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Discovery of microvertebrates from the Pleistocene deposits of the Central Narmada Valley, India

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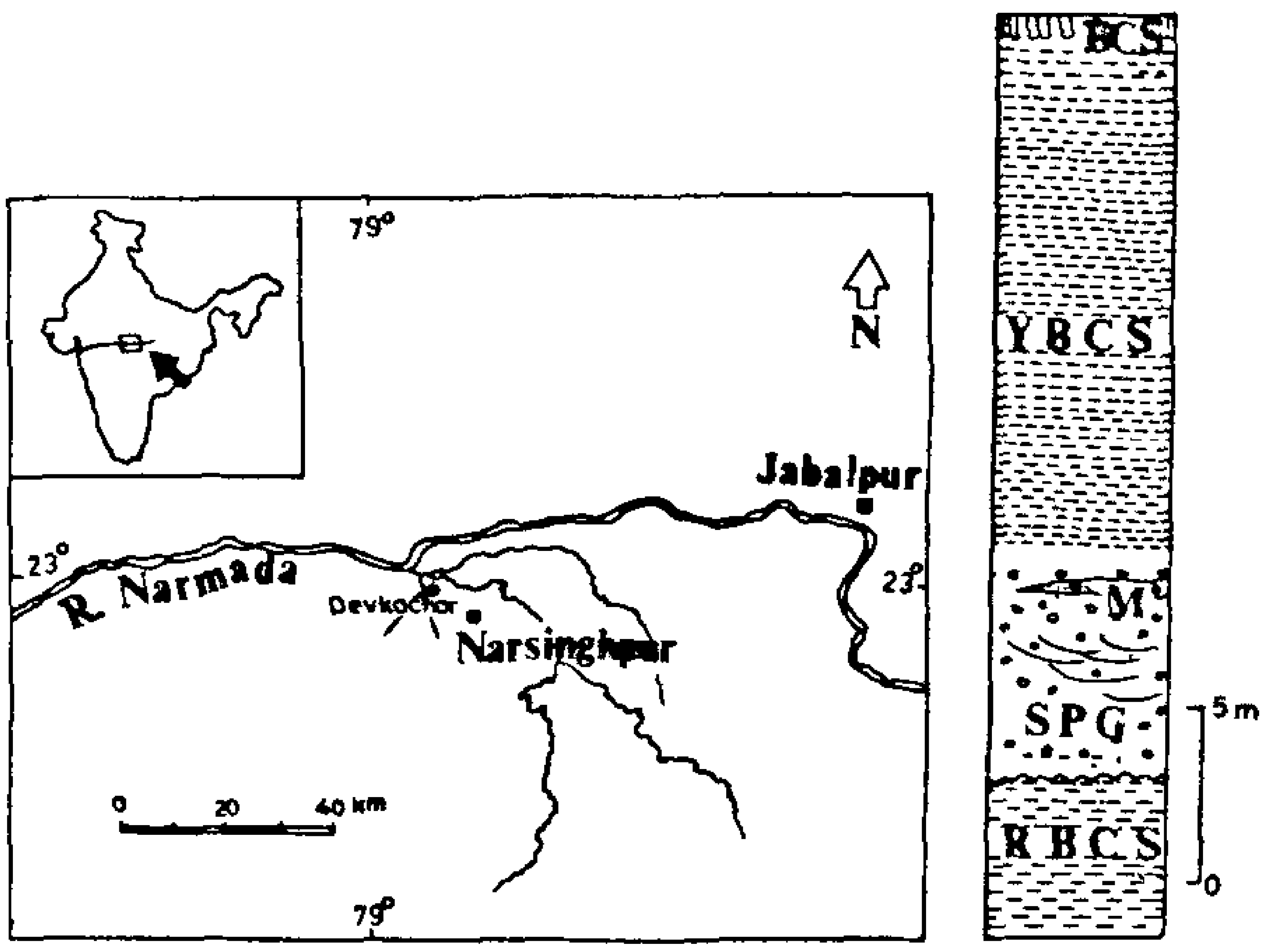
Pleistocene sediments of the Central Narmada Valley, Madhya Pradesh, widely known for their wealth of large vertebrates[1–4], have yielded a partial hominid skull[4,5] and an array of Stone Age implements[6] for the first time, along with a diverse microvertebrate assemblage (micromammals, fish, amphibian and reptiles) during the 1991–92 field season. Preliminary taphonomical investigations reveal that the small mammal remains, primarily derived from scats, were deposited by fluvial processes. Faunal assemblage suggests the presence of sandy plains, grasslands with high sub-soil moisture content and shallow stream systems. Rodents like *Millardia* cf. *M. meltada*, *Bandicota* cf. *B. bengalensis*, *Tatera* cf. *T. indica* and *Gerbillus* sp. indicate an early emergence of the modern rodents of the Indian subcontinent.

THE present announcement marks the first report of fossil microvertebrates from the Pleistocene sediments of the Central Narmada Valley. It may be noted that taphonomical and palaeoecological interpretations of the Central Narmada Valley were so far based on large mammal assemblages[7,8]. However, due to the absence of fossil microfauna, paleoecological interpretations could not be deduced with precision. In this context, the recent discovery of microvertebrate assemblage from the Narmada Valley assumes greater significance. The present collection (Table 1) comes from a freshwater mollusc-bearing pebbly horizon (Figure 1 *b*) exposed near village Devakachar (23°23′N: 79°07′E) in Distt. Narsinghpur of Madhya Pradesh state (Figure 1 *a*).

As regards the chronological framework for the fossil occurrences, the molluscan shells (collected around Devakachar) were earlier analysed for ^{14}C dating, which yielded a radiocarbon date[9] of $31,750^{+1820}_{-1625}$ BP. Apart from this, based on fluorine/phosphate correlation[10], palaeomagnetic studies[11], percentage of nitrogen (late K. P. Oakley, personal communication) and occurrence of fossilized remains of large mammals like *Cervus duvauceli*, *Hexaprotodon palaeindicus*, *Elephas hysudricus*, *Bubalus* cf. *B. bubalis*, *Equus namadicus* and *Bos namadicus*[8,12], the fossiliferous sediments at Devakachar were assigned a Middle to Upper Pleistocene time bracket.



a *b*

Figure 1. Locality map (*a*) and lithostratigraphy (*b*) at Devakachar (after Badam and Grigson[24]) BCS (black cotton soil), YBCS (yellow brown concretionary silt), M (microvertebrate-yielding horizon), SPG (sandy pebbly gravel) and RBCS (red brown concretionary silt)

[†]For correspondence

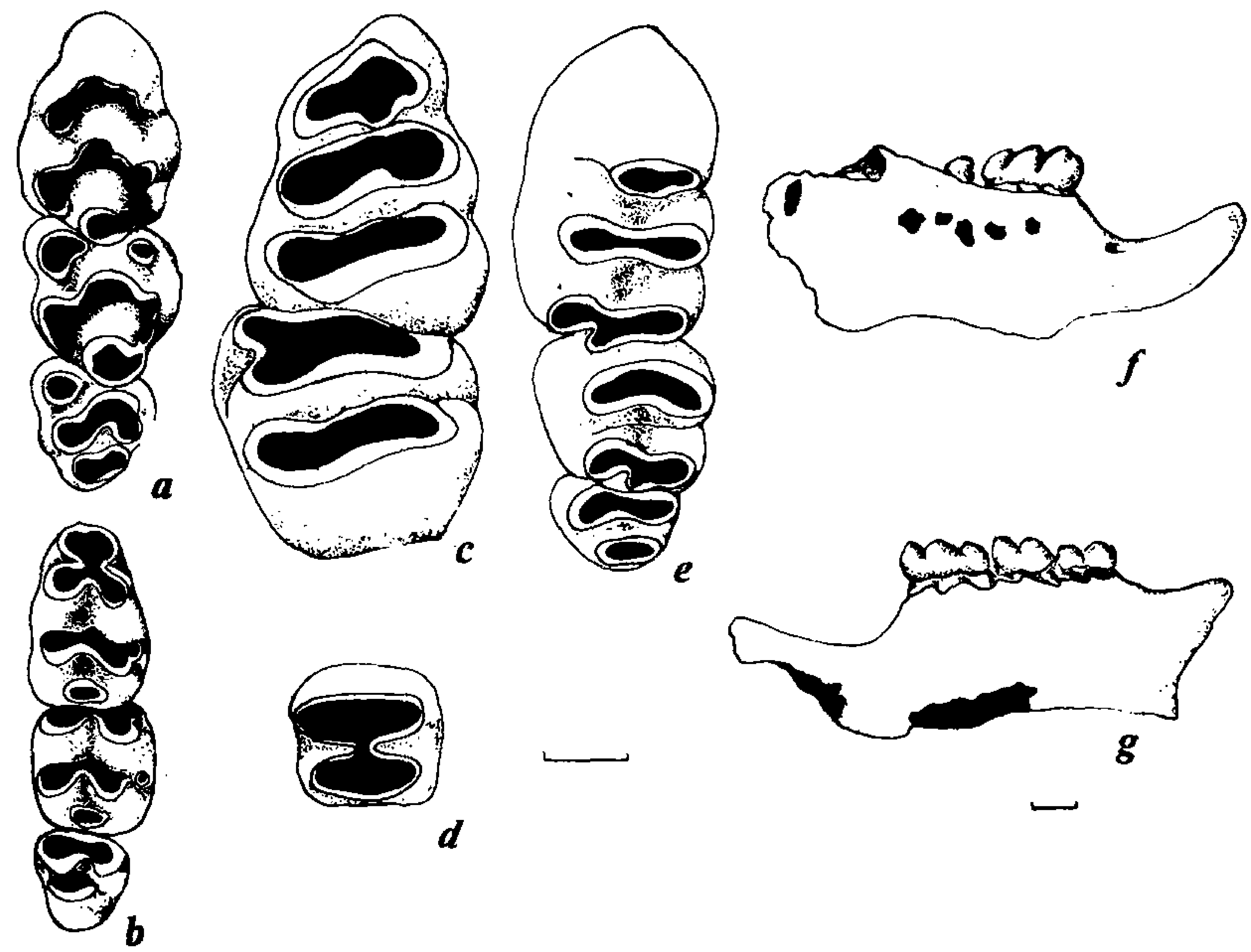


Figure 2. *a* and *b*, Occlusal views of the upper and the lower molars of *Millardia* cf *M meltada*, *c*, occlusal view of lower M1, M2 of *Bandicota* cf *B bengalensis*. *d*, occlusal view of upper M2 of *Gerbillus* sp , *e*, occlusal view of upper M1, M2, M3 of *Tatera* cf *T indica*, *f* and *g*, lateral views of the lower jaws of *Millardia* cf *M. meltada* (bars represent 1 mm)

Table 1. List of microvertebrates recorded from Devakachar

Mammalia
- Rodentia
  - Muridae
    - *Millardia* cf *M meltada* Gray
    - *Bandicota* cf *B bengalensis* Gray and Hardwicke
    - cf *Mus*
  - Cricetidae
    - *Tatera* cf *T indica* Hardwicke
    - *Gerbillus* sp indet
- Insectivora
  - Soricidae indet
- Reptilia
  - Crocodilidae
    - *Crocodylus* sp indet
  - Chilonidae
    - cf *Trionyx*

Pisces
- Cyprinidae
  - *Cyprinus* cf *C carpio communis*
  - (subspecies of *Cyprinus carpio* Linn)

Amphibia
- Anura
  - ?cf *Rana*

Table 2. Numbers and proportional percentage of small mammal skeletal elements

Elements	Number	Percentage
Skull	1	0.19
Mandible	37	7.25
Maxilla	22	4.31
Incisor	223	43.72
Molar	4	0.78
Scapula	6	1.17
Humerus	44	8.62
Radius	30	5.88
Ulna	12	2.35
Vertebrae	7	1.37
Pelvis	8	1.56
Femur	50	9.80
Tibia	53	10.39
Calcaneum	1	0.19
Metapodials	12	2.35

Several comprehensive experiments carried out on scatological and fluvial microvertebrate accumulations[13–17] provide the bases of interpretations in the present communication. The micromammal assemblage under consideration comprises a high percentage of complete limb bones, of which a few show angular breakages. Bones like femora, scapulae and humerii show frequent abrasion of their ends and processes. Most of the mandibles have their angle, coronoid and condyle worn out and commonly the sockets of the molars and pulp cavity for the incisors show holes at the base (Figure 2*f*, *g*). There is a higher proportional representation of incisors, tibia, femur and humerus, respectively (Table 2). The distribution of skeletal elements shows almost an entire range of skeletal parts, together with those of fish, turtle, crocodile and frog (Table 1), well-rounded pebbles and concretions and haphazardly oriented molluscan shells. The nature and the extent of breakage, wearing and abrasion observed on the skeletal parts indicate a scatological origin. A comparison of the proportional percentage representation with skeletal elements in some of the Pleistocene microvertebrate accumulations[14] suggests that the present microvertebrate remains might have been transported, sorted and finally deposited fluvially in a stream channel area. Large vertebrate fauna (in addition to those mentioned earlier, *Panthera leo*, *Panthera tigris*, *Panthera pardus* (?), *Canis aureus*, *Rhinoceros* sp., *Stegodon insignis ganesa*, *Elephas namadicus*, *Hexaprotodon namadicus*, *Sus* sp., *Antilope cervicapra*, *Cervus* sp., *Axis axis*, etc.) indicates the presence of open grasslands and wooded grasslands interspersed with perennial rivers and swamps[8]. Since most of the taxa in the present collection of microvertebrates closely resemble the living forms, the preliminary interpretations of palaeoecology are based on the principle of actualism. Rodents like *Tatera indica* and *Gerbillus indus* prefer sandy plains and interdunal areas[18]. African *Tatera* is found primarily in dry steppic countries and sometimes in thickets along the edges of alluvial flats[19, 20]. *Bandicota bengalensis* and *Millardia meltada* are found in croplands where the sub-soil moisture is very high throughout the year. The latter sometimes prefer heavy shrubs and rocky terrains[21]. *Cyprinus*, *Crocodylus*, *Trionyx* and *Rana* are commonly associated with freshwater stream systems.

Tatera indica, *Gerbillus indus*, *Bandicota bengalensis* and *Millardia meltada* are presently widespread all over the Indian subcontinent[22]. The molars of *Tatera* cf. *T. indica* and *Gerbillus* sp. (Figure 2 *d*, *e*) resemble those of *Protatera* cf. *P. kabulense* reported from Late Pliocene of Siwaliks. *Bandicota* cf. *B. bengalensis* and *Millardia* cf. *M. meltada* (Figure 2 *a–c*) may have had some relationships with *Bandicota sivalensis* and cf. *Millardia*[23] from Upper Siwaliks. However, keeping in view the relatively meagre record of fossil micromammals, interrelationship of Narmada and Siwalik rodents cannot be ascertained at the present state of our knowledge.

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Daytime measurements of optical auroral emissions from Antarctica

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Optical methods have enabled us to detect auroral emissions during daytime conditions, and to identify a narrow latitudinal region of energetic particle precipitation from the Indian station Maitri (11°38'E; 70°45'S; 62.8°S I-lat.) in Antarctica. These observations are new. The energetic particles originate within the closed geomagnetic field lines close to the plasmapause region and maximize ~0830 h MLT (Magnetic Local Time) (~1200 UT). Enhanced proton precipitation activity could also be inferred during a moderate geomagnetic storm, suggesting the enhancement/activation of acceleration mechanisms during this event.

THE auroral phenomenon, which is caused by the interaction of high-energy charged particles with the atmospheric constituents is usually considered to be restricted to ±75° to ±80° magnetic latitudes in the dayside and ±65° to ±75° magnetic latitudes in the nightside of the earth. Due to the different locations of the geomagnetic