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NEOGENE PLANKTONIC FORAMINIFERAL ZONATION OF RITCHIE'S ARCHIPELAGO, ANDAMAN ISLANDS, INDIA

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ABSTRACT

Seventy five species of planktonic formanifera have been recorded from the Neogene sequence of Ritchie's Archipelago, Andaman Islands. On the basis of these planktonic foraminifera nine assemblage—zones and one acme-zone ranging in age from Early Aquitanian (N. 4) to Pliocene (N. 19) have been delineated.

These assemblage—zones and acme-zone in ascending order are ; *Globigerinoides quadrilobatus primordius-Globorotalia* (*T.*) *pseudokugleri* (N. 4), *Globorotalia* (*T.*) *peripheroronda-Globigerinata dissimilis dissimilis* (N. 6), *Globigerinoides sicanus-Globigerinatella insueta* (N. 8), *Orbulina suturalis-Globorotalia* (*T.*) *brinageae*(N. 9), *Globorotalia* (G.) *praefohsi-Hastigerina* (*H.*) *siphonifera siphonifera* (N. 12), *Sphaeroidinellopsis subdehiscens subehiscens-Globorotolia* (*T.*) *mayeri* (N. 13), *Globigerina nepenthes-Globorotalia* (*T.*). *siakensis* (N. 14), *Globorotalia* (*T.*) *acostanesis acostaensis-Globorotalia* (*G.*) *merotumida* (N. 16), *Globorotalia* (*G.*) *tumida tumida-Sphaeroidinellopsis subdehiscens paenidehiscens* (N. 18), and *sphaeroidinella dehiscens dehiscens* (N. 19) Acme-zone.

Round Formation may partly represent facies varient of Strait Formation.

INTRODUCTION

Schwager (1866) published a monograph describing 109 species of foraminifera from the Car-Nicobar Island and suggested a probable Pliocene age to the rocks containing these fossils. Jacob and Sastri (1957) reported the occurrence of *Orbulina*, a variety of globigerinids and rotalids from the Sawai Bay, suggesting Late Miocene-Pliocene age. Sastri and Bedi (1962) reported the association of *Orbulina universa* with *Miogypsina* sp. and *Lepidocyclina* (*Nephrolepidina*) sp. from Strait Formation of the Archipelago Group of Islands. The sequence containing this association was provisionally dated as Burdigalian. Kumar (unpublished) has identified *Globo rotalia fohsi fohsi* in the material from which Sastri and Bedi (1962) reported the above mentioned assemblage. He suggested a Langhian age equivalent of *Globorotalia fohsi fohsi* Zone, N. 12, Blow (1969). Chatterjee (1964) suggested a Lower Miocene age for the Archipelago Series. The lower Arenaceous Zone containing *Lepidocyclina* (*Eulepidina*) *dilatata, Miogpsinoides deharti, Miogypsina irregularis* etc. in the lower part and *Orbulina* in association with this assemblage in the upper part suggesting an Aquitanian age ; the middle is Argillaceous Zone with clay etc. containing *Orbulina universa, Globorotalia menardii* etc. of Burdigalian age ; and the upper part—Interview Island Stage containing *Lepidocyclina* (*Nephrolepidina*) *sumatrensis* and *Operculinoides niasi* also of Burdigalian age. Kumar (1967) reported twenty eight species of planktonic foraminifera from the Round Formation of Interview Island and assigned it middle to upper Miocene age, correlatable to *Globorotalia mayeri*/*Globorotalia menardii* Zone of Blow (1959). Srinivasan and Sharma (1969) discussed the status of the species described by Schwager (1866) in his monograph on the foraminifera recorded from the Car—Nicobar Islands. Frerichs (1971) reported the distribution of planktonic foraminifera in the sediments of Andaman sea, and suggested that surface salinity, water depth, diagenesis and topography are the controling factors of the distribution of planktonic foraminifera. Influx of large volume of fresh water in the nothern Andaman sea results in a lowering of salinity and exclusion of planktonic foraminifera. It was noted that large number of planktonic foraminifera occur in the upper and middle bathyal environment and on scattered seamounts. He also noted that there is an apperent depth zonation of planktonic species in the sediments of Andaman Sea. Species like *Globigerina rubenscens, Globigerinoides ruber* becomes consistent component of the assemblage at 20 Metres depth, where as *Sphaeroidinella dehiscens* becomes consistent component at 550 Meters and *Globorotalia scitula* at 970 Meters. Mehrotra and Kumar (1972) recorded ten planktonic foraminiferal assemblages ranging in age from Early Aquitanian (N. 4) to Pliocene (N. 19) from the Ritchie's Archipelago, Andaman Islands. Singh *et al.*, (1972) listed a rich assemblage of ostracoda, foraminifera, bryozoa and nanoplanktons from the cream coloured marl exposed on the western coast of the Neill Island indicating Early Pliocene age. Srinivasan and Sharma (1973) gave the complete stratigraphic sequence of Car—Nicobar strata. The Sawai Bay Formation (consisting of mudstone and limestone members) and Malaca Limestone Formation belonging to Archipelago Group were proposed. Three biozones based on the known ranges of the planktonic

foraminifera were established, suggesting an Early to Middle Psiocene age for Schwager's Car—Nicobar foraminifera. Singh *et al.*, (1973) discussed the stratigraphy of Neill Island and recorded foraminifera, radiolaria, nanoplanktons, diatoms and silicoflagellates from the grey fossiliferous mudstone bed of the Neill Island and assigned Early Pliocene age to the mudstone beds.

OBJECT AND LIMITATIONS

The object of this paper is to report the planktonic foraminiferal zones from the Early Miocene to Pliocene outcrop sections of the Ritchie's Archipelago and to work out foraminiferal biostratigraphic zonation scheme.

Due to non availability of the systematic samples for all the time periods some gaps have been left in the proposed biozonation scheme, also it has resulted in not defining the thicknesses for the proposed zones.

PLANKTONIC FORAMINIFERAL ZONATION

In all following ten planktonic foraminiferal zones have been established and correlated with the standard planktonic foraminiferal zonation scheme of Blow (1969). The zones (Table-1) in ascending order are as follows—

Globigerinoides quadrilobatus primordius—Globorotalia (Turborotalia) pseudokugleri Assemblage-zone.

Locality : Western part of Henry Lawrance Island (93°3'23" : 12°7'37"), sample No. HL-1.

Discussion : Globorotalia (T.) pseudokugleri is known to range from ? middle part of Zone N. 4, *Globigerinoides quadrilobatus primordius* first appears at the base of Zone N. 4. Their simultaneous occurrence in the present assemblage is suggestive of its being placed in Zone N. 4, Blow (1969).

Foraminifera : Globigerina praebulloides praebulloides Blow, *Globigerinoides quadrilobatus immaturus* Le Roy, *G. quadrilobatus primordius* Blow & Banner, *G. ruber* (d' Orbigny), *Globigerinata dissimilis dissimilis* (Cushman & Bermudez) *G. dissimilis ciperoensis* Blow & Banner, *G. unicava unicava* (Bolli, Loeblich & Tappan), *Globoquadrina altispira altispira* (Cushman & Jarvis), *G. altispira globosa* Bolli, *G. dehiscens advena* Bermudez, *G. dehiscens dehiscens* (Chapman, Parr & Collins), *G. rohri* (Bolli), *G. venezuelana* (Hedberg), *Globorotalia (T.) peripheroronda* Blow & Banner, *G. (T.) siakensis* Le Roy.

Globorotalia (Turborotalia) peripheroronda—Globigerinita dissimilis dissimilis Assemblage-zone.

Locality : North coast of Wilson Island (92° 59' 10" : 12° 8' 8"), sample No. KW-4.

Discussion : The concurrent ranges of *Globorotalia (T.) peripheroronda, Globigerinita dissimilis dissimilis* and *G. unicava* fixes the age of this assemblage as Late Aquitanian-Early Burdigalian, equivalent of Zone N. 6, Blow (1969).

Foraminifera : Globigerinoides quadrilobatus altiaperturus Bolli, *G. quadrilobatus immaturus* Le Roy, *G. quadrilobatus sacculifer* (Brady), *Globigerinita dissimilis dissimilis* (Cushman & Bermudez), *G. dissimilis ciperoensis* Blow & Banner, *G. unicava unicava* (Bolli, Loeblich & Tappan), *Globoquadrina altispira altispira* (Cushman & Jarvis), *G. altispira globosa* Bolli, *G. dehiscens advena* Bermudez, *G. dehiscens dehiscens* (Chapman, Parr & Collins), *G. rohri* (Bolli), *G. venezuelana* (Hedberg), *Globorotalia (T.) peripheroronda* Blow & Banner, *G. (T.) siakensis* Le Roy.

Globigerinoides sicanus—Globigerinatella insueta Assemblage-zone.

Locality : Yulu Tang Hill of North Havelock Island (93° 0' 19" : 12° 0' 46"), sample Nos. Y-1 to Y-3.

Discussion : Orbulina suturalis occurs within the highest part of range of *Globigerinatella insueta* (Zone N. 9). Therefore, the association of *G. insueta* and *Globigerinoides sicanus* in the absence of *Orbulina suturalis* in a continuous sequence is suggestive of placing this zone prior to the *Orbulina* datum i.e. within Zone N. 8, Blow (1969).

Foraminifera : *Globigerina juvenilis* Bolli, *G. praebulloides praebulloides* Blow, *Globigerinoides obliquus obliquus* Bolli, *G. quadrilobatus immaturus* Le Roy, *G. quadrilobatus sacculifer* (Brady), *G. quadrilobatus trilobus* (Reuss), *G. sicanus* de Stefani, *Globigerinatella insueta* Cushman & Stainforth, *Globoquadrina altispira altispira* (Cushman & Jarvis), *G. conglomerata* (Schwager), *G. dehiscens dehiscens* (Chapman, Parr & Collins), *G. larmuei* Akers, *G. venezuelana* (Hedberg), *Praeorbulina glomerosa glomerosa* (Blow), *Globorotalia (T.) obesa* Bolli, *G. (T.) peripheroronda* Blow & Banner, *G. (T.) scitula praescitula* Blow, *G. (T.) siakensis* Le Roy, *G. (G.) praemenardii archeomenardii* Bolli.

Remarks : This zone is also recognised from the southern coast of Nicholson Island, sample No. NIC-8.

Orbulina suturalis—Globorotalia (Turborotalia) brinageae Assemblage-zone.

Locality : South western and southern coast of Nicholsons Island (92° 57′ 40″ : 12° 5′ 7″), sample Nos. NIC-1 to NIC-7.

Discussion : In the succeeding *Globigerinoides sicanus-Globigerinatella insueta* zone the zonal fossils are not associated with either *Orbulina suturalis* or *Globorotalia (T.) mayeri.* In the present assemblage *Globigerinoides sicanu* is found in association with *Orbulina suturalis* and *Globorotalia (T.) mayeri. Orbulina suturalis* has a world wide recognised datum at the base of Zone N. 9, whereas *Globigerinoides sicanus* has a known range of N. 8 to basal part of N. 9. Therefore, the above association is suggestive of placing this assemblage in Zone N. 9, Blow (1969). This fact is further supported by the presence of *Globorotalia (T.) brinageae* which does not extend beyond middle part of Zone N. 9.

Foraminifera : *Globigerina bradyi* Wiesner, *G. foliata* Bolli, *G. juvenilis* Bolli, *G. praebulloides praebulloides* Blow, *Globigerinoides obliquus obliquus* Bolli, *G. quadrilobatus*

Table 1—Neogene Planktonic Foraminiferal Assemblage Zones in Ritchie's Archipelago Andman Island

Epochs	Stages	Zones	Planktonic Foraminiferal Zonation (Blow, 1969)	Proposed Planktonic Foraminiferal Zonation
Pleistocene Holocene	Calabrian and Younger Stage	Zone N. 23	Gl. calida calida—Spl. dehiscens excavata ASSZ	Not Sampled
		Zone N. 22	G.(G) truncatulinoides truncatulinoides PRZ	
		Zone N. 21	G.(T.) tosaensis tenuitheca CRZ	
Pliocene	Zanclian-Astian	Zone N. 20	G.(G.) multicamerata—Pul. obliqueloculata obliqueloculata PRZ	
		Zone N. 19	Spl. dehiscens dehiscens—Go. altispira altispira PRZ	Spl. dehiscens dehiscens Acme-Zone
		Zone N. 18	G.(G.) tumida tumida—S. subdehiscens Paenedehiscens PRZ	G.(G.) tumida tumida—S. subdehiscens paenedehiscens Assemblage-Zone
Miocene	Tortonian—Messinian	Zone N. 17	G.(G.) tudima plesiotumida CRZ	Not sampled
		Zone N. 16	G.(T.) acostaensis acostaensis—G. (G.) merotumida PRZ	G.(T.) acostaensis acostaensis—G.(G.) merotumida Assemblage-Zone
		Zone N. 15	G.(T.) continuosa CRZ	Not sampled
	Langhian	Zone N. 14	Gl. nepenthes/G. (T.) siakensis CUN	Gl. nepenthes—G.(T.) siakensis Assemblage-Zone
		Zone N. 13	S. subdehiscens subdehiscens—Gl. druryi PRZ	S. subdehiscens subdehiscens—G.(T.) mayeri Assemblage-Zone
		Zone N. 12	G.(G.) fohsi PRZ	G.(G.) praefohsi—H.(H) siphonifera siphonifera Assemblage-Zone
		Zone N. 11	G.(G.) praefohsi CRZ	Not sampled
		Zone N. 10	G.(T.) peripherodacuta CRZ	Not sampled
		Zone N. 9	O. suturalis—G.(T.) peripheroronda PRZ	O. suturalis-G.(T.) brinageae Assemblage-Zone
	Burdigalian	Zone N. 8	Gld. sicanus—Glt. insueta PRZ	Gld. sicanus-Glt. insueta Assemblage-Zone
		Zone N. 7	Glt. insueta—Gld. quadrilobatus trilobus PRZ	Not sampled
		Zone N. 6	Glt. insueta/Gln. dissimilis CUN	G. (T.) peripheroronda—Gln. dissimilis dissimilis Assemblage-Zone
	Aquitanian	Zone N. 5	Gg. dehiscens praedehiscens—Gg. dehiscens dehiscens PRZ	Not sampled
		Zone N. 4	Gld. quadrilobatus primordius/ G.(T). kugleri PRZ	Gld. quadrilobatus primordius-G(T.) pseudokugleri Assemlage-Zone

ABBREVIATIONS :

Gl—Globigerina
Gld—Globigerinoides
Gln—Globigerinita
Glt—Globigerinatella
O—Orbulina
Spl—Sphaeroidinella
S—Sphaeroidinellopsis
Gg—Globoquadrina
G—Globoratalia
T—Turborotalia
Pul—Pulleniatina
Prz—Parital-Rang-Zone
Crz—Consecutive-Rang-Zone
Cun—Cuncurrent-Rang-Zone
Assz—Assemblage-Zone

immaturus Le Roy, *G. quadrilobatus sacculifer* Brady, *G. quadrilobatus trilobus* (Reuss), *G. ruber* (d' Orbigny), *G. sicanus* de Stefani, *Praeorbulina glomerosa glomerosa* (Blow), *P. traensitoria* (Blow), *Orbulina suturalis* Bronnimann, *O. universa* d' Orbigny, *Globoquadrina altispira altispira* (Cushman & Jarvis), *G. altispira globosa* Bolli, *G. conglomerata* (Schwager), *G. hexagonia* (Nutland), *G. venezualana* (Hedberg), *Globorotalia* (*T.*) *brinageae* Blow, *G.* (*T.*) *continuosa* Blow, *G.* (*T.*) *mayeri* Cushman & Ellisor, *G.* (*T.*) *minutissima* Bolli, *G.* (*T.*) *obesa* Bolli, *G.* (*T.*) *peripheroronda* Blow & Banner, *G.* (*T.*) *scitula praescitula* Blow, *G.* (*T.*) *scitula scitula* (Brady), *G.* (*T.*) *siakensis* Le Roy, *G.* (*G.*) *praemenardii archaeomenardii* Bolli.

Remarks—This zone is also established in Yulutang Hill of northern Havelock Island, sample Nos. Y-4 to Y-7 and also in sample Nos. HL-2, collected from western part of Henry Lawrence Island.

Globorotalia (*Globorotalia*) *praefohsi—Hastigerina* (*Hastigerina*) *siphonifera siphonifera* Assemblage-zone.

Locality : Along Havelock Road section, Havelock Island (92° 59' 45" : 12° 0' 38"), Sample No. KB-5.

Discussion: Globorotalia (*G.*) *praefohsi* has a stratigraphic range of N. 11 to N. 12 and *Hastigerina* (*H.*) *siphonifera siphonifera* first appears in Zone N. 12. Therefore, the simultaneous occurrence of the zonal species is taken to correlate this zone with N. 12, Blow (1969).

Foraminifera : Globigerina praebulloides praebulloides Blow, *Globigerinoides obliquus obliquus* Bolli, *G. quadrilobatus immaturus* Le Roy, *G. quadrilobatus sacculifer* (Brady), *G. quadrilobatus trilobus* (Reuss), *Globoquadrina altispira altispira* (Cushman & Jarvis), *G. conglomerata* (Schwager), *G. dehiscens dehiscens* (Chapman, Parr & Collins), *G. larmeui larmeui* Akers, *G. rohri* Bolli, *Globorotalia* (*T.*) *peripheroacuta* Blow & Banner, *G.* (*T.*) *peripheroronda* Blow & Banner, *G.* (*T.*) *scitula scitula* (Brady), *G.* (*G.*) *praefohsi* Blow & Banner, *Hastigerina* (*H.*) *siphonifera siponifera* (d' Orbigny).

Sphaeroidinellopsis subdehiscens subdehiscens—Globorotalia (*Turborotalia*) *mayeri* Assemblage—zone.

Locality : Murlat Jig, western coast of Havelock Island (92° 58' 31" : 11° 58' 4"), sample Nos. MJ-1 to MJ-7.

Discussion : Appearence of *Sphaeroidinellopsis subdehiscens subdehiscens* is a well known datum (which defines the base of Zone N. 13). Association of this form with *Globorotalia* (*T.*) *mayeri* (upper limit upto part of Zone N. 13) enables to place this assemblage wlth upper Langhian, equivalent of Zone N. 13, Blow (1969).

Foraminifera : *Globigerina falconensis* Blow, *G. foliata* Bolli, *G. praebulloides praebulloides* Blow, *Globigerinoides bolli* Blow, *G. obliquus obliquus* Bolli, *G. quadrilobatus immaturus* Le Roy, *G. quadrilobatus sacculifer* (Brady), *G. quadrilo'atus* (Reuss), *G. ruber* (d' Orbigny), *Orbulina univers*a d' Orbigny, *O. suturalis* Bronnimann, *Sphaeroidinellopsis seminulina seminulina* (Schwager), *S. subdehiscens subdehiscens* (Blow), *Globoquadrina altispira altispira* (Cushman & Jarvis), *G. altispira globosa* Boll, *O. conglomerata* (Schwager), *G. dehiscens advena* Bermudez, *G. dehiscens deniscens* (Chapman, Parr & Collins), *G. rohri* Bolli, *G. venezuelana* (Hedberg), *Globorotalia* (*T.*) *mayeri* Cushman & Ellisor, *G.* (*T.*) *obesa* Bolli, *G.* (*T.*) *peripheroacuta* Blow & Banner, *G.* (*T.*) *scitula gigantea* Blow, *G.* (*T.*) *scitula scitula* Brady, *G.* (*T.*) *siakensis* Le Roy, *G.* (*G.*) *cultrata cultrata* (d' Orbigny), *G.* (*G.*) *fohsi* Blow, *Hestigerina* (*H.*) *siphonifera involuta* (Cushman), *H.* (*H.*) *siphonifera siphonifira* d' Orbigny.

Globigerina nepenthes—Globotalia (*Turborotalia*) *siakensis* Assembage—zone

Locality : Yulu Tang Hill of north Hevelock Island (92° 58′ 31″ : 11° 58′ 4″), sample Nos. Y-8 to Y-11.

Discussion : Association of *Globigerina nepenthes* and *Globorotalia* (*T.*) *siakensia* (which have overlapping ranges (within Zone No. 14) in the absence of *G.* (*T.*) *maveri* is taken as to represent the upper part of Langhian, equivalent of Zone N. 14, Blow (1969).

Foraminifera : *Globigerina foliata* Bolli, *G. nepenthes.* Todd, *G. praebulloides praebulloides* Blow, *Globigerinoides bollii* Blow, *G. obliquus obliguus* Bolli, *G. quadrilobatus immaturus* Le Roy, *G. quadrilobatus trilobus* (Reuss), *G. ruber* (d' Orbigny), *Orbulina suturalis* Bronnimann, *O. universa* d' Orbigny, *Biorbulina bilobata* d' Orbigny, *Sphaeroidinellopsis seminulina seminulina* (Schwager), *S. subdehiscens subdehiscens* (Blow), *Globoquadrina altispira altispira* (Cushman & Jarvis), *G. altispira globosa* Bolli, *G. conglomerata* (schwager), *G. dehiscens advena* Bermudez, *G. dehiscens dehiscens* (Chapman, Parr & Collins), *G. larmeui larmeui* Akers, *G. rohri* Bolli, *G. venezuelana* (Hedberg), *Globorotalia* (*T.*) *continuosa* Blow, *G.* (*T.*) *minutissima* Bolli, *G.* (*T.*) *scitulagigantea* Blow, *G.* (*T.*) *scitula scitula* (Brady), *G.* (*T.*) *siakensis* Le Roy, *G.* (*G.*) *cultrata cultrata* (d' Orbigny), *G.* (*G.*) *cultrata menardii* (Parker), Jones & Brady), *Hastigerina* (*H.*) *siphoniferainvoluta* (Cushman), *H.* (*H.*) *siphonifera siphonifera* (d' Orbigny).

Globorotalia (*Turborotalia*) *acostaensis acostaensis-Globorotalia* (*Globorotalia*) *merotumida* Assemblage-zone

Locality : Melville point, western coast of Havelock Island (92°56'12" : 11°59'23"), sample Nos. MP-1 to MP-4.

Discussion : The zonal fossil first appear at the base of Zone N. 16, whereas *Globorotalia* (*T.*) *continuosa* has a definite range upto Zone N. 16, with a doughtful range in the middle part of Zone N. 17. Till a better control is obtained the present assemblage is tentatively correlated with zone N. 16, Blow (1969).

Foraminifera : *Globigerina bulloides bulloides* d' Orbigny, *G. eamesi* Blow, *G. eggeri multiloba* Romeo, *G. falconensis* Blow, *G. juvenillis* Bolli, *G. nepenthes* Todd, *G. praebulloides praebulloides* Blow, *Globigerinoides bollii* Blow, *G. obliquus obliquus* Bolli, *G. quadrilobatus immaturus* Le Roy, *G. quadrilobatus sacculifer* (Brady), *G. quadrilobatus trilobus* (Reuss), *G. ruber* (d' Orbigny), *G. glutinata*(Egger), *Sphaeroidinellopsis seminulina*

seminulina (Schwager), *S. subdehiscens subdehiscens* (Blow), *Globoquadrina altispira altispira* (Cushman & Jarvis), *G. altispira globosa* Bolli, *G. conglomerata* (Schwager), *G. dehiscens advena* Bermudez, *G. dehiscens dehiscens* (Chapman, Parr & Collins), *G. larmeui larmeui* Akers, *G. rohri* Bolli, *G. venezuelana* (Hedberg), *Globorotalia* (*T.*) *acostaensis acostaesis* Blow, *G.* (*T.*) *acostaensis humerosa* Takayanagi & Siato, *G.* (*T.*) *continuosa* Blow, *G.* (*T.*) *minutissima* Bolli, *G.* (*T.*) *obesa* Bolli, *G.* (*T.*) *scitula scitula* (Brady), *G.* (*G,*) *cultrata cultrata* (d' Orbigny), *G.* (*G.*) *cultrata limbata* (Fornasini), *Hastigerina* (*H.*) *siphonifera siphonifera* (d' *Orbigny*).

Remarks : This zone is also established in the Lacum Harbour area northern tip of Havelock Island, sample No. LH-2.

Globorotalia (*Globorotalia*) *tumida tumida-sphaeroidinellopsis subdehiscens paenedehiscens* Assemblage-zone

Locality : North eastern coast of Neill Island (92° 4'7" : 11°49'26"), sample nos. Neill-6 and Neill-8.

Discussion : The concurrent occurrance of *Globorotalia* (*G.*) *tumida tumida* and *G.* (*G.*) *merotumida* fixes the age within the highest part of Messinian (Late Miocene) to Early Pliocene, comparable to Zone N. 18, Blow (1969).

Foraminifera : *Globigerinabulloides bulloides* d'Orbigny, *Globigerinoides conglobatus* (Brady), *G. obliquus obliquus* Bolli, *G. quadrilobatus immaturus* Le Roy, *G. quadrilobatus sacculifer* (Brady), *G. quadrilobatus trilobus* (Reuss), *G. ruber* (d' Orbigny), *Orbulina suturalis* Bronnimann, *O. universa* d Orbigny, *Sphaeroidinellopsis seminulina seminulina* (Schwager), *S. subdehiscens subdeshiscens* (Blow), *Globoquadrina altispira altispira* Cushman & Jarvis), *G. conglomerata* (Schwager), *G. dehiscens* advena Bermudez, *G. dehiscens dehiscens* (Chapman, Parr & Collins), *Globorotalia* (*T.*) *acostanesis acostanensis* Blow, *G.* (*T.*) *minutissima* Bolli, *G.* (*T.*) *obesa* Bolli, *G.* (*T.*) *scitula scitula* (Brady), *G.* (*G.*) *cultrata cultrata* (d' Orbigny), *G.* (*G.*) *cultrata exelis* Blow, *G.* (*G.*) *cultrata menardii* (Parker, Jones and Brady), *G.* (*G.*) *merotumida* Blow & Banner, *G.* (*G.*) *tumida plesotumida* Blow & Banner, *G.* (*G.*) *tumida tumida* (Brady), *Globorotaloides hexagonia variabilis* Bolli, *Hastigerina* (*H.*) *siphonifera siphoniyera* (d' Orbigny).

Remarks : This zone is also established in the Muralat Jig, western coast of Havelock Island, sample nos. MJ-8 to MJ-14.

Sphaeroidinella dehiscens dehiscens Acme-zone

Locality : South coast of Outram Island (93°6'32" : 12°12'11"), sample nos. K-102, and K-103A.

Discussion : The assemblage is characterised by *Sphaeroidinella dehiscens dehiscens* including *S. dehiscens dehiscens* forma *immatura* (which has a stratigraphical range within Zone N. 19), this coupled with the occurrence of *Pullenitina obliqueloculata obliqueloculata*, fixes the age of the assemblage precisely as Pliocene, equivalent of zone N. 19, Blow (1969).

Foraminifera : *Globigerina bradyi* Wiesner, *G. bulloides bulloides* d' Orbigny, *G. eggeri multiloba Romeo*, *G. foliata* Bolli, *G. inflata* d' Orbigny, *Globigerinoides conglobatus conglobatus* (Brady), *G. obliquus obliquus* Bolli, *G. qudrilobatus immaturus* Le Roy, *G. quadrilobatus sacculifer* Brady, *G. ruber* (d' Orbigny), *Orbulina suturalis* Bronnimann, *O. universa* d' Orbigny, *Sphaeroidinella dehiscens dehiscens* (Parkar & Jones), *S. dehiscens dehiscens* forma *immatura* (Cushman), *Sphaeroidinellopsis seminulina kochi* (Caudri), *S. seminulina seminulina* (Schwager), *S. subdehiscens paenidehiscens* Blow, *S. subdehiscens subdehiscens* Blow, *Globorotalia altispira altispira* (Cushman and Jarvis), *G. dehiscens dehiscens* (Chapman, Par & Collins), *Globorotalia* (*T.*) *acostaensis acostaensis* Blow, *G.* (*T.*) *acostaensis humerosa* Takayanagi & Saito, *G.* (*T.*) *obesa* Bolli, *G.* (*G.*) *cultrata cultrata* (d' Orbigny), *G.* (*G.*) *cultrata exelis* Blow, *G.* (*G.*) *cultrata menardii* (Parker, Jones & Brady), *G.* (*G.*) *merotumida* Blow & Banner, *G.* (*G.*) *tumida tumida* (Brady), *Hastigerina* (*H.*) *siphonifera siphonifera* (d' Orbigny), *Pulleniatina obliqueloculata obliqueloculata* (Parker and Jones), *P. obliqueloculata parcursor* Blow & Banner, *P. primalis* Blow & Banner.

Remarks : This zone is also established into south western coast of Neill Island, sample Nos. NEILL-1 and NEILL-2 and north and northeastern coast of Sir Hugh Rose Island, sample nos. H-1 to H-8.

CONCLUSION

This work has led to a finer and much more precise dating of the lowest sequence of the Archipelago Group than could be done by Chatterjee (1964) on the basis or larger foraminifera.

The study has also revealed that Strait and Round Formations have overlapping ages i.e. N. 4 to N. 19 and N. 8 to N. 18 respectively (Table 2), which indicates that the Round Formation represents partially a facies varient of the Strait Formation. Therefore, the ages assigned to these Formations on the lithological identity alone in different Islands may be quite misleading. The Round Formation may represent a deeper facies of the Strait Formation.

Globigerinoides ruber (d' Orbigny) seems to have much longer range (N. 4 to N. 19) in the area under study, than proposed by Blow (1969) for other areas.

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Table 2—Stratigraphic positions of Samples from Strait and Round Formations according to their Ages

Epoches	Stages	Zones	Strait Formation	Round Formation
Pleistocene-Holocene	Calabrian & Younger	N.23		
		N.22		
Pliocene	Zanclain-Astian	N.21		
		N.20		
		N.19	H-2, to B, Neill-1 & 2, K-103 & K-103A	
Miocene	Tortonian-Messinian	N.18		MJ-8 to 14, Neill- 6 & 7
		N-17		
		N.16	MP-1 to 4	LH-2
	Langhian	N.15		
		N.14		Y-8 to 11
		N.13		Mj- 1 to 7
		N.12		KB-5
		N.11		
		N.10		
		N.9	HL-2	Y-4 to 7, Nic-1 to 7
	Burdigalian	N.8		Y-1 to 3, Nic-8
		N.7		
	Aquitanian	N.6	KW-4	
		N.5		
		N.4	HL -1	

Abbreviations :

H—North and east coast of Sir Hughrose island.
HL—Western part of Henry Lawrance Island.
K—South Coast of Outram Island.
KB—Along Havelock Road Section, Havelock Island
KW—North Coast of Wilson Island.
LH—Lacum Harbour, Havelock Road
MJ—Murlat Jig. Western coast of Havelock Island
MP—Melville Point, Havelock Island
Y—Yulu Tang Hill, Havelock Island

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