CHAPTER VII
SUMMARY AND CONCLUSION

Garo Hill, the westernmost hill district of the state of Assam was subjected to geological investigations by number of geologists since 1868. Medlicott (1868) first reported the occurrence of the sedimentary rocks in the north and south of the Tura range and tentatively assigned Upper Cretaceous to Eocene age to these rocks comprised of sandstone, clay and coal seams gradually succeeded by nummulitic limestones and alternating bands of shale, sandstone and limestone of marine origin. Fox (1937) designated the three lithological units from base upwards as Tura Sandstone stage, Siju Limestone stage and Rewak stage. He considered these three units overlying the Archaean basement to be of Eocene age. Later workers (Nagappa, 1951; Wilson & Metre, 1953; Ghosh, 1954 and Samanta, 1968) agreed with the views expressed by Fox and suggested that the Tura stage is of Lower Eocene (Ypresian) age and the succeeding Siju and Rewak stages with diagnostic larger foraminiferal species belong to Middle (Lutetian) and Upper Eocene (Priabonian) age and equivalent to Prang limestone and the Kopili stage of the adjoining Khasi & Jaintia Hills respectively. Nagappa (1959) reported few Upper Eocene marker
smaller foraminiferal species from the Rewak stage which constitute the smaller foraminiferal assemblage so far recorded from these rocks.

This Eocene sequence with a gentle southerly dip is well exposed along the river valleys in Siju-Rewak, Tura-Kherapara and Dareng Era Aning areas of the district. In course of this present investigation undertaken on the stratigraphy and micropalaeontology (dealing with ostracoda and part of smaller foraminifera) of the rocks of these three areas, it has been observed that these units with their maximum development in the type Siju-Rewak area with good exposures along the Simsang river valley, exhibit variation in stratal thickness and in occurrence. The Tura Sandstone stage attaining a maximum thickness of 180 metres, is met with in all the three areas with minor variation in thickness. The Siju Limestone stage gradually reduces in thickness from the maximum of 105 metres in Siju Songmong area towards Tura-Kherapara and Dareng Era Aning areas where only the basal few metres are observed. The youngest Rewak stage of approximately 350 metres in thickness has developed only in the south of the Tura range and absent in the north of it.

Lithologically the Siju stage can be divided into lower and upper members. The lower member extending upto about 30 metres above base, is composed of marls,
limestones and shale partings and comparatively more fossiliferous than the hard limestones of the upper member with higher concentration of ferruginous material. The lower Rewak passing upward to unfossiliferous shale and sandstone of the upper Rewak, consists of about basal 70 metres of highly fossiliferous shale, sandstone and limestone bands. This fossiliferous lower Rewak stage is further divisible into lower and upper units on the basis of minor variation in lithology.

For micropalaeontological study, samples from measured sections (Fig.3) have been analysed in the laboratory. It has revealed that the Turas are devoid of marine organic remains but plant fossils can be observed in some clay bands. The Siju limestone and the Rewak shales are rich with marine organic remains consisting mostly of foraminifera, ostracoda, mollusca, bryozoa, algae etc. Various Middle and Upper Eocene index species of larger foraminifera have been recorded. Corresponding to lithological variations from lower to upper member of the Siju and lower to upper unit of the lower Rewak, the composition of the fauna also changes on the basis of which number of smaller foraminiferal and ostracode zones have been established in the marine part of the Eocene succession. As a whole the fauna of the Siju stage differs strongly from that of the overlying Rewak stage.
The ostracoda and smaller foraminifera encountered in these rocks are very rich in variety and individuals. Ostracode assemblage, almost equal to the total number of species so far described from different horizons in India is composed of 69 species. Practically all the species are new and for the first time they are being recorded from this interesting geological horizon of India. The distribution of ostracode species has enabled to recognise three and two biozones respectively in the Siju and Rewak stages. The *Cythereis sijuensis* and *Echinocythereis spectabilis* zones mark the junction between the Siju and the Rewak stages.

The smaller foraminifera of which only a part of the total assemblage has been included here, is also equally rich in variety and number with many index species of planktons and benthos. Planktons represented by genera such as *Hantkenina*, *Globigerina*, *Guembelia* etc. are entirely confined to the Rewak stage with marked abundance right from the base of this stage. About 76 species including three new species have been recorded. Nearly 70% of the total species appear with sudden proliferation in the lower unit of the lower Rewak. Based mainly on their distribution and density of population, four smaller foraminiferal zones have been erected in the Siju and Rewak stages. The *Hantkenina alabamensis* zone and the *Uvigerina jacksonensis* zone
delimited in the Rewak stage are of intercontinental significance. Again on the basis of ostracodes, the foraminiferal zones can further be subdivided and the boundaries of each zone can be confirmed.

In the systematic palaeontology chapter, a brief review of the classification of ostracoda and foraminifera has been given and all the species of ostracodes and forty-nine species of smaller foraminifera have been described and illustrated and the remaining foraminiferal species are listed only (table 3).

The study of the microfaunal assemblage by the author, their stratigraphic distribution, lithology in the succession of the three stages confirm the observations in the assignment of age assigned to the three units by previous workers. The faunistically barren Tura Sandstone stage conformably overlain by the Assilina regularia (Ghosh), Alveolina elliptica muttallii Davies and Nummulites acutus (Sowerby) bearing Siju Limestone stage of Middle Eocene age is of Lower Eocene though its lower boundary is somewhat doubtful.

Although the Siju stage does not contain any marker planktonic smaller foraminiferal species, but the presence of the smaller benthonic species assemblage (such as, Quinqueloculina goodspeedi Hanna & Hanna, Triloculina trigonula (Lamarck), Guembelitria columbiana Howe, Loxo-
toma claibornense Cushman, Bulimina trigona Terquem) mostly reported from the Claiborne group of Texas, Louisiana and other adjacent Middle Eocene horizons, suggests Middle Eocene age for the Siju stage and supports the view expressed on the basis of larger foraminiferal contents. The Rewak stage with the Upper Eocene marker planktonic species and other benthonic species like Uvigerina jacksonensis Cushman, Bulimina jacksonensis Cushman etc. are undoubtedly of Upper Eocene age.

The Siju Limestone stage embracing a smaller foraminiferal fauna essentially of middle Eocene age, can be correlated with the Middle Eocene Claiborne group of Gulf Coast. This stage is also equivalent to Prang Limestone of Khasi and Jaintia Hills and Kirthar series of western India of Lutetian age.

Ostracode assemblage, though composed mostly of new species, but occurrence of species such as Krithe autochthona Lubimova and Guha and Schizocythere appendiculata Triebel lends support to Middle Eocene age of the Siju stage.

Presence of various diagnostic species of Upper Eocene age of the genera namely Hantkenina, Globorotalia and other benthonic marker species in the Rewak stage not only shows that this stage is of Priabonian age but also enables to correlate it with Jackson formation of Gulf
Coast in particular and Kopili stage of Khasi and Jaintia Hills and Tapti series of India (charts 6,7). Unlike the foraminifera no species of ostracoda essentially of Upper Eocene age has been observed in this stage. However generically the assemblage favours Eocene age. Regarding local correlations, the ostracode assemblage with number of species of short vertical ranges have been found to be suitable as the smaller foraminiferal assemblage (chart 5).

Smaller foraminiferal components confined to the Siju and Rewak stages have made it apparent that the boundary between the Middle and Upper Eocene in Garo Hills coincides with the junction between the Siju stage and the Rewak stage. From the stratigraphical relation of the fresh water Tura stage with the conformably overlying Siju stage of Middle Eocene age it is evident that upper limit of the Turas cannot be younger than the lower Middle Eocene. Though palynological data indicate that the lower boundary extends to lower Eocene and equivalent to Umlatdoh limestone of Khasi and Jaintia Hills, but position of its lower limit is still conjectural. Hence to arrive at a conclusion about the age and correlation of this stage, devoid of any marine fossils, further detailed study on the palynology and other relevant stratigraphical facts are probably indispensable.

It may also be added that as soon as more data is obtained from the studies that have been continued, it may
be possible to provide a much detail and clearer picture of the stratigraphy not only for local correlation, but many also provide characteristic benthonic foraminiferal assemblage and ostracode assemblage which may be utilised in future for correlation purposes in the adjacent areas as well as in adjoining countries, of course belonging to the same faunal province.

A close study of the lithology and faunal contents of the Eocene sediments of Garo Hills, suggests prevalence of fresh water and marine environmental conditions, the former led to the deposition of course, cross-bedded, Tura sandstones with coal seams, and the latter succeeding the fresh water conditions was responsible for the thick accumulation of the Siju limestones and the Rewak alternations with teeming millions of warm shallow marine organic remains. With minor oscillations in the sea water level, the areas south of the Tura range were under the marine influence since the beginning of Middle Eocene extending up to Upper Eocene. From the north of the Tura range, the sea was withdrawn towards south immediately after transgression in the early part of Middle Eocene as attested by the presence of a thin band of limestone belonging to the Paljenborchella indigena zone of the type Siju Songmong-Rewak area.

The presence of a large number of planktons such as Hantkenina, Globigerina and Guembelina in the lower Rewak
beds in contrast to their absence in the Siju stage, is a clear evidence of restoration of open marine condition from the beginning of Rewak stage or immediately following the Siju limestone phase of Lutetian age. The sudden proliferation of other phyla in Rewak stage also strongly implies that during Rewak time environment was more conducive in comparison to Siju time. Faunal constituents recorded from these rocks suggest that the sea was shallow of warm water and normal salinity. Ostracodes recorded from the rocks, except few genera of wide bathymetric range, are mostly inhabitants of littoral to neritic environments of the present-day sea. Though it is presumed that ostracodes are apparently not as greatly affected by ecological conditions such as salinity, depth of water, temperature, bottom conditions etc. as the foraminifera but the consistency observed in the trend of distribution and variation of the smaller foraminifera and the ostracodes in the different lithologies of the marine Eocene sequence of this region, rather gives credence to such inference that ostracodes are not only greatly affected by ecological factors as the foraminifera, but also supports the view expressed by Benson (1959) that they have about the same reaction to environmental changes as the foraminifera.

The top part of the Rewak stage, composed of faunistically barren sandstone and shale with appreciable amount of
carbonaceous matter indicates regression of the sea from this region in a southerly direction.

This region does not show any major structural feature. From the observations made on the nature of the Simsang river valley cutting across the Tura range, the contact between the Archaeans and the overlying sedimentaries both on the northern and southern slopes of the range and the absence of upper Siju in the north of the Tura range, it may be concluded that there is every possibility that the regression of the Siju sea from the north of the Tura range can be tied with the uplift of the Himalayas at the beginning or middle of Middle Eocene.