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MIOCENE MOLLUSCAN BIOSTRATIGRAPHY OF THE GARO HILLS, MEGHALAYA, INDIA

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ABSTRACT

The Garo Group rocks of Oligo-Miocene age are best exposed in the South and West Garo Hills districts of Meghalaya. These rocks have been divided into the Simsang (=Kherapara) Formation (Oligocene), Baghmara (=Boldamagiri) Formation (Lower Miocene) and Chengapara (=Angartoli) Formation (Middle Miocene) and are correlated respectively with the Barail Group, Bhuban Subgroup and Boka bil Subgroup of the Surma Basin (Chakraborty and Baksi, 1972; Karunakaran, 1974).

During the course of field work between 1995-97 in the Garo Hills, three fossiliferous horizons were located besides earlier known ones of Pinfold (1919). Two of the said three horizons (near Sibari and Dabtabibra) belong to the Baghmara Formation whereas the one (near Akhipara) along with the Barengapara of Pinfold to the Chengapara Formation.

Though Mukerjee (1939) gave a detailed account of the molluscan taxa of the Baghmara and Dalu localities, no follow up work was undertaken. Recently, Mishra *et al.* (1996) discussed the biostratigraphy of the post-Kopili sediments of the Garo Hills based on the pollen, molluscs and fish teeth.

Thousands of molluscan fossils have been collected from these four localities along with a few foraminifers, corals, crabs, fish teeth and balanoid barnacles. These have been assigned to 115 species of bivalves and 118 of gastropods and include forms which have been considered age-diagnostic in other parts of the Indo-Pacific region. Based on the ranges of these, two zones, namely, *Ostrea latimarginata* Zone (I) and *Crassostrea gajensis-Conus (Dendroconus) loroissi* Zone (II) have been established in the Miocene sediments of the area. These correspond to the zones of the Miocene sediments of Kachchh (Srivastava, 1988). The *Ostrea latimarginata* Zone is further divided into two, namely, the *Anadara submultiformis-Turritella narica baluchistanensis* Subzone (IA) and the *Mactra (Eomactra) protoreevesii-Turritella pinfoldi* Subzone (IB). Subzone IA occurs within the Baghmara Formation, Subzone IB near the base of the Chengapara Formation and Zone II near the middle of the Chengapara Formation. These zones and subzones are respectively dated to an Aquitanian-Burdigalian, Burdigalian and Burdigalian-Helvetian age.

Key words : Miocene, molluscs, Biostratigraphy, Garo Hills, Meghalaya.

INTRODUCTION

Sequences of the Cenozoic Era are generally dated and classified on the basis of microfossils mainly foraminifers and pollens. Since 1950, expanding knowledge of planktic foraminifers has greatly helped in delineating smaller divisions within the sequences of each epoch of the Cenozoic Era. In the Miocene epoch itself as many as eight zones are recognised by various workers. Though microfauna greatly help in precise dating and biozonation of strata, sometimes the inferences drawn are not free from contradictions. For instance, as many as four different horizons (N1-N4) are chosen to mark the base of the Miocene (Palaeogene/ Neogene boundary) on the basis of the foraminifers. This view is well elaborated by Davies (1975).

As regards molluscs, Lyell (1830-33) was the first to attempt division of the Cenozoic Era into periods and epochs using relative proportions of the living molluscan species (Lyellian percentages) among the Tertiary fossils of the Mediterranean region. He delimited four units in the Tertiary period and named these, in ascending order, the Eocene, Miocene, Pliocene and Recent. The Oligocene epoch was introduced much later by Beyrich (1854). Nicol (1953), with his study on the late Cenozoic species from the Atlantic coastal plain, observed that the average duration of a bivalve species was 6.5 million years and short lived ones had duration of 1-2 million years. After this time the species would either become extinct or evolve into a new one.

In Indian Subcontinent, marine Miocene strata are recognised on the basis of the occurrence of *Ostrea latimarginata* – a bivalve species. Srivastava

(1988) advocated a two-fold division of the Burdigalian strata in the Kachchh region, namely, into an *Ostrea latimarginata* Zone and *Ostrea gajensis* Zone. These instances show the importance of molluscs in biostratigraphic zonations.

Several workers have studied the entombed molluscan fauna of the Miocene strata from different parts of the Indian subcontinent, *viz.*, Lower and Upper Gaj of Sind, Kachchh and Kathiawar (Vredenburg, 1925, 1928; Jain 1997), Quilon (Dey, 1962), Ceylon (Davies, 1923; Eames, 1950), Baripada (Sarma, 1959), Garo Hills (Mukerjee, 1939), Mizoram (Tiwari, 1992) and Kama and Pyalo stages of Myanmar (Noetling, 1895, 1901). Thousands of molluscan individuals are known from these localities with precise horizon and age. It is interesting to note that the marine Miocene strata of India are generally poor in planktic foraminifers and nannoplankton which are very useful biota in biozonations and correlations of the Neogene sediments (Mathur, 1988). It is in this context that the establishment of a molluscan biostratigraphy of the Miocene succession of the Garo Hills, Meghalaya is attempted.

GEOLOGY OF THE AREA

Tertiary geology of the Garo Hills, Meghalaya is known through the work of Evans (1932), Mathur and Evans (1964), Baksi (1962), Chakraborty and Baksi (1972) and Murthy *et al.* (1976). The general stratigraphic succession of the post-Kopili sediments (Upper Eocene) of the Garo Hills is given in Table 1 (Mishra *et al.*, 1996).

Table 1 : Geology of the post-Kopili sediments of the Garo Hills.

	Dihing Formation	- Poorly bedded sand with pebbles
	----------Unconformity----------	
	Dupitila Formation	-Mottled clays, pink and white gritty silt /sandstones.
	----------Unconformity----------	
G	Chengapara Formation	-Argillaceous sequence in association with very fine grained non-feldspathic micaceous sandstones and siltstones.
A		
R		
O	Baghmara Formation	-Feldspathic sandstones, pebble bed with vein quartz, shales and locally carbonised fossil wood.
G		
R		
O	Simsang Formation	-Very fine grained sandstones alternating with yellowish brown claystone/siltstones.
U		
P		
	----------Unconformity----------	
	--------Kopili Formation----------	

The Garo Group sediments of Oligo-Miocene age are best exposed in the South and West Garo Hills districts of Meghalaya. The Simsang (Oligocene), Baghmara (Lower Miocene) and Chengapara (Middle Miocene) Formations of the Garo Group are equivalent to the Kherapara, Boldamagiri and Angartoli Formations of Chakraborty and Baksi (1972) respectively. These are age correlates of the Barail Group, Bhuban Subgroup and Boka bil Subgroup of the Surma Basin (Chakraborty and Baksi, 1972; Karunakaran, 1974).

PREVIOUS WORK

The palaeontological and biostratigraphical studies carried out so far in the Miocene sediments of the Garo Hills are summarised below.

Pinfold (1919) was the first to discover two fossiliferous localities in the Surma sediments, one just to the north of Dalu and the other near Baghmara. Vredenburg (1921) and Mukerjee (1939) described and illustrated more than a hundred species of molluscs with records of the fish, reptiles and a foraminifer–*Rotalia beccari* (Linné). Mukerjee (1939) assigned an Aquitanian-Burdigalian age to these beds.

Banerjee (1964) described monolete, trilete, tricolpate and tricolporate spores and pollen from the Surma sediments of the Simsang River. Saluja, Rehman and Kindra (1973) have floristically distinguished the Bhuban and Boka bil sediments of the Garo Hills. Madan Mohan (1973) reported a foraminiferal assemblage of Upper Miocene (Sahelian) age from the Upper Surma sediments of the Bugi river section in the Garo Hills. Nandi and Sharma (1984) have subdivided the *Coniferipites-Cicatricosisporites* assemblage Zone of Baksi (1974) into two subzones. These, in the ascending order, are: *Cicatricosisporites-Palmaepollenites* assemblage Subzone, and *Polygonaceaepites zonoides* Subzone.

Mishra *et al.* (1996), while describing the biostratigraphy of the post-Kopili sediments of the Garo Hills, Meghalaya, established five zones based

on molluscs, pollen and fishes in the area. Zone I is represented by pollen and lies within the Simsang Formation of the Oligocene age and is correlatable with palyno-zone III of Baksi (1962). Zone II is again a palyno-zone, lies within the Baghmara Formation (Aquitanian-Burdigalian) and is correlatable with palyno-zone IV of Baksi (1962). Zone III and IV are molluscan zones, lie within the Chengapara Formation and are of Aquitanian-Burdigalian age. The former zone is characterised by *Ostrea* sp., *Anadara* sp. and *Cardium* sp. with a host of gastropods, whereas the latter one is characterised by tellinids, ungulinids and an absence of gastropods. Zone V is represented by selachians and batoids, lies within the Chengapara Formation, and is of Upper Burdigalian age. Recently, Tiwari *et al.* (1998) described an interesting fish assemblage from the Miocene of the Garo Hills, Meghalaya.

BIOSTRATIGRAPHIC ZONATION

A number of traverses were undertaken in the Garo Hills in order to prepare composite stratigraphic sequence for the Baghmara and Chengapara Formations. It could not, however, be achieved due to jungle-covered country, lack of exposures, ill-defined bedding and lateral litho-facies variations. Three new fossiliferous beds – two within the Baghmara and one within the Chengapara Formations – were located and collections were made from these besides the one of Pinfold (1919) north of Dalu (fig. 1). The collections include thousands of molluscs, a few foraminifers, corals, crabs, fishes and barnacles. The molluscs consists of 115 species and varieties of bivalves and 118 of gastropods.

In all, two biostratigraphic zones have been recognised in the Garo Group (Miocene) rocks of the Garo Hills (Table 2). These are based on the total range of the molluscan species, hence are range zones. They have been named after the molluscan species which are more or less restricted in range to the zones and correspond to the concerned ages in the Indo-Pacific regions. These zones are the *Ostrea latimarginata* Zone (I), and the *Crassostrea gajensis-Conus (Dendroconus) loroisii* Zone (II). The first zone is subdivided into two subzones, namely, *Anadara submultiformis-Turritella narica baluchistanensis* Subzone (IA) and *Mactra (Eomactra) protoreevesii-Turritella pinfoldi* Subzone (IB). The age of these zonal taxa is mainly based on the work of Davies (1975). Detailed description of these zones along with the subzones is given in table 2.

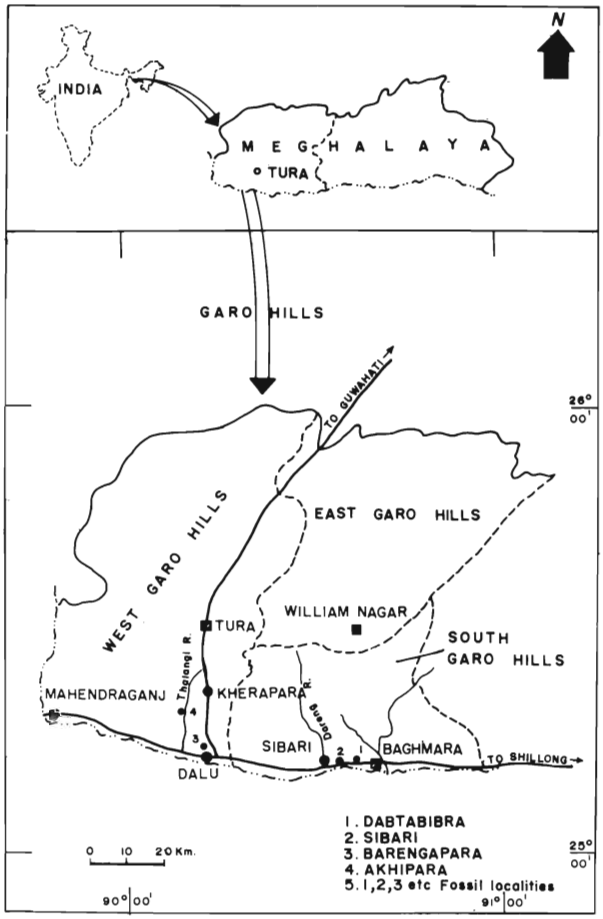

Fig. 1. Map of the Garo Hills showing fossil localities.

Table 2: Biostratigraphic Zones in the Garo Group of Meghalaya.

Epoch	Age	Horizon	Faunal Zones
MIOCENE	Burdigalian-Helvetian	Chengapara Formation	Zone II: *Crassostrea gajensis - Conus (Dendroconus) loroisii* Zone
	Burdigalian	Chengapara Formation	Zone I: *Ostrea latimarginata* Zone
			IB. *Mactra (Eomactra) protoreevesii-Turritella pinfoldi* Subzone.
	Aquitanian-Burdigalian	Baghmara Formation	IA. *Anadara submultiformis - Turritella narica baluchistanensis* Subzone

Zone I

***Ostrea latimarginata* Zone :** This zone extends from the middle part of the Baghmara Formation to the base of the Chengapara Formation and corresponds to an Aquitanian-Burdigalian to Burdigalian age. *Ostrea latimarginata* Vredenburg is confined to this zone, hence its name. It is further divided into two subzones, namely, *Anadara submultiformis-Turritella narica baluchistanensis* Subzone (IA) and *Mactra (Eomactra) protoreevesii-Turritella pinfoldi* Subzone (IB) in ascending order.

Subzone IA *(Anadara submultiformis-Turritella narica baluchistanensis* Subzone) : This subzone is 2.08m-2.30m thick, exposed near Dabtabibra and Sibari localities of the South Garo Hills district (fig. 1) and comprises strata of the middle part of the Baghmara Formation. Near Dabtabibra, between 5-6 km in the Baghmara to Barengapara road on the left cutting wall, the zonal sequence is 2.30m thick and consists of grey coloured, fine-grained micaceous, silty-sandstones (fig. 2A). Near Sibari, between 20-21 km in the Baghmara to Barengapara road on the right cutting wall, it consists of two units. The lower one comprises a 0.8m thick, brick-red colour, impure limestone, while the upper one is a 2.0m thick, grey, soft, silty-sandstone (fig. 2B). The bulk of the taxa come from the lower unit and preservation is also better within it. The taxa mostly are of bivalves and gastropods, though Neogene operculinid foraminifers, corals and barnacles also occur.

Anadara submultiformis (Vredenburg) and *Turritella narica baluchistanensis* Vredenburg of Aquitanian-Burdigalian age characterise this subzone, hence the name. Other forms confined to this subzone which have a restricted age range of Aquitanian-Burdigalian are: *Arcopsis bataviana* Martin var. *carinata* (Noetling), *Astarte (Digitariopsis) grateloupi* Deshayes, *Trachycardium protosubrugosum* (Noetling), *T.* aff. *minbuense* (Noetling), *Mactra (Allomactra) grateloupi* Deshayes, *Dosinia (Phacosoma) protojuvenilis* Noetling, *Corbula harpa* d' Archiac, *Turritella affinis* d' Archiac and Haime, *Cerithium (Ptychocerithium) perlamellosum* Vredenburg, *Rimella subrimosa* d' Orbigny var. *narica* Vredenburg, *Fusinus recticulatus* (Vredenburg), *Cancellaria inornata* Noetling, *Galeodea dubia* (Noetling), *Volutospina jacobsi* Vredenburg, *Ficus pamotanensis* (Martin) var. *kachchhensis* Vredenburg and *Sinum aquensis* var. *praecedens* (Sacco).

The following taxa are also confined to this subzone but are long ranging elsewhere: *Trisidos semitorta* (Lamarck), *Anadara multiformis* (Martin), *Astarte (Ashtarotha) trigonoequilaterata* Jain, *Cardita mutabilis* d' Archiac and Haime, *Eucrassatella (Hypholobus) rostrata* (Lamarck), *Tellina (Tellinella) hilli* Noetling, *T. (T.) pseudohilli* Noetling, *T.* cf. *rostrata* (Linne'), *Callista (Costacallista) erycina* (Lamarck), *Turritella*

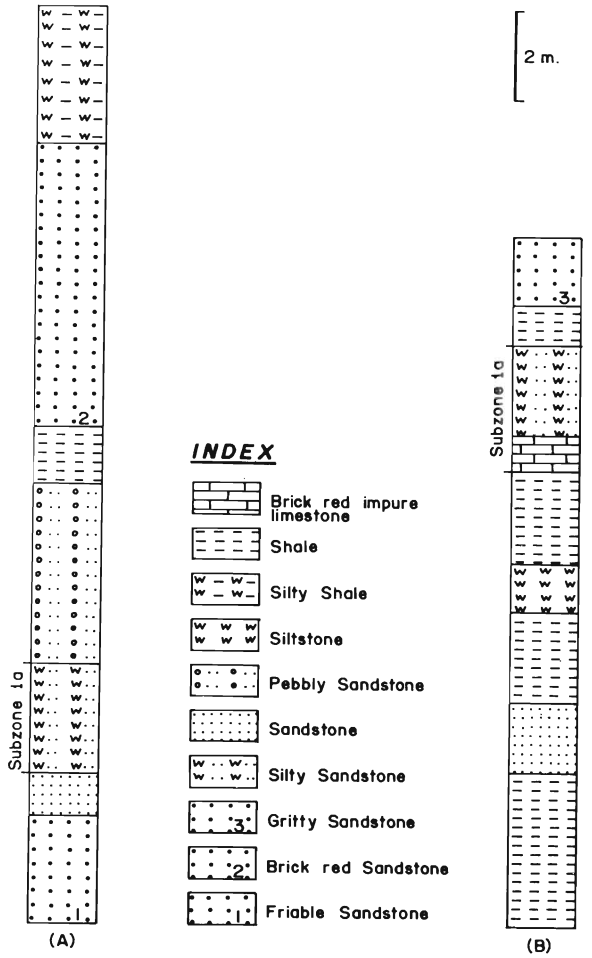

Fig. 2. Litho-columns of the Baghmara Formation near Dabtabibra (A) and Sibari (B) (Garo Hills) showing Subzone IA (*Anadara submultiformis-Turritella narica baluchistanensis* Subzone).

horrisoni Cox, *T. kayalensis* Dey, *T. pseudobandongensis* Vredenburg, *Protoma subrenevieri* Vredenburg, *Bittium quilonense* Dey, *Calyptraea chinensis* (Linne'), *Natica didmia* (Bolten), *Sinum protoneritoides* Vredenburg, *Semicassis mekranica* (Vredenburg), *Babylonia zeylonia* (Lamarck), *Volutospina mekranica* (Vredenburg), *Olivancillaria* (*Agaronia*) *nebulosa* (Lamarck) var. *pupa* Sowerby, *Volvaria kayalensis* (Dey), *Conus* (*Leptoconus*) *viminens* Reeve, *C.* (*L.*) cf. *tomlini* Dey, *Turris* (*Gemmula*) *congener* (Smith) var. *mekranica* Vredenburg, *Drillia* (*Cassispira*) *cotteri* (Noetling), *Terebra gedrosiana* Vredenburg and *Ficus recticulata* (Lamarck).

The following taxa from this subzone are left in open nomenclature: *Anadara* sp., *Chlamys* (*Argopecten*) n. sp., *Pecten* (*Amusiopecten*) sp., *Gryphaeostrea* sp., *Astarte* sp., *Crassatella* sp., *Eucrassatella* (*Hybolophus*) *rostrata* n. var., *Vepricardium* (*Hedecardium*) sp., *Cerastoderma* sp., *Mactra* (*Allomactra*) sp., *Tellina* (*Eurytellina*) sp., *T.* (*Quidnipagus*) sp., *Donax* (*Hecuba*) sp., *Amiantis* sp., *Bassina* sp., *Corbula* sp., *Thracia* sp., '*Pleurotomaria*' sp., *Turritella* sp., *Strombus* sp., *Natica* sp. B, *Semicassi* sp. and *Cypraeacassis* sp.

Twenty-one taxa have been found to range from Subzone IA to IB. These are: *Trisidos* n. sp., *Chlamys senatoria* (Gmelin), *Ostrea latimarginata* Vredenburg, *Milthona* sp., *Diplodonta incerta* d' Archiac and Haime, *D. incerta* var. *narica* Vredenburg, *Acrosterigma* (*Vasticardium*) *njalindungense* Martin var. nov., *Fragum thetregyinense* (Cotter), *Clinocardium* sp., *Lutraria saingengai* Tiwari, *Macrosolen madlumensis* (Kanno), *Dosinia exolerata* (Linné), *Corbula* (*C.*) *tunicosulcata* Vredenburg, *Turritella noetlingi* Vredenburg, *Architectonica affinis* (Sowerby), *Natica obscura* Sowerby, *N. tigrina* Defrance, *N.* sp. A, *Babylonia pangakenis* (Martin), *Terebra coxi* Dey and *Strioterebrum mukerjeei* Dey.

Nine taxa, namely, *Trisidos prototortuosum* (Noetling), *Trachycardium minbuense* Noetling, *Gari* (*Gari*) *natensis* Noetling, *Dosinia subpenicillata* Vredenburg, *Corbula* (*Varicorbula*) *sulcata* Lamarck, *Turritella* (*Turritella*) *terebra bantamensis* Martin, *Sinum cymba* Menke, *Ostrea angulata* Sowerby, and *Solecurtus luzonensis* Kanno are known to range from Subzone IA to Zone II.

This subzone has been assigned an Aquitanian-Burdigalian age.

Subzone IB ***(Mactra (Eomactra) protoreevesii-Turritella pinfoldi* Subzone) :** This zone lies at the base of the Chengapara Formation and is exposed 3.2 km north of Barengapara on the right cutting (fig. 1). It is 16m thick and comprises two fossiliferous litho-units which are separated by about 2.0m thick shale and a 2.6m thick pebbly sandstone (fig. 3A). The lower fossiliferous unit is composed of a 2.9m thick calcareous sandstone, while the upper one is a 1.5m thick friable sandstone. The lower unit is highly fossiliferous and has yielded well-preserved taxa of bivalves, gastropods, fish teeth and scaphopods. The upper unit has yielded only fragmentary remains of bivalves.

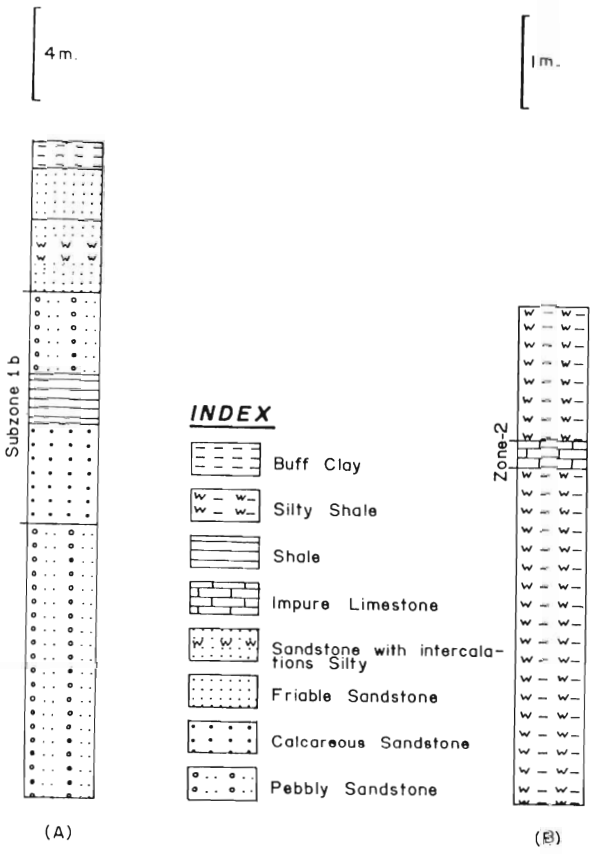

Fig. 3. Litho-columns of the Chengapara Formation near Barengapara (A) and Akhipara (B) (Garo Hills) showing Subzone 1B (*Mactra protoreevesi-Turritella pinfoldi* Subzone) and Zone 2 (*Crassostrea gajensis-Conus (Dendroconus) loroisii* Zone).

Mactra (*Eomactra*) *protoreevesii* Noetling and *Turritella pinfoldi* Vredenburg of Burdigalian age are the characteristic forms of this subzone, hence the name. The other taxa confined to this subzone having a restricted age range include eight forms of bivalves and eighteen of gastropods. These are: *Nuculana virgo* (Martin), *Anadara daviesi* Mukerjee, *Trachycardium sindensis* Vredenburg, *Apolymetis grimesi* (Noetling), *Pitar porrecta* Koenen, *Clementia protopapyracea* Vredenburg, *Callista* (*Costallista*) *splendida* Merian, *Timoclea subspadicea* (Cossmann), *Turritella heberti* var. *garoensis* Mukerjee, *Protoma rectrodialatatum* Vredenburg, *Vermetus javanus* Martin, *Rimella* (*Dientomochilus*) *javana* (Martin), *Natica coxi* Mukerjee, *Nassaria birmanica* (Vredenburg), *N. neocolubrina* (Noetling), *Ancilla djocdjocarte* (Martin), *A.* (*Sparella*) *birmanica* Vredenburg, *Architectonica cyclostomum* (Menke), *Mitra granatiformis* Martin, *Terebra birmanica* (Vredenburg), *T.* aff. *birmanica* (Vredenburg), *T. recticulata* Sowerby, *T. samarangana* (Martin), *Turricula* cf. *promensis* (Vredenburg), *T. promensis* var. *silistrensis* (Vredenburg) and *Turris* (*Gemmula*) *sindiensis* (Vredenburg).

Seventeen forms of bivalves and twenty-three of gastropods, though long ranging elsewhere, are restricted to this subzone. These are: *Nucula pulchra* Hinds, *Trisidos tortuosa* (Linné), *Anadara granosa* Linné, *A. craticulata* (Nyst), *A. verbeeki* (Woodward), *Scapharca ferruginea* (Reeve), *S. gendingensis* (Martin), *Chlamys* (*Aequipecten*) *prototransquebaricus* Vredenburg, *Crassostrea brongniarti* Bronn, *Lucina pagana* Noetling, *Diplodonta rotundatus* (Montagu), *Meretrix persica* Cox, *Pitar* aff. *simonnei* Dey, *Callista* (*Costacallista*) *florida* (Lamarck), *Pahia* (*Callistotapes*) *pseudoliratus* Vredenburg, *P.* (*C.*) cf. *pseudoliratus* Vredenburg, *Corbula* (*Varicorbula*) *socialis* (Martin), *Architectonica perspectivum* (Linné), *A. nitens* (Noetling), *Torinia buddha* (Noetling), *Natica alapapilionis* (Chemnitz), *Gyrineum tuberculatum* (Risso), *G. bituberculatum* (Lamarck), *Ficus conditus* (Brongniart), *Murex* (*Tubicauda*) cf. *sondeiamus* Martin, *M.* (*Chicoreus*) *arrakensis* Noetling, *Cantharus eurythrostoma* (Reeve), *Indomitrella* cf. *kobayashii* Shuto, *Nassarius ovum* (Martin), *Latirus duplicatus* Vredenburg, *Oliva* (*Anazola*) *djocdjocarte* Martin, *Mitra* (*Chrysome*) *sowerbyi* d' Orbigny, *Cancellaria* (*Bivetopsia*) *dertonensis* Bellardi, *Conus* (*Leptoconus*) *bonneti* Cossmann, *Drillia intertincta* (Smith), *Terebra* aff. *coxi* Dey, *Duplicaria woodwardiana* (Martin) var. *mindegyiensis* Vredenburg, *D. protoduplicata* (Noetling), *Acteon ghoshi* Dey and *Paradrillia serana* (Fisher). In addition, the sharks, *Isurus spallanzanii* Rafinesque and *Galeocerdo cuvieri* are also known from this zone.

Sixteen forms of bivalves, six of gastropods and two of fishes from this subzone are left to open nomenclature. These are *Nucula* (*Lamellinucula*) n. sp., *Anadara* n. sp., *A. dichotoma* n. var., *Bentharca* n. sp., *Scapharca* n. sp. 1, *Scapharca* n. sp. 2, *Cucullaea* n. sp., *Ostrea* sp., *Diplodonta* n. sp., *Mactra* (*Allomactra*) n. sp., *M.* (*Eomactra*) n. sp., *Ensis* sp., *Meretrix* n. sp., *Pitar* n. sp., *Callista* (*Costacallista*) n. sp. II, *C.* (*C.*) sp., *Hipponi* sp., *Semicassis* sp., *Murex* sp., *Cantharus* sp., *Mangelia* sp., *Subula* sp., *Carcharodon* sp. and *Myliobatis* sp.

Eight forms of bivalves and eleven of gastropods are known to range from Subzone IB to Zone II. These are: *Anadara* sp. indet., *A. dichotoma* Deshayes, *A. garoensis* Mukerjee, *Anadara* (*Lunarca*) sp., *Arctica* sp., *Callista* (*Costacallista*) sp. nov. I, *Paphia* (*Callistotapes*) *liratus* Phillips, *Corbula* (*Solidicorbula*) n.sp., *Archimedella* (*Torculoidella*) *angulata* Sowerby, *Bursa elegans* (Becks), *Ficus conditus* var. *theoboldi* Noetling, *Siphonalia* (*Kelletia*) *subspadicea* Vredenburg, *Lyria* n.sp., *Oliva* (*Strephona*) *australis* var. *indica* Vredenburg, *Ancilla* (*Sparella*) *indica* Vredenburg, *Conus* (*Lithoconus*) *ineditus* Michelotti, *Turricula promensis* Vredenburg, *Terebra subtessellata* var. *oligocenica* Vredenburg and *T.* sp.

This subzone is assigned a Burdigalian age.

Zone II

***Crassostrea gajensis-Conus* (*Dendroconus*) *loroisii* Zone :** This zone occurs within the middle part of the Chengapara Formation and is exposed along the Thalangi river about 7.5km north-west of Barengapara (fig. 1). It is 0.25m thick and

lithologically consists of impure limestone which is highly fossiliferous (fig. 3B). A large number of oyster shells are found embedded in the limestone. The litho-unit has yielded bivalves, gastropods and shark teeth.

This zone includes two characteristic forms of Burdigalian-Helvetian age, namely, *Crassostrea gajensis* (Vredenburg) and *Conus* (*Dendroconus*) *loroisii* Kiener and is named accordingly. Besides, *Placuna* (*Indoplacuna*) *birmanica* (Vredenburg), *Tellina* (*Moerella*) *indifferens* Noetling, *Turris* (*Lophiotoma*) *quilonica* Dey and *Duplicaria maunguensis* (Vredenburg) of Burdigalian-Helvetian age are also confined to this zone. *Pinna choudhuryi* Tiwari, *Cypraea* (*Cypraeotrivia*) *oppenheimi* Vredenburg, *Clavilithes* (*Crytulus*) *seminudus* Noetling and *Conus* (*Lithoconus*) *kyndiawoensis* Vredenburg of Aquitanian- Burdigalian age are also present in this zone.

Six molluscan taxa and three fishes which are long ranging elsewhere, are also restricted to this zone. These are: *Ostrea pseudorissensis* Vredenburg, *Xenophora birmanica* Noetling, *Turbinella mekranica* Vredenburg, *Conus* (*Lithoconus*) *odengensis* Martin, *Clavatula* (*Perrona*) *birmanica* Vredenburg and *Bathytoma cataphrata* var. *gedrosiana* Vredenburg, *Carcharodon carcharias* Linné *Scoliodon sorrakowah* and *Sphyrna diplana* Springer. Five molluscs and two fishes from this zone, namely, *Arca* sp., *Placuna* (*Indoplacuna*) n. sp., *Bassina* (*Callanaitis*) sp., *Conus* (*Lithoconus*) sp., *Conus* (*Dendroconus*) sp., *Negaprion* sp., and *Desyatis* sp. are left in open nomenclature.

This zone is assigned a Burdigalian-Helvetian age.

CONCLUSION

Two biozones are recognised in the Baghmara and the Chengapara Formations of the Garo Group (Miocene) of the Garo Hills, Meghalaya based on the molluscan assemblages. These are: *Ostrea latimarginata* Vredenburg Zone (I) and *Crassostrea gajensis* - *Conus* (*Dendroconus*) *loroisii* Zone (II). Two subzones, namely, *Anadara submultiformis-Turritella narica baluchistanensis* (IA) and *Mactra* (*Eomactra*) *protoreevesii-Turritella pinfoldi* (IB) are proposed in Zone I. Subzone IA constitutes the middle strata of the Baghmara Formation and has been assigned an Aquitanian-Burdigalian age. Subzone IB lies at the base of the Chengapara Formation and is referred to a Burdigalian age. Zone II represents the middle part of the Chengapara Formation and is assigned a Burdigalian-Helvetian age.

REOPOSITORY

All the figured specimens are housed in the Palaeontology Museum of the Department of Geology, Pachhunga University College, North-Eastern Hill University, Aizawl-796 001, Mizoram, India.

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EXPLANATION OF PLATES

Plate I

1. *Ostrea latimarginata* Vredenburg, Locality-Barengapara (Sp. No. BP/256); ext. of left valve; Horizon-Chengapara Formation; X1.02.
2. *Ostrea latimarginata* Vredenburg, Locality-Barengapara (Sp. No. BP/505); ext. of left valve; Horizon - Chengapara Formation; X 1.09.
3. *Crassostrea gajensis* Vredenburg, Locality-Akhipara (Sp. No. AK/37); Int. of right valve; Horizon – Chengapara Formation; X 1.16.
4. *Crassostrea gajensis* Vredenburg, Locality Akhipara (Sp. No. Ak/37); ext. of right valve; Horizon-Chengapara Formation; X1.16.Plate 2.

Plate II

1. *Placuna (Indoplacuna) birmanica* Vredenburg, Locality - Akhipara (Sp. No. AK/122); ext. of right valve; Horizon-Chengapara Formation); X 0.89.
2. *Timoclea subspadicea* (Cossmann), Locality-Barengapara (Sp. No. BP/408); ext. of left valve; Horizon-Chengapara Formation; X 3.11.
3. *Timoclea subspadicea* (Cossmann), Locality-Barengapara (Sp. No. BP/403); ext. of left valve; Horizon-Chengapara Formation; X 4.28.
4. *Mactra (Eomactra) protoreevesii* Noetling, Locality-Barengapara (Sp. No. BP/514); ext. of right valve; Horizon-Chengapara Formation; X 2.87.
5. *Crassostrea gajensis* Vredenburg, Locality- Akhipara (Sp. No. AK/118); int. of right valve; Horizon-Chengapara Formation; X 1.32.
6. *Clementia protopapyracea* Vredenburg, Locality-Barengapara (Sp. No. BP/109); ext. of left valve; Horizon-Chengapara Formation; X 1.2.
7. *Anadara submultiformis* (Vredenburg), Locality-Sibari (Sp. No. SB/338); ext of right valve; Horizon-Baghmara Formation; X 1.12.
8. *Corbula harpa* d' Archiac, Locality- Sibari (Sp. No. SB/495); ext of right valve; Horizon-Baghmara Formation; X 2.57.

Plate III

1. *Turritella narica* Vredenburg var. *baluchistanensis* Vredenburg, Locality-Sibari (Sp. No. SB/365); apertural view; Horizon-Baghmara Formation; X 2.87.
2. *Turritella narica* Vredenburg var. *baluchistanensis* Vredenburg, Locality-Sibari (Sp. No. SB/22); Horizn-Baghmara Formation; X).75.
3. *Turritella pinfoldi* Vredenburg, Locality-Barengapara (Sp. No. BP/902); Horizon-Chengapara Formation; X 1.4.
4. *Turritella pinfoldi* Vredenburg, Locality-Barengapara (Sp. No. BP/665); Horizon-Chengapara Formation; X 1.4.
5. *Turritella pinfoldi* Vredenburg, Locality-Barengapara (So. No. BP/888); Horizon-Chengapara Formation; X 1.4.
6. *Turris (Lophiotoma) quilonica* Dey, Locality-Akhipara (Sp. No. AK/54); apertural view; Horizon-Chengapara Formation; X 1.4.
7. *Turricula promensis* (Vredenburg), Locality-Barengapara (Sp. No. BP/ 686) apertural view; Horizon-Chengapara Formation; X 2.52.
8. *Turricula promensis* (Vredenburg), Locality- Barengapara (Sp. No. BP/688); apertural view; Horizon-Chengapara Formation; X 2.52.
9. *Bathytoma cataphrata* Brocchi var. *gedrosiana* Vredenburg, Locality-Akhipara (Sp. No. AK/173); apertural view; Horizon-Chengapara Formation; X 1.59.

Plate IV

1. *Conus (Dendroconus) loroisii* Kiener, Locality-Akhipara (Sp. No. AK/52); Horizon-Chengapara Formation; X 1.56.
2. *Volutospina jacobsi* (Vredenburg), Locality-Sibari (Sp. No. SB/510); Horizon-Baghmara Formatiom; X 1.2.
3. *Volutospina jacobsi* (Vredenburg), Locality-Sibari (Sp. No. SB/17); Horizon-Baghmara Formation; X 1.2.
4. *Nassaria neocolubrina* (Noetling), Locality-Barengapara (Sp. No. BP/139); apertural view; Horizon-Chengapara Formation; X 5.27.
5. *Nassaria neocolubrina* (Noetling), Locality-Barengapara (Sp. No. BP/139); Horizon-Chengapara Formation; X 5.27.
6. *Conus (Dendroconus) loroisii* Kiener, Locality- Akhipara (SP. No. AK/52); Horizon-Chengapara Formation; X 1.56.

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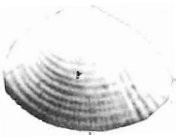

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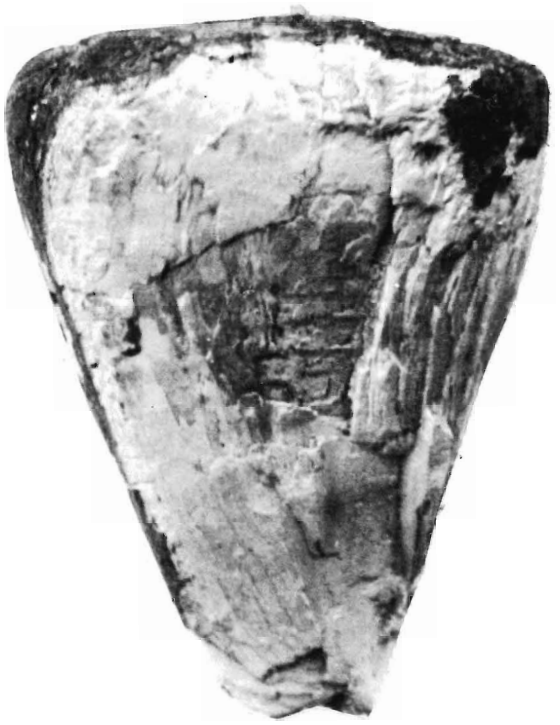

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