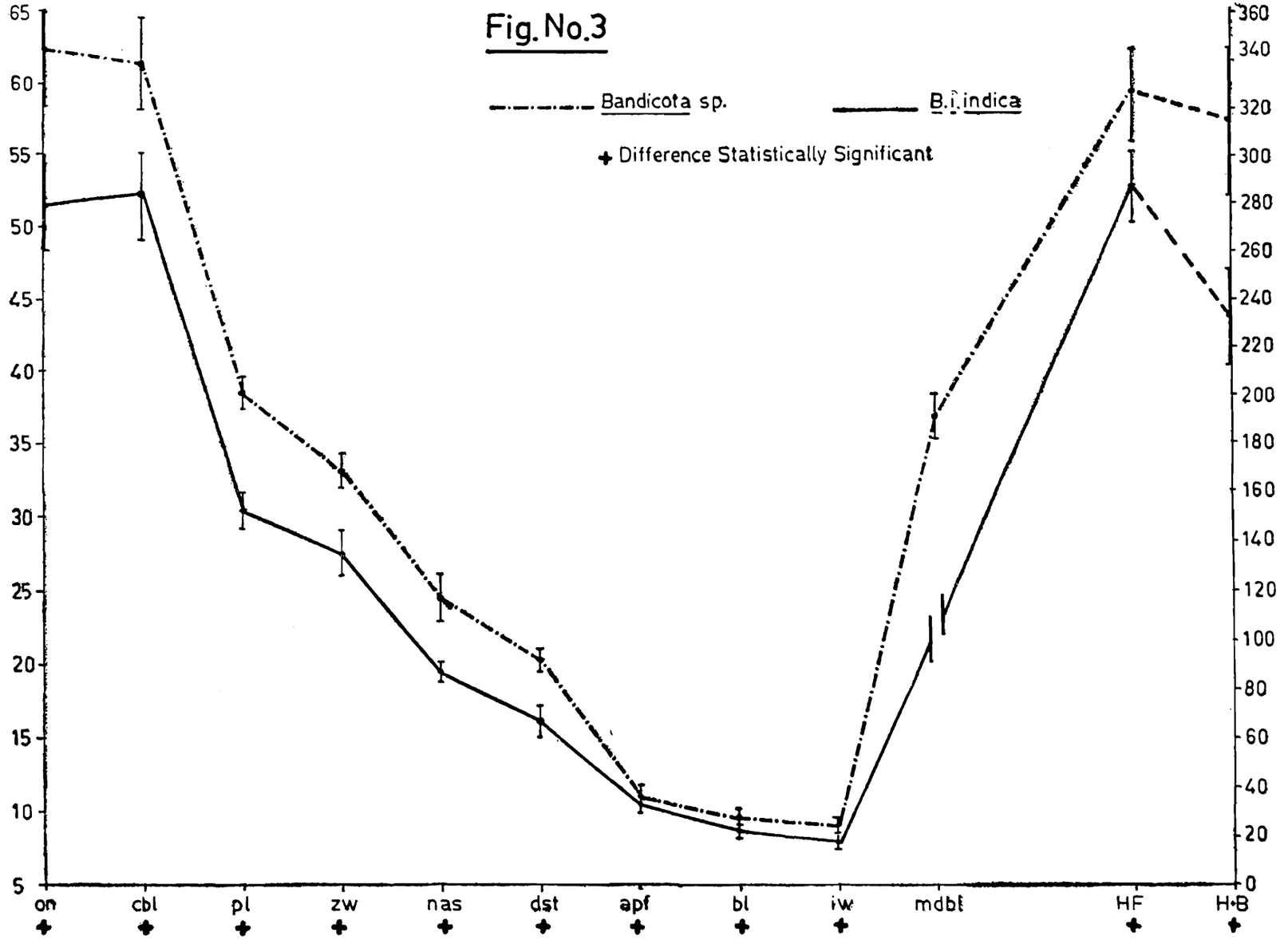


Fig. No.3
Bandicota sp.
B. indica
+ Difference Statistically Significant
65
60
55
50
45
40
35
30
25
20
15
10
5
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
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nas
dst
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bl
iw
mdbl
HF
H·B

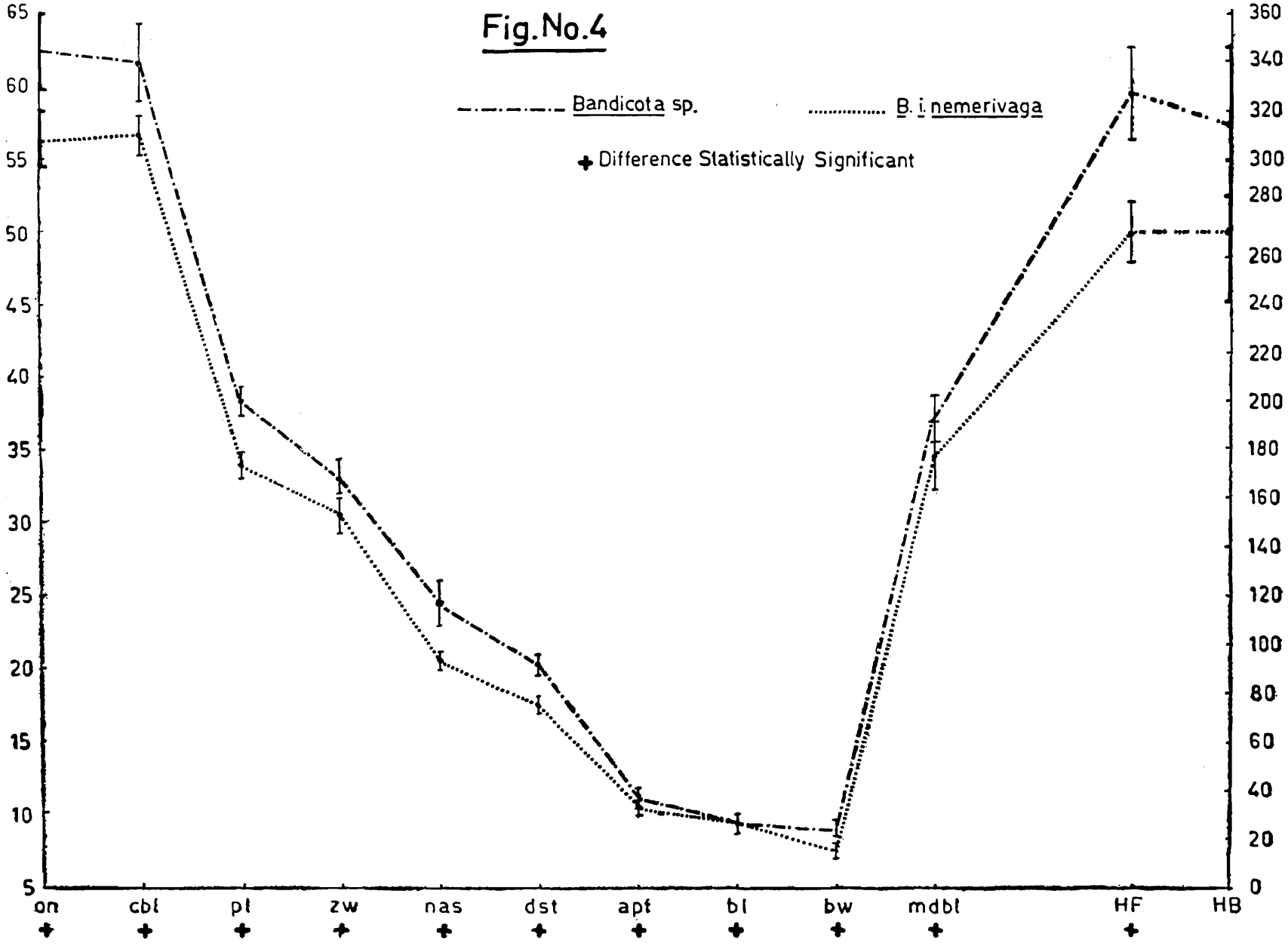
Fig.No.4
Bandicota sp.
B. i. nemerivaga
Difference Statistically Significant
65
60
55
50
45
40
35
30
25
20
15
10
5
360
340
320
300
280
260
240
220
200
180
160
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HB

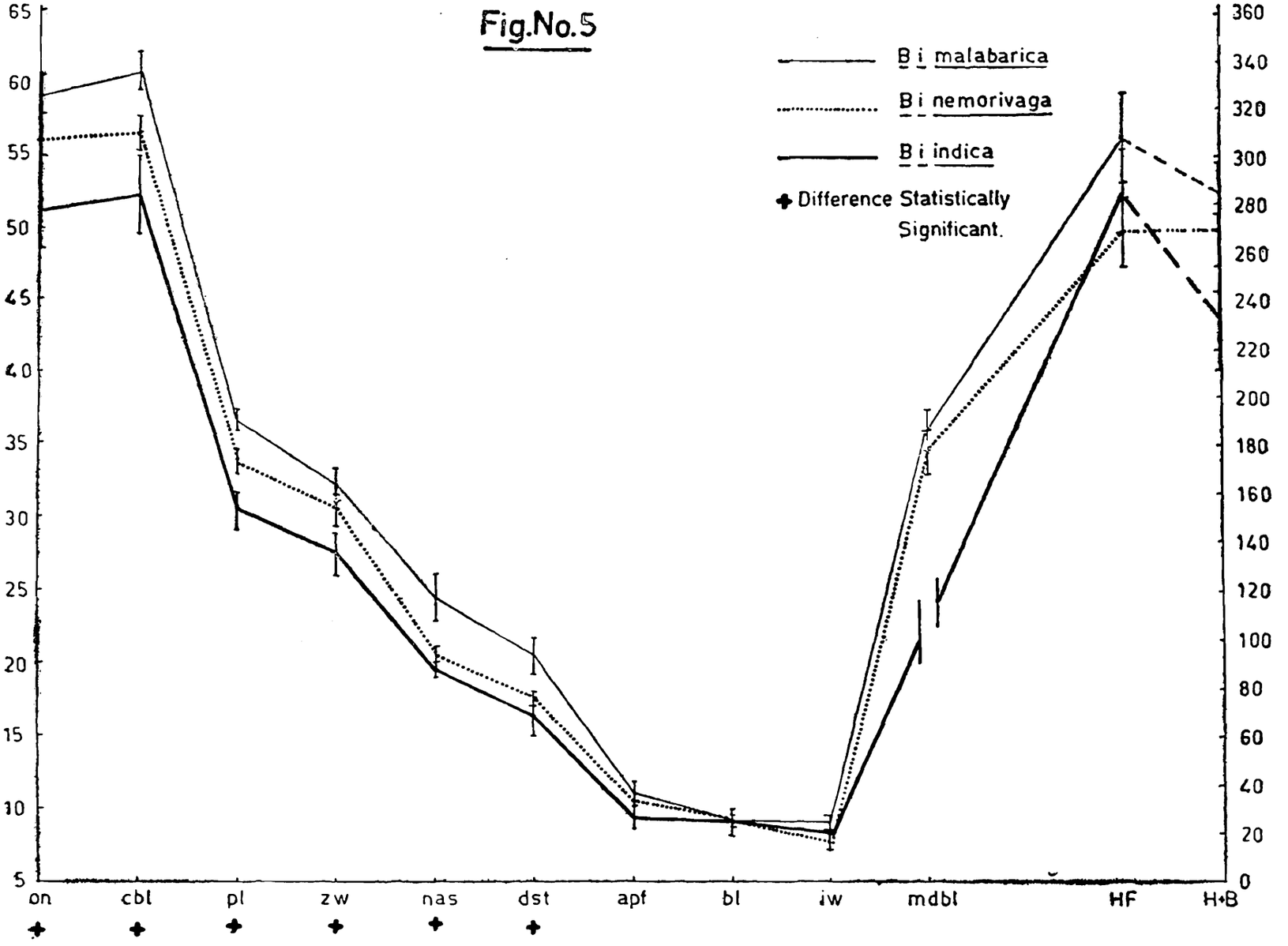
Fig.No.5
B i malabarica
B i nemorivaga
B i indica
Difference Statistically Significant.
65
60
55
50
45
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35
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25
20
15
10
5
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340
320
300
280
260
240
220
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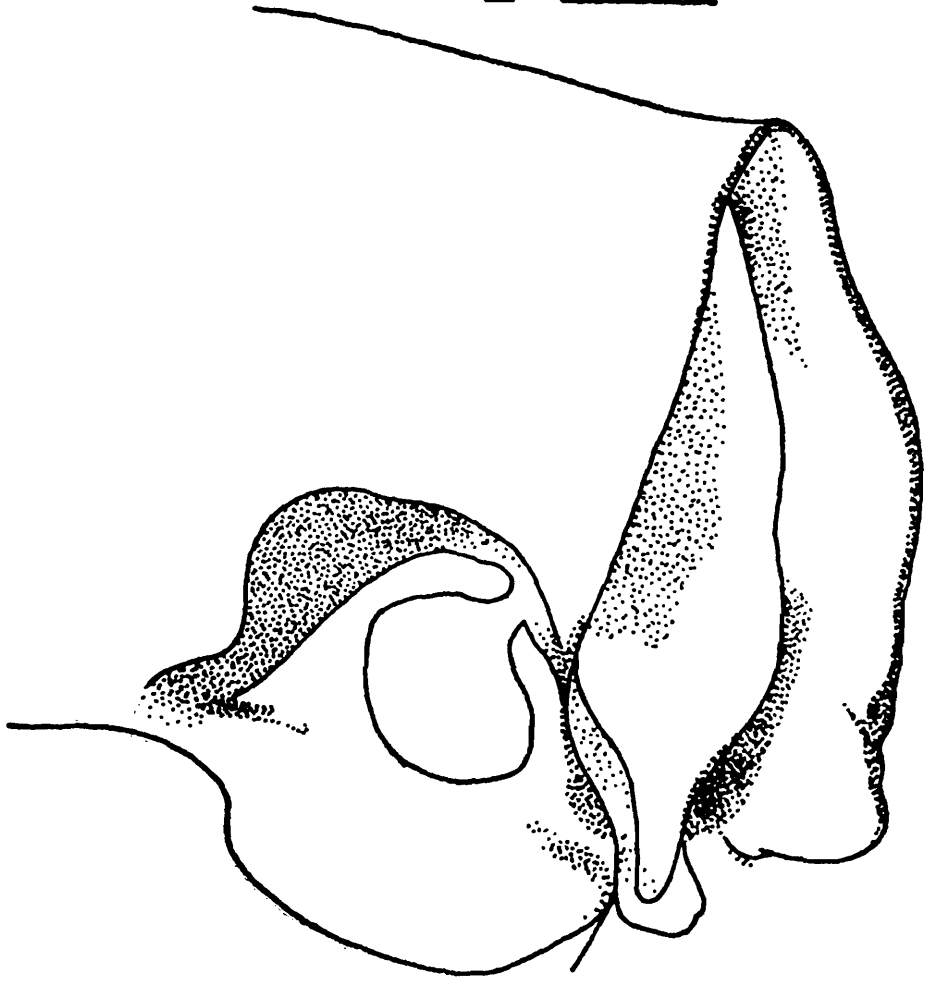
180
160
140
120
100
80
60
40
20
0
on
cbl
pl
zw
nas
dst
apf
bl
iw
mdbl
HF
H+B

the proteins separated during the present study. On the basis of the data on I values and also applying the UPGMA method of cluster analysis, dendrograms showing relationships of the *Bandicota* species were also constructed (Fig. 11).

FIG. 6

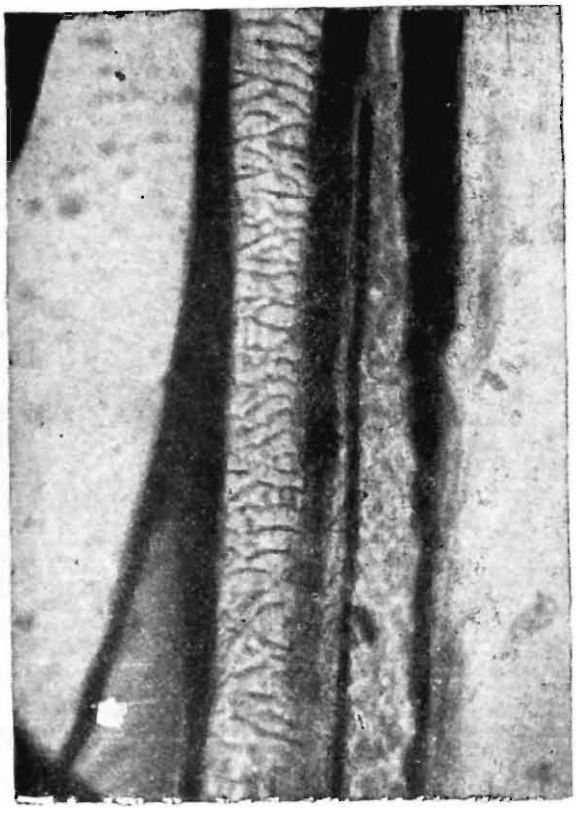
Occiput region of B. indica skull (M/415)



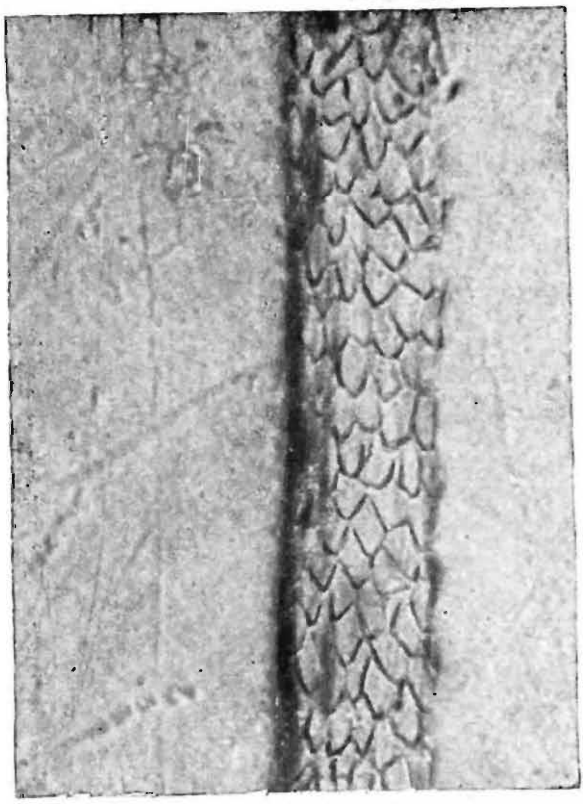
Pradhan *et al.* (1989) have discussed at lenght the status of the large-sized bandicoot population and have doubted its inclusion in *B. indica.* Along with several osteomorphological characters they had used two protein fractions, Hb and eye lens proteins, to examine the differences. During the present study, additional proteins namely LDH, non-specific esterases and plasma low molecular proteins in the albumin zone representing a total of about 52 gene locii in the populations were used to examine homologies at functional (enzyme) levels. From the tests (Table 4) it is

PLATE—I

A



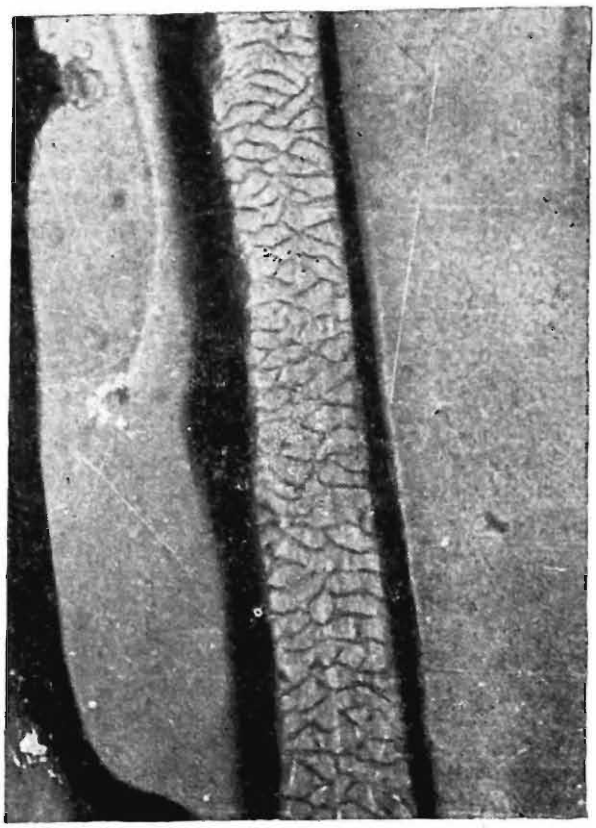
B



A : Photograph showing cuticular impression pattern of *B. indica* (M/415) hair between basal and middle region. Kindly ignore air bubbles. (Magnification : Photographed at X200).

B : Photograph showing cuticular impression pattern of *Bandicota* sp. (M/98) hair between basal and middle region. Kindly ignore air bubbles. (Magnification : Photographed at X200).

C



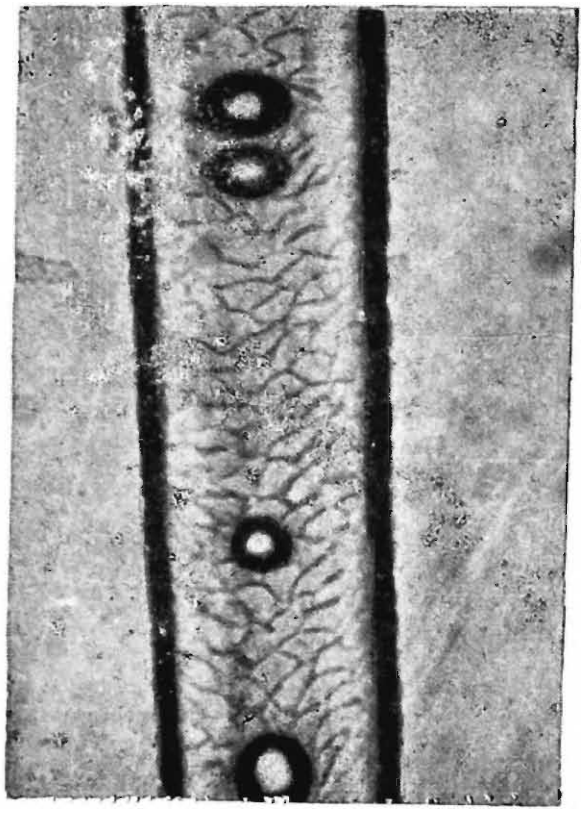
D

C : Photograph showing cuticular impression pattern of *B. indica* (M/248) hair between basal and middle region. (Magnification : Photographed at X200).

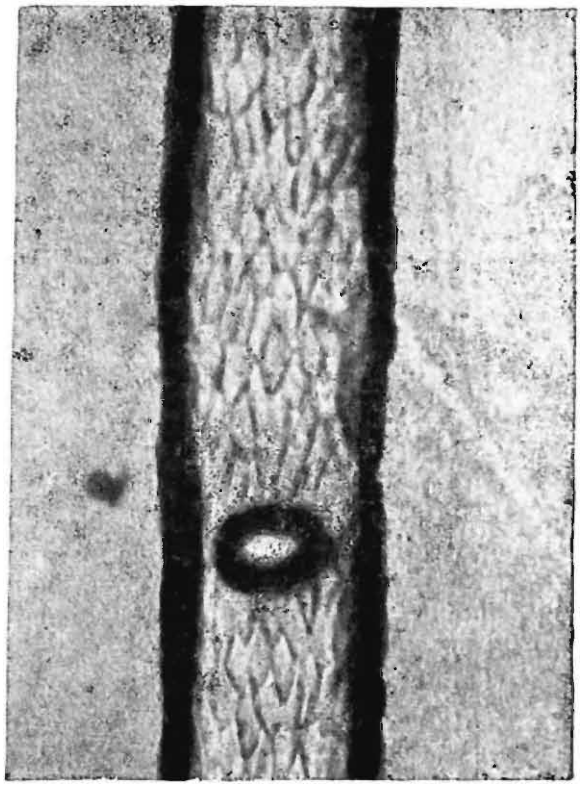
D : Photograph showing cuticular impression patter of *Bandicota* sp. (M/125) hair between basal and middle region.. (Magnification : Photographed at X200).

PLATE—II

A



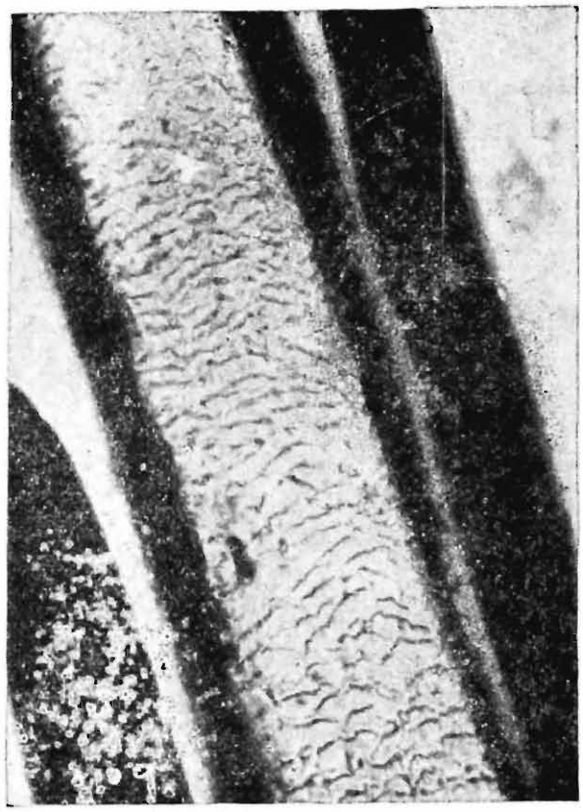
B



A : Photograph showing cuticular impression patter of *B. indica* (M/415) hair near middle region.
(Magnification : Photographed at X200).

B : Photograph showing cuticular impression pattern of *Bandicota* sp. (M/98) hair near middle region.
(Magnification : Photographed at X200).

C



D

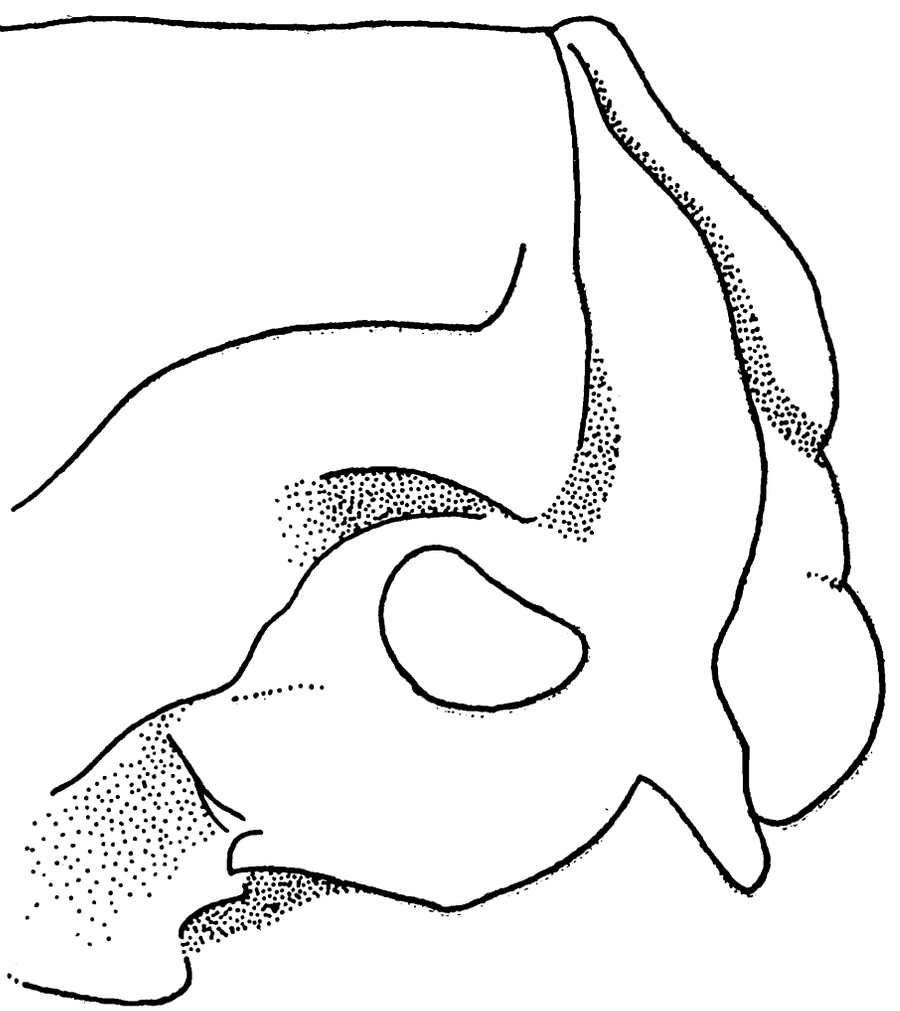
C : Photograph showing cuticular impression pattern of *B. indica* (M/415) hair in the middle region.
(Magnification : Photographed at X200).

D : Photograph showing cuticular impression pattern of *Bandicota* sp. (M/98) hair in the middle region.
(Magnification : Photographed at X200).

observed that for the two enzyme fractions, *B. bengalensis* showed a greater gene identity with the proposed *Bandicota* sp. than with *Bandicota indica* which had the least gene identity. The genes representing low molecular plasma proteins showed greater identities in the populations of *B. bengalensis* and *B. indica* (0.85). Here again, the genetic identity between *B. indica* and proposed *Bandicota* sp. was the least (0.64).

FIG. 7

Occiput region of Bandicota sp. skull (M/95)

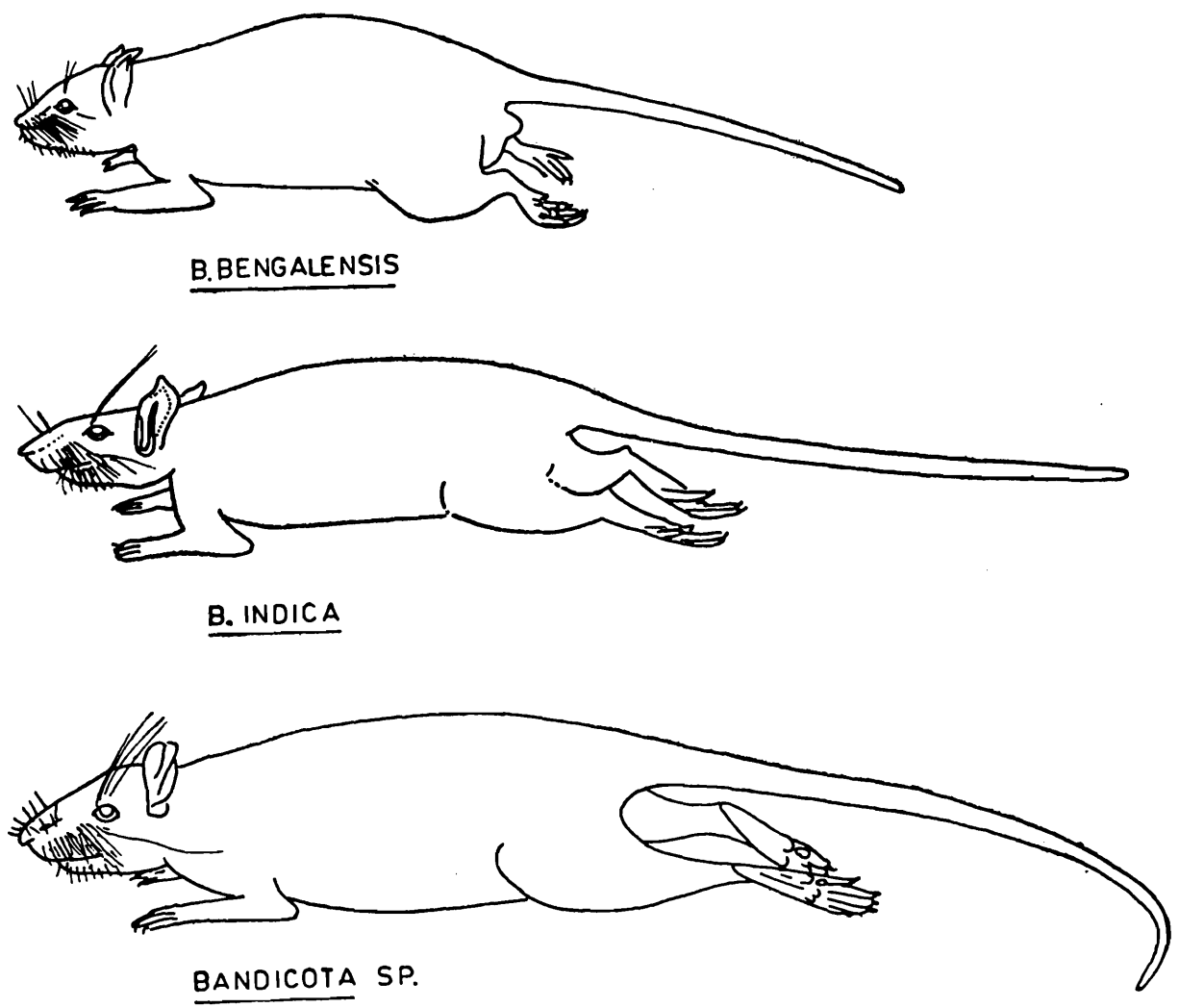


Dendrograms constructed from the above data (Fig. 11) clearly establish the patterns of branching in phylogeny of the three species. The dendrogram representing average genetical identities at locii controlling the five specific proteins suggests that all the three species of genus *Bandicota* were separated from each other more or less at the same time. However, it was *B. indica* that got separated early from the common

ancestral stock, whereas *B. bengalensis* and proposed *Bandicota* sp. separated at a latter stage in the phylogeny.

Selander and Yang (1969) have suggested that subspecies should not have less than 90% identity at genomic level. They further state that sibling species show an identity close to 50% ; and when identity is about 30% the population should be

FIG.8



treated as a distinct species. Our results average about 50% identity for five protein expressions studied. Therefore, if one looks at the entire genome level and with a larger number of species specific proteins, this identity might come down to the level of distinct species. To conclude, therefore, it may be stated that on the basis of the analysis of five protein expressions the populations of *B. indica* and proposed *Bandicota* sp. cannot be treated as a single species. All the three species (*bengalensis*, *indica* and *B.* sp.) appear to be genetically distinct and hence, should be given the status of independant species.

Fig.No. 9

DIAGRAMATIC REPRESENTATION OF THE ELECTROPHORETIC PATTERNS OF THE SPECIES SPECIFIC PROTEINS IN THE DIFFERENT SPECIES OF THE GENUS BANDICOTA

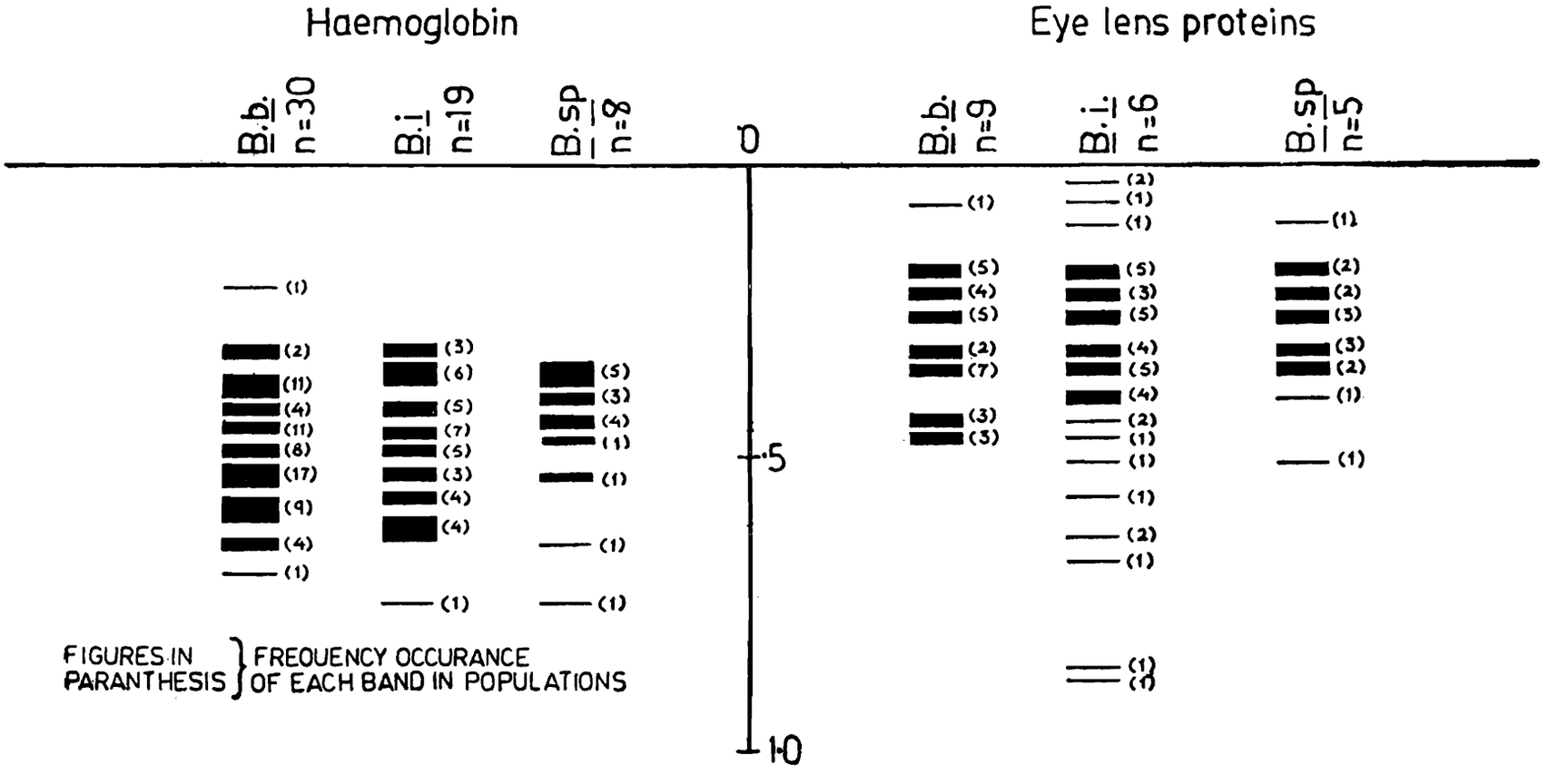
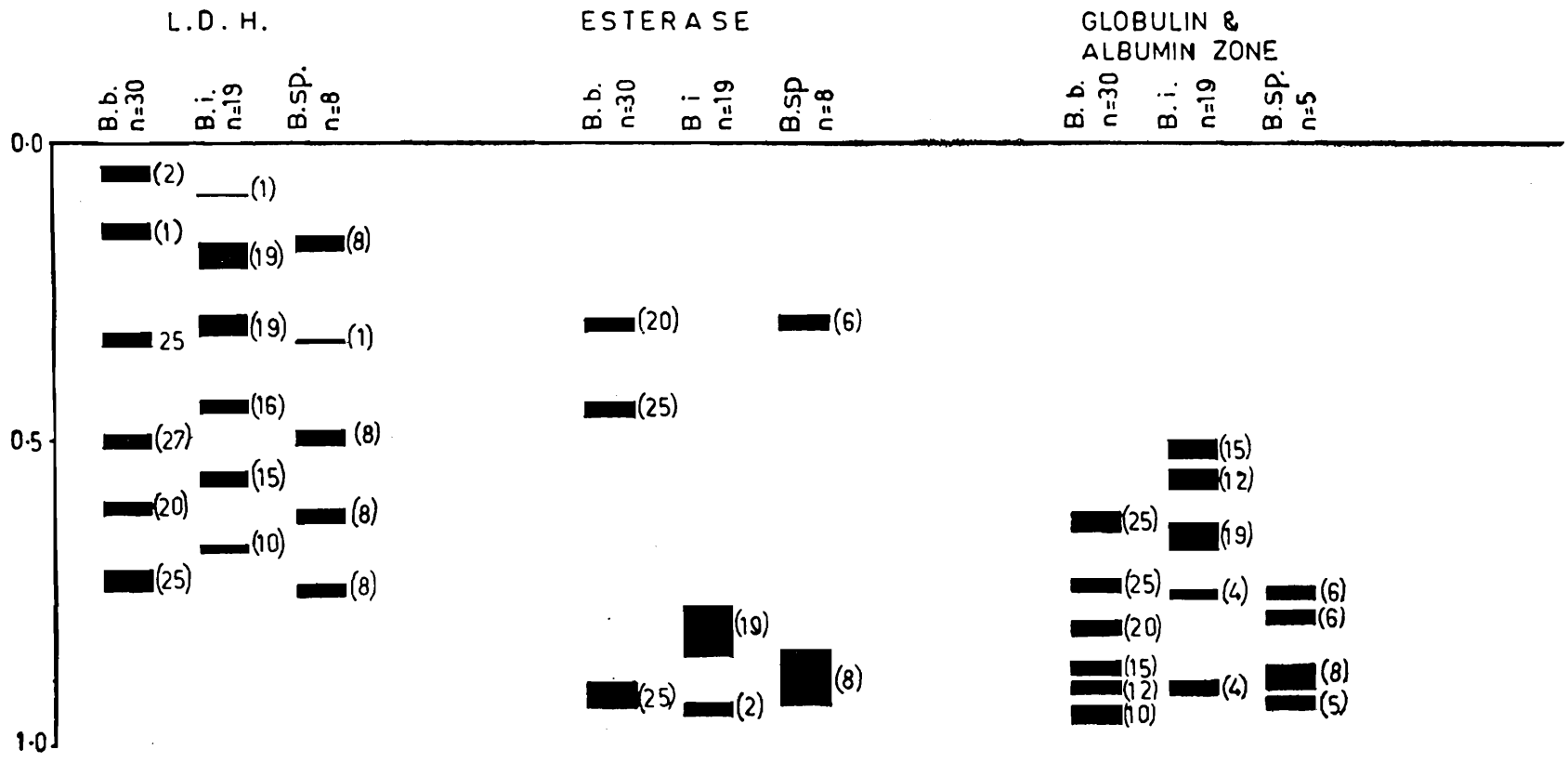


FIG. 10

Electrophoretic patterns (PAGE) of some enzymes and low molecular plasma proteins of Bandicota spp.



Figures in paranthesis } Frequency of occurance of each band in populations

FIG. 11

Dendrograms constructed using UPGMA method of cluster analysis & data in table

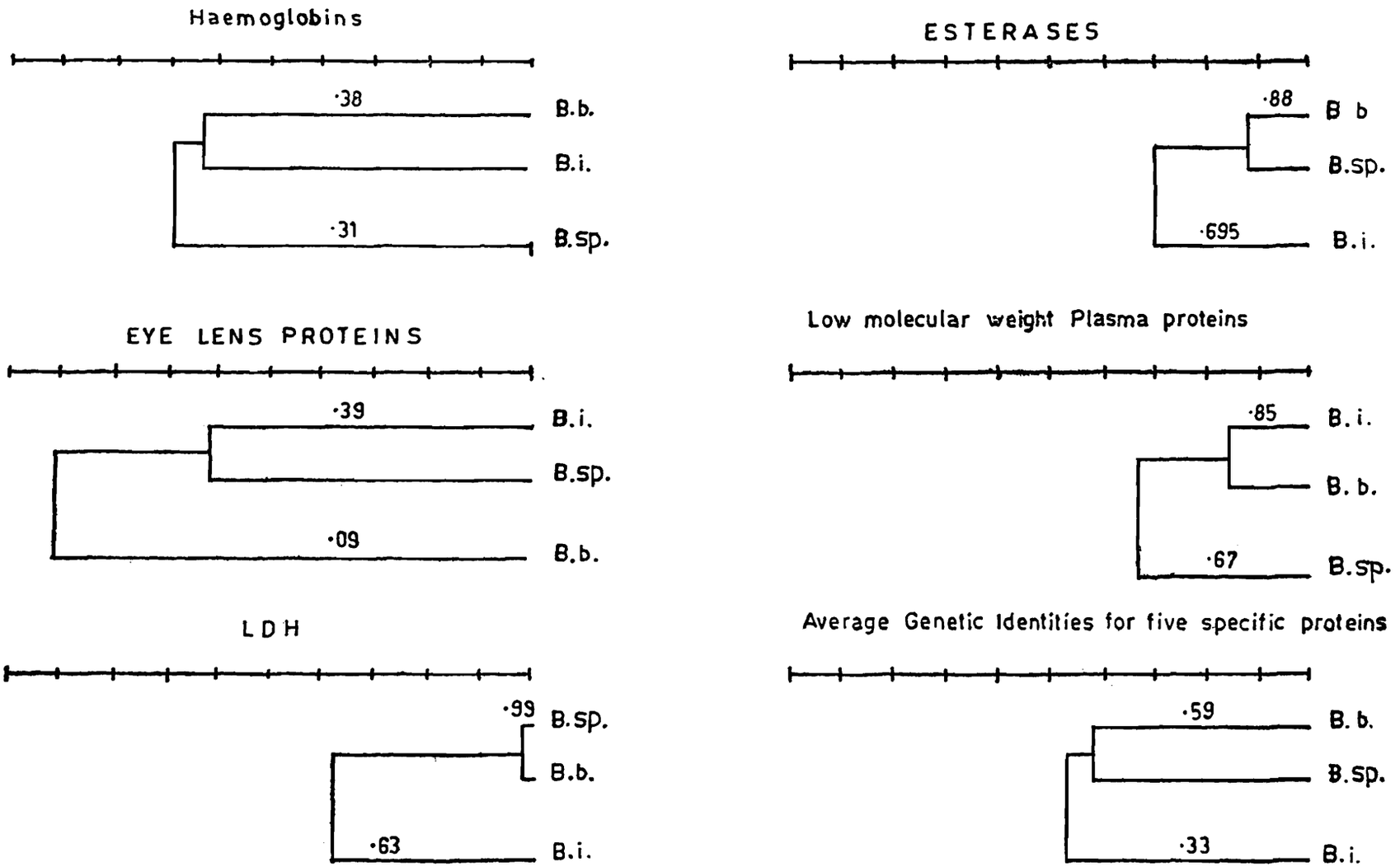


TABLE No. 1

Table showing the measurements with S. D. and relative percentages of different key characters of *Bandicota* sp. and the Indian subspecies of *B. indica* (Bech.)

Type		Head + Body	Hind foot	Occipito-nasal	Condylo-basal	Nasals	Palate	Molar tooth row (upper)	Bullae	anterior palatal foramina	zygomatic width	inter orbital width	mandibles	diastema
Bandicota sp. n=20	Range	250.0-370.0	55.0-63.0	58.5-68.1	57.2-67.9	23.3-27.0	37.2-40.2	10.0-10.3	8.9-10.0	10.1-12.6	31.2-36.5	8.6-9.6	35.0-38.8	19.0-21.6
	Mean (X)	314.71	59.42	62.6	61.62	24.55	38.12	10.18	9.66	11.15	33.14	9.1	37.08	20.28
	Standard Deviation	±30.26	±3.14	±2.71	±2.96	±1.56	±1.08	–	±0.41	±1.04	±1.42	±0.36	±1.37	±0.85
	Percentage (of HB/on)	100%	18.91%	100%	98.43%	39.22%	60.89%	16.26%	15.43%	17.81%	52.92%	14.21%	59.22%	32.31%
B. i. malabarica (Shaw) n=45	Range	270 0-305.0	53.0-61.0	57.5-61.2	59.0-63.4	23.5-26.6	36.2-37.7	10.2-10.4	8.8-10.0	9.8-11.8	30.7-35.5	8.6-9.3	34.7-37.5	19.5-22.0
	Mean (X)	284.3	56.16	59.04	60.88	24.28	36.67	10.27	9.3	11.1	31.97	8.9	36.06	20.4
	Standard Deviation	±10.14	±3.02	±1.15	±1.37	±2.82	±0.60	–	±0.56	±0.63	±1.01	±0.23	±1.15	±0.95
	Percentage (of HB/on)	100%	19.74%	100%	103.11%	41.19%	62.05%	17.39%	18.79%	18.79%	54.15%	15.08%	61.08%	34.51%
B. i. indica (Bechstein) n=15	Range	208.0-267.0	50.0-57.0	48.0-55.8	48.8-56.5	18.5-20.1	29.2-32.0	10.0-10.3	8.2-9.4	8.9-9 4	25.5-30.4	7.8-8.0	–	15.1-18.0
	Mean (X)	233.33	52.83	51.4	52.18	19.4	30.35	10.2	8.8	9.15	27.66	7.85	–	16.12
	Standard Deviation	±23.99	±2.74	±2.72	±2.93	±0.67	±1.05	–	±0.45	±0.22	±1.74	±0.007	–	±1.10
	Percentage (of HB/on)	100%	22.64%	100%	101.51%	37.74%	39.06%	19.84%	17.12%	17.82%	53.81%	15.27%	–	31.36%
B. i. nemorivaga (Hodgson) n=20	Range	245.0-290.0	48.0-51.0	53.5-57.7	54.3-57.6	20.0-21.0	32.3-34 4	9.2-10.0	9.0-10. 0	9.6-11.2	29.7-31.9	7.2-7.9	32.4-35.5	17.2-18.1
	Mean	270.0	50.0	56.27	56.67	20.52	33.75	9.62	9.45	10.65	30.6	7.63	34.43	17.65
	Standard Deviation	±25.0	±2.25	±1.63	±1.37	±0.43	±0.87	–	±0.36	±0.64	±0.80	±0.27	±1.72	±0.33
	Percentage (of HB/on)	100%	18.52%	100%	100.71%	36.48%	59.98%	17.09%	16.77%	18.92%	54.38%	13.56%	61.19%	31.36%

Table No. 2

Morphological differences between *Bandicota* sp. & *B. indica*

Bandicota sp.	*Bandicota indica*
1. Hindfoot exceeds 57 mm in adults.	Hindfoot less than 57 mm except in *malabarica* where it sometimes exceeds 57 mm.
2. Occipitonasal length exceeds or equal to condylobasal length.	Occipitonasal length less than condylobasal length.
3. Zygomatic width in adulth less than 53.6% of occipitonasal.	Zygomatic width in adults more than 53.6% of occipitonasal.
4. Mandibular length below 60% of occipitonasal length.	Mandibular length exceeds 60% of occipitonasal length.
5. Occiput inflated, ridges less prominent.	Occiput flattened, ridges prominent.

Table No. 3

Morphological differences between subspecies of *Bandicota indica* (*indica*, *malabarica* and *nemorivaga*).

B. i. malabarica	*B. i. indica*	*B. i. nemorivaga*
1. Hindfoot less than 20% of head & body length.	Hindfoot exceeds 20% of head & body length.	Hindfoot less than 20% of head & body length.
2. Nasals exceed 40% of occipitonasal length.	Nasals below 40% of occipitonasal length.	Nasals below 40% of occipitonasal length.
3. Zygomatic width less than 55% of occipitonasal length.	Zygomatic width less than 55% of occipitonasal length.	Zygsmatic width exceeds 55% of occipitonasal length.
4. Diastema more than one-third of occipitonasal length.	Diastema less than one-third of occipitonasal length.	Diastema less than one third of occipitonasal length.
5. Palate more than 35 mm in length in adults.	Palate less than 32 mm in length in adults.	Palate 32-35 mm in length in adults.
6. Occipitonasal length in adults more than 58 mm.	Occipitonsal length in adults less than 58 mm.	Occipitonasal length may cross 58 mm in adults.

Table No. 4

Genetic Identities (above diagonal) and Genetic Distances (below diagonal) for the locii representing five specific proteins of the three *Bandicota* species in question.

Haemoglobins
(from Pradhan et al. 1989)

Species	*B. b.*	*B.i.*	*B.* sp.
B. b.	–	0.38	0.28
B. i.	0.98	–	0.35
B. sp.	1.27	1.05	–

L D H

Species	*B. b.*	*B. i.*	*B.* sp.
B. b.	–	0.63	0.99
B. i.	0.46	–	0.63
B. sp.	0.01	0.46	–

Low molecular weight
Plasma Proteins

Species	*B. b.*	*B. i.*	*B.* sp.
B. b.	–	0.85	0.70
B. i.	0.16	–	0.64
B. sp.	0.36	0.45	–

Eye lens proteins
(From Pradhan *et. al.* 1989)

Species	*B. b.*	*B. i.*	*B.* sp.
B. b.	–	0.06	0.12
B. i.	2.12	–	0.39
B. sp.	2.81	0.85	–

Esterases

Species	*B. b.*	*B. i.*	*B.* sp.
B. b.	–	0.65	0.88
B. i.	0.43	–	0.74
B. sp.	0.13	0.30	–

Average Genetic Identities
for all the five proteins

Species	*B. b.*	*B. i.*	*B.* sp.
B. b.	–	0.51	0.59
B. i.	0.67	–	0.55
B. sp.	0.53	0.60	–

HAIR SCULPTURE

The pattern of hair was analysed on the basis of nomenclature given by Brunner and Coman (1974) and Keogh (1983, 1985). Recently, Ingale (1986) studied hair sculpture pattern of some rodents using SEM, and used the patterns to establish phylogenetic relationships amongst them. The hair sculpture and scale patterns of *Bandicota indica* and *Bandicota* sp. are represented in Pls. I and II. Under low magnification, the hair of *B. indica* shows an irregular waved mosaic pattern at near base and half-way mark. There are not more than two scales across the width of the hair. The scales are of fairly uniform depth. The margins of the scales are slightly rippled and crenate. A very shallow groove on the hair is also visible at lower magnification. The scale margins appear to be distant. The scale characteristics more or less remain constant even in the near apical region of the hair, however, due to

reduction in diameter, the number of scales across the width of the hair is further reduced to one scale.

The hair of *Bandicota* sp. (Plates I & II) exhibits a distinct chevron pattern which in the near middle region appears double chevron. Thus, there is only one scale across the width of the hair in the basal and the near middle regions. The scales are wider then deep and their ends overlap the base in front. The margins of the scale are almost smooth at lower magnification. Though the general scale pattern remains more or less identical in the middle and apical regions, the margin patterns become sharper in the near middle region.

The scale pattern in the hair of *Bandicota bengalensis* (*vide* Ingale, 1986) is petaloid, with several scales across the width of the hair. Scales are of uniform size and have crenate margins. Thus the pattern of scales in *Bandicota bengalensis* does not match with those exhibited by *Bandicota indica* and *Bandicota* sp.

The differences on the scale pattern observed in the present study on *B. indica* and *Bandicota* sp. are very distinct, waved mosiac (Plate 1A) and chevron (Plate 1B) respectively.

Conclusion

From the above study it is clear that four populations of the large-sized bandicoot rats occur in India, which differ from each other in one or more characters (Tables 1-4, figs. 2-5). The three, namely, *indica*, *nemorivaga* and *malabarica* are allopatric in distribution, hence, treated here as three subspecies of *Bandicota indica* ; *malabarica* occurring in Western Ghats, *nemorivaga* in West Bengal and northeastern India and *indica* in the rest of India.

The fourth population of the large-sized bandicoot rats is India wide in distribution and differs from the other three (*indica*, *nemorivaga* and *malabarica*) together in the structure of skull, biochemical characters and hair-sculpture. Hence, the same is described below as a new species.

Systematic Account

Pradhan *et al.* (1989) described this population of large-sized bandicoot rats as *Bandicota gigantea non* Hardwicke. But since the skull of the type of *B. gigantea* present in the British Museum is broken, it is not possible to confirm (the main key character), whether the ONL was more than CBL in that specimen or not. Hence, it is described here as a new species.

Bandicota maxima sp. nov.

Material examined : Holotype : ZSI/WRS, Reg. No. M/98, adult female ; Nanapeth, Pune, Maharashtra ; 3 Aug 1977 ; collected by M. S. Pradhan.

Paratypes : ZSI/WRS Reg. No. M/125 ; adult female ; Raviwarpeth, Pune, Maharashtra ; 8 May 1979 ; collected by M. S. Pradhan. ZSI/WRS Reg. V/1182 ; adult male ; Barisha, 24 Parganas district, West Bengal ; 14 Jan 1980 ; collected by A. K. Mondal.

All the collections are deposited at the Western Regional Station, Zoological Survey of India, Pune. All measurements are in millimetre (Table 5).

Description : A very large-sized rat (Fig. 8), with triangular head, rounded snout, and tail shorter than head and body length. Body covered with smooth coarse

Table No. 5

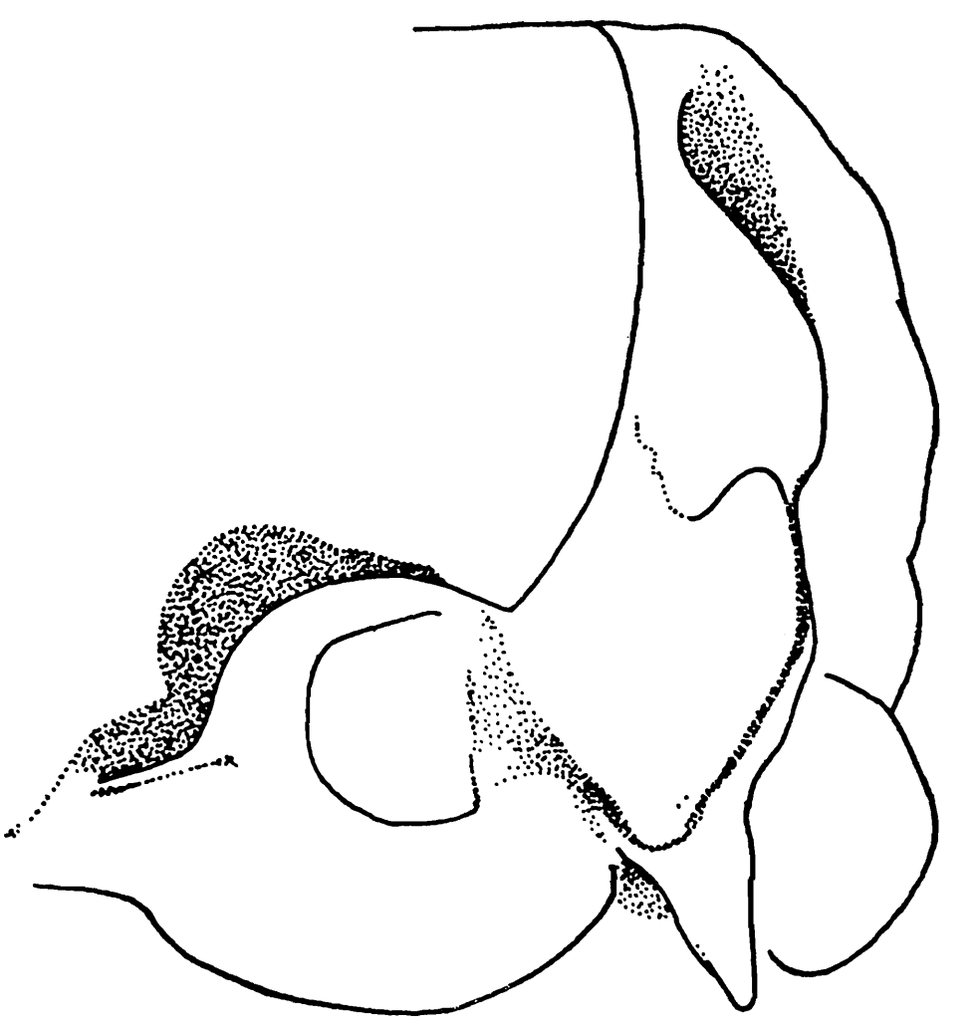
Measurements of type series
(All measurements in mm.)

Measurements	Holotype	Paratypes	
	1 ♀	1 ♀	1 ♂
External :			
Head+Body	370	292	340
Tail	290+	271	280
Hindfoot	63	58	55
Ear	33	31	23
Cranial :			
Occipitonasal	67.8	62.4	59.7
Condylobasal	67.6	61.6	58.8
Nasal	27.0	23.3	24.1
Interorbital width	9.6	8.5	9.0
Zygomatic width	36.5	32.1	31.7
Palate	40.2	38.1	35.3
Molar teeth row	10.2	10.2	10.2
Bullae	9.8	10.0	8.9
Diastema	21.6	19.9	19.0
Palatal foramina	12.6	12.0	10.8

fur ; long bristles present in hind quarter. Tail thinly covered with short hairs but has a leathery texture due to presence of broken scales along its entire length. Dorsal colour varies from dark slaty to light brown, ventral greyish white ; specimens from Calcutta lighter in overall coloration than those from Bombay-Pune region. Tail dark and unicoloured. Thumb rudimentary but with a blunt claw. Legs having 5 toes, studded with prominent claws. Soles dark, bearing six plantar pads. Mammae 3+3 =12.

FIG.12

Occiput region of B. maxima sp.n. (M/98)



Skull (Figs. 12-14 and Table 5) more or less similar to that of *Bandicota indica* except the swollen occiput (Fig. 7). Occipito nasal length equal to or more than

condylobasal length ; interparietal prominent ; palatal foramina long, more than 10 mm

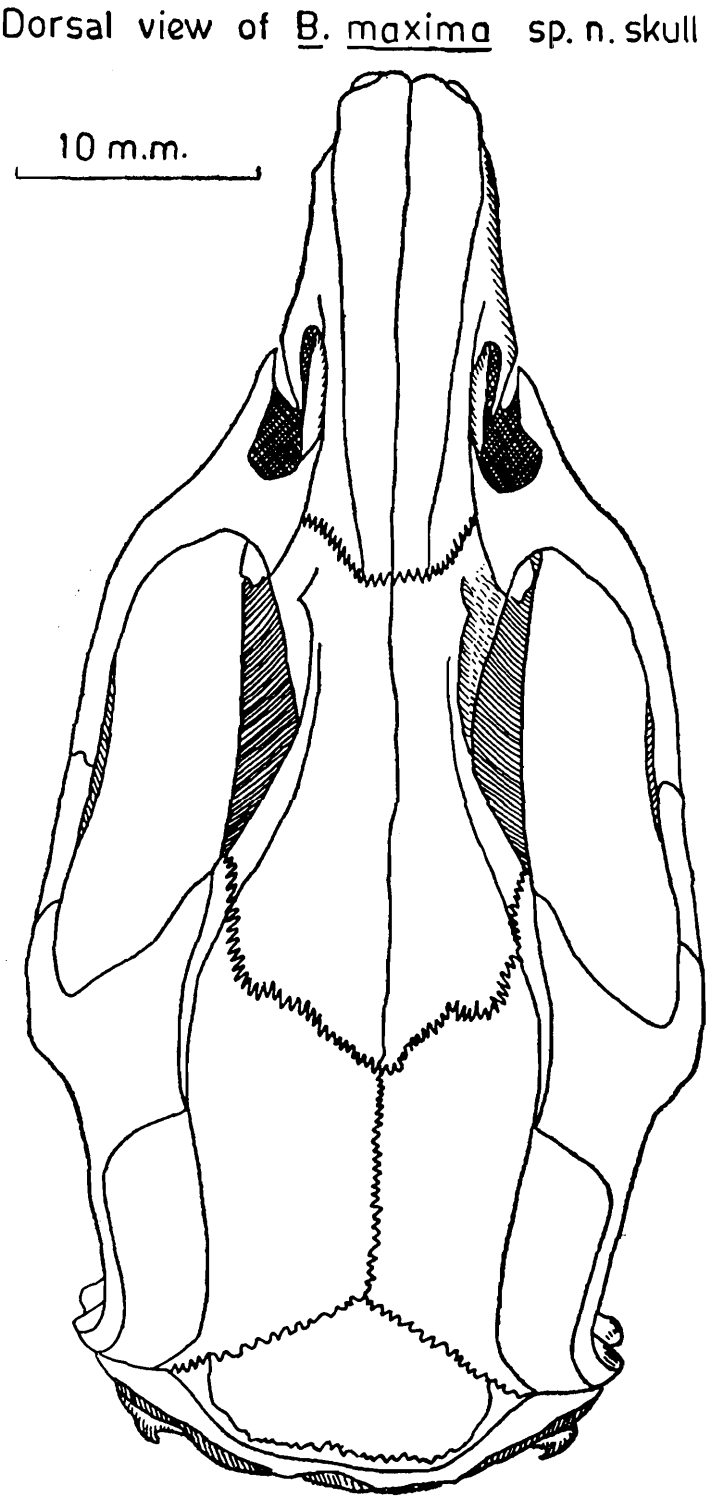


FIG. 13

or more than 18% of occipitonasal length. Postero-internal (7th) cusp present in first and second upper molars.

Hair sculpture : Hair of *Bandicota maxima* exhibits distinct chevron pattern (Wildman, 1954) as against irregularly waved mosaic pattern in *Bandicota indica*.

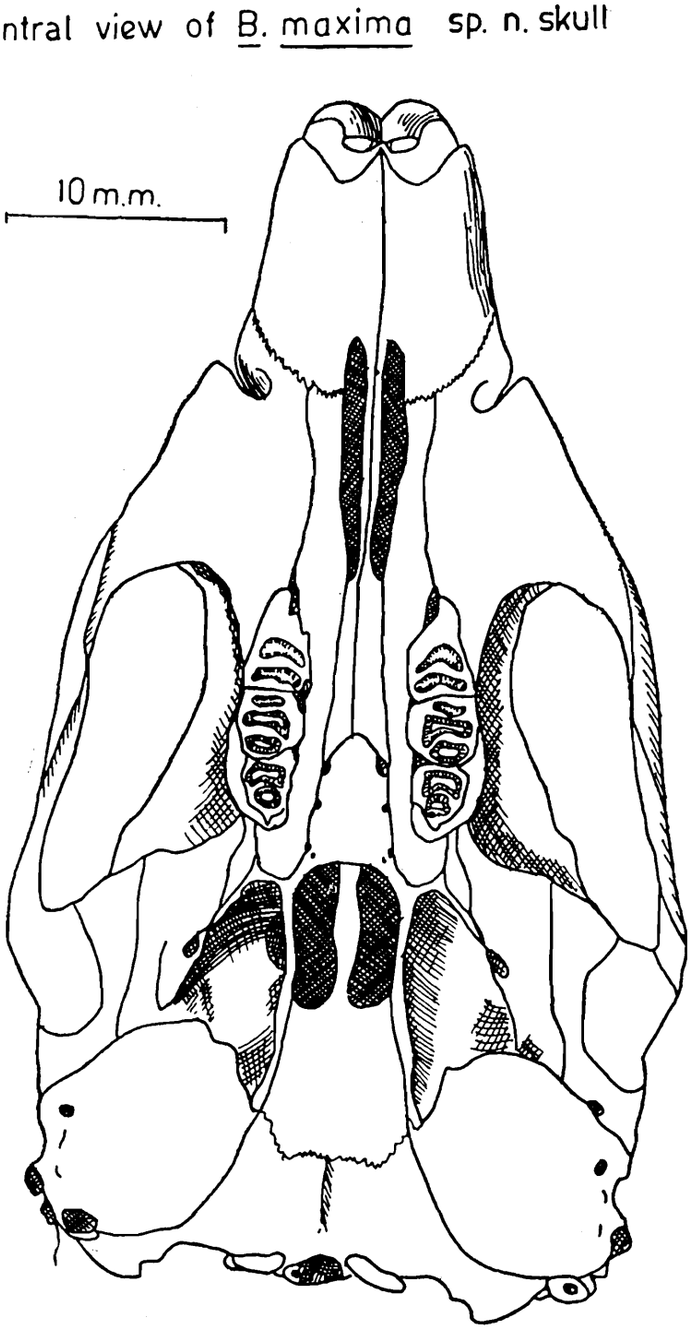


FIG. 14

Relationship : *Bandicota maxima* comes close to *Bandicota indica* but differs from it in the occipito nasal length of skull being more than condylobasal, and chevron type of hair sculpture pattern.

Distribution : The species was recorded from Gujarat, Maharashtra, Rajasthan, Karnataka, Kerala, Andhra Pradesh and West Bengal ; also Nepal and Bangladesh. Hence, its distribution appears to be throughout India.

Habitat : *Bandicota maxima* normally occurs near human habitation and lead epizotic life. It is nocturnal and fossorial. It makes burrows in open yards, gardens, under the foundations of residential premises, granaries, store houses, etc. Its preferred food is grains and vegetables but can switch over to other diet.

To accommodate the new species *Bandicota maxima*, the genus *Bandicota* may be redefined as large rats having proodont / orthodont incisors, condylobasal length may or may not exceed occipitonasal length, anterior palatal foramina more than 6.5 mm or over 15% of ONL, and the postero-internal cusp present in first and second upper molars.

Key to species of genus *Bandicota*

1.	Occipitonasal length, in Indian species, less than 45 mm ; Zygomatic width more than 57%, bulla more than 20%, and nasals less than one-third of occipito-nasal length. ...	*B. bengalensis*
	Occipitonasal length more than 45 mm ; Zygomatic width less than 57%, bulla less than 20%, and nasals more than one-third of occipitonasal length. ...	2
2.	Occipitonasal length less than condylobasal length ; sculpture pattern of dorsal hair mozaic (at lower magnification). ...	*B. indica*
	Occipitonasal length equal to or more than condylobasal length ; sculpture pattern of dorsal hair chevron (at lower magnification). ...	*B. maxima*

Key to Indian subspecies of *Bandicota indica*

1.	Nasals and diastema exceeds 40% and 33% of ONL respectively. ...	*B. i. malabarica*
	Nasals and diastema less than 40% and 33% of ONL respectively. ...	2

2.	Zygomatic width less than 55% of ONL ; hindfoot more than one-fifth of head and body length. ...	*B. i. indica*
	Zygomatic width more than 55% of ONL ; hindfoot less than one-fifth of head and body length. ...	*B. i. nemorivaga*

Summary

Rodent genus *Bandicota* was split earlier, into a number of species. Ellerman (1961) reduced the number and merged all species into two species *viz. B. bengalensis* and *B. indica*. His studies were based on the British Museum material. However, it has been found out by the present workers that it is rather difficult to allot any taxonomic status to the freshly collected bandicoot material based an Ellerman's keys (1961). It was, then, decided to undertake a detailed comparative osteo-morphological, biochemical and hair impression analysis studies of such a bandicoot population which is not fitting in Ellerman's keys. The studies show that large-sized bandicoot rat populations belong to a separate species. This species has been named as *B. maxima*. Keys to the identification and description of the new species have also been given in the present communication.

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