INTRODUCTION

The following dissertation was undertaken to workout the biostratigraphy and microvertebrate palaeontology of the Lameta Formation (infratrappean) and Takli Formation (intertrappean) of the Nagpur region, Maharashtra. The primary objectives of the current research are:-

To measure sections of the ossiferous sequence in order to build up a framework for biostratigraphic work; to delineate the ossiferous horizon in the intertrappean beds and geologically map and trace these in the area concerned; to establish the faunal succession between the intertrappean vertebrate faunas with those of the intertrappean; to determine the age of the Lameta and Takli Formation on the basis of microvertebrate and microinvertebrate assemblages; to discuss the affinities of Lameta and Takli vertebrate assemblages to those in other vertebrate localities in the Indian subcontinent as well as from adjacent countries and lastly, to reconstruct the palaeogeography of the peninsular region during the Cretaceous-Palaeocene times with special reference to plate tectonic models.

Vertebrate biostratigraphical studies of the Lameta and Takli Formations of Nagpur District, Maharashtra are confined to a few localities, selected for their easy accessibility and good yield of fossils. In the wide area chosen, work was concentrated within the confines of Nagpur City itself, with additional studies
being undertaken within a radius of 50 kms (Text Fig.1). The intertrappean localities investigated are situated near Takli Police Line and Ambajheri within Nagpur City limits. The Lameta dinosaurs localities are at Udasa near Umrer coal field. During field work in the outskirts of Nagpur, a Pleistocene ossiferous gravels was recognized for the first time from the Ganda Nala about 9 km south of Nagpur.

The Takli Police Line is situated about 4 km northwest of Nagpur Railway Station and lies at Lat. 21° 0'9"; Long. 79° 04'19". Ambajheri is situated about 6 km southwest from the Nagpur Bus Stand. Other known localities around Nagpur are Sitabardi, Telankhedi, Seminary Hills and Putala Tank. At Kelod (Lat. 21°30', Long. 79°0'2"), the intertrappean beds are well exposed but are poor in microvertebrates. The intertrappean beds of these localities are horizontally bedded between Deccan Flow 1 and Flow 2.

The Lameta dinosaurian localities are at Udasa near Umrer coal field and lie at Lat. 20°52', Long. 79°21'. Udasa is situated about 39 km southwest of Nagpur Bus Stand on the Nagpur - Umrer road. The Lameta beds are also exposed in discontinuous thin bands of orthoquartzitic sandstone along Amrawati Road near Law College at Nagpur.

In India, outcrops of Cretaceous-Palaeocene sediments are also present in Assam, Simla, Jammu and Kashmir, Uttar Pradesh (Lalitpur), Andhra Pradesh (Asifabad, Rajahmundry, Narsapur), Maharashtra (Nagpur, Pisdura and Bombay), Gujarat (Kutch), and Rajasthan (Text Fig. 2).
TEXT FIG. 1 LOCATION MAP OF THE AREA SHOWING MEASURED SECTION LOCALITIES
TEXT FIG. 2 STRATIGRAPHIC CORRELATION OF CRETACEOUS TO EOCENE STRATA OF THE INDIAN SUBCONTINENT.
In peninsular India, the greater part of the Cretaceous-Palaeocene sequence is of freshwater origin. The type and standard section of Palaeocene marine rocks in the Indian subcontinent lies in Sind-Baluchistan Province of Pakistan. This area has been comprehensively examined by a number of workers for over a century and has been biostratigraphically zoned on the basis of foraminifera and ostracodes in great detail. In Sind-Baluchistan, the Ranikot Series shows an excellent development of Palaeocene rocks which are equivalent to the Rajahmundry and Nagpur intertrappeans, (Bhalla, 1965). However, no clearcut correlation exists between marine and non-marine sections of India in fact, and no independent non-marine Upper Cretaceous-Palaeocene section has yet been designated for biostratigraphic purposes in South Asia. This current work attempts to establish biostratigraphy of freshwater faunas during this time interval.

Pioneering work on the infra and intertrappean beds of the area was carried out by Voysey and Jenkins in 1829 (in Hislop and Hunter, 1855) and later by Hislop and Hunter (1855) Hislop (1860) Murray (1860), Jones (1860), Blanford (1872a), Lydekker (1890) and Prasad and Verma (1967). Recently, interest in these beds has been rejuvenated through the works of Bhatia and Mannikeri (1976), Sahni et al. (1982b) and Sahni et al. (1984).

Investigations of the Lameta and Takli vertebrate and invertebrate assemblages were carried out at Nagpur where a sequence ranging from Upper Cretaceous to Palaeocene is well exposed. The basement rocks are Archaean in age underlying the Lower Gondwana Group (comprising of Talchir, Barakar, Motur and
Kamthi Formations), the latter being well developed in the Nagpur region. The Lametas are Upper Cretaceous in age and are succeeded by basalt overlain by a thin but widespread lacustrine deposit. A Pleistocene ossiferous gravel overlying the Lameta Formation is also well developed in Nagpur District.

The Lameta Formation is exposed on low-lying areas (fields and nalas) underlying Deccan Trap Flow 1. These beds comprise red and green silicified shales; minor orthoquartzitic sandstones are also found in patches. Large vertebrate bones have been recovered from Udasa (Prasad and Verma, 1967). Lameta beds are also exposed along Amrawati Road near Law College. These beds consist of white coarse-grained sandstones. A specimen of *Paludina normalis* (Gastropoda) has been reported from this area for the first time. During the field investigations at Udasa near Umrer in December 1981, March 1982 and October 1982, the following vertebrates were collected:– *Titanosaurus indicus* (Dinosauria), Pelomedusid turtle and crocodilian scutes.

After the deposition of the Lameta Formation, a large portion of peninsular India was affected by stupendous outburst of volcanic activity, resulting in the eruption of a thick series of lava flows, known as the Deccan Traps. In the present investigated area, basalts are represented by two lava flows, one overlying (Flow 2) the Takli Formation and the other underlying it (Flow 1). The exposures of the Deccan Trap occupy almost half of the district. The volcanic flows are usually dark grey, compact and fine-grained with clinkery surfaces and irregular vesicles. Flow 2 shows characteristic spheroidal weathering,
exfoliation, resulting in the formation of large rounded boulder on the outcrop.

The intertrappean bed is fossiliferous at various localities. These beds comprise of green, white and grey ash shale which is a thin and highly porous layer. In the present work, the term "Takli Formation" as proposed by Sahni et al. (1984) is accepted and used. The new nomenclature helps to remove the ambiguity resulting from the usage of the informal term "Intertrappean" for various beds extending from Rajmahal to the Worli Beds of Bombay. Wherever used in the present work, the terms 'infratrappean' and 'intertrappean' relate only to the relative position of sedimentary beds with regard to the Deccan volcanics.

Hislop and Hunter (1855) and Hislop (1860) have recovered many species of gastropods, viz., Physa prinsepii, Unio deccanensis, U. hunteri, Paludina deccanensis, P. normalis and P. takliensis. From the same horizon, several mega and micro remains such as ganoid and cycloid fish scales were also collected. Blanford (1872a) also recovered some species of Physa in the intertrappean beds of Nagpur. Lydekker (1890) reported Massospondylus rawesi, a serrated dinosaur tooth from Takli, Nagpur. He, however, expressed some doubt as to its exact locality. The microfloral remains: Platychara sahnii, P. raoi and Microchara sp., have been reported by Bhatia and Mannikeri (1976) from the same horizon and locality. Hora's (1938) contribution was the last systematic study of intertrappean vertebrates in the Hoshangabad area. After that, no detailed attempt was made to study the vertebrate palaeontology of the beds until the present work. Oldham (1871) was the first to report the Pleistocene gravel from the Nagpur region. Later on, Sahni et al. (1982a) have reported Equus and Bos from these beds.
During field investigations (December 1981, March and October, 1982 and December 1983), several hundred kilograms of matrix was screened to recover microvertebrates. About 38 genera and 42 species of vertebrate have been recognized, 5 species of ostracodes, 5 species of gastropods and 4 species of charophytes have been identified. The microvertebrates are represented by fishes (isolated teeth, scales, otoliths and vertebrae); amphibians (limb bones, maxillae, iliac bones and vertebrae); reptiles (maxillae, dentary, isolated teeth and egg shell fragments) and mammals (phalanges, claws and an isolated tooth). Most of the vertebrate taxa from the Takli Formation are being reported for the first time.

The freshwater vertebrates recovered from the Cretaceous - Palaeocene beds of Nagpur and Chanda districts are important because they throw light on the possible dispersal corridors operating into India from other neighbouring landmasses. One of the important aspect is from the point of view of the plate tectonic model which visualizes India as an isolated and drifting subcontinent separated from adjacent landmasses by oceanic water. In such conditions, the freshwater fauna should presumably have a high endemic content. The present dissertation shows that inspite of diversified assemblages, there is no great degree of faunal endemism.

TECHNIQUES OF FOSSIL COLLECTION:

During the field investigation and the microvertebrate prospecting of the ossiferous horizons of Takli Formation, a large and varied collection of microvertebrates was found from the various
localities. The collection was obtained by applying the washing and screening technique for microvertebrate-bearing rocks, previously treated with kerosene or gasoline. This treatment resulted in the complete disintegration of the sediments. Over 4000 kg of matrix was macerated.

In the maceration technique, first of all, the material is dried in sunlight to eliminate moisture in the sediments. The dried material is dissolved in kerosene oil for two or three hours, then the kerosene is decanted from the matrix and the material is again immersed in water for four to five hours. During this process, the sediments first soak the oil into the pore spaces and along bedding planes. When water is added, the oil is forced out from the interstitial spaces and is replaced by water as the density of kerosene oil is lower than that of water. The pressure created by the outward movement of the oil, results in the breaking up of the matrix into a slurry. The slurry is diluted by adding more water and then the screening and washing process is carried out. The material is screened in different sized screens of 16, 25, 40 and 60 mesh. The washed and screened material is shifted on to a cloth to dry in the sunlight. The concentrate is examined under the microscope. Over 4000 identifiable skeletal elements were recovered by this process.

The present collection is housed in the vertebrate Palaeontology laboratory of Centre of Advanced Study in Palaeontology and Himalayan Geology, Panjab University, Chandigarh.

All the measurements are given in the metric system.
In the present work Romer's (166) classification has been adopted for classifying vertebrates collected in the present work.

ABBREVIATIONS:

A.M.N.H.             American Museum Natural History.
A.S.T.M.             American Society for testing Materials.
B.M.N.H.             British Museum Natural History.
Geol. Soc. India     Geological Society of India.
G.S.I.               Geological Survey of India.
I.F.V./R.            Infratrappean Vertebrate/Rana, Catalogue number.
I.T.C/R.             Intertrappean charophytes/Rana, Catalogue number.
I.T.IV./R.           Inter and Infratrappean Invertebrate/Rana, Catalogue number.
Jour.                Journal.
Mem.                 Memoir.
No.                  Number.
N.S.                 New Series.
Pal. Indica          Palaeontologia Indica.
Palaeo.Soc.Ind.      Palaeontological Society of India.
Pat.                 Part.
Rec.                 Record.
SEM                  Scanning Electron Microscope.
Sem.                 Seminar.