INTRODUCTION

Quaternary vertebrate palaeontological research has received a great impetus with the increase in the number of palaeontological discoveries, made over the last three decades. There is a remarkable change in the patterns of documentation of the fossil assemblages which display an increasing attention towards the methods of recovery, analysis of factors involved in the formation of palaeontological records and the basic problems of evaluating skeletal assemblages. Incorporated with recent advances, it has been possible to understand and evaluate diversity, community ecology and evolution in ancient ecosystems which has made palaeontological studies more meaningful.

Anatomy and taxonomy have been traditionally, the main areas of study in vertebrate palaeontology. These help in understanding the types of adaptations and habits of extinct species and throw light on their probable position in the evolutionary history. Taxonomy and descriptive palaeontology, augmented by ecological and biogeographic explanations, are imperative for a better understanding of the various problems faced by palaeontologists (Weller, 1965). The role and significance of fossils, as a source of environmental reconstruction, their distribution and migration which are controlled by changes, conditions has effectively brought out a comprehensive picture of the Pleistocene fauna in India.
These areas have become the focal points of multidisciplinary research for more than a century. It is in this context that the recent discovery of several fossil bearing sites in the Manjra Valley, in the Central Godavari basin, assumes great importance for the palaeobiogeographical distribution and possible migratory routes of large mammals during the early Quaternary.

River Manjra, a major southerly tributary of the Godavari, rises in the northern edge of the Balaghat plateau (18°53'45" N : 75°23'30" E), near Gaurwadi village in Bhir district of Maharashtra. It passes through parts of Bhir, Latur, Osmanabad and Nanded districts of Maharashtra; Bidar district of Karnataka; Sangareddi and Nizamabad districts of Andhra Pradesh, covering a distance of about 480 Km before joining Godavari at Kandakarti in Nizamabad district. The Manjra is essentially an easterly flowing river (at places south easterly) from its source, for a total distance of about 300 Km, but near Sangareddi it takes a right angle turn and flows northwards up to its confluence with the Godavari. The Balaghat range, a transverse offshoot of the western Ghats with south eastern trend, forms a major hill complex in the upper reaches of the Manjra. The region is covered by rolling plateaux. The Balaghat plateau is narrow and high with summits over 750 m in the northwest and gradually widens towards the southeast; lowering also in elevation to about 600 m. Dixit (1970) has suggested that the capture of Manjra river over the plateau of Balaghat by a tributary of the Godavari has resulted in the anomalous course of this river, which is
evident in its shift to right angle near Sangareddi in Andhra Pradesh. The occurrence of well developed erosional surfaces at 800 to 500 m MSL on the Deccan Traps and pre-Cambrian formations are attributed to the tectonic movements and climatic changes of the Neogene period (Dixit, 1970). During its long course, the Manjra passes through Cretaceous - Eocene Deccan Traps in the upper and middle streams while the Archaeans are met with in the lower reaches of the valley. Extensive laterite outcrop cappings of the Late Neogene age, are observed over Deccan Traps on the interfluve between the Manjra and Bhima rivers, in Bidar district of Karnataka.

A number of palaeontological sites viz., Tadula, (18°32'50" N : 76°23' E), Wangdari (18°33' N : 76°24'25" E), Ganjur (18°32'37" N : 76°24'40" E) and Dhanegaon (18°34'30" N : 76°09'32" E), in the upper streams and Yendikol and in the lower Manjra Valley have been brought to light in recent years. However, the sites in the upper reaches are richer than those of the lower reaches.

Pleistocene formations in the area under consideration are of fluvial origin and are confined to broad and shallow valleys cut into lower pediplanned surfaces. The faunal material discovered from these deposits are represented by several medium to large types of herbivores, crocodiles, turtles and fresh water molluscan shells. These fossil yielding deposits have been dated to late Pleistocene on the basis of their comparative study with those of the main Godavari. Two c dates, obtained from Tadula and Wangdari,
further support the dating of these horizons to the late Pleistocene period.

A detailed systematic study of the diverse fossil fauna from the Upper Manjra Valley is undertaken in the present work. The aim is to evaluate the fossil assemblages through palaeological studies, in order to obtain a broader perspective for the palaeontological record. Earlier works carried out in the middle and lower reaches of the valley have brought forth the evidence of Middle Palaeolithic and Mesolithic tools. However, no such discovery has been made from the upper reaches so far. Efforts to find out such remains from the area of field study by the present author, have proved unsuccessful. The region is completely devoid of archaeological material, contemporary to the vertebrate fauna of late Pleistocene. Hence, it was thought necessary to shed more light on the animal history and its influence on the ecological interpretations of the faunal assemblages in the area under consideration.

PREVIOUS WORK

It is essential to summarise the contributions made by previous workers in the Godavari Valley, before we discuss the Manjra Valley. This would help towards a better understanding of the regional environment.

Eversince the discovery of an elephant skull from Paithan by General Twemlov in the middle of the 19th century and that of an agate artefact from the gravel near Paithan by
Wynne in 1863 (Oldham, 1868), Central Godavari basin has attracted several researchers in the field of palaeontology. However, one of the earliest systematic reports on the fossil bones was given by Pilgrim in 1905. He discovered the fossils of *Elephas namadicus* (*antiquus*), in association with those of *Hippopotamus palaeindicus*, *Equus namadicus*, crocodilian teeth and molluscan shells from the gravels exposed at Nandur-Madhameshwar (20°01' N : 74°11' E) in the Upper Godavari Valley. Based on comparable resemblance with the faunal assemblages found from Narmada, he assigned these areas to the time bracket of Pliocene to the Middle Pleistocene. Vrendenburg (1906) assigned the Older Alluvium of the Godavari to the early Pleistocene period, based on geomorphological and palaeontological evidence.

As early as in 1943, Sankalla conducted a systematic survey in the upper Godavari and its tributaries. He discovered implementiferous and fossiliferous gravel deposits at Nandur-Madhameshwar, and assigned these deposits to the Middle Pleistocene. Further, Sankalia (1952) brought to light three Acheulian sites and an insitu assemblage of about sixty artefacts. Zeuner (1950) examined the cliff sections of Godavari and its tributaries viz., Vaitarna, Kadva etc and advocated two cycles of fluviatile aggradation separated by an erosional phase in the Upper Godavari system. Further, he suggested that Godavari has shifted its course from north to south which may be attributed to the tectonic activity or upliftment of the Godavari basin due to aggradation.
Excavations were carried out (Joshi et al. 1966) in an extensive gravel and cross bedded sandy deposit, lying on red clay and overlain by dark brown silt, at Gangapur. Mandibular fragments of Bos namadicus in association with Acheulian artefacts were discovered from this region. The excavators (Joshi et al., 1966) assigned these findings to the Middle Pleistocene period.

One of the significant palaeontological discovery was made by Tripathy (1967), who discovered a rich assemblage of Bos namadicus, Bubalus palearindicus, Equus namadicus, Hexaprotodon namadicus, Palaeoloxodon namadicus, Stegodon insignis, Crocodylus sp. and molluscan shells, with Upper Palaeolithic and Acheulian tools. Comparing the archaeological and palaeontological findings from Narmada, he suggested a Middle Pleistocene age for the Godavari Alluvium. These observations have been further substantiated by new discoveries and fresh theory (Joshi et al., 1978; Badam, 1979; Rajaguru, 1983; Rajaguru and Badam, 1984 and kumar, 1985).

Middle Palaeolithic tools have been reported from the high level gravel at Paithan (Joshi et al. 1978), suggesting their higher antiquity (> 40,000 yrs B.P.). Rajaguru (1983), on the basis of geoarchaeological investigations in the river valleys of Krishna, Godavari and Bhima, suggested that the climatic conditions during the deposition of sediments in the late Pleistocene were primarily of semi-arid type with streams flooding their valleys during short, but torrential rains of south-western monsoons.
Palaeontological reports mostly concern the taxonomic
details, and palaeoecological inferences are based on
megafossils. Badam (1979) gave a comprehensive account of
vertebrate fossil material from major fossiliferous sites
located in several Peninsular river valleys. This area has
been subjected to extensive research for the reconstruction of
biocoenoses and has been assigned a temporal frame from the
late Middle Pleistocene to the early Holocene. Badam (1985) is
of the opinion that the fauna belonging specifically to Bos
namadicus, Equus namadicus, Elephas namadicus and Elephas
maximus is not older than late Pleistocene, and appears to be
the holdovers of Middle Pleistocene times. The tentative
14
dating is supported by a few C assays on fresh water shells
and drift wood found from the source region of the Godavari
(Rajaguru and Badam, 1984). One of the most comprehensive and
multidisciplinary study was carried out recently by Arun
kumar (1985). Through the application of various modern
techniques in geomorphology and palaeontology, he has shown
that the Gangapur Acheulian industry can be dated to late
Pleistocene. This is further supported radiometrically (26,635
\( \pm \) 425 B.P.) at Nandur – Madhameshwar. In his exhaustive
treatment of the Bos sp., he suggested that the evolution and
progressive nature of Palaeolithic culture, does not reflect
any concomitant micro / macro – morphological changes in their
dental pattern. However, cranial indices and nonmetric
variables of skulls do help in such a distinction.
The Hanjra has yielded one of the most potential fossil bearing deposits in the Peninsular India and therefore a multidisciplinary UGC sponsored project was undertaken in late seventies to study the Quaternary geology, palaeontology and prehistoric cultures of the valley.

While discussing geological formations in this region (Joshi et al., 1981), it was explained that the earliest developed laterites found in the middle reaches are of late Tertiary or early Pleistocene age, and have in turn given rise to the laterites at lower levels, after subsequent cycles of erosion. Quaternary formations are not older than late Pleistocene and are comparable with the Older Alluvium of Upper Group of Central Narmada, Upper Godavari, Upper Bhima and the Upper Krishna. This is further substantiated by the palaeontological record which includes Elephas maximus, Bubalus palmicus, Cervus unicolor, C. duvaucelii, Equus namadicus (Badam, 1979; Joshi et al., 1981).

Evidence of cultural material indicates that the lower Manjra Valley was occupied by Middle Palaeolithic man, while Mesolithic culture existed throughout the valley during early Holocene times. Middle Palaeolithic sites, 11 in total, are distributed in the lower and middle reaches, yielding assemblages comprising of choppers, scrapers, points, borers, burin, flakes and cores chiefly made on chert and chalcedony. Mesolithic sites distributed throughout the valley are thirty four in number. The assemblage is represented by scrapers,
burins, blades, flakes and cores.

No record of Lower Palaeolithic and Upper Palaeolithic culture has been made in any part of the valley. However, typologically the Middle Palaeolithic from Nandikalli in lower reaches (total 27 in number), exhibit advanced Acheulian character (Joshi et al., 1981).

Some new fossil finds were described and their implications discussed while reconstructing the palaeoecology of the Upper Manjra Valley (Badam et al. 1984). Badam (1985) took into account the geomorphological evidence together with the fossil discoveries at Tadula, Wangdari, Dhanegaon and Ganjur, and advocated that the distribution of the various animals during the late Pleistocene was controlled by local ecological factors.

AIMS OF THE PRESENT STUDY

1. To study in detail the palaeontology of the megavertebrates collected from Manjra Valley and their palaeobiogeographical distribution in Indian context.

2. To study the palaeohistology of dental enamel of the Manjra vertebrates.

3. To find out ultrastructural relationships in the enamel of extinct and extant mammalian taxa and trace out phylogenetic relationships, if any, between them.
4. To highlight the importance of the Palaeolithic assemblage discovered in the lower and the middle reaches of the valley by earlier workers.

5. To reconstruct the palaeontology of the Upper Manjra basin on the basis of fossil evidence and geomorphological observations.

6. To study the nature of fossil assemblages by taphonomical processes.

FIELD AREA AND METHODOLOGY

Field investigations were carried out during four field seasons (1982 to 1985) in the upper streams of the proper Manjra. The total field area under consideration comprises an approximate stretch of 65 Km between Kallam (18°34'45" N : 76°01'15" E) and Latur (18°24’ N : 76°01’15” E) Osmanabad and Latur districts respectively.

The application of ecological data of extant biota, to the palaeontological record is a major operational foci of the present study. It involves the environmental interpretation of fossils, based on the habitat characteristics of the most closely related living taxa, an approach termed by Lawrence (1971) as "taxonomic uniformitarianism".

The methodology adopted in the present study comprises a number of interdependent disciplines which collectively help
Flowchart of the various components interdependently involved in present study.
In reconstructing biological environment of the region under consideration. As noted earlier, the analogy in terms of the osteological and ecological details of living descendants or survivors of the Pleistocene mammals, supplies information of great potential.

Descriptive palaeontology dealing with morphological details and the metrical analysis of fossil vertebrates is given an exhaustive treatment, in the study. This has increased our knowledge of the animal communities that might have lived in the Manjra Valley during the Upper Pleistocene.

A comparative study has been made in this research, between the cervids found from the Siwaliks of NW India, the Narmada Valley, and the Manjra Valley. Their living descendents have also been taken into account to analyse the phylogenetic history of the family cervidae. However, inadequate yield of the fossil fauna, remains a main deterrent for a complete analysis. It may also be mentioned that, because of the paucity of the cervid material in general and the lack of the complete specimens, it was not possible to give detailed comparative measurements of different species of cervids, referred to in the study.

The Scanning Electron Microscopy (SEM) of dental tissues is a recently initiated field of research in India. It assists in taxonomic studies by comparing the dental enamel ultrastructure of the various extinct and extant mammals. In the light of these recent researches, it has also helped in tracing possible phylogenetic relationships between extinct
and extant animal species, which hitherto depended upon the
gross morphological features in classical palaeontology. In
the present study, dental SEM analysis has been done on
several large extinct and living mammals viz., Dipotherium,
Stegodon insignis ganseen, Elephas hysudricus, Elephas maximus,
Leptobos, Bos namadicus, Bos indicus, Equus sivalensis,
Equus namadicus, Equus caballus and Hexaprotodon sp. Most of
the material was obtained by the author from the Manjra
Valley. These were compared in dental ultrastructural details
with various supposedly ancestral forms from the Siwaliks of
NW India (housed in Vertebrate Palaeontology laboratory, Dept.
of Geology, Panjab University, Chandigarh); Ghod Valley
(housed in Deccan College) and their living descendants. The
results are quite stimulating with regard to the phylogenetic
correlations. The results correspond to the inferences made by
earlier workers to establish links between the evolutionary
stages of proboscideans and other ungulates.

While discussing the palaeoecology of the upper Manjra
Valley during the Upper Pleistocene, there appears to be a
relative diverse floral and faunal abundance that was
controlled by the local ecological factors. The present study
postulates the existence of several forest refuges which
probably sheltered these animals to overcome the problem of
survival and migration. These elements play a vital role in
the overall animal community reconstruction and hence need to
be critically counter-examined and substantiated by relevant
examples.
As contended by Efremov (1940), Lawrence (1971a), Olson (1980), Dodd & Stanton (1981), Shipman (1981), the taphonomical studies are crucial and need to precede palaeoecological studies. They have gained a firm base in palaeontology over the last three decades. This proposes several variables for its role in understanding postmortem events on a death assemblage prior to final burial. Preliminary observations on the nature of faunal assemblage from Manjra Valley, in the context of geomorphological setting, has thrown some light on the Upper Pleistocene ecology of some areas in the Valley.

The epilogue constitutes the inferences derived from the synthesis of palaeontological and SEM studies, which has been integrated to focus upon the relevance of the problem taken up in the Manjra Valley.
Fig. 1: MAP SHOWING AREA OF RESEARCH IN THE MANJRA VALLEY
Fig. 2: LOCATION OF KALLAM AND THE FOSSIL SITE DHANEGARH
Fig. 4: Locality map showing fossil sites in a part of upper Manjra Valley.
Table 1
Site-wise distribution of fossils from the Upper Manjra Valley

<table>
<thead>
<tr>
<th>Species</th>
<th>Dhanegaon</th>
<th>Wangdarl</th>
<th>Tadula</th>
<th>Ganjur</th>
</tr>
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<tbody>
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<td>Stegodon insignis ganesa</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Elephas nysudricus</td>
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<td>+</td>
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<td>Elephas sp. (namadicus)</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
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<tr>
<td>Equus namadicus</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Hexaprotodon palaeindicus</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Antilope cervicapra</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
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<tr>
<td>Bos namadicus</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
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<tr>
<td>Bubalus palaeindicus</td>
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<td>+</td>
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<td>+</td>
<td>+</td>
<td>-</td>
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<tr>
<td>Cervus duvauceli</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Axis axis</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Crocodylus sp.</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Trionyx sp.</td>
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