8. SUMMARY AND CONCLUSIONS
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Geologically, Mizoram is a part of the Tripura - Mizoram miogeosynclinal basin where Neogene argillaceous and arenaceous sediments occur alternatively in the form of anticlines and synclines with a N - S trend. The rocks have a general strike of N - S dipping either to east or west with the amount varying from 20° to 50°.

The rocks of the Surma Group occupy about 75 per cent of the area in Mizoram and consist of sandstones, silty sandstones, shales, silty shales, siltstones, siltstone - shale alternations and a few pockets of shell limestones and calcareous sandstones. The group is divisible into a lower Bhuban and an upper Boka Bil Subgroups. The Bhuban Subgroup is further divided into Lower, Middle and Upper Bhuban Formations, the basis of the classification being lithological, i.e., predominance of argillaceous component over the arenaceous one and vice versa.
Though a fairly good account of the general geology of Mizoram is available, palaeontological information is meagre. Fossils have been simply listed as reporting items without any discriptions and illustrations, mostly at the generic level. It is in this background that the present study on the mega-biota (both invertebrates and vertebrates) has been taken up. There are good exposures of Bhuban rocks around Aizawl and Lunglei and an area of about 140 sq. km around Aizawl and roughly a similar area around Lunglei has been selected for palaeontological and biostratigraphic studies.

During the course of field work, altogether 10 road sections (four around Aizawl and six around Lunglei), involving sediments of the Middle and Upper Bhuban Formations, have been studied and the following information has been obtained: 1. lithological characters of the rocks; 2. delineation and sequence of beds; and 3. location of fossiliferous beds. Based on these, litho-columns for each of the sections have been prepared and fossiliferous beds (14 in number) shown. The gross lithology and fossil content of the beds are described in detail in chapter 2.

The total collection of available mega-biota exceeds one thousand five hundred specimens and comprises bivalves, gastropods, decapods, echinoids, pisces and scaphopods, in decreasing order of abundance. In general, preservation of fossils is not good and these are difficult to extract either due to their occurrence as fragments or due to the indurated nature of the associated rocks.

After the necessary cleaning and preparation of the specimens, their identification has been carried out with the help of available
literature and type specimens of earlier known forms in the libraries and laboratories of the Geological Survey of India in Calcutta, Shillong, Lucknow; in the Post-graduate Department of Geology, North Eastern Hill University, Nagaland Campus, Kohima and the Department of Geological Sciences, Gauhati University, Guwahati.

A total of 125 forms have been identified, described and illustrated in chapters 3, 4 and 5. Group-wise distribution of these are: bivalves - 91, gastropods - 16, decapods (crabs) - 7, echinoids - 5, shark teeth - 4 and scaphopods - 2. Around one-sixth of the forms are known to survive till date while a few of them appear to the archaic forms of the existing ones.

The 91 forms of bivalves (chapter 3, plates 3-16) have been assigned to 41 genera (20 subgenera), belonging to 24 families (21 subfamilies) which are grouped into 19 superfamilies and are included in seven orders of four subclasses. Out of 41 genera, 19 have already been reported by earlier workers from the present areas and the remaining 22 are being reported for the first time. Family-wise, Veneridae has the largest number of genera (seven) namely, Antigona, Meretrix, Pitar, Callista, Dosinia, Clementia and Paphia. Generically, however, only 11, namely, Nucula, Anadara, Pinna, Chlamys, Pecten, Astarte, Tellina, Apolymetis, Arctica, Callista and Paphia have a large number of individuals and diverse species. The remaining ones commonly have a single taxon based on one representative. Since some of the forms could not be accommodated in the existing subgenera, a new subgenus, i.e., Indometis has been proposed under the genus Apolymetis. The two known forms, viz., Tellina (Metis) grimesi Noetling and Tellina
(Arcopagia) tazuvensis Cotter, are included in this, besides two new ones, namely, Apolymetis (Indometis) rambalaki and Apolymetis (Indometis) ramashrayi, as they show constant characters of the new subgenus.

Sixteen forms of gastropods (chapter 4, plate 17) are grouped into 12 genera (three subgenera), belonging to 10 families (seven subfamilies) and are referred to eight superfamilies ranking in one order and one subclass. Other than Turritella, Ficus and Conus, the rest are less in number as well as in forms. Out of the 12 genera, only three are known ones and the remaining nine are being reported for the first time from the studied areas. It is noteworthy that the Lower Miocene sediments in India, Myanmar and Pakistan show predominance of gastropods over bivalves whereas the opposite is the case in the present areas. The decapods (crabs, chapter 4, plate 19) are represented by five genera belonging to four families and three superfamilies. Portunus is the only known genus from the present areas and it has a large number of individuals. The two genera of echinoids, viz., Cidaris and Schizaster belong to one family and one order each (chapter 4, plate 18). The former has one form while the latter has four. The shark teeth (chapter 5, plate 20) have been assigned to three genera and two families and were already reported by earlier workers from the areas investigated. The scaphopods (chapter 4, plate 18) are represented by the genus Dentalium with two known forms.

It has been found that 14 genera/subgenera occurring in the areas of study have so far not been reported from the Miocene of India. These are (without asterisks):
Acila* (Truncacila), Yoldia* (Megayoldia), Anadara* (Lunarca), Brachidontes* (Austromytilus), Limaria* (Limatulella), Astarte* (Bythiamena), Astarte (Digitariopsis), Salaputinum, Solena* (Plectosolen), Vepricardium* (Hedecardium), Tellina* (Angulus), Tellina* (Eurytellina), Tellina* (Oudardia), and Xantho.

On the basis of the present findings, the range of some genera and subgenera, which are known to occur in the older or younger horizons, has been extended. For instance, the range of genus Meretrix (Upper Miocene to Recent) and subgenera Austromytilus (Pliocene to Recent), Hemimetis (Recent) and Angulus (Recent) is to be lowered down to Lower Miocene whereas for the subgenus Plectosolen (Lower Eocene to Middle Eocene), it is to be extended upward to Lower Miocene.

Out of 125 forms described and illustrated (chapters 3, 4 and 5; plates 2-20), the following 35 species, one variety and one subgenus have been designated as new:

Nucula (Nucula) agrawali
Nucula (Nucula) sahnii
Nucula (Nucula) tewarii
Acila (Truncacila) kachharai
Yoldia (Yoldia) satsangii
Barbatia (Barbatia) duttai
Anadara (Anadara) barmani
Anadara (Anadara) narayanai
Anadara (Anadara) babui
Anadara (Lunarca) singhi
Pinna (Pinna) choudhuryi
In all, 64 forms have been reported for the first time from the present areas in addition to the above mentioned new ones and, of
these, 36 are not known even from the Northeastern India. These are:

- Nucula warsarensis Eames
- Arca feddeni Vredenburg
- Arca newtoni Vredenburg
- Glycymeris sindiensis Vredenburg
- Chlamys (Chlamys) quilonensis Dey
- Pecten (Pecten) pascoei Cox
- Tellina (Eurytellina) pilgrimi Cox
- Tellina (Tellinella) hilli Noetling
- Tellina (Tellinella) pseudohilli Noetling
- Tellina salinensis Cotter
- Gari (Gari) natensis Noetling
- Arctica islandica (Linne')
- Meretrix persica Cox
- Pitar altoumbonata (Nagao)
- Callista (Callista) pseudounbonella Vredenburg
- Dosinia (Dosinia) perlata Vredenburg
- Clementia (Clementia) protopapyracea Vredenburg
- Paphia (Paphia) rotundata (Linne')
- Paphia (Paphia) persica Cox
- Paphia (Callistotapes) pseudoliratus Vredenburg
- Corbula mekranica Vredenburg
- Dentalium boettgeri Noetling
- Turritella pseudobandongensis Vredenburg
- Turritella narica Vredenburg
- Architectonica buddha (Noetling)
- Xenophora bimanica Noetling
The range of several forms has been extended upward or downward in the light of their earlier records and the present findings. These are:

<table>
<thead>
<tr>
<th>Species Name</th>
<th>Original Range</th>
<th>Extended Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arca (Arca) newtoni Vredenburg</td>
<td>Upper Miocene</td>
<td>Lower Miocene</td>
</tr>
<tr>
<td>Chlamys (Chlamys) quilonensis Dey</td>
<td>Middle Miocene</td>
<td>Lower Miocene</td>
</tr>
<tr>
<td>Pecten (Pecten) pascoei Cox</td>
<td>Pliocene</td>
<td>Lower Miocene</td>
</tr>
<tr>
<td>Tellina (Tellina) pilgrimi Cox</td>
<td>Oligocene</td>
<td>Lower Miocene</td>
</tr>
<tr>
<td>Tellina salinensis Cotter</td>
<td>Eocene</td>
<td>Lower Miocene</td>
</tr>
<tr>
<td>Meretrix persica Cox</td>
<td>Middle Miocene</td>
<td>Lower Miocene</td>
</tr>
<tr>
<td>Pitar altoumbonata (Nagao)</td>
<td>Oligocene</td>
<td>Lower Miocene</td>
</tr>
<tr>
<td>Clementia (Clementia) protospyracea</td>
<td>Oligocene</td>
<td>Lower Miocene</td>
</tr>
<tr>
<td>Vredenburg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dosinia (Dosinia) perlata Vredenburg</td>
<td>Upper Miocene</td>
<td>Lower Miocene</td>
</tr>
<tr>
<td>Paphia (Paphia) rotundata (Linne')</td>
<td>Pliocene</td>
<td>Lower Miocene</td>
</tr>
<tr>
<td>Paphia (Paphia) persica Cox</td>
<td>Middle Miocene</td>
<td>Lower Miocene</td>
</tr>
</tbody>
</table>
The vertical distribution of forms in various lithocolumns has been ascertained and shown in table 6.2. The horizon-wise age has been discussed in the light of fauna in the type section of the Miocene in Sind and detailed succession in Myanmar. Besides, Gaj fauna of Kachchh and Kathiawar, Lower Miocene fauna of Garo Hills, Meghalaya, and Kanchanpur bed, Assam, have also been considered for dating fossil yielding horizons of the concerned areas. Accordingly, 14 fossiliferous beds have been arranged into 4 categories. These are: 1. Bed No. 5 in Lunglawn - Sazaikawn section of Aquitanian age; 2. Bed No. 8 in Haurang - Pachang section, Bed No. 4 in Maubawk - Tuikual Lui section, Bed No. 8 (lower part) in Kulikawn - Hlimen section and Bed No. 6 in Rothlang - Luangmual section of Aquitanian - Burdigalian age with affinity towards the former; 3. Bed No. 8 (upper part) in Kulikawn - Hlimen section, Bed No. 7 in Rothlang - Luangmual section, Bed Nos. 3 and 5 in Lunglei - Zotlang section, Bed Nos. 1 and 5 in Serthum - Theiriat section and Bed No. 3 in Ghhekpuikawl - Vanhe section of Aquitanian - Burdigalian age with proximity towards the latter; and 4. Bed No. 7 in Rangvamu - Sairang section and Bed No. 6 in Pukpui - Saza section of Burdigalian age.

On the whole, Bhuban sediments are assigned Aquitanian - Burdigalian (Lower Miocene) age. From scrutiny of the earlier records,
it has been found that a large number of forms from the present areas are common to the Lower Miocene forms elsewhere in Indian-subcontinent and these are shown below:

<table>
<thead>
<tr>
<th>Area</th>
<th>Formation</th>
<th>Number of Common Taxa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Garo Hills, Meghalaya</td>
<td>Lower Miocene</td>
<td>26</td>
</tr>
<tr>
<td>Myanmar</td>
<td>Kama and Pyalo Formations (Pegu Group)</td>
<td>27</td>
</tr>
<tr>
<td>Kachchh, Gujarat</td>
<td>Gaj beds</td>
<td>15</td>
</tr>
<tr>
<td>Kathiawar, Gujarat</td>
<td></td>
<td>13</td>
</tr>
<tr>
<td>Sind, Pakistan</td>
<td>Gaj beds</td>
<td>14</td>
</tr>
</tbody>
</table>

Based on the restricted occurrence of certain forms in the type section of Miocene in Sind and detailed succession in Myanmar, three biozones have been tentatively established in Bhuban rocks of Mizoram. These, in descending order, are (Fig. 7.1; table 7.1):

<table>
<thead>
<tr>
<th>Number</th>
<th>Name of Biozone</th>
<th>Other Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone 3</td>
<td>Calappa protopustulosa-</td>
<td>Occurs within Upper formation at about 700 m above its base. Age: Burdigalian.</td>
</tr>
<tr>
<td></td>
<td>Carcharodon carcharias Zone</td>
<td></td>
</tr>
<tr>
<td>Zone 2</td>
<td>Chlamys senatoria - Pinna Zone</td>
<td>Occurs within the Upper Bhuban Formation at about 70 to 400 m above its base.</td>
</tr>
<tr>
<td></td>
<td>2B. Diplodonta incerta -</td>
<td>Age: Aquitanian - Burdigalian with proximity towards Burdigalian.</td>
</tr>
<tr>
<td></td>
<td>Diplodonta rotundatus Subzone</td>
<td></td>
</tr>
</tbody>
</table>
Number | Name of Biozone | Other Details
---|---|---
2A. Mactra protoreevesii | **Zone 1** | Age: Aquitanian - Burdigalian with proximity towards Aquitanian.
Conus (Leptoconus) bonneti Subzone | Glycymeris sindiensis - Nuculana virgo Zone | Occurs within the Middle Bhuban Formation at about 200 m below its top.

The above mentioned biozones have been found to be very useful in stratigraphic correlation both local as well as regional. Accordingly, the local sequences have been correlated with each other (table 7.2) and the Bhuban rocks of the present areas have also been correlated with the Lower Miocene beds elsewhere. This is shown briefly below.

**Formations**

- Kanchanpur bed, Assam
- Lower Miocene beds of Baghmara and Dalu, Garo Hills
- Pyalo of Myanmar
- Kama of Myanmar
- Upper Gaj and Sind
- Lower Gaj
- Gaj of Kachchh
- Gaj of Kathiawar

**Correlatable Biozones**

- Zone 1 and Subzone 2A.
- Zones 1 and 2.
- Subzones 2B and Zone 3.
- Zone 1 and Subzone 2A.
- Subzone 2B and Zone 3.
- Zone 1 and Subzone 2A.
- Zones 2 and 3.
- Zones 1 and 2.