CHAPTER - 2

RESUME OF PREVIOUS INVESTIGATIONS

This chapter deals with the stratigraphical and palaeontological investigations on the marine Neogene Baripada beds of Orissa carried out by a galaxy of workers since the beginning of the twentieth century. The notable contributions available to the author are summarised in the chronological order in the Table 1.
TABLE - 1: List of research contributions on the stratigraphy and palaeontology of the marine Neogene Baripada beds of Orissa.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Name of the workers</th>
<th>Year of contribution</th>
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<tbody>
<tr>
<td>1.</td>
<td>Bose, P.N.</td>
<td>1904, 1906</td>
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<td>2.</td>
<td>Tipper, G.H.</td>
<td>1906</td>
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<td>3.</td>
<td>Sahni, M.R.</td>
<td>1934</td>
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<td>4.</td>
<td>Eames, P.E.</td>
<td>1936</td>
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<td>5.</td>
<td>Hora, S.L.</td>
<td>1939</td>
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<td>7.</td>
<td>Chatterjee, S.C.</td>
<td>1945</td>
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<td>8.</td>
<td>Modak, G.</td>
<td>1952</td>
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<td>11.</td>
<td>Chaudhari, A.</td>
<td>1958</td>
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<td>18.</td>
<td>Chatterjee, B.P.</td>
<td>1972, 1973</td>
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<tr>
<td>23.</td>
<td>Naik, A.</td>
<td>1976</td>
</tr>
<tr>
<td>25.</td>
<td>Mishra, V.P.</td>
<td>1982</td>
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The salient features of observations made by different workers regarding the stratigraphy and palaeontology are described in brief in the following lines:

Bose (1904) discovered the existence of richly fossiliferous limestones containing abundance of *Ostrea* exposed in Burhabalanga river section which is located at Mahulla (Molia) at a distance of 3 km south of the Baripada town. These beds were observed to be followed by thinly bedded clays and by a thick cover of laterite. The fossil collection was examined by Pilgrim (fide Bose, 1904) and he compared a few specimens of *Ostrea* and *Ostrea multicostata* Deshayes recorded from the Upper Eocene of Paris basin and *O. torresi* from the Megallanean beds (Oligocene) of Patagonia. Pilgrim observed that the specimens exhibit similarity with a underscribed species of *Ostrea* occurring in the upper Nari beds of Baluchistan (Oligocene). The Baripada beds were assigned an age from Eocene to Oligocene.

Bose (1906) recorded 35 rock units in a 50 metres deep boring at Baripada. The fossil collection from limestone horizon occurring at a depth of 43.28 m was studied by Pilgrim who observed abundance of *Amphistegina* (most commonly occurs in the Miocene and also found in Recent seas) in association with a few fragment of *Ostrea* and regarded these beds to be of marine nature and of Miocene age.

Tipper (1906) made a revaluation of the specimens of *Amphistegina* identified by Pilgrim and recognised them as *Rotalia*
possibly *Rotalia orbicularis* d' Orbigny and also revealing affinities with *Rotalia beccarii* Linnaeus. According to him, the conclusion regarding the age could not be drawn on the basis of this find because of the wide geological range of the genus *Rotalia*.

Sahni (1934) studied and identified three specimens of lamellibranchs collected by Miss Elizabeth Studd from fore shore at Puri, 250 km from Baripada and identified them as *Paphia gregaris* (Partsch). These specimens revealed close similarity with *Tape gregaria* Partsch occurring in the Sarmatian (Miocene) of Austria. The matrix infillings of these specimens was found to be the same as those of Baripada and Balasore borings. He (Sahni, op cit.) considered that these fossils are of Miocene age and visualised the possibility of occurrence of Miocene strata near Puri.

Eames (1936, vide etium Fermor, 1936) studied a few specimens of *ostrea* collected by Bose (1904) and identified them as *Ostrea (Crassostrea) gajensis*. This specimen was described by Vredenburg (1928) from the upper Gaj (Lower Miocene) of north west India and also from the Pegu beds (Lower Miocene) of Burma. Based on this evidence, a Gaj (Lower Miocene) age to the limestone of the Baripada beds was assigned by Eames (1936).

Hora (1939) described and illustrated a fossil fish fauna recovered from the subcrops of the Balasore area which is adjacent to Baripada. The fauna included teeth of sharks and dorsal spines of cat fishes. He described a new genus of elasmobranch -
Carcharolamna along with species of Oxyrhina Agassiz, Prionodon Muller and Henle, Scoliodon Cuvier, and Trichiurus Linnaeus. Hora (op. cit.) considered a Tertiary age for the enclosing sediments on the basis of fossil assemblage.

Jena (1942) reported fossil fauna comprising lamellibranchs gastropods, remains of fish, crabs, and fragmentary bones of vertebrates from the exposures of Ostrea limestones at Mukurmatla which is about 11 km south of Baripada. In a subsequent publication, Jena (1943) recorded a fairly rich prolific fossil assemblage from an obscure limestone exposure at Baripada and gritty clay band exposed at Usurdihi about 3 km south of township of Baripada. The faunal assemblage included Ostrea, Oxyrhina and other forms of lamellibranchs, gastropods, crabs, bones of vertebrates and fish remains. On the basis of fossil fauna, Jena (1942, 1943) suggested that the Baripada beds can be correlated with the Pegu Beds (Miocene) of Burma.

Chatterjee (1945) published a brief report on the occurrence of several species of Ostrea and a specimen of Nucula from the exposure of limestone bed developed along the bank of Burhabalanga river near the village of Usurdihi located south of Baripada.

Modak (1952) recorded a fossil fauna containing Trigonia, Cardita, Nucula, Ostrea, shark teeth, Mylobatis spine and a
fragment of fish vertebra from the limestones and shales of the Baripada beds, exposed at Mukurmatia. He recognised the presence of *Ostrea promensa* Noetling and *Hemipristis serra* Agassiz, recorded earlier from the Pegu beds (Lower Miocene) of Burma. Based on fossil evidence, Modak (*op. cit.*) suggested that the Baripada beds are of Lower Miocene age and deposited as a result of marine transgression in the Baripada region during the Lower Miocene period.


Sarma (1956) for the first time, reported and illustrated an assemblage of smaller foraminifera from the Baripada beds exposed at Usurdihi, Satpautia and Mukurmatia. The foraminiferal fauna
included representatives of Anomalina, Bolivina, Buliminella, Cibicides, Discorbis, Elphidium, Eponides, Globigerina, Lagena, Nonion, Nodosaria, Rotalia and Uvigerina. Besides these forms, the microfauna also comprised of remains of echinoids and ostracods. However, the specific identifications and descriptions were not mentioned by him.

Sarma (1957) described a faunal assemblage from the Baripada beds which contains Astarte, Cardita, Cardium, Leda, Lucina, Nucula, Yoldia, Eucrossatella, Barbatia, Ostrea and crabs, Carcharias, Carcharodon, Hemipristis, Mylobatis, Odontaspis, Pristis, Oxyrhina and Gavialis. He has published figures of the following species. Ostrea spp., Cardita spp., Mylobatis, Odontaspis cuspidata Agassiz, Oxyrhina pagoda Noetling, Hemipristis serra Agassiz, Carcharodon megalodon Agassiz, Carcharias (Prionodon) gangeticus Muller, Oxyrhina spallanzanii Bonaparte, Onchopristis sp. and Gavialis gangeticum Gmelin. A Miocene age for the Baripada beds is indicated by the megafaunal assemblage, but he observed that on the basis of foraminiferal evidence, particularly the absence of smaller index forminifera of either Eocene or Miocene, these beds appear to be more younger than the Miocene and may be even Pliocene or Pleistocene in age.

Chaudhari (1958) recorded and described the mammalian teeth belonging to Potamochoerus and Gazella from clay and sand bands of the exposures of Baripada beds at Mukurmatia. He considered that the presence of Potamochoerus suggests a Lower
Pleistocene age for the Baripada beds.

Chatterji and Rao (1960) carried out a study on the subsurface geology and tectonic framework of Balasore region which is adjacent to Baripada. These authors observed that clays, sand sheets and bands of fine grained limestones encountered in the exploratory boreholes, yield a rich benthonic fauna consisting of brachiopods, molluscs, and crabs. The clays associated with limestone band show the presence of abundant shark teeth. A tentative correlation of these limestones with Minhagalkanda (Miocene) of Ceylon and the overlying clays with the argillaceous facies of Cuddalore and Rajahmundry formations (? late Tertiary) was proposed by Chatterji and Rao (op. cit.). Further, these authors visualised a "Nuclear" basin along the eastern margin of Chhota Nagpur plateau which controlled the sedimentation of Balasore region during Tertiary period. The basin extended into the Bay, off Balasore and was having a marine environment during Miocene times which afterwards became estuarine.

Tewari and Awasthi (1960) recorded the occurrence of fairly rich fossil fauna consisting of teeth, tail spines, and fragments of bones of sharks from the Baripoda beds at Orissa. The assemblage of shark teeth contains representatives of Carchariolamna heroni Hora, Hypoprion horai Tewari, Prionodon gangeticum Noetling, Aprionodon horai Tewari and Awasthi, and Aprionodon misrai Tewari and Awasthi. Besides these species, the faunal assemblage also includes species of Bolivina, Buliminella, Cibicides,
Elphidium, Globigerina, Nonion, Uvigerina and Rotalia. These authors (Tewari and Awasthi, 1960) on the basis of Prionodon gangeticus and Myliobatid tail spines which have also been recorded from Yenangyoungian (lower Miocene) of Burma, suggested a Miocene age for the Baripada beds.

Guha et al. (1965), while undertaking study of the Neogene microfauna recorded from a well section at Karikal in Tanjore district, Tamilnadu (South India), also examined the material of Baripada beds of Orissa. These authors observed abundance of Ammonia papillosus along with Cibicides, Elphidium and Nonion from Baripada beds and concluded that the Baripada beds may be equivalent to the upper 110 metres of the Burdigalian sequence met within the Karikal well section.

Mohanti (1966, 1980) reported the presence of a rich faunal assemblage from the subcrops of Baripada beds at Baripada and also from exposures at a few places in Mayurbhanj district. The Baripada fauna contains species of lamellibranchs, gastropods, and fish remains along with a few fragmentary specimens of bryozoans, balanids, echinoids, reptiles and mammals. The fauna from the subcrops yielded - Parallelipipodium cf. prototortuosum Noetling, Pecten cf. kokenianus Noetling, Ostrea cf. papyracea Noetling, Dosinia cf. protojuvenillus Noetling; Leda, Arca, Barbatia, Crassatella, Cardita, Linga, Cardium, Venus, Paphia, Solen, Thracia, Turritella cf. lydekkeri Noetling, Natica cf. gracilior Noetling, Calyptraea aff. rugosa Noetling, Ficus (ficus) conditus
Brogn; Verrutus, Torinia, Cypraea, Ramella, ? Olivia, Conus; Ginglymostoma sp. Odontaspis (Synodontaspis) cuspidata (Agassiz), Oxyrhina, spallanzanii Bonaparte, Hemipristis serra Agassiz, Galeocerdo aduncus Agassiz, Carcharhinus egertoni (Agassiz), Carcharhinus pagoda (Noetling) Hypoprion cf. acanthodon (Le Hon), Scollodon cf. taxandrie Leriche, Aprionodon cf. collata (Eastman), Sphyrna prisca Agassiz, Galeus cf. canis Bonaparte, Pristis sp., Raja sp., Hypolophus sp., Rhinoptera cf. studeri Agassiz, Myliobatis sp. Aetobatis arcuatus Agassiz, Silurold remains, Tetrodon cf. lecointre Leriche, and Sphyraena sp. On the basis of the gross palaeontological evidence, Mohanti (1966, 1980) considered a Neogene age and a shallow marine environment of deposition with the probability of an estuarine zone for the sequence of Baripada beds.

Pattnaik and Gupta (1971) stated that the occurrence of fossil wood fragments of Palmoxyylon and Shoreoxylon under the soil tract, north of Baripada and the subsurface geological data, suggest that the Baripada beds probably continue for about 25 km to the north of Baripada, upto districts of Singhbhum and Midnapur, thereby indicating the existence of a sedimentary unit which is Miocene or younger in age. The upper part of the unit was deposited in an environment characterised by estuarine and partly fluvival conditions.

Sahni et al. (1971) recorded a fish microfauna from Baripada beds which is dominated by species of teleosts and .
elasmobranchs. The fauna includes teeth, spines, vertebrae and fragments of skull and points out an age between Miocene and lower Pleistocene for these beds of Mayurbhanj region.

Bhalla and Dev (1972), for the first time, published an illustrated record of fossil vertebra of reptile (probably a Crocodile) from limestone band of the Baripada beds. A shallow, near shore, rather protected, marine environment of deposition has been inferred on the basis of petrographic study of limestone of Baripada beds. Chatterjee (fide Balasundram, 1972) studied a microfauna of foraminifera from the Baripada beds which contains Elphidium sp. Cibicides sp. Bolivina sp. Uvigerina sp., Textularia sp. and Bullimina sp. In a subsequent publication, Chatterjee (1973) recorded that the Baripada foraminiferal assemblage consisting of 19 genera is characterised by the abundance of calcareous benthonic forms but it also includes Globigerina and Globorotalia. He (Chatterjee, op. cit.) on the basis of abundant Valvulineria and Ammonia, suggested a Miocene age for the Baripada beds and visualised a hemipelagic depositional environment.

Mehrotra et al. (1973) described and illustrated 22 species of Miocene sharks from the eastern and western coastal regions of India namely, Baripada (Orissa) Kutch and Piram Island (Gujarat). The fish fauna from the Baripada beds indicates Carcharinus jhingareni Mehrotra, Mishra and Shrivastava, C. (Prionodon) gangeticus Muller and Henle, Hypoprian macloti Muller
and Henle, Scoliodon sorarakowah Cuvier, Isurus spallanzanii Bonaparte, Isurus pagoda Noetling, Isurus rameshi Mehrotra, Mishra and Shrivastava; Carcharodon carcharias Linnaeus; C. tandoni Mehrotra, Mishra and Shrivastava; Sphyrna diplina Springer, Carcharias baripadensis Mehrotra, Mishra and Shrivastava. These authors (Mehrotra et al. 1973) favoured a lower Miocene age for the Baripada beds.

Bhalla and Dev (1974) recorded for the first time, the presence of Orbiluna sturalis Bronnimann from the limestone unit of the Baripada beds developed at Satpautia. These authors on the basis of the first appearance of this species have suggested a Middle Miocene age for the Baripada beds.

Bhalla and Dev (1975 a) described and illustrated three species of Ostrea viz.: Ostrea (Crassostrea) gajensis Vredenburg, Ostrea papyracea Noetling and Ostrea promensis Noetling and mentioned that the megafauna also includes Leda, gastropod molds and fragmentary remains of vertebrates such as scute of Chelonia which was reported for the first time. The comparison of Ostrea species was made with those described from the Gaj beds (lower Miocene) of Pakistan and Miocene beds of Burma. These authors favoured a middle Miocene age as opined earlier by Bhalla and Dev (1974).

Bhalla and Dev (1975 b) reported the occurrence of three species of planktonic foraminifera Orbulina suturalis Bronnimann,
Globigerina cf. quadrilobata d' Orbigny and Globorotalia sp. from the Baripada beds of Orissa. These authors, on the basis of Orbulina suturalis and Globigerina quadrilobata, considered a Middle Miocene age for these beds.

Bhalla and Dev (1975 c) recorded a rich and varied assemblage of microfossils belonging to foraminifera, ostracoda, echinoid spines and fish remains. Twenty eight species of elasmobranchs have been identified in the fish fauna. On the basis of the presence of identical Miocene species of Burma such as Alopias vulpes Gmelin, Carcharhinus collata (Cape) C. egertoni (Agassiz), C. frequens Dames and Hemipristis serra Agassiz. These authors visualised a free sea communication of Baripada area with Burma during the Miocene period.

Bhalla and Dev (1975 d) reported the occurrence of a foraminiferal assemblage containing 32 species from the Baripada beds of Orissa including the well known Middle Miocene species namely Orbulina suturalis Bronnimann, Globigerina cf. quadrilobata, d' Orbigny, Ammonia tanosawaensis (Iwasa and Kikuchi). The Baripada foraminiferal assemblage indicates a Middle Miocene age and exhibits a correlation with that of the Teli-salower Palembang Formation (Middle Miocene) of Sumatra belonging to Indo-Pacific Zoogeographical province.

Dev (1975), made a detailed systematic study of microfossils from the Baripada beds, for the first time. The microfaunal
assemblage consists 35 species of foraminifera and 30 species of fishes. Three new species of foraminifera - *Elphidium ludbrookae*, *Planulina saistryi* and *Nonion baripadaensis*. On the basis of *Orbulina suturalis* Bronnimann in the faunal assemblage, a Middle Miocene age has been assigned to the Baripada beds. This gets credence from several other species which commonly occur in the Middle Miocene of the different parts of the world. The Baripada beds were correlated with the Middle Miocene deposits of Andaman Island, Sumatra, Taiwan, Australia and New Zealand belonging to Indo-Pacific Zoogeographical province. A free sea communication between Baripada and Burma during Miocene times was suggested on the basis of common Miocene fish species. The Baripada beds were considered to be deposited in a shallow, near shore, marine basin which witnessed occasional tides or sea-storms.

Naik (1976) carried out a detailed geological investigation around Baripada in Mayurbhanj district of Orissa, with a view of study the marine nature of Tertiary marine transgression. He has illustrated and described the mega and micro faunal assemblages from the Baripada beds. The following is the check list:

**Vertebrates:**


Invertebrates:

Pelecypods: Ostrea gajensis Vredenburg, Ostrea promensis Noetling, Ostrea papyracea Noetling, Ostrea sp. A, Ostrea sp. B.

Gastropods: Conus sp.


Ostracods: Aurila aff. chaasraensis var. robusta Lubimova and Guha.

On the basis of the faunal assemblage, Naik (1976) supported the view of Miocene age for the Baripada beds which were correlated with the lower Miocene sediments of Gaj (Gujarat), Kahri stage of Kutch and Pegu system of Burma. It was considered that the limestones of these beds were deposited in a shallow near shore fluctuating marine warm water with medium (12-35%) salinity condition. Regarding the palaeogeographic condition, he remarked that during lower Miocene times a shallow arm of the sea in the east coast enclosed to Baripada and adjoining area which was in free communication with Burma sea.

Singh et al. (1976 a,b) reported and described seventeen species of foraminifera from the limestones and shales of Baripada beds. The microfauna yields - Ammonia beccarii kooboensis (Le Roy), Cribroelphidium subincertum (Asano), Turborotalia obesa (Bolli), Turborotalia continua Blow, Florilus communis (d’ Orbigny), Buliminella ? hanzawai Asano, Buliminella ? brevior Cushman, Buliminella aff. B. longicamerata Bandy, Brizalina singhi Singh, Jauhari and Vimal; Valvulineria sastrii Singh, Jauhari and Vimal, Cibicides hazzardi tawari Singh, Jauhari and Vimal, Cribrononian dattai Singh, Jauhari and Vimal; Triloculina sp., Lagena amphora Reuss, Lagena sp., Uvigerina sp. and Virgulopsis sp. These authors considered an Early Miocene age to the limestones and Early Miocene to Late Miocene age to the shales of the Baripada.
beds of Orissa and suggested a shallow, inner-neritic environment of deposition.

Sahni and Mehrotra (1981) published an elaborated account of the elasmobranch fauna of coastal Miocene sediments of Peninsular India. These authors described an assemblage of 36 species including seven new ones collected from Miocene sediments of Piram Island, Ghogha coast, Kutch and Baripada. The new species recorded from the Baripada area are: Carcharinus robustus, Hypoprion minidenticulata, Scoliodon alae, Dasyatis mahuliensis; D. menoni, Rhinobatus sahnii, and Raja tewarii. On the basis of Carcharodon carcharias, suggested an age not older than the upper Burdigalian. The correlation between the Miocene fauna of the east coast of India and the Miocene fauna of Burma and New Zealand on the one hand and that of the west coast Miocene fauna of Portugal; North America and South Africa on the other hand, has been established by these authors.

Mishra (1982) recorded, for the first time, fossil fish teeth of teleost genus Cybium from the Baripada beds. This find from the east coast of India suggests that the genus flourished along both the east and west coast of India during the Miocene time. He favoured an early Miocene age for the Baripada beds on the basis of fish assemblage and vertebrate fossils and considered deposition of these beds in tropical, shallow water, marine conditions.

Bhalla and Dev (1984 a) presented a concise account of the
stratigraphy and microfauna of the Baripada beds exposed at four localities in the river cuttings of Burhabalanga towards south of Baripada town. The microfauna yielded thirty five species of foraminifera and thirty species of fishes. All the species were listed and on the basis of microfaunal evidence the age of the Baripada beds has been inferred to be Middle Miocene.

Bhalla and Dev (1984 b) described and illustrated a rich assemblage of fish teeth containing 28 species of chondrichthyes and two species of osteichthyes from the Baripada beds of Orissa. On the basis of the occurrence of several well known sharks in the Baripada assemblage a free sea communication between Baripada on the east coast with western India, Burma, Australia and New Zealand during the Miocene times has been visualised by Bhalla and Dev (op. cit.).

Bhalla and Dev (1984 c) discussed the phenomena of heterodonty in sharks by making a detailed variation study of fossil teeth belonging to Caracharodon megalodon Agassiz and Galeocerdo abuncus Agassiz collected from the Baripada beds.

Bhalla and Dev (1986) presented a case study of variation and dimorphism revealed by three species of rotalid foraminifera: Cancris auriculus (Fichtel and Moll) Pararotalia sumatrana (Le Roy) and Cavarotalia annectens (Parker and Jones) recovered from the Middle Miocene Baripada beds of eastern India.
Bhalla and Dev (1988 a) described and illustrated three new species of smaller foraminifera namely - *Elphidium ludbrookeae*, *Pararotalia sumatrana* and *Nonion baripadaensis* in the microfaunal assemblage of Baripada beds which contains a total of 35 species of foraminifera. A Middle Miocene age has been favoured by these authors.

Bhalla and Dev (1988 b) discussed the problem of geologic age of the Baripada beds on the basis of palaeontological evidence. These authors gave following check list of microfauna:

baripadaensis Bhalla & Dev, Nonion bouleanum (D'Orbigny), Nonion aff. N. laeve (D'Orbigny) marginatum Cushman & Ellisor, Nonion cf. N. microumbilicus Le Roy, Florilus scaphus (Fichtel & Moll), Florilus scaphus mesonensis (Cole & Gillespie), and Nonionella sp.


Bhalla and Dev (1988 b), based on the evidence of foraminiferal assemblage containing Middle Miocene species the age limit of Baripada beds has been assigned as the Middle Miocene. These authors remarked that the precise placement within the Middle Miocene is possible only after the discovery of marker species of either Helvitian or Tortonian.
Bhalla and Dev (1988c) described the palaeoenvironment of the Baripada beds deriving evidence from micro and mega-faunal assemblages. It has been suggested that the deposition of Baripada beds took place as a result of marine transgression along Orissa coast indicating rather fluctuating conditions of deposition in shallow near shore environment.