THE PHYSIOLOGICAL RESPONSE OF EQUATORIAL NEogene
BATHYAL BENTHIC FORAMINIFERA TO LOW OXYGEN
CONDITIONS

by

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ABSTRACT

A comprehensive taxonomic evaluation of equatorial Neogene bathyal benthic foraminifera is presented for the first time.

Two wells from offshore Cabinda, West Africa, are examined. A diverse Miocene benthic foraminiferal fauna is described and illustrated, significant affinities to Venezuelan Agua Salada Fauna type material are observed. Paleoecological zonation and correlation provide original data on previously proprietary material. Palaeoenvironmental proxies and faunal data validate a periodic northward oscillation of the Benguela oceanographic system during the late early Miocene. Morphogroup analysis in conjunction with contemporaneous Total Organic Carbon data provide evidence for a dynamic shift in assemblage parameters with respect to palaeoenvironmental pressures.

Taxonomic comparison of Agua Salada Fauna type material from Eastern Falcon, Venezuela, with previous records reveal additional taxa in this study. These are described and illustrated. The benthic foraminiferal faunal succession records a high productivity period and the development of an Oxygen Minimum Zone during the late Serravallian to early Tortonian. This is coincident with the initial shoaling of the Isthmus of Panama and associated bottom water restriction.

Provincialisation amongst elements of the agglutinated foraminiferal assemblage between the Venezuelan and African localities is apparent. The Alveovalvulinidae and Liebusellinae of Venezuela are paleoecologically replaced by the Eggerellininae and Textulariinae offshore Cabinda. Similarly, the genus *Popovia* at the Venezuelan locality replaces morphologically similar *Pavonitinacea* common to Cabinda. Members of the Cyclaminidae are observed to follow a trend towards greater internal complexity with time at both the Venezuelan and Cabindan sites. In both cases this is coincident with the development of Oxygen Minimum Zone conditions.
CONTENTS LIST
VOLUME I

<table>
<thead>
<tr>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABSTRACT</td>
</tr>
<tr>
<td>Acknowledgements</td>
</tr>
<tr>
<td>1. GENERAL INTRODUCTION</td>
</tr>
<tr>
<td>2. LOCALITIES</td>
</tr>
<tr>
<td>2.1 Venezuela</td>
</tr>
<tr>
<td>2.2 West Africa</td>
</tr>
<tr>
<td>2.3 Romania</td>
</tr>
<tr>
<td>3. OCEANOGRAPHY AND ENVIRONMENT</td>
</tr>
<tr>
<td>3.1 Oceanography introduction</td>
</tr>
<tr>
<td>3.2 Miocene oceanography</td>
</tr>
<tr>
<td>3.3 Palaeoenvironment</td>
</tr>
<tr>
<td>3.4 Preservation</td>
</tr>
<tr>
<td>4. MATERIALS</td>
</tr>
<tr>
<td>4.1 Sample Preparation</td>
</tr>
<tr>
<td>4.1.1 Introduction</td>
</tr>
<tr>
<td>4.1.2. Foram retrieval procedure</td>
</tr>
<tr>
<td>4.2 Taxonomy</td>
</tr>
<tr>
<td>4.3 Introduction</td>
</tr>
<tr>
<td>4.4 Systematics</td>
</tr>
<tr>
<td>Phylum PROTOZOA</td>
</tr>
<tr>
<td>FORAMINIFERA J. J. Lee</td>
</tr>
<tr>
<td>ALLOGROMIDA Loeblich &amp; Tappan</td>
</tr>
<tr>
<td>Superfamily ASTROHIZACEA Brady</td>
</tr>
<tr>
<td>Family BATHYSIPHONIDAE Avnimelech</td>
</tr>
<tr>
<td>Genus BATHYSIPHON Sars</td>
</tr>
<tr>
<td>Genus NOTHIA Pfiaumann</td>
</tr>
<tr>
<td>Family RHABDAMMINIDAE Brady</td>
</tr>
<tr>
<td>Subfamily RHABDAMMININAE Brady</td>
</tr>
<tr>
<td>Genus RHABDAMMINA Sars</td>
</tr>
<tr>
<td>Genus RHIZAMMINA Brady</td>
</tr>
<tr>
<td>Family SACCAMMINIDAE Brady</td>
</tr>
<tr>
<td>Subfamily SACCAMMININAE Brady</td>
</tr>
<tr>
<td>Genus SACCAMMINA Carpenter</td>
</tr>
<tr>
<td>Superfamily HIPPOCREPINACEA Rhumbler</td>
</tr>
<tr>
<td>Family HIPPOCREPINIDAE Rhumbler</td>
</tr>
<tr>
<td>Subfamily HYPERAMMININAE Eimer &amp; Fickert</td>
</tr>
<tr>
<td>Genus HYPERAMMINA Brady</td>
</tr>
<tr>
<td>Superfamily AMMODISCACEA Reuss</td>
</tr>
<tr>
<td>Family AMMODISCIDAE Reuss</td>
</tr>
</tbody>
</table>
Subfamily AMMODISCINAE Reuss 63
  Genus AMMODISCOIDES Cushman 63
  Genus AMMODISCUS Reuss 64
Subfamily TOLYPAMMININAE Cushman 67
  Genus TOLYPAMMINA Rhumbler 67
Subfamily AMMOVERTELLININAE Saidova 67
  Genus GLOMOSPIRA Rzehak 67
Superfamily HORMOSINACEA Haeckel 68
  Family ASCHEMOCELLIDAE Vyalov 68
    Genus ASCHEMOCELLA Vyalov 68
  Family HORMOSINIDAE Haeckel 68
    Subfamily REOPHACINAE Cushman 68
      Genus REOPHAX de Montfort 68
      Genus SUBREOPHAX Saidova 72
Superfamily LITUOLACEA de Blainville 73
  Family HAPLOPHRAGMOIDIDAE Maync 73
    Genus CRIBROSTOMOIDES Cushman 73
    Genus HAPLOPHRAGMOIDES Cushman 73
    Genus VELERONINOIDES Saidova 78
  Family SPHAERAMMINIDAE Cushman 79
    Genus SPHAERAMMINA Cushman 79
  Family LITUOLIDAE de Blainville 79
    Subfamily AMMOMARGINULININAE Podobina 79
      Genus AMMOBACULITES Cushman 79
      Genus AMMOMARGINULINA Wiesner 81
      Genus AMMOTIUM Loeblich & Tappan 82
      Genus DISCAMMINOIDES Brönnimann 82
Superfamily HAPLOPHRAGMIACEA Eimer & Fickert 82
  Family AMMOSPHAEROIDINIDAE Cushman 82
    Subfamily AMMOSPHAEROIDININAE Cushman 82
      Genus CYSTAMMINA Neumayr 82
      Subfamily RECURVOIDINAE Alekseychik - Mitskevich 83
        Genus BUDASHEVAELLA Loeblich & Tappan 83
        Genus RECURVOIDES Earland 83
        Genus BULBOBACULITES Maync 85
Superfamily LOFTUSIACEA Brady 85
  Family CYCLAMMINIDAE Marie 85
  Subfamily ALVEOLOPHRAGMIINAE Saidova 85
    Genus ALVEOLOPHRAGMIUM Shchnedrina 85
    Genus POPOVIA Suleymanov 86
    Genus RETICULOPHRAGMIUM Maync 87
  Subfamily CYCLAMMININAE Marie 89
Genus CYCLAMMINA Brady 89
Superfamily SPIROPLECTAMMINACEA Cushman 95
Family SPIROPLECTAMMINIDAE Cushman 95
Subfamily SPIROPLECTAMMININAE Cushman 95
Genus SPIROPLECTAMMINA Cushman 95
Subfamily VULVULINAE Saidova 96
Genus VULVULINA d'Orbigny 96
Family TEXTULARIOPSIDAE Loeblich & Tappan 97
Genus TEXTULARIOPSIS Banner & Pereira 97
Family PLECTORECURVOIDAE Loeblich & Tappan 97
Genus PLECTORECURVOIDES Noth 97
Superfamily PAVONITINACEA Loeblich and Tappan 98
Family PAVONITINIDAE Loeblich and Tappan 98
Subfamily SPIROPSAMMIIINAE Seiglie and Baker 98
Genus SPIROPSAMMIA Seiglie & Baker 98
Subfamily PAVONITININAE Loeblich & Tappan 99
Genus PAVONITINA Schubert 99
Genus PAVOPSAMMINA Seiglie & Baker 100
Order TROCHAMMINIDA Saidova 100
Suborder TROCHAMMININA Brönnimann & Whittaker 100
Superfamily TROCHAMMINACEA Schwager (emend. Brönnimann, et.al. emend. Brönnimann & Whittaker) 100
Family TROCHAMMINIDAE Schwager emend. Brönnimann, et.al. 100
Subfamily TROCHAMMINADAe Schwager emend. Brönnimann & Whittaker 100
Genus PARATROCHAMMINA Brönnimann 100
Subgenus PARATROCHAMMINA (LEPIDOPARTROCHAMMINA) Brönnimann & Whittaker 100
Genus TROCHAMMININA Parker and Jones emend. Brönnimann & Whittaker 101
Family PROLIXOPLECTIDAE Loeblich & Tappan 102
Genus EOMARSSONELLA Levina 102
Genus KARRERULINA Finlay 102
Superfamily VERNEUILINACEA Cushman 105
Family VERNEUILINIDAE Cushman 105
Subfamily VERNEUILININAE Cushman 105
Genus GAUDRYINA d'Orbigny 105
Genus VERNEUILINA d'Orbigny 106
Superfamily ATAXOPHRAGMIACEA Schwager 106
Family GLOBOTEXTULARIIDAE Cushman 106
Subfamily GLOBOTEXTULARIINAE Cushman 106
Genus GRAVELLINA Brönnimann 106
Subfamily LIEBUSELLINAE Saidova 107
Genus JARVISELLA Brönnimann 107
Family ALVEOVALVULINIDAE Seiglie, et al. 107
Genus ALVEOVALVULINA Brönnimann 107
Genus ALVEOVALVULINELLA Brönnimann 108
Genus TEXTULARIELLA Cushman 109
Superfamily TEXTULARIAECEA Ehrenberg 110
Family EGGERELLIDAE Cushman 110
Subfamily DOROTHININAE Balakhmatova 110
Genus DOROTHIA Plummer 110
Subfamily EGGERELLINAE Cushman 110
Genus EGGERELLA Cushman 110
Genus KARRERIELLA Cushman 112
Genus MARTINOTTIELLA Cushman 114
Family TEXTULARIIDAE Ehrenberg 116
Subfamily TEXTULARIINAE Ehrenberg 116
Genus BIGENERINA d'Orbigny 116
Genus TEXTULARIA Defrance 117
Subfamily SIPHOTEXTULARIINAE Loeblich & Tappan 126
Genus SIPHOTEXTULARIA Finlay 126
Family PSEUDOGAUDRYINIDAE Loeblich & Tappan 127
Subfamily PSEUDOGAUDRYININAE Loeblich & Tappan 127
Genus CLAVULINOIDES Cushman 127
Genus PSEUDOGAUDRYINA Cushman 127
Family VALVULINIDAE Berthelin 129
Subfamily VALVULININAE Berthelin 129
Genus CLAVULINA d'Orbigny 129
Genus CYLINDROCLAVULINA Bermúdez & Key 129
Genus VALVULINA d'Orbigny 130
Superfamily MILIOLACEA Ehrenberg 131
Family SPIROLOCULINIDAE Wiesner 131
Genus ADELOSINA d'Orbigny 131
Genus SPIROLOCULINA d'Orbigny 131
Family HAUERINIDAE Schwager 132
Subfamily HAUERINIAE Schwager 132
Genus CYCLOFORINA Luczkowska 132
Genus LACHLANELLA Vella 132
Genus MASSILINA Schlumberger 132
Genus QUINQUELOCULINA d'Orbigny 132
Subfamily MILIOLINELLINAE Vella 134
Genus BILOCULINELLA Wiesner 134
Genus PYRGO Defrance 134
Genus TRILOCULINA d'Orbigny 136

Subfamily SIGMOILINITINAE Luczkowska 136
Genus SIGMOILINA Schlumberger 136
Genus SIGMOILINITA Seiglie 137

Subfamily SIGMOILOPSINAES Vella 137
Genus SIGMOILOPSIS Finlay 137

Family ALVEOLINIDAE Ehrenberg 138
Genus BORELIS de Montfort 138

Order LAGENIDA Lankester 139
Suborder LAGENINA Delage & Herouard 139

Superfamily NODOSARIACEA Ehrenberg 139
Family NODOSARIIDAE Ehrenberg 139

Subfamily NODOSARIINAE Ehrenberg 139
Genus DENTALINA Risso 139
Genus LAEVIDENTALINA Loeblich & Tappan 141
Genus NODOSARIA Lamarck 142
Genus PSEUDONODOSARIA Broomgaart 145
Genus PYRAMIDULINA Fornasini 145

Subfamily LINGULININAE Loeblich & Tappan 147
Genus LINGULINA d'Orbigny 147
Genus DAUCINOIDES de Klasz & Rérat 147

Subfamily FRONDICULARIINAE Reuss 147
Genus FRONDICULARIA Defrance 147

Subfamily PLECTOFRONDICULARIINAE Cushman 148
Genus AMPHIMORPHINA Neugeboren 148
Genus PLECTOFRONDICULARIA Liebus 148

Family VAGINULINIDAE Reuss 151
Subfamily LENTICULININAE Chapman, Parr & Collins 151
Genus DIMORPHINA d'Orbigny 151
Genus LENTICULINA Lamarck 151
Genus MARGINULINOPSIS Silvestrii 161
Genus SARACENARIA Defrance 162

Subfamily MARGINULININAE Wedekind 164
Genus AMPHICORYNA Schlumberger 164
Genus ASTACOLUS de Montfort 165
Genus MARGINULINA d'Orbigny 166
Genus VAGINULINOPSIS Silvestrii 169

Subfamily VAGINULININAE Reuss 169
Genus CITHARINA d'Orbigny 169
Genus PLANULARIA Defrance 169
Genus VAGINULINA d'Orbigny 171
Family LAGENIDAE Reuss 172
  Genus LAGENA Walker and Jacob 172
Family POLYMORPHINIDAE d'Orbigny 172
  Subfamily POLYMORPHININAE d'Orbigny 172
    Genus GUTTULINA d'Orbigny 172
    Genus POLYMORPHINA d'Orbigny 173
Family ELLIPSOLAGENIDAE Silvestri 173
  Subfamily OOLININAE Loeblich & Tappan 173
    Genus OOLINA d'Orbigny 173
  Subfamily ELLIPSOLAGENINAE Silvestri 174
    Genus FISSURINA Reuss 174
Superfamily CERATOBULIMINACEA Cushman 175
  Family CERATOBULIMINIDAE Cushman 175
    Subfamily CERATOBULIMININAE Cushman 175
      Genus CERATOCANCRIS Finlay 175
  Family EPISTOMINIDAE Wedekind 176
    Subfamily EPISTOMININAE Wedekind 176
      Genus HOEGLUNDINA Brotzen 176
Superfamily BOLIVINACEA Glaessner 176
  Family BOLIVINIDAE Glaessner 176
    Genus BOLIVINA d'Orbigny 176
    Genus BRIZALINA Costa 182
  Family BOLIVINOIDIDAE Loeblich & Tappan 186
    Genus BOLIVINOIDES Cushman 186
Superfamily CASSIDULINACEA d'Orbigny 187
  Family CASSIDULINIDAE d'Orbigny 187
    Subfamily CASSIDULININAE d'Orbigny 187
      Genus CASSIDULINA d'Orbigny 187
      Genus CASSIDULINOIDES Cushman 190
      Genus GLOBOCASSIDULINA Voloshinova 190
    Subfamily EHRENBERGININAE Cushman 191
      Genus EHRENBERGINA Reuss 191
Superfamily TURRILINACEA Cushman 192
  Family TOSAIIDAE Saidova 192
    Genus TOSAIA Takayanagi 192
  Family STAINFORTHIIIDAE Reiss 192
    Genus HOPKINSINA Howe & Wallace 192
Superfamily BULIMINACEA Jones 193
  Family SIPHOGENERINOIDEIDAE Saidova 193
  Subfamily TUBULOGENERININAE Saidova 193
    Genus SIPHOGENERINA Schlumberger 193
Family BULIMINIDAE Jones 196
Genus BULIMINA d'Orbigny 196
Genus GLOBOBULIMINA Cushman 200
Genus PROTOGLOBOBULIMINA Hofker 202
Family BULIMINELLIDAE Hofker 202
Genus BULIMINELLA Cushman 202
Family UVIGERINIDAE Haeckel 203
Subfamily UVIGERININAE Haeckel 203
Genus UVIGERINA d'Orbigny 203
Genus UVIGERINELLA Cushman 214
Subfamily ANGULOGERININAE Galloway 215
Genus ANGULOGERINA Cushman 215
Genus TRIFARINA Cushman 215
Family REUSSELLIDAE Cushman 216
Genus REUSSELLA Galloway 216
Superfamily FURSENKOINACEA Loeblich & Tappan 216
Family FURSENKOINIDAE Loeblich & Tappan 216
Genus CORYPHOSTOMA Loeblich & Tappan 216
Genus FURSENKOINA Loeblich & Tappan 216
Family VIRGULINELLIDAE Loeblich & Tappan 217
Genus VIRGULINELLA Cushman 217
Superfamily DELOSINACEA Parr 218
Family CAUCASINIDAE Bykova 218
Subfamily CAUCASINIAE Bykova 218
Genus CAUCASINA Khalilov 218
Superfamily PLEUROSTOMELLACEA Reuss 219
Family PLEUROSTOMELLIDAE Reuss 219
Subfamily PLEUROSTOMELLINAE Reuss 219
Genus PLEUROSTOMELLA Reuss 219
Superfamily STILOSTOMELLACEA Finlay 220
Family STILOSTOMELLIDAE Finlay 220
Genus ORTHOMORPHINA Stainforth 220
Genus STILOSTOMELLA Guppy 220
Superfamily DISCORBACEA Ehrenberg 223
Family BAGGINIDAE Cushman 223
Subfamily BAGGININAE Cushman 223
Genus CANCRIS de Montford 223
Genus CIBICORBIS Hadley 224
Genus VALVULINERIA Cushman 225
Family EPONIDIDAE Hofker 226
Subfamily EPONIDINAE Hofker 226
Genus EPONIDES de Montfort 226
Family DISCORBIDAE Ehrenberg 228
  Genus DISCORBIS Lamarck 228
  Genus NEOEPONIDES Reiss 228
Family ROSALINIDAE Reiss 230
  Genus NEOCONORBINA Hofker 230
Family SPHAEROIDINIDAE Cushman 230
  Genus SPHAEROIDINA d'Orbigny 230
Superfamily GLABRATELLACEA Loeblich & Tappan 230
Family GLABRETELLIDAE Loeblich & Tappan 230
  Genus CONORBELLA Hofker 230
  Genus GLABRATELLA Doreen 231
Superfamily SIPHONINACEA Cushman 231
  Family SIPHONINIDAE Cushman 231
    Subfamily SIPHONININAE Cushman 231
      Genus SIPHONINA Reuss 231
Superfamily DISCORBINELLACEA Sigal 232
  Family PARRELLOIDIDAE Hofker 232
    Genus CIBICIDOIDES Thalmann 232
  Family PSEUDOPARRELLIDAE Voloshinova 236
    Subfamily PSEUDOPARRELLINAE Voloshinova 236
      Genus EPISTOMINELLA Husezima & Maruhasi 236
Superfamily PLANORBULINACEA Schwager 237
  Family PLANULINIDEA Bermúdez 237
    Genus PLANULINA d'Orbigny 237
  Family CIBICIDIDAE Cushman 238
    Subfamily CIBICIDINAE Cushman 238
      Genus CIBICIDES de Montford 238
  Family PLANORBULINIDAE Schwager 240
    Subfamily PLANORBULININAE Schwager 240
      Genus PLANORBULINA d'Orbigny 240
Superfamily ASTERIGERINACEA d'Orbigny 240
  Family ASTERIGERINIDAE d'Orbigny 240
    Genus ASTERIGERINA d'Orbigny 240
  Family AMPHISTEGINIDAE Cushman 241
    Genus AMPHISTEGINA d'Orbigny 241
Superfamily NONIONACEA Schultze 241
  Family NONIONIDAE Schultze 241
    Subfamily NONIONINAE Schultze 241
      Genus NONION de Montford 241
      Genus NONIONELLA Cushman 243
    Subfamily PULLENIINAE Schwager 243
      Genus MELONIS de Montford 243
Genus PULLENIA Parker and Jones 245
Superfamily CHILOSTOMELLACEA Brady 246
Family CHILOSTOMELLIDAE Brady 246
Subfamily CHILOSTOMELLINAE Brady 246
Genus CHILOSTOMELLA Reuss 246
Family OSANGULARIIDAE Loeblich & Tappan 247
Genus OSANGULARIA Brotzen 247
Family ORIDORSALIDAE Loeblich & Tappan 248
Genus ORIDORSALIS Andersen 248
Family HETEROLEPIDAE Gonzáles - Donoso 248
Genus ANOMALINOIDES Brotzen 248
Genus HETEROLEPA Fraznenau 249
Family GRAVELINELLIDAE Hofker 250
Subfamily GYROIDINOIDINAE Saidova 250
Genus GYROIDINOIDES Brotzen 250
Subfamily GAVELINELLINAE Hofker 251
Genus GYROIDINA d’Orbigny 251
Genus HANZAWAIA Asano 254
Family COLETIDAE Loeblich & Tappan 256
Genus BUCCELLA Andersen 256
Superfamily ROTALIACEA Ehrenberg 257
Family ROTALIIDAE Ehrenberg 257
Genus PARAROTALIA Le Galvez 257
Family ELPHIDIIDAE Galloway 257
Subfamily ELPHINIINAE Galloway 257
Order ROTALIIDA Lankester 258
Suborder ROTALINA Delage & Hérouard 258
Superfamily NUMMULITACEA de Blainville 258
Family NUMMULITIDAE de Blainville 258
Subfamily NUMMULITINAE de Blainville 258
Genus PLANOSTEGINA Banner & Hodgkinson 258

INDETERMINATE TAXA 259

5. PHYSIOLOGICAL RESPONSE 260
5.1 Phylogenetic response 260
5.2 Assemblage response 262

6. PALEOEENVIRONMENTAL INTERPRETATION 269
6.1 Venezuelan biostratigraphic framework 269
6.2 Venezuela palaeoenvironmental interpretation 285
6.3 CABGOC 128-3 palaeoenvironmental interpretation 294
6.4 CABGOC 115-1X palaeoenvironmental interpretation 300
6.5 Cabinda environmental evolution 308
6.6 Cabinda correlation 310
6.7 Romanian samples

6.7.1 Inclusion of samples

6.7.2 Romanian palaeoenvironmental interpretation

7. TOTAL ORGANIC CARBON

7.1 Introduction

8. CONCLUSIONS

8.1 RECOMMENDATIONS FOR FURTHER RESEARCH

9. REFERENCE LIST

LIST OF TABLES

Table 1. Lithostratigraphy of the Agua Salada Group 19
Table 2. Well data for CABGOC wells 54
Table 3. Location data for Venezuelan samples 54
Table 4. Additional Tertiary localities examined but not included further 54
Table 5. Selected references for ecological characters associated with benthic foraminifera 265
Table 6. Definition of 'Stages' as recognised by Renz (1948) 269
Table 7. Zonal definitions of Renz (1948) (excluding the "Uvigerinella" sparcostata Zone) 270
Table 8. Zonule definitions of Renz (1948) 271
Table 9. Sample location in Zones of Renz (1948) 272
Table 10. Sample location in Zones of Blow (1959) 279

VOLUME II

LIST OF FIGURES

Figure 1. Cenozoic time 353
Figure 2. Neogene zonation 354
Figure 3. Cyclammina phylogeny 355
Figure 4. Diagrammatic summary of the apertural characteristics and basic alveolar wall structures of Alveolophragmium, Reticulophragmium and Cyclammina 355
Figure 5. Location of Eastern Falcon, Venezuela 356
Figure 6. Approximate geographic extent of the Agua Salada Basin, State of Falcon, Venezuela 356
Figure 7. Pozon - El Mene Road Section (A - B) 357
Figure 8. Pozon - El Mene, Eastern Falcon, Venezuela 357
Figure 9. Geological map of Pozon District of Acosta, State of Falcon, Venezuela 358
Figure 10. Summary Diagram of Renz (1948) 359
Figure 11. Correlation of Renz (1948) to Blow (1959) at Eastern Falcon, Venezuela 359
Figure 12. Location map, Cabinda 360
Figure 13. Cabina cross section 360
Figure 14. Transylvanian Basin sample location 361
Figure 15. Miocene chronostratigraphy and biochronology of the Central Paratethys with correlation to the lithostratigraphy of the Transylvanian Basin

Figure 16. Upwelling mechanisms

Figure 17. Surface currents of the South Atlantic

Figure 18. Walvis Ridge and the Benguela Current System

Figure 19. Miocene oceanographic summary

Figure 20. Population size and diversity as a function of oxygen and food availability in the benthic environment

Figure 21. Conceptual model explaining benthonic foraminiferal living depth in terms of food availability and oxygen concentration

Figure 22. Pozon - El Mene Road Section

Figure 23. Popovia johnrolandi n.sp. diagrammatic phylogenetic summary

Figure 23a. Diagrammatic representation of bathyal foraminiferal biofacies

Figure 24. El Mene – Pozon road section diagrammatic summary

Figure 25. CABGOC 128-3 diagrammatic summary

Figure 26. CABGOC 115-1X diagrammatic summary

Figure 27. CABGOC 128-3 and 115-1X correlation

Figure 28. Cabinda Graphic Correlation

Figure 29. Summary diagram

10. PLATES

10.1 Introduction

APPENDICES


2. Bibliography

3. Glossary of terms

ENCLOSURES

1. Venezuela data
2. CABGOC 128-3 data
3. CABGOC 115-1X data
4. Romania data
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"The advice I give to students in science is to move laterally and up and down and peer all around."

Edward O. Wilson, 1994 - Naturalist

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Finally, Antony diolch yn fawr am eich amynedd a chefnogaeth.
1. GENERAL INTRODUCTION

"Most children have a bug period. I never grew out of mine"

Edward O. Wilson, 1994 - Naturalist

Over the past three decades zonation of Cenozoic deep water sediments through plankton stratigraphy has produced a refined global biostratigraphy (Subbotina 1953; Kennett and Srinivasan 1983; Bolli et al. 1985, Berggren et al. 1995; and references therein), see Figures 1 and 2. However, similar attempts using benthonic foraminifera have been hampered by inadequate taxonomy, low abundances, high species dominance, long stratigraphic ranges and species bathymetric migration (Douglas and Woodruff 1981). As Berggren (1984) once eloquently stated, 'Interpretative studies in any aspect of (micro) palaeontology will be no better than the taxonomy upon which they depend'. This sentiment is echoed by Boltovskoy (1984), who states 'the systematics of benthic foraminifera is so confused now that the comparison of faunal lists identified by different researchers is not reliable'. In response to these statements, systematic studies of cosmopolitan deep sea benthic foraminifera, largely as a product of the Deep Sea Drilling Project initiative and in particular through funding by a consortium of oil companies through Woods Hole Oceanographic Institution, have resulted in a clearer understanding of their taxonomy, biostratigraphy and palaeobathymetric distributions, permitting tentative benthonic zonation (Berggren and Miller 1989). The stratigraphic and palaeoenvironmental utility of agglutinated foraminifera was initially addressed by Gradstein and Berggren (1981) and Kaminski (1987). Work on the ubiquitous Cenozoic genus *Uvigerina* and its palaeoenvironmental implications was undertaken by Boersma (1984). More recently Neogene foraminifera of the Gulf Coast and Caribbean region became the focus of attention. Eureka boreholes enabled the correlation of calcareous plankton and benthic foraminifera for a regional late Neogene / Pliocene framework (Aubry 1991a, b, c, 1993a, b, 1997; Katz 1991; Katz and Miller 1991, 1993; Miller and Katz 1991; Schnitker 1991a, b, 1993; Zhang, Miller and Berggren 1991, 1993). The onshore Legs of the Ocean Drilling Program (Legs 150X and 174AX) have facilitated a framework to integrate shallow and deeper water Cenozoic facies along the New Jersey margin (Aubry 1997; Katz and Miller 1996; 1997). However, no modern published studies have been carried out in the marginal basins of West Africa and the Venezuelan type section for the Agua Salada Fauna (ASF).

Neogene sediments from upwelling areas are important targets for modern petroleum exploration. Micropalaeontological analysis has proved beyond doubt, to be instrumental in exploration geology as articulately outlined by Van Hinte (1978). However, in the low latitude basins of the Atlantic, the stratigraphic record of planktonic calcareous microfossils, conventionally used for industrial biostratigraphy and correlation, is at best sporadic. Planktonic microfossils, when present, are often so poorly preserved as to preclude identification. This obstacle to stratigraphy is compounded as the modern tools of stratigraphy and palaeoceanography, the stable isotopes of calcareous plankton microfossils, are by definition
absent. As an alternative, other microfossil groups are considered as biostratigraphical tools (i.e.: diatoms, radiolarians, silicoflagellates, palynomorphs). However these are often similarly poorly preserved, preventing accurate stratigraphical analysis. The only remaining group suitable for small scale stratigraphic appraisal are the benthos. This thesis focuses upon cosmopolitan benthonic foraminifera, both the agglutinating and calcareous components of the Agua Salada Fauna (ASF), as an alternative to plankton stratigraphy in areas such as West Africa and Venezuela where their utility in petroleum bearing basins is demonstrated. In particular, the agglutinated portion is scrutinised in detail where environmental conditions eliminate the preservation and / or colonisation of the calcareous forms. This group of agglutinated foraminifera has a prestigious economic history, initiated at the turn of the last century by Grzybowski (1898) (see Kaminski et. al. 1993 for translation) and continuing into the 1980's through the endeavours of Seiglie and Baker (1982; 1983) and Seiglie et. al. (1986).

West Africa has of late become a major petroleum concern (Brown 1997). Yet the microfauna of this area, necessary for biostratigraphic correlation, is at best under studied. Petters (1982) recognised the equivalent trans-Atlantic faunas of the Caribbean, N. E. Brazil, and the U. S. Gulf Coast in the African region and attributes the foraminiferal fauna to that of the Guinean Faunal Biogeographic Province of Ekman (1953). The Caribbean region remains one of the most thoroughly studied biostratigraphic regions. If the palaeogeographic and palaeoceanographic evolution of the Equatorial Atlantic Region, and the faunal migrations that operate within this area, are to be reconciled an integration of these two faunas has to be undertaken.

Miocene sediments of equatorial upwelling regions contain a distinctive assemblage of opportunistic (r-selected) agglutinated foraminifera termed the 'Agua Salada Fauna' (ASF). First identified from the Oligocene-Miocene Agua Salada Formation of Venezuela (Renz 1948), the ASF is dominated by agglutinated foraminiferal morphogroups considered to be typical of modern dysaerobic environments (Kaminski et. al. 1995; Kaminski and Kuhnt 1995), and identified by the presence of *Valvulina flexilis*. Elements of the assemblage are characterised through the presence of alveolar test walls, for example those of *Reticulophragmium*, *Cyclammina*,†*Alveovalvulinella*. The ASF has received little attention over the last 50 years. Originally examined by Cushman and Renz (1941) and identified by Renz (1948) the fauna has remained largely unstudied. Akers (1954) briefly mentioned the ASF, it was then re-evaluated by Blow some years later (Blow 1959). There has been some confusion owing to changes of lithological nomenclature in the type area of the ASF (Renz 1959). However, since this early work the ASF has only received fleeting reference (Basou 1976; Diaz de Gamero 1985a; Diaz de Gamero 1985b; Diaz de Gamero 1977) until the present day (Giffuni 1991; Moreno-Vaquez 1995; Kaminski et. al. in press, Preece et. al. in press).

The fauna has been identified from diverse sites. Kaminski et. al. (in press) identified the fauna from the Miocene of the Gulf of Mexico and compared it favourably with types from the Smithsonian Institution, Libya and the Sabah Basin. Basou (1976) identified elements of the ASF from the Guinea Bay, offshore Sekonda Takoradi, Ghana, while Akers (1954), in his paper
relating the ecological aspects and stratigraphic significance of *Cyclammina cancellata*, refers to the ASF of Venezuela and *C. cancellata*’s bearing within it. Moy (1968) recovered elements of the ASF from Oligo-Miocene sediments of Libya and Hungary. Similarly, Ujiie (1970; 1979) identified elements of the ASF from the Miocene Sandakan Formation, North Borneo. More recently Preece *et al.* (in press) recorded its presence from offshore Cabinda, Angola, & its response to varying Total Organic Carbon (TOC) values.

The limited body of work conducted upon the ASF since Renz’s comprehensive work in 1948 has neglected to address the now obsolete taxonomy it employs. This work remains one of the most formative references for low latitude Neogene deep water benthonic foraminiferal study. However, without re-examination and the application of modern taxonomic criteria, confusion amongst multiple regional synonyms is inevitable.

It is the environmental significance and concurrent evolution of the ASF that directs the thrust of this project. Alveolar forms have long been considered to have evolved in response to low oxygen conditions (for example beneath a Oxygen Minimum Zone [OMZ]), however, the evolution and phylogeny of these genera remains poorly understood. For example, *Cyclammina*, although often considered to be a ‘well established’ genus, phylogenetically has to be polyphyletic (Berggren & Kaminski, 1990), (Fig. 3). The ability to evolve alveoles and apertural pores is considered to be a primitive character in multiple ancestral *Haplophragmoides* species that are essentially ‘switched on’ given the necessary environmental conditions. In effect, *Cyclammina*, from a phylogenetic view point are a disparate group of foraminifers displaying convergent evolution. Infaunal, opportunistic forms, such as many of those within the Miocene ASF, in modern environments are indicative of increased TOC values as a product of oceanographic upwelling intensity. Extrapolations from these modern responses to Miocene ASF assemblages have not been attempted to date, although are conceivably possible as the major taxonomic turnover at the early Mid Miocene established the modern deep sea benthic foraminiferal fauna (see review in Douglas and Woodruff 1981). Similarly, Deep Water Agglutinated Foraminifera (DWAF), to which the ASF belongs, can be affected by subsidence histories intra-basinally. This, in tandem with faunal trend analysis and hence depositional cycle information provide valuable insights regarding the geologic evolution of a given continental margin. With these parameters in mind it is essential to establish the phylogeny of the alveolar forms and address the systematic chaos presently employed within this group of foraminifers (Fig. 4). This achieved, objective comparison of elements of the ASF from differing localities (in this case, West Africa, Venezuela, Carpathian flysch, Libya and Borneo) together with physical parameters, where possible, gives a comprehensive indication of low oxygen deep water equatorial Miocene benthic foraminiferal evolution and oceanographic organisation.
The primary aims of this study are to:

1. a. Examine wells CABGOC 128-3 and CABGOC 115-1X from offshore Cabinda, Angola, and establish a robust taxonomic framework for this previously unexplored province.
1. b. Taxonomically re-evaluate samples from the type section of the ASF at the El Mene – Pozon road section, Northern Falcon, Venezuela.
1. c. Perform the taxonomic revision of Miocene bathyal benthic foraminiferal fauna necessary to establish a reliable low latitude, deep water, index catalogue.
2. a. Biostratigraphically zone the Cabindan succession and construct a coherent palaeoenvironmental sequence through assessing phylogenetic evolution and assemblage development of the fauna.
2. b. Palaeoenvironmentally assess the Venezuelan series with respect to taxon phylogeny and assemblage variation.
3. Critically compare the foraminiferal fauna recovered from the Venezuelan and Cabindan localities with additional material from Paratethys and museum type collections.
4. Assess the response of low latitude bathyal benthic foraminiferal faunas to oxygen minimum conditions in the Venezuelan and African localities.
5. Evaluate the response of Miocene bathyal benthic foraminiferal faunas to Total Organic Carbon values through morphogroup analysis.

In addition to papers cited in the text of this thesis, a bibliography of additional works consulted during the tenure of this research is provided in appendix 2. A glossary of terms is presented in appendix 3.
2. LOCALITIES
2.1. VENEZUELA

Before the infinite can be thine
You must first break it down
and then recombine.

Goethe

The name Agua Salada Series was coined in 1919 by M. L. Thomas in private petroleum reports. A mining engineer, he conducted exploratory surveys in the Falcon Region of Northern Venezuela, however, the name was first published in 1937 (Weidenmayer 1937) as the 'Agua Salada Series'. In the same year Hedberg (1937) referred to it as the Agua Salada Group, and Suter (1947) referred to the area.

The Agua Salada Basin of Eastern Falcon, Northern Venezuela (Figs. 5 and 6) is filled with Tertiary clays. Tertiary sedimentation is initiated with the Eocene Cerro Mision Formation (and its lateral equivalents), transgressing older, unknown formations. This grades into the conformable Guacharaca Formation and then into the El Salto Sand Member, the oldest component of the San Lorenzo Formation.

The Agua Salada Group is Late Oligocene to Late Miocene in age and divided into two formations upon the basis of lithology, the older San Lorenzo Formation (Late Oligocene) and younger Pozon Formation (Late Oligocene to Late Miocene). The San Lorenzo Formation is again subdivided into two members, the older El Salto Sand Member and younger Menecito Clay Member. The Pozon Formation is divided into three members, the Policarpio Greensand Member; the Husito Clay Member and the Huso Clay Member. Lateral variation within the Agua Salada Group is prevalent.

Table 1. Lithostratigraphy of the Agua Salada Group

<table>
<thead>
<tr>
<th>GROUP</th>
<th>FORMATION</th>
<th>MEMBER</th>
</tr>
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<tbody>
<tr>
<td>Agua Salada Group</td>
<td>Pozon Formation</td>
<td>Huso Clay Member</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Husito Clay Member</td>
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<tr>
<td></td>
<td></td>
<td>Policarpio Greensand Member</td>
</tr>
<tr>
<td></td>
<td>San Lorenzo Formation</td>
<td>Menecito Clay Member</td>
</tr>
<tr>
<td></td>
<td></td>
<td>El Salto Sand Member</td>
</tr>
</tbody>
</table>

The name El Salto originates from El Mene de Salto, the original name for El Mene de Acosta. The sequence is well exposed along the El Mene Road as a massively bedded, medium grained sand with lenses of coarser material locally. Intercalated lenses of clays and silts are present, increasing in frequency towards the base. Some of the sands grade into coarse limestones with larger foraminifera. For petrography and petrology see Renz (1948).
The conformable Menecito Clay is named for Menecito area, West of El Mene de Acosta. This is a uniform grey clay with occasional marly layers.

The Pozon Formation is named for the Pozon Area, State of Falcon, Northern Venezuela. The lithologic differences between the middle and upper members are recognised as being problematic.

The lowest unit of the Pozon Formation, the Policarpio Greensand Member is named for the Policarpio trigonometric point, immediately north of the northern end of the Pozon type section. A slight angular unconformity separates this member from the underlying Menecito Clay of the San Lorenzo Formation. The term Greensand is strictly incorrect, as virtually no sand is present in this shallow band of glauconitic marl and marlstone concretions, but maintained for ease of comparison.

The following conformable Husito Clay Member is named for Husito, a locality near the junction of the east and west branches of the Quebrada Agua Salada. The clay consists of predominantly marly clays, intercalations of foraminiferal marls becoming dominant towards the top.

The final member of the Agua Salada Group, the Huso Clay is named for a locality west of the type section (beyond the boundary of the map). This lies conformably upon the Husito Clay, the boundary considered transitional. It is a grey, noncalcareous clay, well jointed, with intercalations of marls and marly clays. Towards the west of the Pozon type section, this member thins out as a result of facies changes, the overlying Ojo de Agua Formation interfingering and eventually replacing the clay. Towards the east the clay becomes thicker by replacing the Ojo de Agua sands.

Hedberg (1937) correlated the parts of the Agua Salada Formation of Eastern Falcon to the Carapita Formation of the District of Libertad, State of Anzoategui, Northeastern Venezuela upon the basis of benthic foraminifera. Much of the Carapita Formation contains species found throughout the extent of the Agua Salada Formation, however, the greatest similarity occurs within Senn's (1935) A4 zone, roughly equivalent to Renz's (1948) U. sparicostata / L. wallacei / S. transversa zones.

Diaz de Gamero (1985a) used the Agua Salada Formation to aid in interpreting the geological evolution of the East Falcon sub-basin. Planktonic associations were used to define a temporal framework, the benthic component for the altering palaeoenvironmental conditions. She isolated two periods of subsidence. Working in the north of the basin she identified an end Oligocene association of settlement and marked alterations in water mass characteristics, as represented through a wholly agglutinated foraminiferal fauna (Diaz de Gamero 1985b). This was followed by an interruption in sedimentation in the earliest Miocene and renewed downwarping between early and mid Miocene times. In the North of the basin, a rapidly prograding delta formed at the
end of the early Miocene, as the sub-basin underwent renewed subsidence this was covered by deep water marine shales. The construction of a sequence of carbonate platforms in the mid Miocene ensued. Finally, the northern extent of the basin displays evidence of marked uplift at the end Miocene with a strong east-west orientation. The northeastern realm subsided again during the early Pliocene to give rise to the Punta Gavilan Limestone, advancing diachronously from east to west (Diaz de Gamero 1985b). She established a zonation based largely upon planktonic foraminifera, but did not correlate this with the older (Senn 1935; Renz 1948; Blow 1959) established zonations. She had previously examined the stratigraphy and micropalaeontology of the central area of the Agua Salada Basin (Diaz de Gamero 1977) and recognised the lithostratigraphic units defined towards the southern extent of the basin could not be readily correlated in the Eastern Falcon area (Diaz de Gamero 1985b). Diaz de Gamero (1985b) proposed a redefinition of the Agua Salada Group to include the underlying Guacharaca Formation based upon sections to the north. This is composed of similar marine clays belonging to the same sedimentary cycle as the Agua Salada Group. In addition, the Capadare Formation is considered to be coeval with the Mid Miocene section of Agua Salada Group (Pozon Formation), however, in this northern locality it is represented by discontinuous limestone masses, reflecting the shallower carbonate platforms surrounded by a deep sea. The Cenozoic plate tectonic history of Northern Venezuela is concisely placed in context in Erlich and Barrett (1990).

The Agua Salada Fauna (ASF) was named by Renz in 1948. Originally examined by Cushman and Renz (1941) and mentioned by Akers (1954), Cushman had illustrated some of fauna in an earlier work (1929). Gravell (1933), similarly referred to some ASF foraminifera before Renz (1942), listed the most frequent foraminiferal components in a correlative work embracing areas of northern South America, Trinidad and Barbados. The ASF was re-evaluated by Blow some years later (1959). The type area in Northern Venezuela then became a point of contention for a short period (Renz 1959). Wheeler (1963; 1960) continued some work in the area, however, since this early work, the ASF has only received fleeting reference (Basou 1976; Diaz de Gamero 1985a; Diaz de Gamero 1985b; Diaz de Gamero 1977) until the present (Giffuni 1991; Bolli, et al. 1994; Moreno-Vaquez 1995; Kaminski et. al. in press; Preece et. al. in press).

The ASF has been identified from diverse sites. Kaminski et. al. (in press) identified the fauna from the Miocene of the Gulf of Mexico and compared it favourably with types from the Smithsonian Institution, Libya and the Sabah Basin. Basou (1976) identified elements of the ASF from the Guinea Bay, offshore Sekonda Takoradi, Ghana, further along the African margin Preece et. al. (in press) concentrated upon its morphogroup signature offshore Cabinda, Angola. Akers (1954), in his paper relating the ecological aspects and stratigraphic significance of Cyammin cancellata, refers to the ASF of Venezuela and C. cancellata's bearing within it.

More recently, Moreno-Vaquez (1995) listed the key elements of the ASF without assigning the name. The paper concentrated upon the calibration of seismic data with Neogene biofacies in the Maturun sub-basin of Eastern Venezuela. Four biofacies in the Freites and Oficina
Formations of the Pato oil field were identified, biofacies 3 is clearly ASF material. In the Carapitana Formation of the North Monagas oil fields, biofacies B is undoubtedly ASF. Other biofacies recorded all contain modest elements of the ASF. Moy (1968) recovered elements of the ASF from Oligo-Miocene sediments of Libya and Hungary although did not recognise this as such at the time. Similarly, Ujiie (1970; 1979) identified elements of the ASF from the Miocene Sandakan Formation, North Borneo without assigning the correct terminology. Bolli et. al. (1994), provide a succinct review of early work in the type area.

The type area for the ASF lies within El Mene de Acosta and Pozon, State of Flacon, Venezuela (Fig. 7). Named after Quebrada Agua Salada, Pozon, the type sections are approximately 1442 m thick and were initially lithologically subdivided into the San Lorenzo and Pozon Formations. Both type sections (Figs. 8 and 9) occur along the southern flank of the Pozon-El Mene de Acosta Anticline, immediately north of Rio Tocuyo and north of the Cerro Mision Range. The Agua Salada Basin lies within the North Andean depositional basin. (This was originally referred to as a geosyncline; its Eastern component was termed the Venezuelan Geosyncline or Orinoco Geosyncline with the Maracaibo Geosyncline to the west and the Parian Landmass to the north [Renz et. al. 1958].) The Agua Salada Basin is geographically constrained to the north-east and north by the coast line (its exact position obscured by the Caribbean Sea) between Chichiriviche and Boca Rica, east of Cumarebo. To the south-west, the border meanders to Acurigua and through the Gueque Plains to Agua Linda-Riecito and Chichiriviche. At the marginal extremes of the basin the clayey Tertiary deposits are gradually replaced by silts, sands and reefal limestones along restricted uplifts.

Early studies of this area include Thomas (1924); Senn (1935); Cushman & Renz (1941) and Renz (1942). These were all superseded and rendered obsolete by Renz's comprehensive work in 1948.

Cushman (1929) was the first to describe the foraminifera from the Agua Salada group of formations. He used a cliff section in the district of Acosta that is wholly restricted to the *Siphogenerina transversa* Zone of Renz (1948). Cushman & Renz (1941) in a preamble to Renz's later extensive work of 1948, began the description of the Agua Salada Formation of Eastern Falcon. They erected seven foraminiferal zones spanning the upper Oligocene to middle Miocene. The Lower Agua Salada Formation consisted of a *Margulina wallacei* Zone and a *Siphogenerina multicostata* and *Gaudryina thalmanni* Zone. The Upper Agua Salada Formation included a *Cibicides kugleri* Zone; *Margulina basispinosa* and *Lenticulina senni* Zone; *Trochammina sp.* Zone; *Textularia panamaensis* Zone; *Rotalia beccarii* and *Elphidium poeyanum* Zone. These zones were not defined in detail, although the species were described. Renz (1942) revisited the Agua Salada briefly and listed many of the smaller foraminiferal species.

Blow (1959) in his correlative work between Eastern Venezuela and Trinidad, re-termed the San Lorenzo Formation, Tocuyo Formation. He was advised by Dr. H. G. Kugler (a respected
authority on Central American geology) the name 'San Lorenzo' was already in common use for a Tertiary Formation in the Santa Cruz Mountain region of Southern California (Arnold 1906; Atwill 1935). As such, priority should be imparted to the earlier established nomenclature of California. Regardless of potential confusion, Renz (1959), concluded the 6,000 km separation and location upon differing continental landmasses, sufficient to warrant maintaining his original terminology. For ease of comparison, I retain Renz's lexicon throughout this document.

Renz (1948) reported the San Lorenzo Formation of the Agua Salada Formation to extend for 400 m at his designated El Mene de Acosta type section. Working on subsections, he considered it to be mid to late Oligocene in age, conformably overlying Rupelian mid Guachara Formation sediments (Fig. 10). Subsequent refinement of Tertiary stratigraphy renders these age assignments technically incorrect; this will be discussed later. Controversially named for San Lorenzo village, north of an abandoned oil field, the San Lorenzo Formation outcrops along the south of the regional El Mene de Acosta-Pozon anticline. Included within this formation is the lower El Salto Sand Member, a shallow water, near shore, middle Oligocene sediment, and the upper Menecito Clay, a medium depth, mid-upper Oligocene sediment.

Its mid Oligocene component Renz (1948) termed the *Uvigerinella sparicostata* Zone, recognised through the presence of *U. sparicostata* and *Siphogenerina smithi*. Lithologically, its lower extent spans the El Salto Sand, the upper sediment extending into the lower reaches of the Menecito Clay. This unit was reported as showing poor to moderate foraminiferal recovery with barren layers prevalent. However, Renz (1948), despite the poor recovery, subdivided it into two distinct zonules, a lower *Boivina aiazanensis* zonule and an upper *Ammobaculites* *cf. stratheamensis* zonule. A total of 76 taxa were recorded in this original study, these largely occurring as assemblage biozones, a few zonally restricted. Renz (1948) interpreted this as a shallow coastal environment, less than 100m water depth. Blow (1959), although referring to this zone in part as his *Catapsydrax dissimilis* Zone (Fig. 11) in figures, fails to discuss it in the text as it is not present within the Pozon-El Mene Road section he studied.

The Upper Oligocene component of the San Lorenzo Formation is reported as Acostian in age. It is in conformable contact with the underlying *U. sparicostata* Zone and overlying *Aragautian* sediments of the Pozon Formation. Lithologically it is represented by the Menecito Clay. Upon the basis of benthic foraminifera, this zone was subdivided by Renz (1948) into an early *Lenticulina wallacei* zonule and a later conformable *Siphogenerina transversa* zonule. The zone was found to be foraminiferaly rich permitting strong biostratigraphic constraint, its top recognised with the Last Appearance Datum (LAD) of *S. transversa*, the base through the First Appearance Datum (FAD) of a collection of genera not present in earlier sediments. Renz found 154 foraminiferal species, and interpreted the fauna as reflecting an open sea, with a deep continental shelf.

The *L. wallacei* zonule is characterised by the presence of *Lenticulina sublitus*, *Boivina alazanensis*, *Nodosarida nuttalli*, *Planularia venezuelana* and *L. wallacei*. A slight unconformity
towards the top of the *S. transversa* zonule within the Policario Greensand Member identifies the boundary with the overlying Pozon Formation. The *S. transversa* zonule extends into the Pozon Formation. Characterised by the presence of *S. transversa*, *L. wallacei*, *Saracenaria senni* and *Pseudogaudryina jacksonensis*, it is foraminiferally very diverse, containing 117 species.

Blow (1959) referred to this zone as his *Catapsydrax stainforthi* Zone in part. Defined upon the basis of planktonic foraminifera, the topmost part of Renz's *Uvigerinella sparcostata* Zone is correlated with the basal part of this biozone. Blow's (1959) second zone *Globigerinatella insueta* Zone spans the section from the Pozon Formation into the San Lorenzo Formation. He recognised two sub zones within this Zone based upon the evolution of *Globigerinoides bispherica*.

The Pozon formation was named for the area of Pozon in the region of Northern Falcon, Venezuela. Its main topographic feature is the East West striking ridge of the Cerro Ojo de Agua de Pozon. The formation is best developed along the Southern flank of this anticline and in visible contact with the underlying San Lorenzo and overlying Ojo de Agua formations. The type section runs North South along the Loma Luca to the west of the San Lorenzo section. Renz (1948) considered this to represent a marine environment becoming shallow to brackish in a shallowing upward paleobathymetry. The Pozon Formation spans the Late Oligocene (Aquitanian) to Mid Miocene (Tortonian) in age and consists of the lowermost Policario Greensand, the mid Husito Marly Clay and upper Huso Clay. Renz (1948) made no formal attempt to subdivide foraminiferal zones, though some assemblages were recognised.

The Araguatian of the Pozon Formation is conformable upon Acostian sediments and in conformable contact with overlying Lucian sediments. Within the Pozon Formation this spans the Husito Clay and the boundary between the Oligocene Acostian *S. transversa* zonule and the Miocene. Rich in forams, it is biostratigraphically well defined through the presence of *Lenticulina subaculateus* var. *glabratu* and absence of *S. transversa*. Renz (1948) divided it into the *Globorotalia fohsi* zonule, and *Valvulineria herricki* zonule.

The *G. fohsi* zonule, part of the Husito Clay, was identified through the presence of *G. fohsi* and *Bolivina pisciformis*, and the absence of *S. transversa*. Renz (1948) considered this zonule to be an open sea environment, similar to that of the *L. wallacei* zonule, and "Araguatian" in age. Blow (1959) defined a wider *G. fohsi* Zone over this section spanning the interval from Renz's mid *S. transversa* Zone into the overlying *Valvulineria herricki* Zone. This he subdivided into four sub-zones upon the phylogenetic evolution of *G. fohsi* as defined by Bolli (1950).

The overlying *V. herricki* zonule was similarly considered to be ecologically identical to the *L. wallacei* zonule by Renz (1948). Also part of the upper Husito Clay, it is characterised through the presence of *L. subaculateus* var. *glabratu* and *V. herricki* and the absence of *G. fohsi* and *B. pisciformis*. One hundred and thirty five foraminiferal species were recognised, Renz (1948)
considered this zonule to be Upper Araguatian. Blow's (1959) equivalent to this interval is his *Globorotalia mayeri* Zone. Subdivided into two sub-zones this zone extends from the *V. herricki* Zone into the overlying *Marginulopsis basispinosus* Zone of Renz (1948).

The conformably overlying Lucian of the Pozon Formation is a facies influenced interval of local significance. Within this stage the Husito Clay passes into the Huso Clay. According to Renz (1948), the Lucian contains five zonules, its top defined by the contact with an undefined unit at the base the Ojo de Agua Formation.

The uppermost zonule of the Husito Clay, the lowermost zonule of the Lucian, is the *Margulinopsis basispinosus* zonule. Considered by Renz (1948) to be an open sea, continental shelf environment, it contains 117 foraminiferal species. Blow's (1959) *Globorotalia menardii menardii* / *Globigerina nepenthes* Zone is largely an assemblage Zone enclosed within the *M. basispinosus* zonule of Renz (1948).

The primary zone of the Huso Clay is the *Lenticulina senni* zonule conformably overlying the *M. basispinosus* zonule of the Husito Clay. This was found to contain 58 foraminiferal species, the lower diversity interpreted as a decrease in depth to littoral-neritic conditions. Renz (1948) considered this zonule to be of Helvetian age. The marginal character of this zone led Renz (1948) to subdivide it into three zonules based upon benthic foraminifera. He recognised these zonules were only identifiable in the Pozon area and not at El Mene de Acosta to the east.

The *Vaginulina superbus* - *Trochammina cf. pacifica* zonule of the *L. senni* Zone is conformably the first in sequence. Foraminiferaly impoverished, only containing 38 species, Renz (1948) regarded this as a change in deposition to a shallower environment. The presence of *Amphistegnia lessoni* and *Strebulus beccarii* implies lagoonal type conditions. *Trochammina cf. pacifica* and *Textularia panamaensis* are present in most samples implying an overall warm, shallow, neritic environment with subnormal salinity. Renz (1948) assigned no reliable age as the interval is acutely facies influenced, but assumed a mid Miocene, late Helvetian-early Tortonian time span. Blow's (1959) *Sphaeroidinella seminulina* Zone spans Renz's (1948) *L. senni* Zone from the topmost benthic *M. basispinosus* into the *Textularia panamaensis* zonule of the *L. senni* Zone.

The following *T. panamaensis* zonule is again conformable. The 19 species identified imply another acute environmental change to yet shallower conditions, some horizons indistinguishable from other zonules within the *L. senni* Zone. Species are not particularly age diagnostic, but a Tortonian age was assigned by Renz (1948). Blow's (1959) *Globigerina bulloides* Zone initiates within this zonule and carries through into the overlying *Eiphidium poeyanum* - *Reussella spinosa* zonule, however, this designation was only ever regarded as provisional by Blow (1959).
The final zonule of the Pozon Formation within the L. senni Zone according to Renz (1948) is the Elphidium poeyanum - Reussella spinosa zonule. The 16 species identified implied to Renz (1948) a shallow, subsaline, brackish environment. The influence of facies obscured precise dating, but a Tortonian age was assigned.

Both Renz (1948) and Blow (1959) recognised the extreme facies variations in the San Lorenzo and Pozon Formations, and their faunal influence. These were apparent from the differing sections used from the Loma Luca section of Renz (1948) to the Pozon-El Mene Road Section of Blow (1959), a distance of approximately 2,000m. These differences were only considered to become notable within the Upper Pozon Formation, however, intervals of agglutinated, alveolar species (eg: Cyclammina cancellata; Alveovalvulina pozonensis; Gravellina narivaensis; Valvulina flexilis) with robust forms of Haplophragmoides, were identified within the R. wallacei and S. transversa Zones of the San Lorenzo Formation (Blow 1959). These assemblages were found by Blow (1959) to be separated by intervals of calcareous forms, commonly dominated by planktonics. He considered the agglutinated intervals to represent periods of local subsidence and downwarping giving rise to temporary turbid conditions. Stainforth (1948; 1952), similarly, considered these assemblages to indicate slope instability and consequent turbidity. Kugler (1953) related this to the sporadic events associated with a subsiding trough.

Blow (1959) recorded M. basispinosus with V. herricki at Pozon-El Mene, casting doubt upon Renz's (1948) Late Araguatian zonation. Similarly, V. herricki has a sporadic occurrence throughout the V. herricki zone in Pozon-El Mene, implying severe environmental control.

In the V. superbus - T. cf. pacifica and T. panamaensis zonules of the L. senni Zone, Blow (1959), recorded frequent repetitions of assemblages in the Pozon-El Mene road traverse. Initially these consist of intervals of Uvigerina isidroensis, Bolivina imporcata and Bolivina simplex within the V. superbus - T. cf. pacifica zonule alternating with Renz's (1948) defined association. The T. panamaensis zonule of the L. senni Zone displays a three fold rhythmic repetition of intervals of U. isidroensis, B. imporcata and B. simplex in accordance with Renz's (1948) original description, superseded by an agglutinated assemblage of Textularia pozonensis, T. panamaensis and Trochammina spp. Blow (1959) interpreted this procession of faunas to be indicative of fluctuating water depths: the agglutinated assemblage to represent the shallowest extreme, the U. isidroensis, B. imporcata and B. simplex association to represent a 'middling' depth, and the defined (Renz 1948) assemblage to be indicative of deepest conditions. It is this fluctuating environment that renders the zonules of the L. senni Zone impossible to distinguish in the Pozon-El Mene Road section.
2.2. WEST AFRICA

We carry with us the wonders we seek without us:
there is all Africa and her prodigies in us.  

Sir Thomas Browne

Material for this component of this research originated from offshore Cabinda, West Africa (Fig. 12). Cabinda is a small detached enclave of Angola that produces most of that country’s oil. The Cabinda basin, north of Angola, is a Tertiary sequence represented exclusively by Neogene sediments. To the South (Zaire-Kwanza basin), there is a complete Tertiary sequence grading up from Palaeocene sediments. The mixed carbonate-clastic system in the Cabinda area renders log analysis problematic and hinders understanding in the area (Brown 1993). Typical fields are fault bounded rafts with one or more rotated fault blocks, separated through gravity sliding on the underlying salt decollement (McHargue 1990; Spaw and Koehler 1981).

The sedimentary basins of West Africa are bordered by the St. Paul fracture zone to the north and the Walvis ridge to the south. The African continent separated from South America in the Late Jurassic to Early Cretaceous. This separation resulted in the two continents producing differing marginal basins. The West African basins include: the Côte d’Ivoire-Ghana basin; the Nigeria-Cameroon basin and the Gabon-Congo-Angola basins.

The geological history of these basins is intimately linked with the first period of rifting (Vale 1960; Emery, et al. 1975). Alluvial and lacustrine sediments were deposited in grabens at the initial rift. The various basins then record slightly differing environments throughout the Mesozoic (Brun et al. 1983). The Gabon-Congo-Angola Basins are characterised by Aptian lacustrine deposits corresponding to the initial period of rifting. This is succeeded by a transgressive sequence of carbonates of Albian to Turonian age, followed by a Cenomanian to Miocene clastic series. The Eocene is a regressive phase recognised in all the basins. The upper Oligocene is only identified locally (Brice et al. 1982).

Orogenic movements, initiated in the Albian, affected the Tertiary series, principally the Miocene of the Gabon and Angola Basins. The movements resulted in local unconformities, isolated to individual subsiding basins accumulating Tertiary sediments. A following period of ‘drift’ encouraged the development of a carbonate bank along the West African margin, this fragmented and eventually began to ‘slide’ on the Cretaceous salt decollement.

In recent years the petroleum potential of this region has become realised and it now comprises a major player in modern exploration (Laws 1995; Brown 1993). Raft tectonics appears to be the key to West African offshore Geology. Raft like tectonic blocks experiencing gravity induced separation, rotate due to overburden during extension over the Aptian salt decollement.

The pre-salt sequence of Upper Jurassic-Aptian lacustrine deposits corresponding to the period of rifting comprise the source of modern hydrocarbon exploration along the West African margin.
(Brice et al. 1982; Karner and Driscoll 1997). This is succeeded by a transgressive sequence of carbonates of Albian to Turonian age, followed by a Senonian to Miocene clastic series.

During the Cretaceous a thick succession of non-marine sediments accumulated in the proto rift, extensive lake systems dominated, giving rise to the economically important sources. Neocomian rifting is characterised by rapid structurally induced subsidence leading to the development of structurally subdivided sub-basins. Each basin held a stratified lake, each lake characterised by rapid facies changes from alluvial to fluvial sandstone, to lake margin sandstone and anoxic mudstone, to basinal, laminated, organic rich lacustrine marl. During the early Barremian the fault related subsidence gave way to regional rift basin subsidence and the lakes coalesced to form a single body. During lowstands carbonate deposition extended into the basinal setting and organic carbon decreased. During highstands the deposition of a basinal organic shale expanded across the former carbonate regions. During the late Barremian, regional subsidence waned, the lake shallowed and the water column became oxygenated. The lake gradually filled with sediment and massive lake margin carbonates expanded towards the centre. The entire region was uplifted in the early Aptian and was subarially eroded. A period of passive margin subsidence followed. At this time the Walvis Ridge comprised part of the barrier preventing the free exchange of the proto Brazil-Angola Basin with the open ocean. The slowly subsiding shelf accumulated a thin blanket sand, the rapidly subsiding slope a sand, shale and carbonate mixture. Structural control continued to play a major part in the offshore development (Stewart 1997). Pre-rift sedimentary units have not been found in Cabinda (McHargue 1990).

Much of West Africa’s offshore production emanates from Albian carbonate reservoirs in the Lower Cretaceous Pinda Formation. This is a cyclic carbonate-siliciclastic sequence typical of a sabkha to shallow marine type environment. North to north-west trending growth faults, active during Pinda deposition, created the productive and prospective structures (Spaw and Koehler 1981).

However, within the Cabinda area, reservoirs are Neogene siliciclastic dominated braided channel systems, deposited in bathyal depths from the shelf / slope break to the base of slope position (Hanou et al. 1997). Oligocene to Pleistocene sediments rest on a diachronous unconformity. This unconformity ranges in age from Early Oligocene to Late Miocene. Seaward the surface is affected by Tertiary trough development, the landward extreme expressed through Late Miocene physiographic erosion. The wedge of sediments thickens westward offshore, the thickest piles located in troughs developed during rafting upon the salt decollement (Fig. 13). The present Congo Canyon is believed to be no older than Pliocene in age and therefore does not interrupt the Miocene sand reservoirs.

At the end of the Palaeogene the seaward edge of the African continent foundered, resulting in a strong westward tilt. During the Oligocene and Miocene a thick regressive clastic sequence was deposited unconformably upon the older shelf sequence (Brice et al. 1982). These depositional systems in the Tertiary offshore Cabinda have been divided into four main phases by Hanou et.
(1997), they are found to be similar to the Campos Basin of Brazil. A Lower Miocene turbidite fan (CN2-3) is interpreted from a period of significant sediment volume input. Submarine canyons act as a conduit for the sediment load. They consider this to be a base of slope in proximal to mid fan position for turbiditic development. The following middle Miocene shales (CN4 to CN7) were deposited in deeper water. Regional highstand seismic markers identified at CN4-CN5 represent minimal sediment influx and maximum regional sea level. Downlapping units onto this event represent the toe of a prograding shelf / slope system during CN6-CN7. Subsequently late Miocene canyons (CN8-9) introduced an influx of sand rich sediments. Two canyon complexes developed, these consist of an amalgamation of numerous smaller scale events. Shale and sand packages filled the canyons. Lastly, late Miocene to Pliocene Shelf sequences (CN9-11) prograded. Redeposited shelf sands accumulated in an Outer Trough feature or other smaller scale channels. It is these facies changes within the rift section and their abrupt boundaries, laterally and vertically that are crucial to successful exploration.

These rapidly deposited regressive sequences relate to the gravity sliding raft tectonics (Brown 1993). As the region tilted to the west a Neogene regressive sequence of shaley clastics was deposited. Eustatic changes led to extensive channelling (the proto-Za'ire drainage) and cut and fill structures. As deep water shales and turbidites were deposited, the shales became overpressurised and the salt reactivated (Brice et. al. 1982).

Although not fully understood, Cabinda is often used as a model passive margin to better appreciate the petroleum potential of other less well understood similar settings (Reyre 1984) and the opening of the Atlantic (Brice et. al. 1982). Biological marker investigations suggest the common origin of West African petroleum habitats and those of Brazil (Mello et. al. 1990). A commonly used easily accessible analogy is Point Lobos, coastal California (Clifton 1979). This is described by Clifton (1979) as a ‘superbly exposed example of deep water redeposited sandstone and conglomerate crops …… within a submarine canyon’.

Micropalaeontological investigations of the South Atlantic, and west Africa in particular are well reviewed in Jones (1996). For an overview of earlier ideas see Reyment (1965) and references therein. Hanse (1965) reviewed the microfauna of Angola and noted similarities with Gabon. The benthic fauna listed is very similar to the calcareous component found at Cabinda. The most comprehensive micropalaeontological reports on West Africa are those of Kogbe and Mehes (1986) and Petters (1982). These deal with the isolated basins in turn from Angola-Cuanza to Senegal, describing the established zonation and giving a brief overview of the geologic history as understood at that time. Petters (1982) recognised much of the West African foraminiferal fauna as belonging to the Guinean Faunal Biogeographic Province of Ekman (1953). He also recognised the equivalent trans-Atlantic faunas of the Caribbean, N. E. Brazil, and the U. S. Gulf Coast, and devised an early sequence stratigraphic interpretation. Similarly, Bertels and Madeira-Falcetta (1977), draw analogies between South America and the West African basins. They concluded ‘the Miocene South American and West African benthonic assemblages show little features in common’, the African assemblages showing a ‘marked endemism', although
some cosmopolitan and Caribbean species are recognised. Latitudinal zonation amongst the benthos was clearly detected at either Atlantic borderland. The planktonic fauna however is referred to as 'those known from the Caribbean and equatorial areas', with no 'Australoasiatic influences'.

The majority of the pertinent foraminiferal work on West Africa has been completed by a group of eight individuals. Seiglie and Frost (1979) identified the significance of mid Tertiary large foraminifera common to West Africa and the Caribbean and eluded towards the great range of benthic palaeobiological distribution. In addition, they reported observations upon species of smaller benthic foraminifera and their cosmopolitan nature across the widening Atlantic. They recognised the degree to which synonyms between West Africa and Southern America complicate modern correlative studies. Cretaceous foraminiferal zonation of the Cabinda area is comparatively well studied relative to the rest of the stratigraphic column with reference to sea level (Seiglie and Baker 1982), and facies and morphogroups (Dignes 1995; Dignes 1996). Cenozoic West African agglutinated foraminifera became the focus of attention in the early 1980's. Seiglie and Baker (1983) described two new genera and a new subfamily of compressed agglutinates with characteristic inner structures from Tertiary sediments. These genera were ascribed to bathyal to abyssal depths under the influence of pronounced coastal upwelling. Seiglie et. al. (1986) described the Alveovalvulinidae as a new family from the early Miocene to Holocene and commented upon the distribution of agglutinated foraminifera with inner structures between the Gulf of Mexico and West Africa. As research progresses new species continue to turn up, for example Haman et. al. (1993) report a new species of Virgulinella from the Miocene of Cabinda. More recently Preece et. al. (in press) have commented upon morphogroup associations in the Cabinda area and their inferred interpretation.

The recent Ocean Drilling Project Leg 175 along the south-west African margin will go some way to providing a more comprehensive database of benthic foraminiferal taxa. This is still in its initial stages at present (Hermelin 1998), but primary results look promising. Thirteen sites were drilled on the western and south-western coasts of Africa in a bid to reconstruct the late Neogene history of productivity and the associated circulation and upwelling dynamics of the Benguela system. Sites 1075, 1076, and 1077 of the Lower Congo Basin are geographically directly contemporaneous with the west African material used in this study. However, only Site 1075 penetrated Pliocene sediments, Sites 1076 and 1077 recovered sediments of 1.3 Ma and 1.7 Ma respectively. Sites 1078 and 1079 of the Angola Basin belong to a contemporary province. Cored in the Bight of Angola, recovery was limited to late Pleistocene material, Site 1078 terminating at ~0.35 Ma and Site 1079 reaching sediments of ~0.7 Ma (Giraudeau, et. al. in press). The selective dissolution and pyritisation of calcareous fauna in these two areas is noted in this study and attributed to high productivity intervals (Berger, et. al. in press).

Foraminiferal studies elsewhere along the West African margin include amongst others: Debenay et. al. (1996); Gauthron and Moullade (1996); Goua Tokpa et. al. (1996); Holbourn, Kuhnt and Moullade (1997); Kouyoumontzakis (1984); Kouyoumontzakis (1982a);
Kouyoumontzakis (1982b); Kouyoumontzakis (1981); Kucera, Malmgren and Struresson (1997); Lutze (1980); Lutze (1978); Mikhalevich (1983); Mikhalevich (1972); Nzekwue (1983); Ozumba (1996); Redois (1996); Salvatorini and Cita (1978); Schneider et. al. (1992); Shackleton and Cita (1979); Thiede (1983); Thiede and Junger (1992); Thomas (1992); Thomas (1986); Torquoto and Rocha (1969); Weaver and Raymo (1989); Weston et. al. (1997); Widmark and Malmgren (1988).
2.3. ROMANIA

*She is older than the rocks among which she sits; like the vampire, she has been dead many times, and learned the secrets of the grave; and has been a diver in deep seas, and keeps their fallen day about her;*  

*Walter Pater*

Paratethyan material for this research originated from Transylvanian basin (Fig. 14). The following is a brief summary of Paratethyan geologic history, the reader is referred to Filipescu (1996) and Rögl and Steiniger (1984 [and references therein]) for a more comprehensive review. Correlative Paratethyan lithostratigraphic and chronostratigraphic schemes are provided in Fig. 15.

Neogene sedimentary units lie over a series of Mesozoic structures. Transylvanian Rift ophiolites (Triassic-Jurassic) are succeeded by Cretaceous to Paleogene banatites, a product of subduction of the Getic Plate beneath the Pre-Apulian Plate. Mesozoic sedimentary formations form a series of nappes within the Austric Transylvanides, followed by subsequent Post-Austric sedimentary units.

The evolution of the Paratethyan basins are intimately linked to the Alpine-Carpathian Mountain formation. Following the Alpine Orogeny, the Transylvanian Basin began to evolve in the Carpathian area. The Neogene is considered to be tectonically relatively stable, Badenian salt movement the only significant movement. The succession of faunas found in this region is largely controlled by specific paleoenvironments, in turn a product of tecto-eustatic constraint.

Paratethys was a shallow sea, extending along an E-W axis. Temporary connections to the Mediterranean and the Indo-Pacific existed intermittently. However, progressive restriction of these marine connections led to the development of largely endemic fauna and specific facies types. During the Oligocene, the relict Tethys transgressed over Eurasia and Africa. The Alpine Orogenic Event in the early-mid Oligocene forced the initial barriers between the Mediterranean Tethys and its Central European counterpart.

The Paratethyan Basins record a series of marine transgression and regressions throughout the Neogene. Sporadic re-connections with open marine conditions facilitate significant renewal of the fauna. Most pertinently, these occur from the Kiscellian (late Rupelian) to the Ottnangian (late Burdigalian), this transgression was interrupted by a series of sporadic regressions, and during the early Badenian (Langhian).

During the late Egerian (Aquitanian-Burdigalian) a major regression took place forcing substantial unconformities in the Carpathian region. Eggenburgian times (Burdigalian) record a considerable Paratethyan transgression over the entire region, provenance is suspected as Indian in origin. Gradual closure of marine connections with the western part of the Mediterranean restricted communication in the central Paratethyan area during the Ottnangian (Burdigalian). This situation was reversed in the early Badenian (Langhian) by a transgression of
warm, tropical waters in both the Mediterranean and entire the Paratethys regions. Almost simultaneously, seaways connecting to the Persian Gulf area were established with an associated loss of connection to the Mediterranean realm. This forced the gradual decrease in salinity in Central Paratethys during the Sarmatian (Serravallian) and the development of oligohaline lakes in the Pannonian (Tortonian). The lacustrine facies reduced in area during the Pontian (Messinian) as a result of isolation, until only relict refugia remained in the Pliocene.
3. OCEANOGRAPHY AND ENVIRONMENT

3.1. OCEANOGRAPHY INTRODUCTION

"So many questions, so many mysteries. It is only by going down ourselves to the depths of the sea that we can hope to clear them up."

Auguste Piccard

It is only during the past decade that physical oceanographical experiments performed over the continental margins on eastern oceanic boundaries have improved our understanding of coastal upwelling (Smith 1992). Despite their difference in size, the tropical regions of the Atlantic and Pacific are primarily influenced by similar dominant dynamics: remote wind stress. In both oceans equatorial undercurrents impinge their eastern boundaries and act in the formation, in the case of the Atlantic, of the Guinea and Angola Domes (Picaut 1985). However, published temporal and spatial data remains sparse offshore the Cabinda area.

Wells CABGOC 128-3 and 115-1X, offshore Cabinda are located within the West African upwelling province. Upwelling occurs in a variety of ways. The most important modes are considered to be: Equatorial upwelling; Upwelling at oceanic divergences driven by atmospheric convergences; Wind driven coastal upwelling; Kelvin wave driven coastal upwelling; Upward Ekman pumping; Bathymetry driven upwelling; Upwelling through mesoscale and submesoscale cyclonic vortices; Upwelling from thermal domes; Upwelling from divergence within ocean currents (Fig. 16).

The central water masses of the oceans are key in determining whether upwelled waters are productive or nutrient poor. Shallowing or weakening the pycnocline allows the introduction of more nutrients (the pycnocline being the balance of the process between mixing surface waters and that producing deep and intermediate waters). A shallow pycnocline is the result of lessened wind strength and hence low wave action, a less intense pycnocline indicates reduced mixing as well as poorer nutrient input beneath the pycnocline. Therefore, assuming surface mixing is constant, the pycnocline is dependant on the rate of deep and intermediate water production (slow deep and intermediate water production leads to a shallow pycnocline).

The pycnocline separating the surface mixed waters and deeper waters off SW Africa is relatively shallow (less than 100 m below the surface). The Benguela Current itself is thin (approximately 80 m) and overlies a countercurrent of the subsurface cyclonic gyre. It is this gyre that causes subsurface upwelling and introduces nutrients from depth into the Benguela Current system. Therefore, the evolution of this gyre, the Antarctic Intermediate Water (AAIW) is instrumental upon SW African oceanic productivity.

Mediterranean Outflow Water is the densest entering any major ocean basin today. As it enters the North Atlantic it reaches an equilibrium depth at 1.5 km and extends southwards as the North Atlantic Deep Water (NADW). This eventually surfaces at the Antarctic Polar Front and Antarctic Divergence, the portion that continues north remains cold while added to by precipitation. At the Subtropical Convergence it sinks beneath warm subtropical waters of the
South Atlantic gyre and becomes the AAIW, the ultimate source of nutrients upwelled along the Namibian coast.

The dominant oceanographic system in the South Atlantic is the South Atlantic subtropical gyre (Fig. 17). On its eastern side it introduces northward flowing, cold, upwelled water to within 100 nautical miles of the west coast of South Africa and Namibia (Siesser 1980). This gyre is not the rectangular system as often depicted, but an anticyclonic triangular gyre, confined to the south-western Atlantic (Gordon and Bosley 1992; Peterson and Stramma 1991; Stramma 1991; Wacongne and Piton 1992; Berger, et al. in press). Its north-eastern limb extends diagonally across the Ocean from South Africa to Cabo San Rogue as topographic expression of the Walvis Ridge. The north-eastern South Atlantic circulates as a cyclonic gyre, implying organic carbon and opal on the Walvis Ridge and south-eastern Angola Basin could be advected from productive waters to the north. Upwelling is most vigorous on the inner shelf and shelf edge. This is produced by the SE-NW Trade Winds. North-South migrations arise from shifts in the subtropical high-pressure zone towards the equator during austral winters and in the opposite direction during summers. Flowing north parallel to the coast offshore South West Africa the current bears west over the Walvis Ridge (Fig. 18). When warmer tropical water encounters the cooler waters of the Benguela Current at approximately 20°S, eddies of upwelled water form and are carried west with the main current. These cold, upwelled waters are extremely rich in phosphate, nitrate, and silicate, allowing the support of vast populations of phytoplankton. This in turn provides food for fish stock, making this area one of the world's richest fishing grounds today.

A frontal system readily develops over the coastal portion of the Walvis Ridge at about 16° - 17°S. This is termed the Angola-Benguela Front, it fluctuates north and south through approximately 5° with the seasons and is responsible for the differing oceanographic and biogeographic regimes operating on either side of the ridge. The northern Angola Dome is characterised by sluggish cyclonic circulation, high productivity and associated strong oxygen minima.

Within the main body of the gyre productivity is low, however, towards the coastal region of south-western Africa this becomes high. This is a product of vertical mixing and upwelling, particularly near the outflow of the Congo River where, estuarine type circulation disperses the freshwater layer and entrains lower nutrient-rich waters. Within the Angola Dome the same result is achieved through the vertical rising of nutrient-rich waters to the surface by the vertical transport of the gyre (Berger, et al. in press).

The Congo fan region of the African margin is dominated by three factors: freshwater input from the Congo River; seasonal coastal upwelling; incursions of open ocean waters as part of the South Equatorial Countercurrent. Of these, the riverine element is likely to be most influential, the dynamics of the South Equatorial Countercurrent and the Benguela Current of less influence (Berger, et al. in press). These features facilitate a high productivity system and the
development of oxygen minima conditions. Conversely, the mid-Angola region shows a lower productivity index. Upwelling here is weak, the result of seasonal variations.
3.2. MIOCENE OCEANOGRAPHY

The two most important sentences to learn in the English language are 'I don't know' and 'I am wrong'. If you learn to speak those words without trepidation, life will be much easier.

John Huchera, Astronomer

The Miocene was a period of major oceanographic and atmospheric evolution (Fig. 19). By the early Miocene the ocean basins had essentially assumed their present day proportions. The South Atlantic surface circulation pattern and the southern hemisphere Neogene climate were both affected by the evolution of the southern Atlantic system. This in turn was largely driven by variations in the Antarctic ice mass and the coeval development of the Circum-Atlantic Current in the Oligocene. This encouraged the thermal isolation of Antarctica through the separation of sub-tropical and sub-polar gyres, and increasing glaciation and expansion of sea-ice on the Antarctic ice cap.

This glacially enduced system has gradually strengthened since the mid Miocene, and has gradually migrated northward from the Cape Basin in the south to the Walvis Ridge and Angola Dome to the north in a series of small scale cyclic north-south oscillations (Diester-Hass et al. 1990; 1992; Hay and Brock 1992). These oscillations were the product of the varying Antarctic continental ice volumes. The rate of coastal upwelling within this system is known from the initial evidence of ODP Leg 175 (Berger, et al. in press) to have accelerated at approximately 6 Ma and 3 Ma, and then decreased somewhat.

Prior to the mid Miocene, oceanographic temperature gradients were more equable than the present day (Berger 1981; Kennett 1983; Prentice and Mathews 1988; Woodruff and Savin 1989; Wright, et al. 1992). The evolution of modern temperature gradients in the mid Miocene is recorded through a world-wide increase in $\delta^{18}$O values in deep-sea benthic foraminiferal tests in the high and low latitudes, and planktonic foraminiferal tests in the high latitudes (Wright, et al. 1992; and references therein). It was originally argued that this excursion in $\delta^{18}$O values was the product of initial Antarctic continental glaciation after an ice-free world (Woodruff, et al. 1981 and references therein). Subsequent ODP results in the Atlantic and along the Antarctic margin suggests the presence of intermittent ice cover on Antarctica between the Early Oligocene and Early Miocene (Miller, et al. 1991). However, the relative contribution made by deep water cooling and Antarctic ice development towards the mid Miocene $\delta^{18}$O increase remains unknown (Wright, et al. 1992, and references therein). Miller, et al. (1991), proposed that the continental ice expansions and contractions identified in the mid Miocene, and termed Mi zones, are responsible for the $\delta^{18}$O shift at ~13.6 - 12.6 Ma.

Of particular note in the Early to Mid Miocene is the 'Monterey Hypothesis' (Vincent and Berger 1985). The $\delta^{13}$C excursion at ~17.5 Ma is a world wide phenomenon that lasted until about 15.5 Ma. This is considered to be the signal of a world wide change in the productivity of the oceans, removing organic rich deposits on the shelves and burying vast amounts of organic carbon along the north Pacific margin. Alternative causes argue for changes in the balance of CaCO$_3$ to
organic carbon, or a change in $\delta^{13}$C as riverine input (Miller and Fairbanks 1985), or periods of cooling and ice build up in association with rapid burial of organic carbon and lower atmospheric CO$_2$ levels (Woodruff and Savin 1991).

The main upwelling systems of the modern oceans began to evolve during the Mid-Miocene. The development of deep and intermediate cold water masses led to the thermal stratification typical of today's water masses. During the Miocene, Woodruff and Savin (1989) suggest that Tethys was a major source of warm, saline deep water, termed the Tethyan-Indian Saline Water (TISW). TISW is proposed to have given rise to Antarctic Bottom Water (AABW) circulation, and dominant intermediate flow is considered to have travelled from the south to the north. As Tethys began to close, this system weakened during the Mid Miocene. North Atlantic Deep Water (NADW [analogous with Northern Component Water - NCW]) would have intensified in response to the subsidence of the Denmark Strait in the Mid Miocene, thus allowing exchange between the Greenland Sea and the North Atlantic. At ~11 Ma NADW intensified and AABW took on a more modern configuration flowing into the Pacific and Atlantic. Circulation reminiscent of modern arrangement thermohaline flow initiated at ~10 Ma. In as much, thermohaline circulation is considered to have evolved from an 'early Miocene mode' to the establishment of a 'late Miocene mode' more analogous to the present day. These conditions allowed the transition into a 'modern' Neogene benthic foraminiferal fauna from an 'older' Palaeogene ancestor.

Early and early Mid Miocene deep water circulation patterns are difficult to reconcile between workers (Wright, et al. 1992, and references therein). However, modern thought dictates that warm NCW and Tethyan outflow water influences are detected between ~20 to 16 Ma, NCW acting upon the system again between 12.5 and 10.5 Ma. This system warmed the Miocene climate between ~20 to 16 Ma, and then cooled it between 14.8 to 12.6 Ma. Southern Component Water (SCW [analogous to AABW]) ventilated the system at intermediate times. Continental ice expansion episodes of Wright and Miller (1992) and Miller, et al. (1991) during the mid Miocene integrate well into this system. Ramsay, et al. (1998) present a contemporary model of Miocene palaeoceanography.

During the Mid Miocene the Benguela Current did not show a strong upwelling signal. The system is considered to have been flowing from Southwest Africa within the Cape Basin. During glacial periods the system shifted north but was either too weak or the Trade Winds were ineffective in causing upwelling. This period of the Benguela evolution is known as the 'Proto-Benguela' (Diester-Hass et al. 1992).

A mid Miocene benthic foraminiferal turnover was first recognised by Berggren (1972) in the North Atlantic. Subsequent work has identified the event as global (Woodruff 1985; Woodruff and Douglas 1989; Schnitker 1986). A second similar such turnover has been identified in the early to mid Miocene coinciding with an increase in CaCO$_3$ dissolution and the increased $\delta^{13}$C value [discussed above] (Killingley 1985; Vincent, et al. 1985; Thomas 1986, a, b, c; Thomas and Vincent 1987, 1988; Katz and Miller 1985).
The late Miocene was a time of major oceanographic reorganisation marked by two important events. Firstly a negative carbon isotope shift at 6.3 Ma marks the onset of Messinian desiccation. Secondly the Mediterranean isolation followed. Early in the Miocene, as the Arabian plate impinged on the Eurasian plate, the Mediterranean became cut off from the Tethys and Pacific Oceans. This forced the Mediterranean into a landlocked state that persisted until the late Miocene when a connection was re-established between the Red Sea and the Indian Ocean in the south. This triggered the Messinian Salinity Crisis and the drying out of the Mediterranean culminating in the deposition of massive evaporites (Hsü, et al. 1977). As a result of the isolation of the Mediterranean basin and the formation of massive evaporite deposits, a substantial decrease in the salt content of the ocean followed and in turn facilitated ice build up in the Antarctic. The pulsing discharge of heavy brine waters from the Mediterranean to the worlds oceans led to oceanic stratification and a brief period of extreme carbonate dissolution in the latest Miocene.

The late Miocene is characterised by a sharp cooling resulting in the strengthening of the thermocline and intensification of equatorial upwelling (Berger et al. 1981). There is evidence to suggest that the shift is intimately linked to changes in deep and bottom water production, in turn a product of the isolation of the Mediterranean and its role as a source of deep waters and global heat transfer. Simultaneously, the North Atlantic was becoming a source of deep water, forcing a fall of the CCD and facies changes favouring carbonate preservation (Berger and Wefer 1996). This CCD 'crisis' was first recognised in the South Atlantic by DSDP Leg 3 scientists. Leg 175 data remain ambiguous. Berger, et al. (in press), suggest that the cooling episode reached a critical point at which upwelling, if more vigorous, became less efficient in transporting nutrients into the photic layer from the thermocline fertility. They propose nutrients are derived from offshore Angola, transported into the true Benguela upwelling by an upper slope, low oxygen, southward flowing 'compensation current'. This poleward flow is assumed to inversely parallel the strength of the Benguela system, hence, the Angola region is considered the only area capable of maintaining high nutrient and associated OMZ conditions.

The Late Miocene saw a major regression coupled with a major Antarctic cooling event (Vail, et al. 1977 and references therein). The occurrence of opal at this point indicates upwelling, followed by strong glacial-interglacial influenced fluctuations. These fluctuations caused upwelling over the Walvis Ridge during high ice cover periods and westward circulation within the Cape Basin during interglacials. Berger, et al. (in press) find opal maximums linked to incursions of both warm pelagic water and Antarctic water resulting in the formation of chaotic frontal zones. They hypothesise that increased silicate concentration in subsurface waters facilitate the opal optimum.

The early late Miocene records suggest that sustained upwelling began at approximately this time. Biogenic (foraminifera, nannoplankton, radiolarians, silicoflagellates and in particular diatoms) accumulation increases rapidly (Siesser 1980), their absence in older sediments
implies no upwelling occurred over the Walvis Ridge before the early late Miocene. This record is mirrored by known microplankton preferred environments. A general trend is noted that plots a progression from typical tropical species during the Tertiary to early / mid Miocene to cooler water forms such as *Globigerina bulloides*, *G. quinqueloba* and *Globorotalia miozea* from the Late Miocene onward. Nannoplankton support this trend and indicate upwelling (Siesser 1980).

Carbonate dissolution far above the CCD is a common feature of the South Atlantic system and is considered to be related to sea level fluctuations and Antarctic ice extent (Diester-Hass 1988). Varying organic matter input as a result of sea level fluctuations, in turn a product of glacio-eustatic variation (the only major mechanism capable of forcing rapid world wide sea level fluctuations), affects carbonate dissolution. Lower sea level enhances the supply of organic matter from shallow shelf areas, during warm interglacials sea level rises and organic flux becomes reduced. Dissolution above the CCD is proposed as a product of organic matter which decomposes through bacterial consumption and thus increases CO$_2$ content and carbonate dissolution above the lysocline, reducing the absolute number of foraminiferal tests. This is reflected in the fragmentation of planktonic foraminifera and changes in the ratio of benthonic / planktonic foraminifera (Diester-Hass 1988). Berger, et. al. (in press), find organic matter abundance is not necessarily a proxy for productivity, diagenetic processes result in an overall decreasing preservation of organic matter with depth below seafloor yielding a false pattern of productivity with increasing time.

The Late Pliocene displays a major change in the composition of deep sea benthic foraminifera. Intensification of the Northern Hemisphere's glaciation (2.4 Ma) induces severe climatic changes. Between 3.2 to 3.1 Ma, deep sea cooling coincides with a global $\delta^{18}$O and $\delta^{13}$C shift indicative of the Northern Hemisphere glaciation. Continued cooling continues throughout the Pliocene interrupted by intermittent warm periods (Gupta and Srinivasan 1990). The causes for observed benthic foraminifera faunal turnovers at this point are still not fully understood.

Quaternary sediments from the Walvis Ridge area have been found to contain two distinct alternating sediment types. Interglacial sediments have higher opal contents. Glacial sediments have characteristically heavier $\delta^{18}$O values and decreased opal contents (Diester-Hass 1985). Physically these sediments are immediately identifiable as interglacial-glacial cycles as light-dark alternations (Diester-Hass et. al 1986; Hay, et. al. 1982). This is the result of varying carbonate dissolution in waters above the lysocline on the continental margins. This is likely to be achieved through the decomposition of organic matter and the resultant production of pore water CO$_2$. In turn, dissolution is the product of either surface water productivity or lateral supply of organic matter from the upper slope. Both these variables vary with ice cover, migrations of the interglacial-glacial shoreline vary the organic supply from the continental slope (increased supply during regressions and limited supply with transgressions [Wyatt 1993]). Productivity on the continental margins will also generally increase during glacial times in comparison to interglacials. Thus, this will lead to a net increase in organic matter accumulation and enhanced carbonate dissolution during glacial times, coupled with increased clastic input this results in
darker sediments (Meyers 1992). This effect is mirrored by oxygen isotope data (Diester-Hass et. al. 1990).

During glacial times the Benguela Current flowed farther north towards the continent in a general SE-NW direction to about 17°S at the southern extreme of the Angola Basin. This glacial intensification appears to be a consistent geologic feature. This history of upwelling is recorded through enhanced bioproductivity typical of upwelling systems. Biogenous sediments deposited above the calcite compensation depth (CCD) record variations in intensity and duration. The principal upwelling signal used is the opal (radiolaria and diatom remains) content of the sediment. The amounts of opaline silica and organic carbon within the sediment increase from the latest Miocene to the latest Pliocene, and then decline to the present day. During the late Pliocene opaline silica accumulated ten times faster than during the late Pleistocene (Hay and Brock 1992).

The Plio-Pleistocene shows small scale periodicity overprinted by larger scale fluctuations. Northward migration of the polar front during the Late Pliocene may well have intensified the current on a temporary basis (Diester-Hass et. al. 1992). Interestingly, maximum biological productivity during this period occurs during the interglacials rather than glacials of previous maximum productivity, an effect of sea-level change on productivity opposite to that of most parts of the globe.

Although the geologic evolution and sedimentation is reasonably well understood for the eastern tropical Atlantic (Dean, et. al. 1984), reconstruction of the Benguela and associated currents has been hampered until recently by the lack of long sediment cores from beneath the upwelling region. DSDP Leg 40 Sites are too far offshore, Leg 75 Sites are well beyond the extent of the upwelling currents. However, the history of the changing direction of flow (westward 'W' configuration), was reconstructed from the Walvis Ridge DSDP Sites 362 and 532 of Legs 40 and 75 through mineralogy. The present day mineral assemblage of these sites is characterised by montmorillonite / illite ratios, illite being of local origin from the arid Namib area and the montmorillonite supplied from the Orange River of South Africa and transported within the current (Diester-Hass et. al. 1990).

The recent ODP Leg 175, the 'Benguela Leg' has gone some way to providing a more detailed reconstruction of the late Neogene Angola-Benguela upwelling system history. The forty holes drilled at 13 Sites along the south-western African margin identified four regions based on sediment type: the Lower Congo Basin; the Angola Basin; the Walvis Ridge and Basin; the Cape Basin. Of these, the Lower Congo Basin and Angola Basin are pertinent to this study, containing hemipelagic fine grained sediments derived from the Congo River and hemipelagic silts and clays derived from coastal erosion respectively. The distinctive stratigraphy in each area details the competing influences of current regime, proximity to major river outflows and coast, water depth, and the position of major upwelling centres (Pufahl, et. al. in press).
The Lower Congo Basin Sites are found to show a complex depositional system dominated by riverine input, seasonal coastal upwelling, and excursions of the Southern Equatorial Current. Sedimentation is dominated by suspended clay material derived from the Congo River and the settling of pelagic debris. This material is very fine, coarser material being deposited earlier in the Congos provenance or trapped in the river canyon system (Pufahl, et. al. in press). In general, sediments become more nannofossil and diatom rich with increasing distance from the siliciclastic plume of the river. The sediments are glauconite rich and grouped as a single lithostratigraphic unit.

The Angola Basin cores reveal a 'normal hemipelagic sedimentation' influenced by neither riverine input or sustained upwelling. Moderate hemipelagic bioturbation is recorded within intercalated layers of olive-grey, dark olive-grey, glauconite rich, silty clay. Foraminifera fragments and nannofossils are frequent. Traction currents appear to have a slight influence in this area during the Holocene (Pufahl, et. al. in press).

Northwest Africa also records more recent palaeoupwelling signals within its sediments. Driven by the north-east trade winds, upwelling is characterised by arid glacial conditions and high wind stress sustaining elevated euphotic zone palaeoproductivity (Muller et al. 1983; Zahn et al. 1986; Morris et al. 1984). Emerson (1985) suggests low concentrations of oxygen in bottom waters and accompanying enhanced preservation is the nature of the recorded signal. The sedimentary record as well as being biogenic in origin is also highly influenced terrigenously through aeolian dust supply; fluvial sedimentation during humid climate phases and turbidites and other mass debris flows (Dean et. al. 1984; Shimmield 1992). Muller and Seuss (1979) suggest that massive increases in organic carbon (Corg) accumulating during glacials are the result of lowered sea level shifting the upwelling centre farther offshore, or coastal upwelling was more intense as a product of stronger north-east Trade Winds. However, subsequent work by Muller et al. (1983) showed that the organic component of the sediment in this area was marine plankton in origin. This is generally considered to be an example of 'polarised' productivity at the Late Glacial Maximum (LGM), where increased new production in upwelling areas occurs with a simultaneous decrease in the central oceanic gyres (Shimmield 1992).

The most important factors resulting in oceanographic changes along the SW / NW African coast are considered to be:

- The closing of the Central American Isthmus resulted in the salinisation of the North Atlantic and the resulting increase in production of North Atlantic Bottom Water (NABW), Antarctic Intermediate Water (AAIW) and Antarctic Bottom Water (AABW). This increased production caused differentiation of nutrients content and a shallower pycnocline. This thus facilitated the upwelling of nutrient rich water. Sea surface simulation models (Maier-Rainer et. al. 1990) suggest that an open isthmus leads to the disappearance of the present sea surface slope from the Caribbean to the Norwegian-Greenland Sea. The Gulf Stream
would reduce in intensity, leading to an overall effect of increased mixing of the Atlantic and Pacific, reducing salinity in the North Atlantic and therefore hindering the production of NADW. It is expected that the strength of the Benguela Current remained unaltered. However, this model does not take into account the effect of the drifting continents and the build up of ice. The oceanographic response including these two factors in the Mid Miocene is expected to have been more complex (Hay and Brock 1992). Westward flowing north and south equatorial currents were probably deflected to the north, the open passage across the Americas preventing a build up of water along the coast. The South Equatorial Countercurrent would have deflected to the south with proximity to the African margin, encouraged by the Niger River discharge. During the late Miocene the restriction of the isthmus would have forced some water to the north Atlantic. Simultaneously, differentiation of Pacific and Atlantic salinities would intensify NADW (Woodruff and Savin 1989). The steady closure of the isthmus by the end of the Miocene to the Pliocene terminated the Pacific-Atlantic flow which kept the salinities approximately equal. Water vapour action across the Isthmus caused a salinity increase and the subsequent increase in NADW. The closure of the Central American Isthmus and the concurrent increase of upwelling intensity over the Walvis Ridge suggests a cause and effect which, to date, remains an enigma.

- The northward migration of the subtropical high and Intertropical Convergence Zone (ITCZ) during the late Miocene as a response to the growth of the Antarctic ice cap may have initiated upwelling. Subsequent southward movement of the ITCZ, as a result of the altering nature of the globe from a unipolar to bipolar glaciation enhanced the Angola Coastal Current and upwelling at the Angola Thermal dome. The stronger Angola Current would have transported high productivity waters from the Angola Dome upwelling along the Namibian shelf and over the Walvis Ridge Abutment Plateau. A subsequent reduction of strength reflects the southern shift of the upwelling centre, as a result of the growth of the northern hemisphere icecap, to its present location at Lüderitz.

- The Messinian salinity crisis that desiccated the Mediterranean, drew the ITCZ to its most northerly position. Its reflooding coincides with the swap from glacial maximum upwelling intensity to interglacial maximum upwelling. During glacial periods the NADW was reduced, AAIW was replaced with nutrient deficient North Atlantic Intermediate Water (NAIW) and hence upwellings were not productive. Increased Mediterranean saline outflow has subsequently caused the expansion of nutrient poor NAIW to the South Atlantic during glacial periods and may be responsible for the decline in productivity since 1.7 Ma (Hay and Brock 1992). Nutrient rich AAIW is characteristically low salinity and cold. It is formed and distributed by the dilution of upwelled NADW through excess precipitation between 40° and 50°S. Hence, if the NADW is reduced, dilution can become
more extreme and the formation of AAIW cease. If this occurs, nutrient poor NAIW would become the dominant water mass during glacials in the southernmost Atlantic. Thus, even though Namibian margin and Angola Dome upwelling may become more vigorous, it would contain less nutrients and record a weaker upwelling signal within the sediments.

- The northward drift of South America and Africa, by approximately 5°N has undoubtedly affected both atmospheric and oceanic circulation. The ITCZ has been pushed northward, remaining over the land mass. Oceanic circulation is altogether more complex. South Atlantic circulation is intimately linked to South Atlantic symmetry, and the interchange of water masses between the two hemispheres. Ideas on the nature of this circulation have recently been altered away from the previously classic rectangular gyre of Tchernia (1980), to an anticyclonic triangular gyre (Peterson and Stramma 1991; Stramma 1991; Waconge and Piton 1992).

- Changes in topographic relief and substantial increases in elevation in the past few million years is believed by some workers to affect global climate (Ruddiman and Raymo 1988; Hay et al 1986; and others). Molnar and England (1990) present a lucid interpretation of the sedimentary and palaeontological record that invoke scenarios of massive climate change through presenting an argument that places the responsibility of 'apparent' elevation with Cenozoic climate change.

- Late Cenozoic sea-level changes invoke marked alterations in the configurations of the world's shorelines. Namibia's coastal plain would expand with a lowstand from its present position of 20km width to approximately 100km (Wyatt 1984, 1993). This westward migration reduces the orographic effect of the Kalahari Plateau and Ekman Pumping. This significant reduction in shelf areas off Southwest Africa would force bathymetry driven upwelling. However, the correlation of low productivity with glacial cycles in the south-east Atlantic suggests that sea level may have no real effect on the upwelling signal recorded at Walvis Ridge.

To quantify the physical oceanography and hence interpret palaeoceanographic signals more accurately greater understanding of earth / atmosphere interactions are needed. Although certain regions are well known for the upwelling phenomena (i.e.: Benguela), the vertical mixing processes by which deep waters travel to the surface are still fundamentally unknown. There exists an historical database drawing upon half a century of measurements of temperature and salinity, allowing general description of oceanic circulation using water mass properties to trace subsurface currents and the gross impact of horizontal mixing. The determination of velocities is always ambiguous, due to the lack of a clear reference value in the deep water and the difficulty in determining the level of sea water relative to the geoid. The extent of sea ice is subject to major interannual variations that are similarly, not well understood, particularly around the Antarctic continent and ice shelves. However, more advanced computational methods allow for
greater understanding and re-evaluation, for example MacDonald and Wunsch (1996), and may elucidate towards a refined palaeo interpretation.
3.3. PALAEOENVIRONMENT

Quantitative is just poor qualitative. Number is just one of an enormous variety of mathematical qualities that can help us understand and describe nature. We will never understand the growth of a tree or the dunes in the desert if we try to reduce all of nature's freedom to restrictive numerical schemes.

Ian Stewart

The interaction between individuals and their physical and chemical environment, and each other, define the objective of ecology. Benthic foraminifera are the single most abundant member of the benthos with hard parts that are found in deep-water environments. Though often considered to be largely cosmopolitan, they display significant patterns of endemism relative to individual oceanographic provinces. Deep-sea benthic foraminiferal assemblages, through the nature of their habitat are affected by oceanographic phenomena. For example, assemblages located above the Calcium Compensation Depth (CCD) will contain calcareous genera, those below the CCD will be dominated by agglutinating taxa.

Ecologic parameters influencing benthic foraminiferal assemblages include parameters such as water temperature, salinity, water energy, and substrate type. These may affect an assemblage singularly, or more likely in association with one another. In addition, biotic factors such as oxygen, food availability, predation, etc. play a vital role. Depth has long been considered a limiting factor to the foraminifera, however, modern thought suggests that it is the parameters associated with it (temperature, light, density, etc.) that have greater control (Murray 1991).

It is necessary to understand modern ecological dynamics before attempting to interpret fossil data. Neogene deep water systems are considered to be analogous to modern ocean floor environments (e.g.: Boltovskoy 1980; Berggren 1972). Recent investigations into modern slope and deep-sea settings (e.g.: Bernhard and Reimers 1991; Corliss 1985; Corliss and Chen 1988; Corliss and Silva 1993) has gone some way towards a greater understanding of fossil systems beyond those of Bandy (1960). This permits relatively increased accuracy in the comparison of assemblages.

The modern deep water environment, while showing a certain degree of variability, shows nothing approaching the diversity of the modern shallow marine sector. However, the variables that do act upon the benthos show a profound affect upon assemblage composition therein.

Food can be considered one of the most pertinent influences upon deep-water benthos. In general, benthic biomass tends to be greatest near the continental margins and beneath upwelling regions. This decreases towards the central oceanic areas where oligotrophic conditions tend to persist. Upwelling systems, through the introduction of nutrient rich waters to the surface, facilitate phytoplankton blooms. This is essentially a function of upwelling rate and the nutrient concentration. Particulate organic matter (POM) descends through the water column, utilising oxygen as it is oxidised thereby expanding the Oxygen Minimum Zone (OMZ).


While benthic foraminifera abundance is largely subject to carbonate preservation, species composition remains a valuable instrument. However, basic species ranking systems oversimplify the oceanographic picture, account has to be taken of all data necessary. Variations in sedimentation rate, quality and quantity of food supply, oxygen content of the water mass, substrate properties, etc. are all contributory. Indices of diversity minimise the effects of sample size to give an indication of productivity. Organic rich environments trend toward a reduced diversity and high abundance (Berger, et al. in press). Particular taxa are recognised as 'high productivity forms', i.e. *Bolivina* spp. and *Bulimina* spp. (Douglas and Woodruff 1981). *Uvigerina* spp. *c̅* linked to low oxygen conditions in pelagic environments (Burke, et al. 1993). Berger, et al. (in press) propose high values of various Late Neogene *Bulimina* species in the Lower Congo Basin track a high productivity pulsing upwelling system and associated OMZ. Dominance of *Bolivina* spp. in the same area at the expense of *Bulimina* spp. are interpreted as low oxygen conditions at the sea floor (Phleger and Soutar 1973) where terrigenous silts dominate and productivity is moderate to high. Brun, et al. (1983) recognised discrete associations of *Bolivina* along the West African margin in relation to varying oxygen minima conditions. Increased
values of *Uvigerina* spp. are found to border the Angolan OMZ confirming the idea that this genus selects for a moderate productivity condition within an OMZ. *Cibicidoides* spp. are well adapted to a variety of environments. However, the genus (and associated *Cibicides*, *Cibcorbis*, *Planulina*, etc.) appear to avoid periods preferred by *Bolivina* spp. and other high productivity genera. Berger, et. al. (in press) note a pattern of alternating dominance between *Cibicidoides* spp. and *Bulimina* spp. offshore Lüderitz, suggesting a considerable fluctuation in productivity and supporting the notion of cyclic upwelling and mixing. In general, single taxon ecologic parameters while a useful guide, remain ambiguous (Table 5).

Morphogroup analysis for ecological and palaeoecological interpretation is a useful tool. It is independent of species level taxonomy and is thus relatively elementary to translate from one worker to another. This approach permits comparison of assemblages of differing ages. The power of this relatively simple tool is demonstrated by the plethora of studies (for example: Severin 1983; Katz and Thunell 1984 Jones and Charnock 1985; Bernhard 1986; Corliss and Chen 1988; Nagy 1992; Tyszka 1994; amongst others). Successful work based upon wall composition and structure has also been conducted, for example Murray (1973).

Opportunism and morphogroup analysis has been extensively studied on modern foraminiferal faunas, however, these studies have concentrated mainly on calcareous forms. Hermelin and Shimmield (1990) and Hermelin (1992) isolated assemblages indicative of OMZ conditions in the Arabian Sea that were considered to be r-selected, while Sen Gupta and Machain-Castillo (1993) identified opportunistic species dominating low oxygen environments, these taxa were always present in low numbers until adverse conditions predominated when they essentially 'bloomed'. In particular, they noted the predominance of elongate morphotypes (*Bolivina*) in low oxygen conditions, but found no modern characteristic morphology indicative of poor oxygen levels. Similarly, Gooday (1993), identified modern abyssal calcareous opportunists that were characteristically small, trochospiral with thin, transparent tests. These calcareous species are interpreted as being opportunistically adapted to seasonal food pulses (Smart et. al. 1994). Infaunal taxa typify areas of intense upwelling off NW Africa where food flux is more constant through time. Linke and Lutze (1993) observed microhabitat preferences in living benthonic foraminifera showed a flexible approach towards food acquisition among specific faunas and were considered as opportunistic in life habit. Flexible approaches towards life habit are similarly outlined by Hilbrecht and Thierstein (1996), who record benthic behaviour in planktic foraminifera.

Kaminski et. al. (1988; 1995) noted Deep Water Agglutinating Foraminifera (DWAF) in modern seasonally dysaerobic environments to be dominated by tapered, elongate morphotypes. These were considered as infaunal and opportunistic in life habit and correlate to morphogroup 'C' of Charnock and Jones (1985). Similarly, Koutsoukos et. al. (1990) noted elongate, tapered agglutinates in the latest Cenomanian-earliest Turonian of north-east Brazil and the Anglo-Paris Basin to proportionally increase in numbers with decreasing oxygen levels in an OMZ. Tyszka (1994) subsequently described Jurassic calcareous benthonic foraminiferal assemblages that
decreased with interpreted falls in $O_2$, while agglutinated, opportunistic faunas increased. Conversely, Preece et al. (in press) recorded a shift in microhabitat preference amongst a Neogene West African assemblage of elongate agglutinated morphogroups utilising the model of Jorissen, et al. (1995), (Fig. 21).

Through applying morphologic and taxonomic parameters to benthonic foraminifera, Kaiho (1994) erected a dissolved oxygen index for palaeoenvironmental interpretation, although indexes have been developed using other aspects of the meiofauna, for example, by Wignall and Myers (1988), Allison, et al. (1995 [and references therein]).

Post-mortem alteration of assemblages must be born in mind when considering fossil benthic foraminifera. Pyrite infilling of the test, a common phenomenon beneath an upwelling region, is not necessarily a reflection of anoxic conditions (Love and Murray 1963), but is more common to lower oxygen environments (Murray 1991). Water mass characteristics may enhance or diminish certain aspects of the fauna. Alkaline-poor waters beneath OMZs can increase the preservation potential of calcareous taxa (Douglas and Heitman 1979), however, corrosive waters can lead to substantial dissolution (Schrader et al. 1983). Loubere, et al. (1993) highlight this issue through examining the taphonomic filtering processes that generate fossil assemblages, Bremer and Lohman (1982) find that the distribution of certain Atlantic benthonic foraminifera is most consistently correlated with the degree of $CaCO_3$ saturation.

Boltovskoy and Boltovskoy (1988) stated "the makeup and relative proportions of foraminiferal assemblages are much more influenced by geographic location and by ecological factors than by their evolutionary history". This statement was made in dismissal of benthic foraminiferal use as a biostratigraphic tool. Clearly, benthic assemblages will reflect to a certain extent the characteristics of the dominant oceanographic system. It has long been recognised that palaeogeographic and / or palaeoclimatic events affect circulation and concomitantly foraminiferal biogeography throughout the Neogene. Berggren (1977) cited six major influences upon Atlantic circulation as the: Separation of eastern and western Tethys in the Burdigalian; Growth of the Antarctic Ice Cap during the mid-late Miocene; Gradual closure and separation of western Tethys and the Atlantic Ocean basins in the Late Miocene; Reconnection of the Atlantic and Mediterranean in the Early Pliocene; Severing of the marine connection between the Atlantic and Pacific through the shallowing of the Isthmus of Panama in the Early Pliocene; Initiation of polar glaciation in the Mid Pliocene. However, benthic bathyal to abyssal zonations have been attempted upon the basis of foraminifera as a supplement to planktonic biostratigraphy (Boltovskoy 1980; Berggren and Miller 1989). These schemes remain under-used as their basis, basic taxonomy, is continually revised (i.e.: Kaminski in press).

Depth zonation studies upon the basis of benthic forams have proved to be a popular approach. Early works such as Bandy and Arnal (1960) assumed that an isobathyal relationship existed between taxa. Subsequent work, for example that of Culver and Buzas (1980), identified water masses as a primary control upon distribution. Modern approaches adopt a more rigorous
perspective. Culver (1988), on the Gulf of Mexico, defined palaeobathymetries upon the basis of
generic identification (thereby gaining the advantages of the morphogroup approach outlined
above). However, the results of Kurihara and Kennett (1988) have to be born in mind. They
found certain species to significantly (~2000 m) alter their water depth in the Pacific during
Neogene time.

Through careful examination of the fauna and consideration of the mechanics of natural
systems, inferences may be made toward palaeoceanographic settings and
palaeoenvironmental controls. However, it is important to stress the necessity to become wary of
circular reasoning in this approach. 'Controls' are impossible to establish and much data remain
open to interpretation. Despite the recent plethora of studies conducted upon benthic
foraminifera, the ecological factors controlling their distribution remain poorly understood.
3.4. PRESERVATION

"Not everything that can be counted counts, and not everything that counts can be counted."
Albert Einstein (1879-1955)

Selective preservation is an inherent problem amongst deep water foraminiferal assemblages beneath oxygen minima. Douglas (1979) promotes 'preservational stratigraphy' as an excellent tool for stratigraphic correlation. While this is somewhat subjective, a lack of data, or loss of data, is data none the less.

The physical conditions at the ocean's surface and the sea floor controls the preservation of any benthic fauna, this may alter assemblages during their life, as a post-mortem process, or a combination of the two (Murray 1982; 1984). Faunal loss is noted within recent assemblages (i.e.: Lutze 1980; Hermelin and Shimmield 1990) as well as fossil material (i.e.: Koutsoukos, et al. 1990). Preservation of calcareous foraminifera in particular, reflects the state of saturation of the ocean in respect to calcium carbonate, this is in turn a product of mixing rate and productivity.

In general, there is a loss of carbonate with depth in the modern ocean, dissolution suddenly expands at the lysocline. Below the lysocline the rate of particle supply is balanced by dissolution marking the onset of the Calcite Compensation Depth (CCD). This zone is known to vary both temporally and spatially, commonly it rises towards the coast and in high productivity regions (i.e.: upwelling regions). As outlined previously (see oceanography section), oxygen is also prone to reduce beneath upwelling centres creating an oxygen minimum and increasing soluble CO$_2$ forcing a lowering of pH, and acidic conditions in respect to calcite. Emerson and Bender (1981) developed a model to explain this at the sediment-water interface in the response to degradation of organic matter.

This system clearly has a profound effect upon microfossil assemblages. Schrader, et al. (1983) record the varied response to surface productivity of benthic preservation in the Gulf of California, and extreme post-mortem dissolution in the Monterey Formation. Bremer and Lohmann (1982) use this relationship between the benthos and calcium carbonate saturation to 'map' abyssal Atlantic hydrography. Rathburn and Miao (1995) note little alteration in assemblages from the Sulu Sea, however, dissolution experiments reveal a severe discrepancy to be born in mind whenever 'flysch - type' fauna are recovered (Alve and Murray 1995; Murray and Alve 1994).

Above the CCD preservation is still problematic. Although chemical denudation is less likely, biologic action may still bias the fossil record (Peebles and Lewis 1988).

In addition, sea-level can be argued to play an important role in preservation potential. A lowering of sea-level introduces increased chemical yield and hence nutrient flux to the water column (Wyatt 1993), this in turn may encourage the intensification of oxygen minimum
conditions and erosive bottom waters. When considering relative sea-level fluctuations, the caution of Miall (1992) must be considered. Synthetic sections constructed from tables of random numbers were 77% correlatable to published eustatic curves. Miall (1992) highlights the issue of greater precision to global cycle charts than the best available chronostratigraphic techniques, correlation hence becomes a statistical inevitably rather than stratigraphic logic.
4. MATERIALS

4.1 SAMPLE PREPARATION

"I choose a block of marble and chop off whatever I don't need."

Rodin (1840-1917) - when asked how he managed to make his remarkable statues

Material examined for this study was not processed by the author. CABGOC 128-3, CABGOC 115-1X and the Romanian material were processed as outlined below. The procedure used on the Venezuelan material is unknown.

4.1.1. INTRODUCTION

Methods commonly used to break down samples for retrieval of forams are: water wash, detergent wash, kerosene (Thinner 450) wash, and sodium hydroxide (NaOH) wash. The objective is to break down the matrix of a ditch sample, or to break down the mass of an outcrop rock, core, or sidewall core in a manner safe to preserving the forams intact. After the break down of the sample, the material is sieved with water and washed from each sieve into filter paper. The filters are then dried in ovens, folded, and placed in coin envelopes.

4.1.2. FORAM RETRIEVAL PROCEDURE

A. Water wash.

Wash sample into sieve screens. After water has cleared, decant the sample into filter paper.

B. Detergent wash.

Soak the sample in a beaker containing water with a small amount of detergent and heat on stove for 20 - 30 minutes. Then process as with the water wash.

C. Kerosene wash (Chevron Thinner 450).

Using a 600ml beaker, fill it with sample to one-quarter to one-third. The material may have to be washed or crushed first. Place beaker on a hot plate under a fume hood and heat for approximately thirty minutes. Remove samples to a fume hood and add enough kerosene to cover all material. Stand for 15 - 20 minutes. Drain the kerosene into a recovery - funnel beaker, add approximately ten drops of detergent to the beaker and fill with water. Heat samples on a stove for 15 - 20 minutes and water wash the samples.

D. Sodium hydroxide wash.

One-quarter to one-third fill a 600ml beaker with sample. The material may have to be crushed or washed first. Fill beaker with less than two-thirds water and approximately one-third NaOH (50% solution). Stir the sample gently. Place on a stove and allow to boil until broken down (water may have to be added during boiling). Sample may break down in several minutes to hours. If the sample does not break down easily then prewash in a +150 screen and add new water and NaOH and boil. Once sample has broken down, remove from stove and allow to cool for fifteen to twenty minutes. Prewash in a +150 screen and then water wash.

Figure 22 and Tables 2, 3, and 4, outline the nature of the material used in this study.
TABLE 2:
Well data for CABGOC wells.

<table>
<thead>
<tr>
<th>Country</th>
<th>Well</th>
<th>Operator</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Age (based upon Nannofossil biostratigraphy)</th>
<th>Depth Investigated</th>
<th>No. of samples examined</th>
<th>Environment</th>
<th>Sediments (detailed logs remain proprietary)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cabinda, Angola</td>
<td>128-3</td>
<td>Cabinda Gulf Oil Company</td>
<td>5° 48' S</td>
<td>11° 47' E</td>
<td>Late Oligocene - Late Miocene (Tortonian / Messinian)</td>
<td>630' - 10,160'</td>
<td>76 composite ditch cuttings</td>
<td>Mid - lower slope</td>
<td>Laminated fissile silty shales</td>
</tr>
<tr>
<td>Cabinda, Angola</td>
<td>115-1X</td>
<td>Cabinda Gulf Oil Company</td>
<td>5° 74' S</td>
<td>11° 66' E</td>
<td>Late Oligocene? - Late Miocene (Tortonian)</td>
<td>1,790' - 10,020'</td>
<td>138 composite ditch cuttings</td>
<td>Mid - lower slope</td>
<td>Laminated fissile silty shales / clays</td>
</tr>
</tbody>
</table>

TABLE 3:
Location data for Venezuelan samples:

<table>
<thead>
<tr>
<th>Location</th>
<th>Age (based upon Blow 1959 zonation)</th>
<th>No. of samples examined</th>
<th>Environment</th>
<th>Sediments (not personal observation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>El Mene - Pozon Road section, Eastern Falcon</td>
<td>Early Miocene (Burdigalian) - Late Miocene (Tortonian)</td>
<td>57 outcrop samples</td>
<td>Mid - low upper slope</td>
<td>Laminated clay</td>
</tr>
</tbody>
</table>

TABLE 4:
Additional Tertiary localities examined but not included further:

<table>
<thead>
<tr>
<th>Location</th>
<th>Nature of material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Borneo</td>
<td>12 outcrop samples - mid slope - Miocene</td>
</tr>
<tr>
<td>Gulf of Sirte, Libya</td>
<td>Well C1-41, Arabian Gulf Oil Company - 38 composite ditch cuttings - neritic - Miocene</td>
</tr>
<tr>
<td>Cipero Formation, Trinidad</td>
<td>24 outcrop samples - upper slope - Miocene</td>
</tr>
<tr>
<td>Northern Falcon, Venezuela</td>
<td>33 outcrop samples - mid / lower slope - Paleogene</td>
</tr>
</tbody>
</table>
4.2. TAXONOMY

An Oceanographer's Dream

I built myself a stately treasure house
Beside the rolling ocean's swell,
With cunning apparatus to disclose
The gems below that dwell,-

Those frail living gems "of purest ray serene"
Oft frail, fantastic, strange and rare,
Whose lives sheer mysteries have ever been,
But need not be - with care.

Walter Garstang, 1951 - Larval Forms

Five hundred and seventy-five benthic foraminiferal taxa are described; two hundred and thirty-four agglutinating species and three hundred and forty-one calcareous species. Of these, four hundred and sixty taxa are illustrated; one hundred and ninty agglutinating taxa, and two hundred and seventy calcareous taxa.
4.3. INTRODUCTION

The Catalogue of Foraminifera (Ellis and Messina 1940, et. seq.) has been used for the basis of species identification. Loeblich and Tappan's (1983) comprehensive work revising suprageneric and generic level classification is followed herein. Loeblich and Tappan (1964) has also been consulted, and the caution referred to by Haynes (1990; 1992) adhered to. Modifications where necessary are described. Having established the taxonomic position of the taxa, a literature search was then expanded to other Cenozoic locations, confirming their cosmopolitan nature in many cases. The following Miocene collections held in the Natural History Museum, London, were examined and compared: Adams (Cyprus); Bagg (Jamaica); Bhahia (Isle of Wight); Birley (Palestine); Brady (Costa Rica, Vienna Basin); Brönnimann (Trinidad); Burrow and Holland (Vienna); J. Doreen (Dominican Republic); Earland (Trinidad); Gubler (Morocco); Hanson and Rögl (Austria); Henson (Florida); Heron-Allen and Earland (Borneo, Cuba, Malta, Trinidad, Australia); T. R. Jones (Cyprus); Macfadyen (Cyprus); Palmer (Cuba); Parker (France, Hungary, Jamaica, Vienna Basin); M. S. Srinivasan (Car Nicobar); E. O. Teale (Victoria, Australia); Whittaker (Ecuador, Panama). Natural History Museum numbers are given unless the collection in unnumbered, this is shown by '(NHM)'. In addition comparisons have been made to proprietary industrial West African material, but not recorded here.

Each species is listed alphabetically within its generic group. Determination of species is based upon the author's experience of Neogene foraminiferas from Venezuela, West African, Borneo, Libya, and Romania. This represents the author's appreciation of a species concept at the time of writing. In general, where preservation is poor, species are 'lumped' rather than 'split'. The temptation to needlessly create new taxa upon the basis of few specimens of poor preservation has been resisted, the author preferring to affiliate a specimen to a well defined group.

Plates are arranged taxonomically within a geographical area (Venezuela, Africa, Romania) for publication purposes. Scanning Electron Microscope (SEM) micrographs are used to illustrate most species. In some cases, light microscope photographs and camera lucida line drawings are used in preference or addition to demonstrate features not evident with the SEM. Preservation in some cases precluded the production of useful illustrations.

The following abbreviations have been used:

- **cf.** for taxa similar to a known species but different in some detail.
- **aff.** for taxa showing a close affinity to a well defined taxonomic group.
- **sp. 1, 2, ..** for species which do not correspond to published descriptions.
- **spp.** for taxa not determinable at the specific level.

'Occurrence' denotes incidence in the samples examined by the author for this thesis. 'Remarks', in addition to general comments about a taxon, records literature references where no figure is given.
4.4. SYSTEMATICS

Phylum PROTOZOA
Class FORAMINIFERA J. J. Lee, 1990
Order ALLOGROMIDA Loeblich & Tappan, 1961
Superfamily ASTROHIZACEA Brady, 1881
Family BATHYSIPHONIDAE Avnimelech, 1952
Genus BATHYSIPHON Sars, 1872

*Bathysiphon taurinense* Sacco

Plate 39, figure 1; Plate 67, figures 1 - 2

*Bathysiphon taurinense* Sacco 1893, pl. 2, fig. 2 (fide Ellis & Messina 1940, *et seq.*)
*Bathysiphon taurinense* Sacco. --SOUYA 1965, pl. 1, fig. 1. --POPESCU 1975, pl. 1, fig. 2. --LUCZKOWSKA 1990, pl. 2, figs. 6 - 8. --CICHA, *et al.* 1998, pl. 1, figs. 1 - 2

**Description:** Robust tubular test of light coloured sandy material with characteristic black surface. Compressed.

**Occurrence:** Offshore Cabinda found in CABGOC 115-1X intermittently between 6,720' and 9,960'. Observed in the Chechis Marls in Romania.

**Remarks:** Originally described from the Miocene of Italy. Specimens compare well with topotype material of the M. S. Srinivasan collection (P47543).

*Bathysiphon sp.*

**Description:** Large flattened fragments. Fine grained test, smooth.

**Occurrence:** Offshore Cabinda found in CABGOC 115-1X between 2,630' and 3,890', rare. Observed in the Chechis Marls in Romania.

**Remarks:** Small fragments of re-silicified individuals.

Genus NOThIA Pflaumann, 1964

*Nothia excelsa* (Grzybowski)

Plate 9, figure 1

*Dendrophrya excelsa* GRZYBOWSKI 1898, pl. 1, figs. 2 - 4 (fide Kaminski & Geroch 1993)
*Dendrophrya ex. gr. excelsa* Grzybowski. --KAMINSKI, *et al.* 1989a, pl. 1, figs. 10 - 11
*Nothia excelsa* (Grzybowski). --KAMINSKI & GEROCH 1993, pl. 1, figs. 2 - 3, 15, (not 4 - 6). --GEROCH & KAMINSKI 1992, pl. 1, figs. 1 - 4, pl. 2, figs. 1 - 11
*Rhabdammina excelsa* (Grzybowski). --CHARNOCK & JONES 1990, pl. 1, fig. 27 (not fig. 26)

**Description:** Tubular test, moderately thickened test wall. Wall fine to moderately coarse. Compressed. Occasionally bifurcates.

**Occurrence:** Single occurrence in sample 2701 of the G. *fohsi* Zone, Venezuela.

**Remarks:** Originally described from Paleogene of the Carpathian region. Small fragment recovered.
**Nothia sp. 1**  
Plate 39, figure 2  
**Description:** Coarse grained fragments, inflated, parallel sides, some evidence of constrictions.  
**Occurrence:** Offshore Cabinda found in CABGOC 128-3 between 4,770' and 5,180', rare.  
**Remarks:** Poorly preserved fragments.

**Nothia sp. 2**  
Plate 39, figure 3  
**Description:** Irregular flattened test, sub-parallel sides. Coarse grained light coloured material, occasionally incorporating planktonic foraminifera.  
**Occurrence:** Offshore Cabinda found in CABGOC 128-3 between 7,820' and 9,080', rare.  
**Remarks:** Poorly preserved fragments.

**Nothia sp. 3**  
Plate 39, figure 4  
**Description:** Slender elongate test, parallel sides. Fine grained, twists gently about a single axis.  
**Occurrence:** Offshore Cabinda found in sample 6,860' of CABGOC 128-3.  
**Remarks:** Poorly preserved fragments.

Family Rhabdamminidae Brady, 1884  
Subfamily Rhabdammininae Brady, 1884  
Genus Rhabdammina Sars, 1869  
*Rhabdammina robusta* (Grzybowski)  
Plate 39, figure 5  
*Dendrophrya robusta* GRZYBOWSKI 1998, pl. 10, fig. 7 (fide Kaminski, et. al. 1993)  
*Rhabdammina robusta* (Grzybowski). --KAMINSKI & GEROCH 1993, pl. 1, figs. 7, 16  
*Nothia robusta.* --OSTERMAN & SPIEGLER 1996, pl. 2, figs. 8 - 9  
**Description:** Flattened tube, parallel sides, thick fine grained test wall.  
**Occurrence:** Offshore Cabinda found in CABGOC 128-3 between 2,630' and 6,080', rare.  
**Remarks:** Poorly preserved fragments. Sponge spicules referred to by Kaminski and Geroch (1993) are unobserved in these specimens.

**Rhabdammina sp. 1**  
Plate 39, figure 6  
**Description:** Bulbous inflated test, medium grain size, sub-parallel sides, occasional constrictions, thin wall.  
**Occurrence:** Offshore Cabinda found in CABGOC 128-3 between 5,240' and 5,960', rare, and in CABGOC 115-1X between 6,120' and 10,202', common.  
**Remarks:** Poorly preserved fragments.
**Rhabdammina sp. 2**
Plate 39, figure 7

**Description:** Large inflated test, moderate grain size, high proportion of cement. Parallel sides, thick wall.

**Occurrence:** Offshore Cabinda found in sample 10,160 of CABGOC 128-3 and between 4,430' and 9,840' of CABGOC 115-1X, common.

**Remarks:** Poorly preserved fragments.

**Rhabdammina sp. 3**
Plate 39, figure 8

**Description:** Flattened slender test, moderate grain size with little cement. Parallel sides, irregular growth, medial furrow apparent on some specimens.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 between 6,860' and 7,820', rare, and between 5,760' and 9,720' of CABGOC 115-1X, common.

**Remarks:** Poorly preserved fragments.

Genus RHIZAMMINA Brady, 1879

**Rhizammina sp. 1**
Plate 67, figures 3 - 4

**Description:** Flattened test, slender, with coarse grain size, curved growth, parallel sides.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 at 10,160', and in CABGOC 115-1X between 9,000' and 9,300'.

**Remarks:** Poorly preserved fragments.

**Rhizammina sp. 2**
Plate 39, figure 9; Plate 67, figure 5

**Description:** Robust test, small grain size, large proportion of cement, parallel to sub-parallel sides, occasional slight constrictions.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 between 6,500' and 6,980', and in CABGOC 115-1X between 6,480' and 9,540'.

**Remarks:** Poorly preserved fragments.

**Rhizammina sp. 3**
Plate 39, figure 10; Plate 67, figure 6

**Description:** Slender test, parallel to slightly tapering sides, fine grained, occasional abrupt 'cornering' of growth.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 at 10,100', and in CABGOC 115-1X between 6,300' and 9,660'.

**Remarks:** Poorly preserved fragments.
Rhizammina sp. 4  
Plate 39, figure 11  
**Description:** Bulbous test, inflated, smooth wall, sub-parallel to tapering sides, thick wall, constrictions.  
**Occurrence:** Offshore Cabinda found in CABGOC 128-3 at 10,160', and in CABGOC 115-1X between 5,700' and 9,960'.  
**Remarks:** Poorly preserved fragments.

Rhizammina sp. 5  
Plate 39, figure 12  
**Description:** Large robust test, some flattening, moderate grain size, thick wall, roughened surface, oblique constrictions.  
**Occurrence:** Offshore Cabinda found in CABGOC 128-3 at 10,160', and in CABGOC 115-1X between 4,980' and 10,020'  
**Remarks:** Poorly preserved fragments.

Rhizammina sp. 6  
Plate 39, figure 13  
**Description:** Slender test, flattened, parallel sides, small grain size with large proportion of cement, light colour with darkened central furrow, thin wall.  
**Occurrence:** Offshore Cabinda found in CABGOC 128-3 between 6,980' and 9,080', and in CABGOC 115-1X between 6,600' and 9,240'.  
**Remarks:** Poorly preserved fragments.

Rhizammina sp. 7  
Plate 39, figure 14  
**Description:** Semi-inflated narrow test, sub-parallel sides, moderate grain size, occasional slight constrictions and inflated portions.  
**Occurrence:** Offshore Cabinda found in CABGOC 128-3 at 7,040', and in CABGOC 115-1X between 6,480' and 7,920'.  
**Remarks:** Poorly preserved fragments.

Rhizammina sp. 8  
Plate 39, figure 15  
**Description:** Distinctive fragments, parallel sides and flattened. Finely agglutinated. Irregularly coiled.  
**Occurrence:** Single specimen in sample 2709 of Venezuela. Offshore Cabinda found in CABGOC 128-3 at 9,080', and in CABGOC 115-1X between 7,080' and 9,300'.  
**Remarks:** Possibly grew attached to a rounded surface. Poorly preserved fragments. Possibly *Tolypammina vagans* (Brady), insufficient material recovered for absolute identification.
Rhizammina sp. 9
**Description:** Delicate slender test, coarse grained, parallel sides, occasional irregular constrictions.
**Occurrence:** Occurs in Lapugiu du Sus and the Chechis Marls, Romania.
**Remarks:** Poorly preserved fragments.

Rhizammina sp. 10
**Description:** Light coloured, robust test, coarse grained, thick wall, parallel to sub-parallel sides.
**Occurrence:** Observed in Sacel, Romania.
**Remarks:** Poorly preserved fragments.

Rhizammina sp. 11
**Description:** Elongate brittle test, narrow, parallel sides, smooth irregular wall, coarse grain size with high proportion of cement, dark colour.
**Occurrence:** Observed in Sacel, Romania.
**Remarks:** Poorly preserved fragments.

Rhizammina spp.
**Description:** Small fragile remains of agglutinating tubes. Cylindrical to compressed in cross section, of varying lengths. Parallel sides.
**Occurrence:** Intermittent recovery throughout Venezuelan section, acme in *V. herricki* Zone.
**Remarks:** Due to the fragmentary recovery of these taxa they have been grouped informally.

Family SACCAMMINIDAE Brady, 1884
Subfamily SACCAMMININAE Brady, 1884
Genus SACCAMMINA Carpenter, 1869
*Saccammina placenta* (Grzybowski)

Plate 40, figures 1 - 2
Reophax placenta GRZYBOWSKI 1898, pl. 10, figs. 9 - 10 (*fide* Kaminski & Geroch 1993)
Reophax triloba DYLAZANKA 1923, pl. 17, fig. 11 (*fide* Kaminski & Geroch 1993)
*Saccammina placenta* (Grzybowski). --CHARNOCK & JONES 1990, pl. 1, figs. 5 - 6, pl. 13, fig. 4. -- KAMINSKI & GERICH 1993, pl. 2, figs. 5 - 7, pl. 17, fig. 11
**Description:** Moderate sized, compressed, round test. Periphery often slightly thickened. Wall of moderate grain size. Aperture a simple opening with a short neck.
**Occurrence:** Offshore Cabinda found intermittently in CABGOC 128-3 between 4,770' and 10,160', and frequently in CABGOC 115-1X between 4,370' and 10,020'.
**Remarks:** Preservation poor, samples often fragmented. Known from Tertiary flysch deposits in Switzerland and France (Brouwer 1965). Comparable forms are evident in the J. Doreen collection.
**Saccammina sphaerica** Sars

Plate 9, figure 2; Plate 40, figure 3; Plate 67, figure 7

*Saccammina sphaerica* SARS 1872, p. 532, fig. 272 (fide Ellis & Messina 1940, et seq.)


**Description:** Specimens often crushed. Small, rounded periphery, medium to coarse grained with smooth exterior, dark in colour. Aperture round with neck.

**Occurrence:** Occurs at a low frequency from the *L. wallacei* Zone to the *V. herricki* Zone in Venezuela. Occurrence sporadic. Offshore Cabinda found intermittently in CABGOC 128-3 between 4,770' and 10,160' and frequently in CABGOC 115-1X between 5,040' and 9,300'. Two specimens recovered from Sacel, Romania.

**Remarks:** First record of this species from the Agua Salada Formation. Originally described from the Recent of Norway. Known from the Recent sediments of the Philippines (Cushman 1921) and additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966). In CABGOC 115-1X specimens occasionally recovered as just the apertural region.

**Saccammina sp. 1**

Plate 9, figure 3

*Tholosina* sp. 1 POPESCU 1975, pl. 1, fig. 3

**Description:** Specimens smaller than *S. sphaerica* and very finely grained. Polished appearance. Aperture normally visible as rounded with a short neck, though not always visible.

**Occurrence:** Very rare, very few specimens recovered. Found between *S. transversa* and *V. herricki* Zones in Venezuela. Offshore Cabinda found in CABGOC 115-1X between 4,920' and 9,960'.

**Remarks:** In CABGOC 115-1X becomes more frequent towards the base of the well.

**Saccammina sp. 2**

Plate 67, figure 8

**Description:** Small nondescript, flattened, light coloured test, aperture not apparent in most specimens, small simple opening without neck in others.

**Occurrence:** Recovered from Vâlcele, the Chechis Marls, and Sacel, Romania.

**Saccammina sp. 3**

**Description:** Single specimen with distinctive peripheral flattening giving 'halo' appearance.

**Occurrence:** Observed in Sacel, Romania.
Superfamily HIPPOCREPINACEA Rhumbler, 1895
Family HIPPOCREPINIDAE Rhumbler, 1895
Subfamily HYPERAMMININAE Eimer & Fickert, 1899
Genus HYPERAMMINA Brady, 1878

Hyperammina sp. 1
Plate 40, figure 4
Description: Elongate slender test, parallel sides. Fine grained, high proportion of cement, distinctive horizontal 'corrugations' on some portions of test.
Occurrence: Offshore Cabinda found in CABGOC 128-3 at 6'980'.
Remarks: Poorly preserved fragments.

Hyperammina sp. 2
Plate 40, figure 5
Description: Robust, large test, inflated, slightly flattened. Moderate grain size, roughed surface, thick wall, occasional bulbous inflations.
Occurrence: Offshore Cabinda found in CABGOC 128-3 at 6'920'.
Remarks: Poorly preserved fragments.

Superfamily AMMODISCACEA Reuss, 1862
Family AMMODISCIDAE Reuss, 1862
Subfamily AMMODISCINAE Reuss, 1862
Genus AMMODISCOIDES Cushman, 1909

Ammodiscoides japonicus Asano & Inomata
Ammodiscoides japonicus ASANO & INOMATA 1952, p. 3, tf. 9 - 11, 2 (fide Ellis & Messina 1940, et seq.)
Description: Small test, conical. Spiral chamber of uniform diameter, overlaps previous whorls slightly with growth. Medium grain size, smoothly finished with high proportion of cement. Aperture not observed.
Occurrence: Confined to sample 2610 in the V. herricki Zone in Venezuela.
Remarks: Originally described from the Miocene of Japan. First record of this taxon from the Agua Salada Formation. Diaz de Gamero (1985a) refers to an Ammodiscoides sp., however, this is unfigured so comparison is impossible.

Ammodiscoides cf. turbinatus Cushman
Plate 9, figures 4a, 4b, 4c
Ammodiscoides turbinatus CUSHMAN 1909, pl. 33, figs. 1 - 6 (fide Ellis & Messina 1940, et seq.)
Description: Test free, spiral chamber forms a hollow cone gradually increasing in diameter towards the periphery. Cushman (1909) describes the species s.s. then changing its plane of coiling to produce a 'broadly flaring usually slightly concave' portion. These specimens do not display this characteristic, all halting growth within the conical phase of development. Wall finely agglutinating, aperture terminal.
Occurrence: Sporadic recovery between the *V. herricki* Zone and *S. transversa* Zone. Acme occurrence in sample 2610.

Remarks: First record of this taxon from the Agua Salada Formation. Diaz de Gamero (1985a) refers to an *Ammodiscoides* sp., however, this is unfigured so comparison is impossible.

*Ammodiscoides* sp.1
Plate 9, figures 5a, 5b


Occurrence: Confined to sample 2610 of the *V. herricki* Zone. Single specimen found offshore Cabinda in CABGOC 115-1X at 4,010'.

Remarks: This taxon is unnoted in previous reports from the Agua Salada Basin. Diaz de Gamero (1985a) refers to an *Ammodiscoides* sp., however, this is unfigured so comparison is impossible.

Genus AMMODISCUS Reuss, 1862

*Ammodiscus* cf. *aequispiralis* Subbotina
Plate 40, figure 6

*Ammodiscus aequispiralis* SUBBOTINA 1960, pl. 1, figs. 6 - 7 (*fide* Ellis & Messina 1940, *et. seq.*)

Description: Small test, three to four whorls visible. Whorls divided by distinct deep sutures, though filled in through re-silification. Initial whorl appears much larger than subsequent growth. Wall smooth and fine grained

Occurrence: Offshore Cabinda found in CABGOC 115-1X at 5,640' and 5,760'.

Remarks: Originally described from the Lower Miocene of the Ukraine.

*Ammodiscus augustus* Friedberg
Plate 40, figure 7; Plate 67, figure 9

*Comuspira augustus* FRIEDBERG 1902, pl. 22 (1), fig. 8 (*fide* Kaminski, *et al.* 1993)

*Grzybowskia angusta* (Friedberg). - MJATLIUK 1970, pl. 9, fig. 15 (not 12, 14), pl. 12, fig. 5 (not 1 - 4, 6)

Description: Test somewhat extended in one plane to give elongate appearance. Six or more closely spaced whorls, the last of which may become slightly broader. Successive whorls overlap slightly.

Occurrence: Offshore Cabinda found in CABGOC 128-3 at 5,840' and 10,040', in CABGOC 115-1X intermittent recovery between 4,860' and 10,020'. Single specimen identified in Sacel, Romania.

Remarks: Originally described from the Campanian of the Carpathians. Kaminski, *et al.* (1993) place this taxon as a senior synonym to *A. peruvianus* Berry. However, this study finds *A. peruvianus* Berry to be much smaller than *A. augustus* Friedberg, the latter showing a somewhat rougher finish to the test wall.
Ammodiscus incertus (d'Orbigny)

Plate 9, figure 6; Plate 67, figure 10

Operculina incertus D'ORBIGNY, 1840, p. 49, pl. 6, figs. 16 - 17 (fide Ellis & Messina 1940, et. seq.)

Ammodiscus incertus (d'Orbigny). --CUSHMAN 1918, pl. 39. --LE ROY 1939, pl. 9, figs. 17 - 18 pl. 1, fig. 4. --CUSHMAN 1921, pl. 5, figs. 1 - 2. --PETTERS 1982, pl. 1, figs. 16 - 17. --SCHROEDER 1988, pl. 2, fig. 11. --KAMINSKI et. al. 1989b, pl. 3, figs. 3 - 4. --FINGER, et. al. 1990, pl. 4, fig. 30. --FINGER 1992, pl. 1, figs. 2 - 5. --KAMINSKI, et. al. 1990, pl. 2, figs. 3 - 4. --BOLLI, et. al. 1994, pl. 76, figs. 38 - 39

Ammodiscus cf. incertus (d'Orbigny). --CUSHMAN & STAINFORTH 1945, pl. 1, figs. 10 - 11

Description: Test free, planispiral. Spiral coiling on single plane gradually increases in size towards the periphery. Finely agglutinating species with high proportion of cement. Specimens often deformed and may be recovered as partial individuals. Aperture formed by open end of the chamber.

Occurrence: Confined to sample 2610 of the V. herricki Zone in Venezuela. Offshore Cabinda found in CABGOC 115-1X between 6,900' and 9,120', becoming more common down well. Also identified as a single specimen in Sacel, Romania.

Remarks: Renz (1948) noted its presence in 'Uvigerinella' sparsicostata Zone, the Acostian, Araguatian, and the Lucian. Blow (1959) records it from his G. insueta, G. fohsi, and G. mayeri Zones extending greatly the range of this species from this data set. Cushman (1918) highlights the species as cosmopolitan, found in all the oceans apart from the Atlantic. Le Roy (1939) describes the taxon as 'seldom found' in the Central Sumatran region. Known from Trinidad (Nuttall 1927; Cushman and Renz 1947) and Venezuela (Hedberg 1937). Examples in the Heron-Alien and Earland collection show a high degree of variability similar to that of this study. Cursory examination of previously unexamined faunal slides of Whittaker (1988) reveal comparable forms in the Tosagua Formation, Ecuador. In addition, comparable forms are evident in the J. Doreen collection.

Ammodiscus peruvianus Berry

Plate 9, figures 7a, 7b; Plate 40, figure 8

Ammodiscus peruvianus BERRY, 1928, p. 342, pl. 27 (fide Ellis & Messina 1940, et. seq.)

Ammodiscus peruvianus Berry. --RÖGL 1976, pl. 2, fig. 23. --KAMINSKI et. al. 1988. --BELLAGAMBA & COCCIONI 1990, pl. 1, fig. 8

Description: Elliptical outline to test, finely agglutinated. Successive whorls slightly overlap, seven to eight whorls visible. Square outline in side view.

Occurrence: Confined to V. herricki Zone, acme in sample 2610 in Venezuela. Offshore Cabinda found in CABGOC 128-3 between 3,810' and 10,160', becoming more common down well, in CABGOC 115-1X occurs between 7,560' and 9,660'.

Remarks: First record of this species from the Agua Salada Formation. Comparable forms are evident in the J. Doreen collection. Differs from A. augustus Friedberg in its smaller size and smoother test wall.
**Ammodiscus aff. planus** Loeblich

Plate 9, figure 8; Plate 40, figure 9

_**Ammodiscus planus** LOEBLICH 1946, pl. 22, fig. 2 (fide Ellis & Messina 1940, et. seq.)_

_**Ammodiscus planus** Loeblich. --CHARNOCK & JONES 1989, pl. 2, figs 6 - 7, pl. 14, fig. 5_

**Description:** Test small and compressed, with thin walls. Diameter of chamber increases slightly in last whorl. Five to six whorls visible, successive whorls slightly overlapping earlier stages.

**Occurrence:** Occurs in low frequency between the _T. panamaensis_ zonule and _G. fohsi_ Zone, acme in sample 2610 of the _V. herricki_ Zone in Venezuela. Offshore Cabinda found in CABGOC 115-1X between 4,980' and 9,240'. Also found as single specimens at Vâlcele, the Chechis Marls, and Sacel, Romania.

**Remarks:** First record of this species from the Agua Salada Formation.

**Ammodiscus tenuissimus** Grzybowski

Plate 40, figure 10

_**Ammodiscus tenuissimus** GRZYBOWSKI 1898, pl. 10, fig. 35 (fide Kaminski & Geroch 1993)_

_**Ammodiscus tenuissimus** Grzybowski. --GEROCH & OLSEZEWSKA 1990, pl. 2, figs. 6 - 8. --KAMINSKI, et. al. 1990, pl. 2, fig. 6 (not 7). --KAMINSKI & GEROCH 1993, pl. 5, figs. 1 - 3. --CICHA, et al. 1998, pl. 2, fig. 1_

**Description:** Small flattened planispiral. Six to ten whorls visible, increasing in diameter with growth. Last whorl much larger than previous portion. Fine grain size with high proportion of cement.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 between 4,410' and 10,160', and in CABGOC 115-1X between 5,700' and 10,020', becoming more frequent down well.

**Remarks:** Originally described from the Upper Eocene of Poland.

**Ammodiscus sp.1**

Plate 9, figure 9

**Description:** Large spiral test. Eight to nine whorls visible. Whorls increase in diameter with growth. Finely grained test wall.

**Occurrence:** Recorded between the _V. herricki_ and _S. transversa_ Zones sporadically, acme in sample 2702 of the _S. transversa_ Zone in Venezuela.

**Remarks:** No note has previously been made to this taxon from the Agua Salada Basin.

**Ammodiscus sp. 2**

Plate 40, figure 11

**Description:** Small test, large proloculous, two whorls visible, rapidly increase in diameter with growth, last whorl significantly larger. Smooth wall, extremely fine grained.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 at 6,440'.

**Remarks:** Single specimen recovered.
Subfamily TOLYPAMMININAE Cushman, 1928
Genus TOLYPAMMINA Rhumbler, 1895

*Tolypammina* sp. 1

**Plate 41, figure 1**

**Description:** Small, delicate tube, parallel sides, flattened. Irregular open coiling. Smooth thin wall.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 at 10,100', and in CABGOC 115-1X at 8,700'.

**Remarks:** Single specimens recovered.

Subfamily AMMOVERTELLININAE Saidova, 1981
Genus GLOMOSPIRA Rzehak, 1885

*Glomospira charoides* (Jones & Parker)

**Plate 10, figures 1a, 1b; Plate 41, figures 2a, 2b**

*Trochammina squamata* JONES & PARKER, var. gordialis JONES & PARKER 1860, p 263 (fide Ellis & Messina 1940, et. seq.)

*Glomospira charoides* (Jones & Parker). --CUSHMAN & STAINFORTH 1945, pl. 1, figs. 12 - 13. --WEBB 1975, pl. 1, fig. 12. --RÖGL 1976, pl. 2, figs. 26 - 27; pl. 3, fig. 40. --BOCK 1980, pl. 1, figs. 5 - 6. --HULSBOS 1987, pl. 1, fig. 8. --BERGGREN & KAMIŃSKI 1989, pl. 1, fig. 2. --KAMIŃSKI, et. al. 1989a, pl. 2, fig. 8. --GEROCH & OLZEWSKA 1990, pl. 1, figs. 31 - 32, pl. 2, figs. 12 - 13. --KAMIŃSKI, et. al. 1990, pl. 3, fig. 2. --SCHRÖDER-ADAMS 1990, pl. 2, fig. 9. --KAMIŃSKI & HUANG 1991, pl. 2, fig. 1. --REPMANINA charoides* (Jones & Parker). --CICHA, et. al. 1998, pl. 2, fig. 3

**Description:** Winding about a single axis to form 'bee-hive' profile. Finely granular.

**Occurrence:** Occurs sporadically throughout the Venezuelan section, not present in the *M. superb* zonule and *M. basispinosus* Zone. Offshore Cabinda found in CABGOC 128-3 between 9,260' and 10,160', and in CABGOC 115-1X between 9,000' and 10,020'. Single specimen recognised in the Chechis Marls, Romania.

**Remarks:** First record of this species from the Agua Salada Formation. Known from Trinidad (Nuttall 1927; Cushman and Renz 1947). Specimens compare well to those of the Henson collection (NHM). Known from Tertiary flysch deposits in Switzerland, France and Italy (Brouwer 1965). Specimens in the Heron-Allen and Earland collection show a reasonable comparison.

*Glomospira inconsueta* Subbotina

*Glomospira inconsueta* SUBBOTINA 1960, pl. 1, fig. 8

**Description:** Small irregularly winding tube, tends to increase diameter slightly with growth. Fine grain size, high proportion of cement.

**Occurrence:** Offshore Cabinda found in CABGOC 115-1X at 5,760'.

**Remarks:** Originally described from the Lower Miocene of the Ukraine. Single specimen recovered.
Glomospira sp. 1  
Plate 10, figure 2  
Description: Initial winding about a single axis. Later growth changing axis to wind perpendicularly.  
Occurrence: Single occurrence in sample 2702 of the S. transversa Zone in Venezuela.  
Remarks: Partial abraded specimen. No note has previously been made to this species in the Agua Salada Basin.  

Superfamily HORMOSINACEA Haeckel, 1894  
Family ASCHEMOCELLIDAE Vyalov, 1966  
Genus ASCHEMOCHELLA Vyalov, 1966  
Aschemocella grandis (Grzybowski)  
Reophax grandis GRZYBOWSKI 1898, pl. 10, figs. 13 - 15 (fide Kaminski & Geroch 1993)  
Aschemocella grandis (Grzybowski). --KAMINSKI & GEROCH 1993, pl. 2, figs. 8 - 10  
Description: Sac-like chambers branch and overlap near periphery. Aperture a simple opening, may posses a lip. Wall of moderate grain size.  
Occurrence: Offshore Cabinda found in CAGOC 128-3 between 5,360' and 6,440', rare.  
Remarks: Originally described from the Paleogene of Poland. Specimens are always compressed and broken.  

Reophax acosta Bermúdez  
Plate 41, figure 4  
Reophax acosta BERMÚDEZ 1949, pl. 1, figs. 28 - 31 (fide Ellis & Messina 1940, et. seq.)  
Reophax acosta Bermúdez. --KOHL 1985, pl. 1, fig. 3  
Description: Test free, short, cylindrical, consisting of as many as three coarse grained, inflated chambers. Sutures depressed, wall coarsely agglutinating. Aperture a terminal elongate slit with short neck. Loss of apical end and aperture in some specimens.  
Occurrence: Low frequency in the M. basispinosus and V. herricki Zones in Venezuela. Offshore Cabinda found in CAGOC 128-3 at 6,080', and in CAGOC 11-51X between 6,180' and 9,660'. Single specimen in the Chechis Marls, Romania.  
Remarks: Renz (1948) made a fleeting reference to Reophax ? sp. from the Upper Araguatian and Lower Lucian of the Isidro area. This taxon was referred to as 'doubtful generic position',
and was undescribed and unfigured. Originally described from the Pliocene of the Dominican Republic. First record of this species from the Agua Salada Formation. Some specimens recovered as juvenile single chambers in CABGOC 115-1X.

*Reophax agglutinans* Cushman

**Plate 67, figure 14**

*Reophax agglutinans* CUSHMAN 1913, pl. 79, fig. 6

**Description:** Large test, three to four uniserial chambers steadily increasing in size as added. Globular periphery, wall composed of varying sized particles of quartz and *Globigerina* spp. tests. Aperture a simple opening in the centre of the last formed chamber.

**Occurrence:** Found in Sacel, Romania.

**Remarks:** Originally described from Recent sediments from offshore the Philippines. Cursory examination of faunal slides of Whittaker (1988) reveal comparable forms in the Tosagua Formation, Ecuador.

*Reophax davepopei* Smith

**Plate 67, figure 11**

*Reophax davepopei* SMITH 1948, pl. 11, figs. 7 - 8 (fide Skinner & Glaser 1972)

*Reophax davepopei* Smith. --SKINNER & GLASER 1972, pl. 1, fig. 1.

**Description:** Coarsely agglutinating species. Consists of normally three chambers flattened, with terminal aperture on short neck. Preservation poor.

**Occurrence:** Occurs intermittently in the *V. herricki* and *S. transversa* Zones in low frequencies in Venezuela. Offshore Cabinda found in CABGOC 115-1X between 6,360' and 9,660; becoming more common down well. Single specimen identified in the Chechis Marls, Romania.

**Remarks:** First record of this species from the Agua Salada Formation. Previously recorded from the Gulf Coast.

*Reophax duplex* Grzybowski

**Plate 10, figure 3**

*Reophax duplex* GRZYBOWSKI 1896, pl. 8, figs. 23 - 25 (fide Kaminski & Geroch 1993)

*Reophax duplex* Grzybowski. --FRIEDBERG 1901, pl. 1, fig. 7. --MJATLIUK 1970, pl. 10, fig. 1, 3 - 4, pl. --WEBB 1975, pl. 2, fig. 3. --DE KLASZ & DE KLASZ 1990, pl. 13, fig. 4

**Description:** Finely arenaceous, surface smooth. Test comprises of two almost equal spherical chambers overlapping, always flattened. Aperture terminal on the smaller of the two chambers, but often obscured and without neck.

**Occurrence:** Sporadic occurrence between *M. basispinosus* and *S. transversa* Zones of Venezuela. Single spurious occurrence in *R. spinulosa / E. poeyanum* zonule. Offshore Cabinda found in CABGOC 128-3 between 9,440' and 10,160', in CABGOC 115-1X intermittent recovery between 2,690' and 9,840', becoming more frequent down well.

**Remarks:** First record of this species from the Agua Salada Formation. Originally described from the Campanian of the Polish Carpathians. Cursory examination of faunal slides of
Whittaker (1988) reveal comparable forms in the Tosagua Formation, Ecuador. In addition, comparable forms are evident in the J. Doreen collection.

Reophax cf. duplex Grzybowski

Plate 41, figure 5

Reophax duplex GRZYBOWSKI 1896, pl. 8, figs. 23 - 25 (fide Kaminski & Gerch 1993)

Description: Small taxon. Inflated spherical chambers of same size and shape separated by distinct suture. Wall of moderate grain size with smooth finish. Aperture unobserved.

Occurrence: Offshore Cabinda found in CABGOC 115-1X between 5,820' and 9,540'.

Remarks: Poor preservation.

Reophax subfusiformis Earland emend. Höglund

Plate 10, figure 4; Plate 41, figure 6; Plate 67, figures 12 - 13

Reophax subfusiformis EARLAND 1933, pl. 2, figs. 16 - 19 (fide Ellis & Messina 1940, et seq.)
Reophax subfusiformis Earland emend. HÖGLUND 1947, pl. 9, figs. 1 - 4, pl. 26, figs. 1 - 36, pl. 27, figs. 1 - 19, p. 84, text figs. 43 - 45, p. 85, text figs. 46 - 50 (fide Ellis & Messina 1940, et seq.)
Reophax subfusiformis Earland emend. Höglund. —KAMINSKI, et. al. 1989b, pl. 2, fig. 14. —CHARNOCK & JONES 1990, pl. 4, fig. 19, pl. 15, fig. 17. —SCHRÖDER-ADAMS 1990, pl. 3, fig. 11, pl. 6, fig. 8

Description: Large test, up to four chambers, sequentially increasing in size, the last formed comprising the majority of the test. Chambers tend to be slightly ovoid in shape and inflated, sutures are incised. Aperture terminal on a elongate neck giving the last formed chamber a tapered appearance. Aperture a simple opening.

Occurrence: Offshore Cabinda found in CABGOC 128-3 between 6,500' and 10,160', rare. In CABGOC 115-1X recovered intermittently between 4,980' and 9,360'. Identified in the Chechis Marls and Sacel, Romania.

Remarks: Originally described from Recent sediments of the South Atlantic.

Reophax sp.1

Plate 10, figure 5

Description: Small taxon, consists of five or more chambers gradually increasing in size. Chambers rounded and flattened perpendicularly and joined to one another by a short stout neck. Aperture terminal on last chamber with short neck.

Occurrence: Single occurrence in sample 2619 of the M. basispinosus Zone in Venezuela.

Remarks: First record of this taxon from the Agua Salada Formation.

Reophax sp.2

Plate 10, figure 6

Description: Small taxon. Three rounded and flattened chambers increasing in size as added. Sutures incised, periphery lobate. Test wall coarse grained. Aperture a central terminal opening with short neck.

Remarks: First recording of this taxon from the Agua Salada Basin.

**Reophax sp. 3**
Plate 41, figure 7


*Occurrence*: Offshore Cabinda found in CABGOC 128-3 intermittently between 4,890' and 10,160'.

*Remarks*: Poor preservation.

**Reophax sp. 4**

*Description*: Similar to *R*. sp. 2 of Venezuela, but possess four to five rounded flattened chambers increasing in size as added. Sutures incised, periphery lobate. Test wall fine grained and smooth. Aperture a central terminal opening, no neck.

*Occurrence*: Offshore Cabinda found in CABGOC 128-3 intermittently between 4,770' and 10,160'.

*Remarks*: Poor preservation.

**Reophax sp. 5**
Plate 41, figure 8

*Description*: Moderate sized test, extremely flattened to give subacute periphery with slight 'keeled' appearance. Four to five chambers of similar size and shape, slightly inflated giving 'undulating' profile, sutures indistinct, slightly depressed toward centre of test, dissipating toward margin. Moderate grain size, roughened surface. Aperture terminal with slight neck.

*Occurrence*: Offshore Cabinda found in CABGOC 128-3 at 5,060'.

*Remarks*: Poor preservation.

**Reophax sp. 6**

*Description*: Moderate size test, semi-inflated. Three to four bulbous chambers, increase in size slightly as added. Initial sutures indistinct, separation between ultimate and penultimate depressed and distinctive. Wall smooth, fine grained with high proportion of cement. Aperture a terminal simple opening, without neck.

*Occurrence*: Offshore Cabinda found in CABGOC 128-3 at 6,140'.

*Remarks*: Poor preservation.
Genus SUBREOPHAX Saidova 1975

*Subreophax cf. scalaris* (Grzybowskí)

Plate 10, figure 7; Plate 41, figure 9

*Reophax guttîfera* Brady var. *scalaria* GRZYBOWSKI 1896, p. 277. pl. 8. fig. 26 (fide Ellis & Messina 1940, et. seq.)

*Subreophax scalaria* (Grzybowski). --KAMINSKI, et. al. 1988, pl. 2, fig. 16 - 17. --KAMINSKI, et. al. 1989a, pl. 3, fig. 14. --KAMINSKI & HUANG 1991, pl. 2, fig. 11. --OSTERMAN & SPIEGLER 1996, pl. 1, fig. 8

**Description:** Large species, coarsely agglutinated. Invariably three or more slowly enlarging chambers, rounded and flattened, separated by constriction of the wall and slightly overlapping one another. Aperture terminal.

**Occurrence:** Occurs sporadically in the *V. herricki* and *G. fohsi* Zones, acme occurrence at sample 2609B of the *V. herricki* Zone in Venezuela. Rare offshore Cabinda, found in CABGOC 128-3 between 5,480’, and 10,160’, and in CABGOC 115-1X between 7,620’ and 9,720’.

**Remarks:** First record of this species from the Agua Salada Formation.

*Subreophax sp. 1*

**Description:** Small coarse grained taxon. Three chambers, increase in size rapidly as added, form a stack of three ‘discs’, separated from one another by deeply incised sutures. Aperture a central terminal opening in the last and largest chamber, with slight neck.

**Occurrence:** Single occurrence in the *V. herricki* Zone in Venezuela.

**Remarks:** First recording of this taxon from the Agua Salada Formation.

*Subreophax sp. 2*

Plate 41, figure 10

**Description:** Fine grained elongate taxon. Smooth walls, near parallel sides, chambers inflated in the horizontal plane, sutures indistinct. Aperture unobserved.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 at 6,380’ and 10,100’.

**Remarks:** Poor preservation.

*Subreophax sp. 3*

**Description:** Moderate sized test, slender, flattened. Five to six chambers of similar and size and shape, rounded, often middle chambers slightly larger than initial and ultimate growth. Sutures distinct and depressed. Aperture a terminal opening with slight neck.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 between 9,980’ and 10,160’.

**Remarks:** Poor preservation.
Superfamily LITUOLACEA de Blainville, 1827
Family HAPLOPHRAGMOIDIDAE Maync, 1952
Genus CRIBROSTOMOIDES Cushman, 1910

*Cribrostomoides* sp. 1
Plate 42, figures 1a, 1b

**Description:** Moderate sized taxon, rounded periphery. Involute, inflated, four to five chambers visible in last whorl, of similar size and shape. Sutures depressed, more distinct toward centre of test over peripheral area. Umbilical areas depressed. Coarse grain size with high proportion of cement giving smooth appearance. Aperture often obscured through preservation but apparent as cribrate and low on the apertural face in some specimens.

**Occurrence:** Offshore Cabinda in CABGOC 128-3 between 4,530' and 7,040', and in CABGOC 115-1X between 7,260' and 10,020'.

**Remarks:** Tests often compressed.

Genus HAPLOPHRAGMOIDES Cushman, 1910

*Haplophragmoides* cf. bulloides (Beissel)
Plate 42, figures 2a, 2b

*Haplophragmium bulloides* BEISSEL 1886, (1891), pl. 2, figs. 1 - 3, pl. 4, figs. 24 - 30 (fide Ellis & Messina 1940, et seq.)

**Description:** Small distinctive taxon, bulbous. Inflated test, rounded periphery, five to six chambers in the last whorl. Straight sutures, slightly depressed. Wall finely agglutinating. Aperture a low slit at the base of the apertural face.

**Occurrence:** Offshore Cabinda found in CABGOC 115-1X between 7,920' and 10,020', acme at 8,820'.

**Remarks:** Originally described from the Cretaceous of Germany and the Netherlands.

*Haplophragmoides carinatus* Cushman & Renz
Plate 1, figures 1a, 1b, 1c; Plate 10, figure 8; Plate 42, figure 3

*Haplophragmoides carinatus* CUSHMAN & RENZ 1941, pl. 1, fig. 1

*Alveolophragmium ? carinatum* (Cushman & Renz). --BLOW 1959, p. 110

*Haplophragmoides carinatum* (Cushman & Renz). --CUSHMAN & STAINFORTH 1945, pl. 1, fig. 18. -- CUSHMAN & RENZ 1947, pl. 1, fig. 3

*Haplophragmoides carinatus* Cushman & Renz. --RÖGL 1976, pl. 4, fig. 17. --DIAZ de GAMERO 1977, pl. 3, fig. 1. --BOLLI, et. al. 1994, pl. 76, fig. 33. --CICHA, et. al. 1998, pl. 3, figs. 1 - 2

**Description:** Planispiral, involute, medium sized test. Umbilical region depressed, periphery lobate, acute and slightly carinate. 8 - 10 chambers in adult whorl, uniform shape, slightly increasing in size, sutures distinct, wall finely arenaceous and smooth. Aperture at base of apertural face.

**Occurrence:** Occurs intermittently throughout the Venezuelan section at a low frequency. Acme in sample 2610 in the *V. herricki* Zone and 2702 in the *S. transversa* Zone. Offshore Cabinda found in CABGOC 128-3 between 4,170' and 10,160', and in CABGOC 115-1X between 4,370' and 7,840', acme between 5,220' and 5,760'.
Remarks: Both Cushman & Renz (1941) and Renz (1948) reported this species from the Agua Salada Formation, although neither study found it in the youngest sediments. Blow (1959) noted an alveolar species of *H. carinatus*, this is likely more a product of grain size than the structure of the test in this case. His specimens were confined to the arenaceous facies and occasionally in the *S. seminulina* Zone. Diaz de Gamero (1985a) also refers to a *Haplophragmoides* sp. although a stratigraphic range is not given and the illustration is obscure. Cursory examination of faunal slides of Whittaker (1988) reveal comparable forms in the Cacelta Formation, Ecuador. Known from additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966). In addition, comparable forms are evident in the J. Doreen collection (NHM).

**Haplophragmoides coronatum** (Brady)

**Plate 10, figures 9a, 9b; Plate 42, figure 4**

*Trochammina coronata* BRADY 1879, pl. 5, fig. 15

*Haplophragmoides coronatum* (Brady). --RENZ 1948, pl. 1, fig. 5. --BLOW 1959, p. 112

*Haplophragmoides coronatus* (Brady). --BOLLI, et al. 1994, pl. 76, fig. 32

**Description:** Test involute, biconcave, compressed of 2 - 3 whorls; peripheral margin lobate and rounded. Chambers indistinct, variable in number, inflated. Simple interomarginal aperture on terminal face of the last chamber. Surface may be smooth or roughened, not polished.

**Occurrence:** Intermittent occurrence between the *R. spinulosa / E. poeyanum* zonule and *V. herricki* Zone, low frequency in Venezuela. Offshore Cabinda found in CABGOC 128-3 between 5,180' and 10,160', and in CABGOC 115-1X between 4,490' and 9,480', acme at 4,920'.

**Remarks:** Renz (1948) recorded this species as 'scarce' throughout the Agua Salada Formation, in broad agreement with this study. This species represents Blow's (1959) single record for the genus. He describes it as frequently deformed and only apparent in his arenaceous faunas between the *C. stainforthi* and *G. insueta* Zones, this is not evident on the basis of this study. Originally described from deep water stations offshore the West Indies and South America. Known from Trinidad (Nuttall 1927). Cursory examination of faunal slides of Whittaker (1988) reveal comparable forms in the Tosagua and Viche Formations, Ecuador.

**Haplophragmoides discus** (Rzehak)

**Plate 42, figure 5**

*Haplophragmium discus* RZEHAK 1886, pl. 1, fig. 1 *(fide* Ellis & Messina 1940, et. seq.)*

**Description:** Small flattened taxon. Rounded periphery, seven to nine chambers in the last whorl of equal size. Sutures straight and slightly depressed. Umbilicus a low depression. Aperture an arched opening at the base of the apertural face. Wall of moderate grain size with roughened finish.

**Occurrence:** Offshore Cabinda found in CABGOC 115-1X between 7,740' and 9,900'.

**Remarks:** Originally described from the Neogene of Czechoslovakia.
**Haplophragmoides inaequilateralis** Subbotina

Plate 42, figure 6

*Haplophragmoides inaequilateralis* SUBBOTINA 1936, pl. 1, fig. 5 (fide Ellis & Messina 1940, et seq.)

**Description:** Large test, involute and compressed obliquely. Periphery rounded, may become lobate. Six to eight chambers in the last whorl, increase slightly in size as added. Sutures straight and depressed. Umbilici deep. Wall finely agglutinated with high proportion of cement. Aperture obscured through nature of oblique growth.

**Occurrence:** Offshore Cabinda found in CABGOC 115-1X between 3,650’ and 7,740’, acme between 4,430’ and 4,670’.

**Remarks:** Originally described from upper Oligocene / lower Miocene of North Caucasus, Russia. Differs from *H. obliquicameratus* Marks in the lesser number of chambers.

**Haplophragmoides narivaensis** Brönnimann

Plate 42, figures 7a, 7b

*Haplophragmoides narivaensis* BRÖNNIMANN 1953, pl. 15, fig. f, textfigs. 3a, 5j-p

**Description:** Small, planispiral, involute, deep umbilicus. Last chamber larger than previous. Sutures obscured by large grain size. Aperture interiomarginal.

**Occurrence:** Sporadic occurrence in *V. herricki, G. fohsi,* and *L. wallacei* Zones in Venezuela. Offshore Cabinda found in CABGOC 128-3 between 5,180’ and 9,260’, and in CABGOC 115-1X between 5,940’ and 10,200’, acme at 8,880’. Single specimen identified in the Chechis Marls, Romania.

**Remarks:** First record of this species from the Agua Salada Formation. Brönnimann (1953) also describes *H. aff. H. narivaensis* as a flattened variation of the species s.s. Here, occasional flattened specimens of similar size and chamber arrangement of the named taxon have been included within the *H. narivaensis* designation. Brönnimann (1953) describes this taxon ‘as a rule strongly deformed’, post mortem compression is believed to be responsible for occasional flattened specimens. Originally described from the Oligo-Miocene of Trinidad.

**Haplophragmoides cf. narivaensis** Brönnimann

Plate 43, figures 1a, 1b

*Haplophragmoides cf. narivaensis* BRÖNNIMANN 1953

**Description:** Taxon differs from the typical in the bilateral compression of the test.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 between 4,980’ and 10,100’, and in CABGOC 115-1X between 4,430’ and 9,900’. Two specimens tentatively referred to as this taxon in the Chechis Marls, Romania.

Haplophragmoides obliquicameratus Marks

Plate 11, figures 1a, 1b; Plate 43, figures 2 - 4; Plate 68, figures 1 - 2

Haplophragmoides obliquicameratus MARKS 1951, pl. 5, fig. 1 (fide Ellis & Messina 1940, et. seq.)
Haplophragmoides obliquicameratus Marks. --DíAZ de GAMERO 1977, p. 38, pl. 3, fig. 2. --DíAZ de GAMERO 1985a, pl. 4, fig. 2

Description: Planispiral, vertically and tangentially compressed. Chambers slightly inflated, sutures straight and depressed, wall finely arenaceous. Eight to ten chambers visible in last whorl, gradually increase in size sequentially. Aperture invariably obscured. Preservation variable.

Occurrence: Occurs sporadically throughout the El Mene Road section, Venezuela, apart from the M. superbus zonule, where it is absent. Acme occurrence across the G. fohsi / S. transversa Zonal boundary. Offshore Cabinda found in CABGOC 128-3 between 4,350' and 10,160', and in CABGOC 115-1X between 4,070' and 10,020', becomes more frequent down well. Present in Sacel, Romania.

Remarks: DíAZ de Gamero (1985a) makes reference to this species from the Agua Salada Formation in her upper and lower arenaceous units. Originally described from the upper middle Miocene of the Vienna Basin. Cicha, et. al. (1998) find alveolar structures in holotype material; none of the material examined in this study exhibits a alveolar wall structure. Cursory examination of faunal slides of Whittaker (1988) reveal comparable forms in the Viche Formation, Ecuador.

Haplophragmoides cf. obliquicameratus Marks

Haplophragmoides obliquicameratus MARKS 1951, pl. 5, fig. 1 (fide Ellis & Messina 1940, et. seq.)
Haplophragmoides obliquicameratus Marks. --LUCZKOWSKA 1990, pl. 1, fig. 11

Description: Differs from the taxon s.s. in the extreme coarse grained nature of the test wall.

Occurrence: Confined to sample 2614 of the G. fohsi Zone, Venezuela.

Remarks: First record of this form in the Agua Salada Formation.

Haplophragmoides quinqueilocularis Subbotina

Plate 43, figure 5

Haplophragmoides quinqueilocularis SUBBOTINA 1960, pl. 2, figs. 1 - 2

Description: Small test, flattened obliquely. Periphery weakly lobate, rounded. Five triangular chambers visible in the last whorl, sutures depressed and sigmoidal. Umbilici indistinct. Wall finely agglutinated with high proportion of cement. Aperture not observed.

Occurrence: Offshore Cabinda occurs in CABGOC 115-1X between 4,430' and 9,480', acme between 5,400' and 6,060'.

Remarks: Originally described from the Lower Miocene of the Ukraine. Differs from H. obliquicameratus Marks in the reduced size and distinctive five chamber arrangement.
**Haplophragmoides sphaeriloculus** Cushman

**Plate 11, figure 2**

*Haplophragmoides sphaeriloculus* Cushman 1910, p. 107, tf. 165

*Haplophragmoides sphaeriloculus* Cushman. --Cushman 1921, pl. 15, fig. 3. --Schroeder 1988, pl. 17, figs. 5 - 7. --Schröder 1988, pl. 3, fig. 3. --Schröder-Adams 1990, pl. 1, fig. 12, pl. 7, figs. 13 - 15. -Murray & Alve 1994, pl. 1, fig. 11

**Description:** Large partially evolute test consisting of five to six bulbous chambers separated by pronounced, slightly curving, depressed sutures. Periphery lobate, but can become somewhat acute in some specimens owing to post-mortem deformation. Medium grain size with large amount of cement. Aperture low ellipse at base of apertural face.

**Occurrence:** Infrequent low abundances occur in *V. herricki* and *G. fohsi* Zones in Venezuela. Offshore Cabinda found in CABGOC 115-1X between 5,700' and 9,900', acme at 9,600'.

**Remarks:** First record of this species from the Agua Salada Formation. Cursory examination of faunal slides of Whittaker (1988) reveal comparable forms in the Tosagua Formation, Ecuador.

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**Haplophragmoides subglobosum** (Sars)

**Plate 43, figure 6**

*Lituola subglobosum* Sars 1868 (1869) p. 250 *(fide* Ellis & Messina 1940, *et. seq.)*

*Haplophragmoides subglobosum* (Sars). --Cushman 1921, pl. 15, fig. 1

**Description:** Bulbous rotund test. Rounded outline, inflated. Five to six chambers visible in the last whorl, inflated. Sutures slightly depressed, straight. Umbilici depressed. Wall moderately coarse grained, smooth finish. Aperture a wide slit at the base of the apertural face.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 between 5,000' and 6,560'.

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**Haplophragmoides suborbicularis** (Grzybowski)

**Plate 43, figure 7**

*Cyclammina suborbicularis* Rzehak 1886

*Cyclammina suborbicularis* Grzybowski 1896, pl. 9, figs. 5 - 6 *(fide* Kaminski, *et al.* 1993)


**Description:** Moderate sized spherical test, rotund, rounded periphery. Up to ten chambers visible in the last whorl, inflated, increase in size gradually as added. Sutures indistinct, straight, may be slightly depressed. Moderate grain size to wall, large proportion of cement, smooth surface. Apertural face slightly inclined, aperture a low horizontal slit, usually obscured.

**Occurrence:** Found offshore Cabinda in CABGOC 128-3 between 4,530' and 7,820'.
**Haplophragmoides walteri** (Grzybowski)

*Plate 44, figure 1*

*Trochammina walteri* GRZYBOWSKI 1898, pl. 11, fig. 31 (*fide* Kaminski & Geroch 1993)

*Trochammina tenuissima* GRZYBOWSKI 1898, pl. 11, fig. 30 (*fide* Kaminski & Geroch 1993)

*Haplophragmoides walteri* (Grzybowski). --DIAZ de GAMERO 1985a, pl. 4, fig. 3. --KAMINSKI, *et al.* 1989a, pl. 4, figs. 3 - 4. --OSTERMAN & QVALE 1989, pl. 5, fig. 6. --CHARNOCK & JONES 1990, pl. 6, figs. 3 - 4, pl. 17, fig. 2. --KAMINSKI & GEROCH 1993, pl. 10, figs. 3 - 7, pl. 11, fig. 3. --OSTERMAN & SPIEGLER 1996, pl. 1, fig. 23 (not pl. 3, figs. 6 - 9)

*Asanospira walteri* (Grzybowski). --MJIATLIUK 1970, pl. 19, figs. 5 - 7, pl. 20, figs. 1 - 2

*Haplophragmoides walteri walteri* (Grzybowski). --KAMINSKI & HUANG 1991, pl. 3, fig. 4

**Description:** Small test, rounded, subacute margin. Involute coiling, triangular chambers, increasing in size as added. Sutures depressed and straight, becoming sigmoidal. Aperture obscured as a result of compression of test.

**Occurrence:** Offshore Cabinda confined to interval between 7,560' and 8,040' in CABGOC 115-1X.


**Haplophragmoides sp. 1**

*Plate 11, figures 3a, 3b*

**Description:** Small coarse grained test. Evolute. Chambers and sutures indistinct. Aperture a simple narrow opening on the apertural face.

**Occurrence:** Single occurrence in sample 2607 of the *V. herricki* Zone, Venezuela.

**Remarks:** Figured specimen broken.

**Haplophragmoides sp. 3**

**Description:** Large test, fine grained, subacute periphery, slightly flattened. Chambers and sutures indistinct. Umbilical areas slightly depressed in some specimens, indistinct in others. Apertural face high and flat, aperture a simple low arch at the base of the face

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 between 5,000' and 10,100', rare.

Genus **VELERONINOIDES** Saidova 1981

**Veleroninoides veleronis** (Cushman & McCulloch)

*Plate 1, figures 2 - 4; Plate 11, figures 4a, 4c; Plate 44, figure 2*

**Description:** Test evolute, planispiral, biumbilicate, with numerous low chambers in about two and a half whorls, increasing in size slowly, margins slightly lobulate, chambers much wider than high. Sutures nearly radial. Wall finely agglutinated, smoothly finished. Aperture areal, a low oval to elliptical opening near the base of the apertural face, bordered by a slight lip, but often obscured.
**Occurrence:** Sporadic specimens in *T. panamaensis* zonule and *M. basispinosus* Zone in Venezuela. More continual occurrence throughout the *V. herricki* to *S. transversa* Zones, reaching acme abundances in sample 2610 and 2701. Offshore Cabinda in CABGOC 115-1X between 5,700' and 10,020', infrequent.

**Remarks:** First record of this species from the Agua Salada Formation. Originally described from Recent sediments of Guadeloupe, Mexico. Cursory examination of faunal slides of Whittaker (1988) reveal comparable forms in the Tosagua and Viche Formations, Ecuador.

**Veleroninoides** sp.

**Plate 68, figures 3 - 4**

**Description:** Evolute test, coarse grained. Two to three whorls visible, coarse nature of the test wall obscures chambers and positioning of sutures.

**Occurrence:** Observed in the Chechis Marls in Romania.

Family **Sphaeramminidae** Cushman, 1933

Genus **Sphaerammina** Cushman, 1910

*Sphaerammina subgaleata* (Vasicek)

*Cystammina subgaleata* VASICEK 1947, pl. 1, fig. 15 (Kaminski pers. comm. 1998)

**Description:** Moderate sized test, bulbous. Lobulate periphery, four to five rotund chambers arranged in involute planispiral. Sutures indistinct. Thick wall, fine grained, high proportion of cement giving smooth appearance. Aperture unobserved.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 between 4,770' and 10,160', infrequent.

**Remarks:** Originally described from the Eocene of the Carpathians. Specimens compressed and deformed.

*Sphaerammina* sp. 1

**Plate 44, figure 3**

**Description:** Small specimen, inflated. Earlier chambers compressed to give 'Saturn-like ring' to the individual.

**Occurrence:** Single specimen found offshore Cabinda in CABGOC 115-1X at 1,790'.

Family **Lituolidae** de Blainville, 1827

Subfamily **Ammomarginulininae** Podobina, 1978

Genus **Ammobaculites** Cushman, 1910

*Ammobaculites agglutinans* (d'Orbigny) emend. Bartenstein

**Plate 44, figure 4; Plate 68, figure 5**

*Ammobaculites agglutinans* (d'Orbigny) emend. BARTENSTEIN 1952, p. 318 (fide Ellis & Messina 1940, et. seq.)

*Ammobaculites agglutinans* (d'Orbigny). --SOUYA 1965, pl. 1, fig. 26. --PAPP & SCHMID 1985, pl. 45, figs. 6 - 9. --CICHA, et. al. 1998, pl. 3, fig. 9

79
Description: Juvenile portion planispirally enrolled, adult portion becomes uniserial. Terminal aperture rounded.

Occurrence: Offshore Cabinda found in CABGOC 128-3 at 5,240' and 10,160', and in CABGOC 115-1X at 9,240'. A few specimens identified in the Chechis Marls, Romania.

Remarks: Originally described from the Tortonian of Austria. Known from Recent sediments of Côte d'Ivoire (Calvez 1963).

*Ammobaculites* cf. *stratheamensis* Cushman & Le Roy

**Plate 11, figure 5**

*Ammobaculites* *stratheamensis* Cushman & Le Roy. --LE ROY 1939, pl. 7, figs. 21 - 22. --RENZ 1948, pl. 1, figs. 7 - 8. --BLOW 1959, p. 111. --PETTERS 1982, pl. 2, figs. 29 - 30. --BOLLI, et. al. 1994, pl. 76, figs. 36 - 37

Description: Strongly compressed test, elongate. Early portion involute consisting of 5 to 6 chambers, later portion uncoiling with indistinct chambers and sutures. Degree to which last few chambers uncoil varies. Test wall coarse, aperture terminal.

Occurrence: Single occurrence in *V. herricki* Zone in Venezuela. Offshore Cabinda found in CABGOC 115-1X at 4,620' and 9,420'.

Remarks: Renz (1948) and Blow (1959) note this taxon as scarce throughout the Agua Salada Basin. Originally described from the lower Miocene of California. Le Roy (1939) finds the taxon frequently in the brackish phases of fluvio-brackish to marine series of Central Sumatra.

*Ammobaculites* sp. 1

**Plate 11, figure 6**

Description: Large robust test. Initial planispiral chambers, becoming uniserial in adult growth. Last formed chamber somewhat inflated. Coarse grained. Aperture terminal in a slight depression on the terminal face.

Occurrence: Intermittent occurrence in *R. spinulosa* / *E. poeyanum* zonule, *V. herricki* and *G. fohsi* Zones.

Remarks: Due to the poor preservation of the specimens identification to a species level is precluded. However, the species may be comparable to A. sp. 1 of Diaz de Gamero (1985a) in Venezuela.

*Ammobaculites* sp. 2

**Plate 44, figure 5**

Description: Distinctive slender taxon, rounded periphery. Initial coiled portion small, majority of test uniserial, parallel sides. Chambers of uniserial portion indistinct, sides parallel, ultimate chamber somewhat enlarged and inflated, extending to apertural projection. Wall coarse grained and roughened. Sutures indistinct. Aperture terminal.

Occurrence: Offshore Cabinda found in CABGOC 128-3 at 5,960', and in CABGOC 115-1X at 7,260' and 8,820', rare.
Ammobaculites sp. 3
Plate 44, figure 6
Description: Moderate sized test, rounded periphery. Coiled portion constitutes majority of test, uniserial portion short. Chambers and sutures indistinct. Test extremely fine grained, wall smooth. Aperture not observed.
Occurrence: Offshore Cabinda found in CABGOC 128-3 at 7,040'.
Remarks: Single specimen.

Ammobaculites sp. 4
Plate 44, figure 7
Description: Moderate sized test, partially flattened. Coiled portion constitutes majority of test, uniserial portion a single inflated chamber. Wall coarse grained with roughened surface. Aperture terminal.
Occurrence: Offshore Cabinda found in CABGOC 128-3 at 7,040', and in CABGOC 115-1X between 6,480' and 9,960', rare.

Ammobaculites sp. 5
Plate 44, figure 8
Occurrence: Offshore Cabinda found in CABGOC 128-3 at 5,000', and in CABGOC 115-1X between 5,640' and 7,140', rare.
Remarks: All individuals poorly preserved.

Genus AMMOMARGINULINA Wiesner, 1931
Ammomarginulina sp. 1
Description: Small taxon, chambers and sutures indistinct. Wall fine grained, large proportion of cement, smooth. Aperture not observed.
Occurrence: Confined to sporadic occurrences in the V. herricki and G. fohsi Zones in Venezuela.
Remarks: First record of this genus from the Agua Salada Formation. Poor preservation.

Ammomarginulina sp. 2
Description: Small taxon. Chambers and sutures indistinct. Roughened wall. Aperture not observed.
Occurrence: Offshore Cabinda found in CABGOC 128-3 between 4,770' and 6,500', and in CABGOC 115-1X at 8,880' and 10,020'.
Remarks: Poor preservation.
Genus AMMOTIUM Loeblich & Tappan, 1953

**Ammotium**

**Description:** Compressed oval test. Poorly preserved planispiral, becoming slightly uncoiled. Coarse grained wall. Aperture not observed.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 between 5,360’ and 6,440’, rare.

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Genus DISCAMMINOIDES Brönnimann, 1951

**Discamminoides tobleri** Brönnimann

Plate 11, figures 7a, 7b; Plate 44, figures 9 - 10; Plate 68, figures 6a, 6b; Plate 83, figures A - B

**Description:** Discoidal, axially compressed, periphery rounded, semi-evolute. Wall finely arenaceous and alveolar. Five to seven chambers in last whorl. Uniserial portion absent. Sutures raised, but obscure. Alveoles filled with diagenetic pyrite giving metallic lustre to specimen. Specimens deformed.

**Occurrence:** Confined to single occurrence in *V. herricki* Zone in Venezuela. Offshore Cabinda found in CABGOC 128-3 between 4,890’ and 10,160’, and in CABGOC 115-1X between 4,980’ and 10,020’. Single specimen recovered from the Chechis Marls, Romania.

**Remarks:** First record of this species from the Agua Salada Formation. Originally described from the Miocene of Trinidad. These samples are poorly preserved in comparison to those of the Brönnimann collection (P41019). The samples recovered in this study display a glassy appearance as a result of re-silification obscuring the internal alveolar arrangement. Sectioning of specimens proved to be unsuccessful. Cursory examination of faunal slides of Whittaker (1988) reveal comparable forms in the Tosagua and Viche Formations, Ecuador.

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**Discamminoides cf. tobleri** Brönnimann

**Description:** Differs from typical in a smaller test, greater compression.

**Occurrence:** Offshore Cabinda found in CABGOC 115-1X at 8,400’ and 8,700’, rare.

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Superfamily HAPLOPHRAGMIACEA Eimer & Fickert, 1899

Family AMMOSPHAEROIDINIDAE Cushman, 1927

Subfamily AMMOSPHAEROIDININAE Cushman, 1927

Genus CYSTAMMINA Neumayr, 1889

**Cystammina sp. 1**

Plate 45, figure 1

**Description:** Moderate sized test, rounded periphery, inflated, though most specimens flattened. Extremely fine grained test, high proportion of cement, smooth. Aperture a simple opening toward the periphery with slight neck.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 at 6,440’, and in CABGOC 115-1X between 6,600’ and 9,780’, acme between 9,540’ and 9,720’.
Subfamily RECURVOIDINAE Alekseychik-Mitskevich, 1973
Genus BUDASHEVAELLA Loeblich & Tappan, 1964

*Budashevaella multicameratus* (Voloshinova & Budasheva)

**Plate 1**, figure 5; **Plate 11**, figures 8a, 8b; **Plate 45**, figures 2 - 3

*Circus multicameratus* VOLOSHINOVA & BUDASHEVA 1961, pl. 7, fig. 6; pl. 8, figs. 1 & 7 (*fide* Ellis & Messina 1940, *et. seq.*)

*Budashevaella multicameratus* (Voloshinova & Budasheva). --KAMINSKI *et. al.* 1988, pl. 5, fig. 1; pl. 10, fig. 1. --KAMINSKI, *et. al.* 1990, pl. 4, fig. 6. --CICHA, *et. al.* 1998, pl. 3, fig. 13

**Description**: Test free, chambers numerous, early stage streptospirally enrolled, later nearly planispiral and partly evolute, sutures curved to sinuate, radial, slightly depressed; wall agglutinated, thick, with considerable cement; aperture interiomarginal.

**Occurrence**: Occurs intermittently between the *M. superbus* zonule and *L. wallacei* Zone, becoming most frequent within the *V. herricki* Zone in Venezuela. Offshore Cabinda found in CABGOC 128-3 between 4,530' and 9,440', common. In CABGOC 115-1X found between 5,340' and 9,960', frequent.

**Remarks**: First record of this species from the Agua Salada Formation. Cursory examination of faunal slides of Whittaker (1988) reveal comparable forms in the Viche Formation, Ecuador.

*Budashevaella cf. multicameratus* (Voloshinova & Budasheva)

**Plate 12**, figures 1a, 1b; **Plate 45**, figure 4

*Circus multicameratus* VOLOSHINOVA & BUDASHEVA 1961, pl. 7, fig. 6; pl. 8, figs. 1 & 7 (*fide* Ellis & Messina 1940, *et. seq.*)

**Description**: This form differs from the species s.s. as it has a pronounced apertural lip. In all other aspects it is identical.

**Occurrence**: Found between the *M. basispinosus* and *G. fohsi* Zones in lower frequencies than its true species counterpart in Venezuela. Offshore Cabinda in CABGOC 15-1X at 9,360'.

**Remarks**: First record of this form from the Agua Salada Formation.

Genus RECURVOIDES Earland, 1934

*Recurvoides contortus* Earland

**Plate 12**, figures 2a, 2b

*Recurvoides contortus* EARLAND 1934, p. 91, pl. 3, figs. 11 - 12 (*fide* Ellis & Messina 1940, *et. seq.*)

*Recurvoides contortus* Earland. --PETTERS 1982, pl. 1, fig. 22. --DIAZ de GAMERO 1985a, pl. 4, fig. 6. --MORLOTTI 1988, p. 280. --KAMINSKI, *et. al.* 1989b, pl. 3, figs. 11 - 12. --OSTERMAN & QVALE 1989, pl. 5, fig. 16. --SCHRÖDER-ADAMS 1990, pl. 3, fig. 16, pl. 7, figs. 3- 4. --OSTERMAN & SPIEGLER 1996, pl. 1, fig. 25

**Description**: Large circular to ovoid species. Umbilicus depressed, opposing side convex with change in axis of convolution. Medium grains comprise wall of red colour, large cement component.

**Occurrence**: Single specimen in *V. herricki* Zone in Venezuela. Offshore Cabinda found in CABGOC 128-3 between 4,410' and 10,160', and in CABGOC 115-1X between 4,980' and 9,480'.
Remarks: Figured specimen deformed and compressed. Diaz de Gamero (1985a) noted this species intermittently throughout the Agua Salada Formation. Originally described from the Recent of deep water stations in the South Atlantic.

Recurvoides obsoletum (Gôes)
Plate 12, figures 3a, 3b; Plate 45, figure 5
Haplophragmium obsoletum GÖES 1896, pl. 3, figs. 14 - 16 (fide Ellis & Messina 1940, et. seq.)
Recurvoides obsoletum (Gôes). --BRÖNNIMANN 1953, pl. 15, fig. 6, textfig. 10 - 13.
Description: Streptospiral, ellipsoid profile. Umbilical side flat, opposite side convex. Sutures indistinct, interioareal aperture with lip. Medium grained wall with large portion of cement.
Occurrence: Occurs infrequently throughout the El Mene Road section, Venezuela, apart from the G. fohsi Zone and M. superbus and R. spinulosa / E. poeyanum zonules. Offshore Cabinda in CABGOC 128-3 between 3,870' and 10,160', and in CABGOC 115-1X between 5,700' and 10,020'.
Remarks: First record of this species from the Agua Salada Formation. Originally described from the Miocene of southern Trinidad in association with V. flexilis, A. suteri, C. cancellata, G. gordialis, G. charoides, G. miocenica, A. tenuis, H. narivaensis and R. higginsi.

Recurvoides renzi (Asano)
Plate 68, figures 7a, 7b
Haplophragmoides renzi ASANO 1950, pl. 12, fig. 3 (fide Popescu 1975)
Recurvoides renzi (Asano). --POPESCU 1975, pl. 2, figs. 2 - 3
Description: Low streptospiral test, robust and semi-compressed. Rounded periphery. Wall coarsely grained with high proportion of cement. Chambers indistinct, slightly inflated. Sutures indistinct and gently compressed, straight to slightly curving. Aperture a low, narrow arch at the base of the apertural face.
Occurrence: Identified in Costei, the Chechis Marls, and Sacel, Romania.
Remarks: Cursory examination of faunal slides of Whittaker (1988) reveal comparable forms in the Viche Formation, Ecuador. Renz (1948) placed this taxon in synonymy with H. coronatum, however, the individuals recovered from the Transylvania Basin display a unmistakable streptospiral coiling not evident Haplophragmoides.

Recurvoides sp. 1
Plate 45, figure 6
Description: Moderate sized test, coarse grained with smooth finish. Bulbous chambers flattened. Periphery rounded. Aperture not observed.
Occurrence: Offshore Cabinda found in CABGOC 115-1X between 6,720' and 9,960'.
Remarks: Poor preservation.
Genus BULBOBACULITES Maync, 1952

Bulbobaculites sp. 1
Plate 12, figure 4
Occurrence: Single specimen in S. transversa Zone in Venezuela.
Remarks: First record of this genus from the Agua Salada Formation.

Bulbobaculites sp. 2
Plate 45, figure 7
Description: Distinctive taxon, flattened, lobulate profile. Initial enrolled portion small, chambers indistinct. Uniserial portion constitutes majority of test, chambers of similar size and shape, inflated, overlapping one another slightly. Sutures depressed. Wall moderately coarse, roughened. Aperture terminal with slight neck.
Occurrence: Offshore Cabinda found in CABGOC 128-3 at 8,240', and in CABGOC 115-1X at 8,460'.
Remarks: Single specimens.

Bulbobaculites sp. 3
Plate 68, figure 8
Description: Indistinct taxon. Moderate size, initial enrolled portion followed by three inflated chambers of similar size and shape. Sutures indistinct, but depressed. Wall coarse grained and roughened. Aperture a simple terminal opening.
Occurrence: Single specimen identified in Sacel, Romania.

Superfamily LOFTUSIAEAE Brady, 1884
Family CYCLAMMINIDAE Marie, 1941
Subfamily ALVEOLOPHRAGMIINAE Saidova, 1981
Genus ALVEOLOPHRAGMIUM Shchnedrina, 1936

Alveolophragmium crassum (Reuss)
Plate 45, figure 8
Haplophragmium crassum REUSS 1867, pl. 1, figs. 1 - 2 (fide Popescu 1975)
Alveolophragmium crassum (Reuss). --POPESCU 1975, pl. 91, fig. 2, pl. 92, fig. 11. --CICHA, et. al. 1998, pl. 4, figs. 1 - 2, textfig. 56
Description: Moderate sized test, partially inflated, involute. Rounded periphery, lobulate profile. Five to six chambers visible in the last whorl, of equal size and shape. Sutures straight and depressed, distinct. Umbilical region slightly depressed, indistinct. Wall thick with numerous perpendicular simple hemisepta apparent as circular patches on the surface. Fine to moderate grain size, smooth surface. Aperture unobserved.
Occurrence: Offshore Cabinda found in CABGOC 115-1X between 4,980' and 6,360'.
Remarks: Wall structure appears slightly more simple than *R. crassum* (Reuss). Differs from *R. cf. venezuelanum* (Maync) in greater inflation of the test.

**Alveolophragmium planum** Bykova

*Plate 12, figure 5; Plate 45, figure 9; Plate 68, figure 9*

*Alveolophragmium planum* BYKOVA 1939, pl. 1, fig. 10, textfig. 1

**Description:** Planispiral compressed test, semi-evolute. Periphery rounded. Coarse grained test wall. One and a half whorls visible, chambers indistinct, rapidly increase in size with growth. Sutures indistinct, flush, straight. Aperture not identified.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 between 4,410' and 9,260', and in CABGOC 115-1X between 4,610' and 9,960'. Observed in the Chechis Marls in Romania.

Remarks: Originally described from the upper Paleocene of Uzbekistan. Examples from Romania extremely coarse grained obscuring all structure. Best identification based upon wetting individuals with small of amount water under reflected light, chambers fill with water to reveal hemisepta and chamberlet arrangement. Differs from *S. primula* and *S. uhligi* in the lack of bulbous alveoles. *P. johnrolandi* n.sp. shows a far greater degree of complication than *A. planum* and is much smaller.

**Alveolophragmium cf. planum** Bykova

*Alveolophragmium planum* BYKOVA 1939, pl. 1, fig. 10, textfig. 1

**Description:** Differs from the typical taxon in a significantly reduced size.

**Occurrence:** Offshore Cabinda found in CABGOC 115-1X 5,940' and 6'060'.

Genus **POPOVIA** Suleymanov 1965

**Popovia johnrolandi** n.sp.

*Plate 2, figures 1 - 6; Plate 3, figures 1 - 6; Plate 4, figures 1 - 4; Plate 5, figures 1 - 4, textfig 23*

**Description:** Small compressed test. Planispiral and evolute. Fine to medium grain size, high proportion of cement. Rounded periphery. Characteristic red to brown colour. Externally featureless. Internally chambers increase in height and width as added, ultimate chamber much increased. Aperture not observed. Juvenile specimens display simple arrangement of chambers, adult specimens more complex, developing hemisepta and chamberlets. Ontogenetic development mirrored through phylogeny, gradual increase in complexity and subdivision of the chambers with time. Development of transverse septa and pillars in ultimate complex stage.

**Occurrence:** Sporadic occurrence in *R. spinulosa / E. poeyanum* and *T. panamaensis* zonules in Venezuela. Greater frequency through the *V. herricki* to *S. transversa* Zones, acme reached in sample 2610 of the *V. herricki* Zone.

Remarks: First record of this genus from the Agua Salada Formation. Best identification based upon wetting individuals with small amount of water under reflected light, chambers fill with water to reveal hemisepta and chamberlet arrangement. Considered to be a low oxygen indicator, the increase in surface area to volume ratio facilitating gaseous exchange in oxygen minima zones.
Derivation of name: Patronymic, in honour of Professor J. R. Haynes.

*Popovia* sp. 1  
Plate 68, figure 10  
Description: Large test for genus. Compressed, acute periphery, profile lobulate in some individuals. Involute, last chamber occasionally becoming detached from the coil in some specimens. Chambers large and of similar shape, sutures depressed. Internal arrangement of complex inner partitioning obscured by coarse grain size and roughened surface. Aperture unobserved.  
Occurrence: Observed in the Chechis Marls in Romania.  
Remarks: Best identification based upon wetting individuals with small amount of water under reflected light, chambers fill with water to reveal hemisepta and chamberlet arrangement.

Genus *RETICULOPHRAGMIUM* Maync, 1955  
*Reticulophragmium crassum* (Reuss)  
Plate 46, figure 1; Plate 69, figures 1 - 2  
_Haplophragmium crassum_ REUSS 1867, pl. 1, figs. 1 - 2 (fide Popescu 1975)  
*Reticulophragmium crassum* (Reuss) --LUCZKOWSKA 1990, pl. 4, figs. 1 - 2. --FILIPESCU 1996, pl. 1, fig. 5  
Description: Large robust test, inflated. Rounded periphery. Involute, three to four chambers visible in the last whorl, of similar shape and size. Chambers inflated, sutures distinct and depressed, umbilical region may be slightly depressed in some specimens, indistinct. Wall coarse grained, high proportion of cement, slightly roughened finish, thick. Inner structures appear to penetrate depth of wall. Aperture unobserved.  
Occurrence: Offshore Cabinda found in CABGOC 115-1X between 5,700' and 6,780'. Common in Sacel, Romania.  
Remarks: Internal structure appears slightly more complex than _A. crassum_ (Reuss).

'_Reticulophragmium' rotundidorsatum_ (Hantken)  
Plate 46, figure 2; Plate 69, figures 3a, 3b  
_Haplophragmium rotundidorsatum_ HANTKEN 1875, pl. 1, fig. 2 (fide Ellis & Messina 1940, et. seq.)  
_Cyclammina (Reticulophragmium) rotundidorsata_ (Hantken) --CHARNOCK & JONES 1990, pl. 7, figs. 13 - 15, pl. 19, fig. 1. --CHARNOCK & JONES 1997, pl. 6, fig. 5, pl. 8, figs. 1 - 2  
_Reticulophragmium_ ex. gr. _rotundidorsata_ (Hantken). --OSTERMAN & SPIEGLER 1996, pl. 1, figs. 18 - 19  
_Reticulophragmium rotundidorsatum_ (Hantken) --CICHA, et. al. 1998, pl. 5, fig. 5  
Description: Taxon typical of _C. rotundidorsata_ but with no evidence of areal apertures and a less complex 'reticulate' wall structure.  
Occurrence: Offshore Cabinda found in CABGOC 128-3 between 3,990' and 7,180', acme at 4,770'. Common in the Chechis Marls, Romania.
'Reticulophragmium' sp. aff. *rotundidorsatum* (Hantken) variant a

Plate 48, figures 4 - 5

*Haplophragmium rotundidorsatum* HANTKEN 1875, pl. 1, fig. 2 (fide Ellis & Messina 1940, *et. seq."

**Description:** This variant differs from the taxon *s.l.* in the possession of a single areal aperture in the centre of the apertural face.

**Occurrence:** Offshore Cabinda specimens are found in CABGOC 128-3 with the typical taxon between 4,470' and 6,680'.

**Remarks:** Form is likely to be an intermediate form towards a *Cyclammina* morphology in response to ecologic forcing.

*Reticulophragmium venezuelanum* (Maync)

Plate 12, figures 6a, 6b; Plate 35, figures 1 - 3; Plate 46, figure 3 - 4; Plate 69, figures 4a, 4b

*Alveolophragmium venezuelanum* MAYNC 1952, pls. 3 - 4 (fide Seiglie & Baker 1983)

*Haplophragmoides emaciatum* (Brady) --RENZ 1948, pl. 1, fig 6. --BOLLI, *et. al.* 1994, pl. 76, fig. 34

*Alveolophragmium venezuelanum* Maync. --BLOW 1959, pl. 6, fig. 2. --POPESCU 1975, pl. 3, fig. 5, textfig. 5

*Alveolophragmium (Reticulophragmium) venezuelanum* Maync. --BANNER 1970, pl. 3, fig. 6, pl. 11, figs. 6 - 7

*Reticulophragmium venezuelanum* (Maync). --SEIGLIE & BAKER 1983, pl. 2, fig 10, pl. 3, fig. 5. --DIAZ de GAMERO 1985a, pl. 4, fig. 9. --LUCZKOWSKA 1990, pl. 2, fig. 11. --CICHA, *et. al.* 1998, pl. 4, fig. 6

**Description:** Planispiral, evolute. Coarsely grained alveole wall. Compressed dorso-ventrally. 6 - 7 chambers in outer whorl, slightly inflated. Sutures straight and depressed. Periphery acute and lobate. Characteristically red brown colour.

**Occurrence:** Sporadic occurrence in *R. spinulosa / E. poeyanum* zonule, *M. basispinosus*, *V. harricki*, *G. fohsi* and *S. transversa* Zones in Venezuela. Offshore Cabinda found in CABGOC 128-3 between 4,410' and 9,260', and in CABGOC 115-1X between 5,760' and 9,600', acme between 5,780' and 6,840'. Identified in the Chechis Marls and Sacel, Romania.

**Remarks:** Diaz de Gamero (1985a) noted the species intermittently throughout the Agua Salada Formation. Renz (1948) referred to the species as *H. emaciatum* (Brady) and recorded it in the Acostian, Lower Araguatian, and Lucian. Blow (1959) found the taxon to be scarce. Found in the Miocene offshore West Africa with a more lobate periphery (Seiglie and Baker 1983), attributed to greater anoxia on the eastern sea-boards. Cursory examination of faunal slides of Whittaker (1988) reveal comparable forms in the Cacelta Formation, Ecuador. Recognised as a constituent of a diverse bathyal benthonic association offshore West Africa (Haman, *et. al.* 1993).

*Reticulophragmium* cf. *venezuelanum* (Maync)

Plate 35, figures 4 - 6

*Alveolophragmium venezuelanum* MAYNC 1952, pls. 3 - 4 (fide Seiglie & Baker 1983)
Description: Differs from the typical taxon in its smaller size and less reticulate wall structure. Phylogenetically becomes more 'complex' to show closer resemblance to *Reticulophragmium venezuelanum* (Maync) s.s.

Occurrence: Offshore Cabinda found sporadically in CABGOC 115-1X between 4,980' and 9,840'.

Remarks: Possibly a juvenile form or a recurrent ancestral form. Krymsalova (1980) describes *A. simplex* from the Oligocene of the Anadir Basin. It is possible that this is a comparable form, however poor illustrations prevent comparison.

*Reticulophragmium* sp.1
Plate 12, figures 7a, 7b

Description: Large test, robust. Rounded inflated profile. Coarse grained wall with high proportion of cement. Involute, three to four chambers visible in the last whorl. Chambers slightly inflated, sutures slightly depressed but indistinct. Aperture a simple rounded opening on the apertural face of the last chamber. Alveolar nature of wall apparent through diagenetic pyrite infilling of alveoles.

Occurrence: Sporadic occurrence from the *V. herricki* to *S. transversa* Zones in Venezuela.

Remarks: First record of this taxon from the Agua Salada Formation. Sectioning of the taxon proved unsuccessful.

*Reticulophragmium* sp. 2

Description: Two small deformed specimens of indeterminate ranking.

Occurrence: Sporadic occurrence in *M. basispinosus* Zone and between the *V. herricki* and *S. transversa* Zones in Venezuela.

Remarks: First record of this taxon from the Agua Salada Basin.

*Reticulophragmium* sp. 3
Plate 46, figure 5

Description: Large test, robust, rounded periphery. Involute, three to four large bulbous chambers visible, rapidly increase in size as added. Sutures slightly curved and depressed, distinct. Distinctive regular reticulate wall structure apparent upon wetting specimen, worn specimens may expose inner structure. Wall fine grained with high proportion of cement, characteristic orange colour. Aperture not observed.

Occurrence: Found in CABGOC 115-1X between 5,280' and 8,460', acme in 5,580'.

Remarks: All specimens compressed slightly tangentially, this is unlikely to be a post-mortem diagenetic effect as all specimens are compressed in a similar manner.

Subfamily CYCLAMMININAE Marie, 1941
Genus CYCLAMMINA Brady, 1879
*Cyclammina acutidorsata* (Hantken)
Plate 13, figures 1a, 1b, 1c; Plate 69, figures 5a, 5b
Haplophragmium acutidorsatum HANTKEN 1868, pl. 1, fig. 1 (fide Ellis & Messina 1940, et. seq.)

Cyclammina acutidorsata (Hantken). --DIAZ de GAMERO 1985a, pl. 4, fig. 7. --CHARNOCK & JONES 1990, pl. 7, figs. 3 - 4, pl. 18, fig. 2

**Description:** Relatively small fragile taxon. Smooth wall, fine grained with high proportion of cement. Twelve to sixteen chambers visible in the last whorl, uninflated. Rounded periphery. Sutures slightly depressed, straight, indistinct. Umbilici strongly depressed. Nature of areal apertures not observed.

**Occurrence:** In Venezuela occurs infrequently throughout section. Offshore Cabinda found in CABGOC 115-1X between 3,530' and 10,020', becoming more common down well. Isolated to the Chechis Marls in Romania.

**Remarks:** Originally described from the Kiscellian of Hungary. Slide P47862 (H. acutidorsatum) of the W. K. Parker collection contains two examples of comparable C. acutidorsata, three additional individuals are more indicative of small C. cancellata.

Cyclammina sp. aff. C. amplectans Grzybowski

**Plate 13, figures 2a, 2b**

Cyclammina amplectans GRZYBOWSKI 1898, pl. 12, figs. 1 - 3 (fide Kaminski, et. al. 1993)

**Description:** Relatively small fragile taxon. Somewhat rhombic in apertural view. Rounded periphery, sub-acute margin. Smooth wall. Ten to twelve triangular chambers in the last whorl, sutures slightly depressed, indistinct, straight to slightly curving. Umbilici slightly depressed. Neat arrangement of alveoles apparent along sutures.

**Occurrence:** Infrequent recovery throughout Venezuelan section. Offshore Cabinda in CABGOC 115-1X between 7,620' and 9,840'.

**Remarks:** Originally described from the Eocene of the Carpathians. This taxon possibly represents a juvenile stage of C. acutidorsata (Hantken), or a new evolutionary appearance in the Miocene. Cursory examination of faunal slides of Whittaker (1988) reveal comparable forms in the Tosagua and Cacelta Formations, Ecuador.

Cyclammina cancellata Brady

**Plate 46, figures 6 - 8; Plate 69, figures 6a, 6b**

Nautiloid lituola CARPENTER 1875, textfigs. 274a - c (fide Ellis & Messina 1940, et. seq.)

Lituola canariensis (d'Orbigny). --CARTER 1877, pl. 13, figs. 26 - 29

Cyclammina cancellata BRADY 1884, pl. 37, figs. 8 - 16

**Description:** Relatively small fragile taxon. Smooth wall, fine grained with high proportion of cement. Twelve to sixteen chambers visible in the last whorl, uninflated. Rounded periphery. Sutures slightly depressed, straight, indistinct. Umbilici strongly depressed. Nature of areal apertures not observed.

**Occurrence:** In Venezuela occurs infrequently throughout section. Offshore Cabinda found in CABGOC 115-1X between 3,530' and 10,020', becoming more common down well. Isolated to the Chechis Marls in Romania.

**Remarks:** Originally described from the Kiscellian of Hungary. Slide P47862 (H. acutidorsatum) of the W. K. Parker collection contains two examples of comparable C. acutidorsata, three additional individuals are more indicative of small C. cancellata.
Description: Test involute, finely arenaceous and polished. Alveolar. Depressed umbilicus, margin lobate, 10 - 16 chambers per a whorl, sutures slightly depressed and sinuate. Apertures areal. Specimens often fragmented and incomplete.

Occurrence: Found between the *M. basispinosus* and the *S. transversa* Zones in Venezuela. Offshore Cabinda found infrequently in both CABGOC 128-3 between 4,530' and 10,160', and CABGOC 115-1X between 4,490' and 10,020'. Identified in the Chechis Marls and Sacel, Romania.

Remarks: Renz (1948) recorded this species in the 'Uvigerinella' *sparsicostata* Zone, Acostian, Araguatian, and Lucian sediments. Blow (1959) encountered the species below the *S. seminulina* Zone, commonly within the *G. insueta* Zone, in broad agreement with the data of this study. Originally described from various dredgings of the North Atlantic and Pacific. Known from Recent sediments of the Côte d'Ivoire (Calvez 1963) and additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966). Cursory examination of faunal slides of Whittaker (1988) reveal comparable forms in the Tosagua and Viche Formations, Ecuador.

*Cyclammina cushmani* Voloshinova & Budasheva

Plate 13, figures 3a, 3b; Plate 69, figures 7a, 7b

*Cyclammina cushmani* VOLOSHINOVA & BUDASHEVA 1961, pl. 12, figs. 3 5 - 6, pl. 17, fig. 5 (fide Ellis & Messina 1940, et. seq.)

Description: Small species, involute and laterally compressed. Rounded periphery. Ten to 12 chambers in the last whorl. Sutures straight and flush with test wall, umbilicus slightly depressed. Aperture a low slit at the base of the apertural face.

Occurrence: Restricted to the *V. herricki* and *G. fohsi* Zones in Venezuela. Offshore Cabinda found in CABGOC 115-1X between 3,890' and 9,840'. Observed in the Chechis Marls in Romania.

Remarks: First record of this taxon from the Agua Salada Formation. Originally described from the Upper Oligocene of Kamchatka, Russia.

*Cyclammina cyclops* McNeil

Plate 47, figures 1a, 1b, 1c; Plate 69, figures 8a, 8b, 8c

*Cyclammina cyclops* MCNEIL 1988, pl. 1 figs. 1 -8, pl. 2, figs. 1 - 9, pl. 3, figs. 1 - 6, pl. 4, fig. 1, text fig. 3

*Cyclammina (Cyclammina) acutidorsata* (Hantken). --CHARNOCK & JONES 1990, pl. 7, figs. 3 - 4, pl. 18, fig. 2. --CHARNOCK & JONES 1997, pl. 6, fig. 2 (not pl. 7, figs. 3 - 5)

Description: Large planispiral test, involute, though may become partly evolute. Specimen may be flat or in some cases become slightly more bulbous. Eleven to seventeen chambers in the last whorl, gradually increasing in size. Sutures slightly depressed, distinct and straight. Primary aperture often obscured by post-mortem diagenetic controls. Secondary aperture a single areal circular opening towards the centre of the apertural face. Walls thick and alveolar.
Occurrence: Offshore Cabinda found in CABGOC 128-3 between 5,180' and 6,380', rare. Found in CABGOC 115-1X at 7,440' and 7,620'. Two specimens identified in the Chechis Marls, Romania.

Remarks: Originally described from the Eocene of the Beaufort Sea, Arctic Canada.

**Cyclammina excavata** Voloshinova

*Plate 47, figures 2 - 3*

*Cyclammina excavata* VOLOSHINOVA 1961, pl. 15, fig. 15 (fide Ellis & Messina 1940, *et. seq.*)

**Description:** Distinctive test, rounded periphery and considerably compressed. Margin slightly carinate and pinched, may show ragged appearance. Numerous elongate chambers in outer whorl, of uniform size and slightly curved. Sutures slightly depressed and somewhat curved. Umbilicus depressed gently. Wall finely grained with high proportion of cement.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 between 4,650' and 10,160', and in CABGOC 115-1X between 4,920' and 9,720', rare.

**Remarks:** Originally described from the Upper Miocene of Sakhalin, Russia. Differs from *C. praecancellata* Voloshinova in the slight curving of the chambers and sutures and compression of the test. Differs from *C. krishtofovitchae* Voloshinova in the greater number of chambers and the ragged nature to the periphery.

**Cyclammina cf. krishtofovitchae** Voloshinova

*Plate 47, figure 4*

*Cyclammina krishtofovitchae* VOLOSHINOVA 1961, pl. 11, figs. 4 - 5, pl. 12, fig. 4 (fide Ellis & Messina 1940, *et. seq.*)

**Description:** Distinctive test of moderate size. Rounded profile, slightly compressed with lenticular profile in apertural view. Profile rounded, may become gently sinuous. Chambers large and flat, slightly convex and curving. Sutures depressed and sinuous toward the periphery. Umbilicus depressed. Wall finely agglutinated with large proportion of cement, polished appearance.

**Description:** In CABGOC 115-1X found between 6,600' and 10,020', rare.

**Remarks:** Originally described from the Oligocene of Kamchatka, Russia. Differs from *C. excavata* Voloshinova in the lesser number of chambers, the lenticular apertural profile, and rounded to sinuous side profile.

**Cyclammina pilvoensis** Voloshinova

*Plate 47, figure 5*

*Cyclammina pilvoensis* VOLOSHINOVA 1961, pl. 13, figs. 5 - 7, pl. 14, fig. 3 (fide Ellis & Messina 1940, *et. seq.*)

**Description:** Small test, rounded outline, sub-rounded periphery, may become 'ragged', involute. Strongly compressed test, ten to fifteen chambers visible of uniform size and shape, weakly curved. Sutures slightly depressed and gently curved. Umbilici slightly depressed. Wall smooth, fine grain size with high proportion of cement. Apertural face narrow, aperture a low slit at the base of the apertural face, obscured.
Occurrence: Offshore Cabinda found in CABGOC 115-1X between 5,880' and 10,020', rare.
Remarks: Originally described from the Middle Miocene of Shmidt Peninsula, Russia. Differs from C. excavata Voloshinova in smaller size and "ragged" periphery.

Cyclammina placenta (Reuss)
Plate 13, figures 4a, 4b; Plate 47, figure 6
Nonionina placenta REUSS 1851, pl. 5, fig. 33 (fide Ellis & Messina 1940, et. seq.)
Cyclammina placenta (Reuss). --NUTTALL 1927, pl. 3, fig. 7. --MJATLIUK 1970, pl. 6, figs. 29 - 33. --DIAZ de GAMERO 1985a, pl. 4, fig. 8.
"Cyclammina" placenta (Reuss). --KAMINSKI, et. al. 1990, pl. 6, fig. 2
Cyclammina placenta (Reuss). --OSTERMAN & QVALE 1989, pl. 5, fig. 11. --KAMINSKI & HUANG 1991, pl. 3, fig. 6
Cyclammina (Cyclammina) placenta (Reuss). --CORMACK & JONES 1990, pi. 4, fig. 8. --CORMACK & JONES 1997, pi. 6, fig. 3. pi. 7, figs. 6 - 7 (not 8)
Description: Robust taxon. Approximately ten chambers in the last whorl. Sutures straight to slightly curving, flush.
Occurrence: In Venezuela most frequent in the V. herricki and G. fohsi Zones. Offshore Cabinda found in CABGOC 115-1X between 4,920' and 10,020', with acmes between 6,180' and 6,420', and 7,380' and 7,500'.

Cyclammina praecancellata Voloshinova
Plate 47, figure 7; Plate 70, figures 1a, 1b
Cyclammina praecancellata VOLOSHINOVA 1939, pl. 1, fig. 1 (fide Ellis & Messina 1940, et. seq.)
Cyclammina praecancellata Voloshinova. --LUCZKOWSKA 1990, pl. 5, fig. 6. --CICHA, et. al. 1998, pl. 5,
Description: Large test, slightly flattened parallel to the plane of coiling. Ten to fifteen narrow chambers in the final whorl, uniform in size. Sutures slightly limbate, slightly depressed, though indistinct. Aperture obscured through post-mortem diagenetic controls though described by Voloshinova as '... a narrow slit at the base of the apertural face, very indistinct.' Margin often compressed to form an irregularly rounded keel.
Occurrence: Offshore Cabinda found infrequently in CABGOC 115-1X between 5,460' and 9,780'. Four specimens identified in the Chechis Marls, Romania.
Remarks: Originally described from the Upper Miocene? or Lower Pliocene of Sakhalin Island, Russia. Considered by Voloshinova (1939) to be a predecessor to C. cancellata.

Cyclammina pussila Brady
Plate 48, figures 1a, 1b, 1c
Cyclammina pussila BRADY 1881, p. 53 (fide Ellis & Messina 1940, et. seq.)
Cyclammina pussila BRADY 1884, pl. 37, figs. 20 & 21
Cyclammina pussila Brady. --CUSHMAN 1921, pl. 16, fig. 4. --SCHROEDER 1988, pl. 3, fig. 7. --KAMINSKI, et. al. 1989b, pl. 4, figs. 1 - 2. --NOMURA 1992, pl. 2, fig. 5
**Description:** Small, involute species. Depressed umbilicus, raised sutures and semi-acute periphery. Finely arenaceous and polished.

**Occurrence:** Only three specimens recovered, from *M. basispinosus, S. transversa,* and *L. wallacei* Zones in Venezuela. Offshore Cabinda found in CABGOC 128-3 between 4,410' and 10,100', and infrequently in CABGOC 115-1X between 3,650' and 9,900'.

**Remarks:** First record of this taxon from the Agua Salada Formation. Poor preservation renders some species identification in Africa uncertain.

* Cyclammina rotundidorsatum* (Hantken)

**Plate 70, figure 2**

_Haplophragmium rotundidorsatum* HANTKEN 1875, pl. 1, fig. 2 (*fide* Ellis & Messina 1940, _et. seq._)

*Cyclammina rotundidorsata* (Hantken). --OSTERMAN & QVALE 1989, pl. 5, fig. 13

**Description:** A medium sized robust taxon. Lobulate periphery. Eight to ten chambers in the last whorl, inflated. Umbilici depressed. Sutures indistinct, depressed and sinuate. Apertural face wide and high. Medium grain size with a lot of cement.

**Occurrence:** Offshore Cabinda single specimen in CABGOC 115-1x at 9,840'. Observed in Sacel, Romania.

**Remarks:** Originally described from lower Oligocene of the Vienna Basin.

* Cyclammina sp. aff. rotundidorsatum* (Hantken)

**Plate 48, figures 2 - 3**

_Haplophragmium rotundidorsatum* HANTKEN 1875, pl. 1, fig. 2 (*fide* Ellis & Messina 1940, _et. seq._)

**Description:** Differs from the typical taxon in greater inflation of the test in apertural view and overall increased size.

**Occurrence:** Offshore Cabinda found in CABGOC 115-1X between 5'820' and 6,660'.

* Cyclammina sp.1*

**Plate 13, figure 5**

**Description:** Poorly preserved *Cyclammina* species. Small test, coarsely grained. Flattened, periphery acute. Four to five chambers in the last whorl, indistinct. Sutures indistinct. Slight inflation of the umbilicus.

**Occurrence:** Specimens in *R. spinulosa/E. poeyanum* zonule and *G. fohsi* Zone in Venezuela.

**Remarks:** First record of this taxon from the Agua Salada Formation.

* Cyclammina sp.2*

**Description:** Three poorly preserved small fragmentary specimens of indeterminate ranking.

**Occurrence:** Intermittent occurrence between the *M. superb* zonule and *L. wallacei* Zone in Venezuela.

**Remarks:** First record of this taxon from the Agua Salada Basin.
Superfamily SPIROPECTAMMINACEA Cushman, 1927
Family SPIROPECTAMMINIDAE Cushman, 1927
Subfamily SPIROPECTAMMININAE Cushman, 1927
Genus SPIROPECTAMMINA Cushman, 1927

**Spiroplectammina barrowi** Cushman & Ellisor

Plate 14, figures 1a, 1b; Plate 49, figures 1a, 1b

_Spiroplectammina barrowi_ CUSHMAN & ELLISOR 1939, pi. 1, fig. 1a - b

_Spiroplectammina barrowi_ Cushman & Ellisor. --SKINNER & STEINKRAUS 1972

**Description:** Compressed test, subacute periphery, broadest at apertural end, tapering to slightly rounded proloculus. Chambers distinct, low and broad, increasing in height. Sutures distinct, slightly curved. Wall finely arenaceous, smooth, aperture narrow in median line of the base of the last chamber.

**Occurrence:** Recorded in the _R. spinulosa / E. poeyanum_ zonule, _V. herricki, G. fohsi_, and _S. transversa_ Zones, acme occurrence in sample 2615 of the _G. fohsi_ Zone in Venezuela. Offshore Cabinda single specimen in CABGOC 128-3 at 6,860'.

**Remarks:** First record of this taxon from the Agua Salada Formation. Previously recorded in Louisiana and commonly referred to as 'Textularia L'. Specimens compare well with example in the Burrow and Holland collection (slide G, NHM).

**Spiroplectammina carinata** (d'Orbigny)

Plate 70, figures 3 - 4

_Textularia carinata_ d'ORBIGNY 1826, p. 263 (fide Ellis & Messina 1940, _et. seq._)

_Spiroplectammina carinata_ (d'Orbigny). --POPESECU 1975, pl. 3, fig. 6, pl. 4, fig. 1. --LUCZKOWSKA 1990, pl. 1, figs. 8 - 10

_Spiroplectammina carinata_ (Subbotina). --DIAZ de GAMERO 1985a, pl. 4, fig. 11

_Spiroplectammina (Spiroplectinella) carinata_ (d'Orbigny). --CHARNOCK & JONES 1990, pl. 21, fig. 3

**Description:** Flattened test, wedge shaped. Initial chambers form a small planispiral, following growth is biserial, chambers low and gradually increasing in size. Chambers may extend laterally to form spinose periphery in some cases. Marginal ridge between chambers. Aperture a low arch at the inner margin of the final chamber.

**Occurrence:** Identified in Vâlcele, Costei, and the Chechis Marls, Romania.

**Remarks:** Originally described from the Upper Cretaceous of northern Caucasus, Russia. Known from the Miocene of the Gulf of Suez region (Souya 1965). Specimens compare well with example in the Burrow and Holland collection (slide G, NHM), Heron-Allen and Earland collection, and to those of the Brady collection (NHM), some of which are labelled as _Textularia carinata._
Subfamily VULVULININAE Saidova, 1981
Genus VULVULINA d’Orbigny, 1826

**Vulvulina jacuraensis** Cushman & Renz

*Plate 14, figures 2a, 2b*

*Vulvulina jacuraensis* CUSHMAN & RENZ 1941, pl. 1, fig. 10

*Vulvulina jacuraensis* Cushman & Renz. —RENZ 1948, pl. 2, fig 2

**Description:** Compressed and deformed, periphery acute, biserial to uniserial. Initial end rounded. Chambers of equal size, strongly limbate. Sutures distinct, raised and limbate. Wall finely grained with high proportion of cement. Aperture a terminal elliptical opening, not observed.

**Occurrence:** Found in the *V. herricki* and *G. fohsi* Zones, spurious occurrence in the *L. wallacei* Zone in Venezuela.

**Remarks:** Cushman and Renz (1941) recorded the species from the Lower to Upper Agua Salada Formation. Renz (1948) found the species as scarce in the Acostian and Araguatian.

**Vulvulina pachyheilus** Hadley

*Plate 49, figures 2 - 3*

*Vulvulina pachyheilus* HADLEY 1934, pl. 1, figs. 2 - 4

*Vulvulina pachyheilus* Hadley. —RENZ 1948, pl. 2, fig. 3

**Description:** Medium sized compressed test, tapered, acute periphery, slight serrate keel. Initial end tapered, greatest breadth towards the apertural end. Biserial chambers, numerous, low and wide, gradually increase in size as added, sloping. Sutures straight, oblique, flush. Wall finely grained, high proportion of cement. Aperture an elongate slip with slight lip high on the apertural face.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 at 5,180’ and 10,040’, and in CABGOC 115-1X between 2,030’ and 3,410’, rare.

**Remarks:** Originally described from the Oligocene of Cuba. Poorly preserved specimens, silification.

**Vulvulina pennatula** (Batsch)

*Plate 70, figures 5 - 6*

*Nautilus pennatula* BATSCH 1791, pl. 4, fig. 13 (not 13e) (*fide* Ellis & Messina 1940, *et. seq.)*

*Vulvulina pennatula* (Batsch). —POPESCU 1975, pl. 4, figs. 3 - 4, pl. 5, figs. 1 - 5, —BOLTOVSKOY 1980, pl. 3, fig. 12. —MIKHALVICH 1983, pl. 5, fig. 76. —CHARNOCK & JONES 1990, pl. 21, fig. 7. —LUCZKOWSKA 1990, pl. 1, fig. 7. —CICHA, *et. al.* 1998, pl. 6, fig. 1

*Bigenerina pennatula* (Batsch). —NUTTALL 1927, pl. 3, fig. 3

**Description:** Penulate compressed test. Periphery subacute. Initial coiled chambers, becoming biserial in adult growth, occasional development to uniserial growth. Chambers broad and low. Sutures of the planispiral portion indistinct, slightly raised and limbate in the biserial and uniserial portion. Finely agglutinating test wall. Aperture a low arch at the base of the apertural face in the biserial portion, in the uniserial portion it becomes a terminal elongate opening.

**Occurrence:** Found in the Chechis Marls and Sacel, Romania.

*Vuululina spinosa miocenica* Cushman

Plate 49, figures 4a, 4b

*Vuululina spinosa* var. *miocenica* CUSHMAN 1932, pl. 10, fig. 10

*Vuululina spinosa* var. *miocenica* Cushman. --CORYELL & RIVERO 1940, pl. 41, fig. 1. --CUSHMAN & RENZ 1947, pl. 1, fig. 10. --RENZ 1948, pl. 2, fig. 1. --DIAZ de GAMERO 1985a, pl. 4, fig. 12

Description: Moderate sized, oblong test, serrate acute periphery, compressed. Initial enrolled chambers rapidly develop to biserial and uniserial growth, majority of test uniserial. Chambers increase in size rapidly as added, strongly curved. Sutures depressed and strongly curved. Fine grained wall, high proportion of cement. Aperture an elongate slit high on the apertural face.

Occurrence: Offshore Cabinda found in CABGOC 128-3 at 5,180' and 10,100', and in CABGOC 115-1X at 6,720'.

Remarks: Originally described from the Miocene of Jamaica. Differs from typical in fewer spinose projections from the margin. Poorly preserved specimens owing to silification.

Family TEXTULARIOPSIDAE Loeblich & Tappan, 1982

Genus TEXTULARIOPSIS Banner & Pereira, 1981

*Textulariopsis* sp. 1

Plate 49, figures 5a, 5b

Description: Small distinctive taxon, tapering, rounded periphery. Initial end acute, chambers indistinct, triserial growth following of low broad chambers, slowly increasing in size as added. Sutures distinct and depressed. Fine grained, high proportion of cement. Apertural end deformed.

Occurrence: Single specimen found offshore Cabinda in CABGOC 128-3 at 6,140'.

Family PLECTORECURVOIDIDAE Loeblich & Tappan, 1984

Genus PLECTORECURVOIDES Noth, 1952

*Plectorecurvoides* sp.

Plate 49, figures 6a, 6b

Description: Small spherical specimen, rounded periphery, inflated. Planispirally enrolled, ultimate and penultimate chambers biserial enrolled giving peripheral extension to the 'apertural face' and a 'horned' appearance. Chambers and sutures indistinct. Wall fine grained, high proportion of cement, smooth. Aperture a low interiomarginal slit, partially obscured.

Occurrence: Single specimen found offshore Cabinda in CABGOC 128-3 at 4,650'.

Remarks: Known as a Late Cretaceous genus.
Superfamily PAVONITINACEA Loeblich and Tappan, 1961
Family PAVONITINIDAE Loeblich and Tappan, 1961
Subfamily SPIROPSAMMIINAE Seiglie and Baker, 1984
Genus SPIROPSAMMINA Seiglie & Baker, 1984

Spiropsammina primula Seiglie & Baker
Plate 36, figures 1 - 7; Plate 49, figures 7a, 7b, 7c

Description: Compressed species, evolute to slightly involute. Externally featureless, 8 - 11 chambers in last whorl, crescent shaped with strongly oblique sutures. Medium grain size, occasionally deformed, high proportion of cement. Last formed chamber characterised by five bulbous alveoles. Aperture not observed.

Occurrence: Offshore Cabinda found infrequently in CABGOC 128-3 between 4,770' and 10,160', and frequently in CABGOC 115-1X between 4,610' and 9,960'. Common in Costei, Romania.

Remarks: Originally described from offshore west Africa. Best identified by wetting the individual with a small amount of water in reflected light. Differs from S. uhligi in the lack of a uniserial chamber arrangement and smaller size. Though of comparative dimensions, distinguished from Popovia through the presence of bulbous alveoles.

Spiropsammina cf. primula Seiglie & Baker
Plate 14, figures 3a, 3b

Description: Semicompressed species, evolute to slightly involute. 8 - 10 chambers in last whorl, crescent shaped with strongly oblique sutures. Coarse grain size, occasionally deformed. Specimens slightly fatter than the typical.

Occurrence: Recovered sporadically in the V. herricki and G. fohsi Zones of Venezuela.

Remarks: First record of this variant form in this section.

Spiropsammina uhligi (Schubert)
Plate 6, figure 1

Cyclammina uhligi SCHUBERT 1902, pl. 1, fig. 27

Spiropsammina uhligi (Schubert). --SEIGLIE & BAKER 1983, pl. 2, figs. 1 - 6, pl. 3, fig. 5. --CHARNOCK & JONES 1990, pl. 20, fig. 4. --CHARNOCK & JONES 1997, pl. 6, fig. 11, pl. 8, fig. 12

Description: Strongly compressed test. Planispiral, evolute chambers in early portion, uniserial uncoiled chambers in adult stage. Chambers crescent shaped with bulbous alveoles in fan arrangement. Sutures oblique. Wall finely agglutinating, though may incorporate the occasional coarse grain. Aperture terminal.

Occurrence: Confined to the V. herricki and G. fohsi Zones in Venezuela. Offshore Cabinda found infrequently in CABGOC 115-1X between 6,160' and 9,540'.

Remarks: First record of this taxon from the Agua Salada Formation. Previously noted from the upper Miocene to lower Pliocene offshore Cameroon and the Oligocene of Northern Italy. Distinguished from S. primula through the uniserial growth chambers. Differs from Popovia taxa
in greater size and the presence of alveoles over hemisepta. Best observed through wetting the specimen with a small amount of water under reflected light.

Subfamily PAVONITININAE Loeblich & Tappan, 1961
Genus PAVONITINA Schubert 1914

*Pavonitina andulana* (Malecki)

**Plate 50, figure 1**

*Phyllopsammina andulana* MALECKI 1954 (*fide* Seiglie & Baker 1983)

*Phyllopsammina andulana* Malecki. --SEIGLIE & BAKER 1983, pl. 1, figs. 1 - 5, pl. 3, figs 1 - 4

*Pavonitina andulana* (Malecki). --LUCZKOWSKA 1990, pl. 5, fig. 8

**Description:** Compressed, palmate test. Proloculus followed by arcuate biserial chambers. Subsequent uniserial chambers are arcuate to crescent shaped. Short partitions project into the chambers from the distal chamber wall to give fan-like appearance. Test wall is finely grained, sutures are depressed. Short blunt spines often apparent on periphery. Aperture a single, terminal, elongate opening.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 between 4,410 and 9,440', common, and in CABGOC 115-1X between 6,180' and 7,380', rare.

**Remarks:** Initial interpretations of this taxon described an early triserial stage, subsequent work has found the early chambers following the proloculus to be biserial. Well known offshore Cabinda where it is recognised as a constituent of a diverse bathyal benthonic association (Haman, et al. 1993). Best observed through wetting the specimen with a small amount of water under reflected light.

*Pavonitina styrica* Schubert

**Plate 37, figures 1 - 2; Plate 38, figures 1a, 1b; Plate 50, figure 2**

*Pavonitina styrica* SCHUBERT 1914, p. 143, pl. 4, figs. 1 - 8 (*fide* Seiglie & Baker 1983)

*Pavonitina styrica* Schubert. --POPEZCUI 1975, pl. 62, figs. 1 - 5, textfig. 9. --SEIGLIE & BAKER 1983, fig. 9. --LUCZKOWSKA 1990, pl. 5, fig. 9. --FILIPESCU 1996, pl. 4, fig. 1. --CICHA, et. al. 1998, pl. 6, figs. 5 - 7

**Description:** Strongly compressed, palmate, flame like species. Initially biserial, becoming uniserial for most of adult. Sutures slightly raised and curved.

**Occurrence:** Single occurrence in the *G. foehi* Zone in Venezuela. Offshore Cabinda found in CABGOC 128-3 between 5,240' and 6,440', rare, and in CABGOC 115-1X at 7,020'.

**Remarks:** First record of this taxon from the Agua Salada Formation. Previously noted offshore West Africa, the Carpathians, and from the Miocene of Germany. Best observed through wetting the specimen with a small amount of water under reflected light.
Genus PAVOPSAMMINA Seiglie & Baker, 1983

*Pavopsammina flabellum* Seiglie & Baker

Plate 38, figures 2 - 3; Plate 50, figure 3

*Pavopsammina flabellum* Seiglie & Baker 1983, pi. 1, figs. 6 - 8

**Description:** Small palmate compressed test. Initial chambers are triserial, followed by a biserial and finally uniserial arrangement. Incomplete partitions project from the distal chamber wall to form a fan-like appearance. Wall fine grained, sutures may be slightly coarser grained in some specimens. Aperture uncertain.

**Occurrence:** Common offshore Cabinda, found in CABGOC 128-3 between 5,360' and 9,080', and in CABGOC 115-1X between 6,240' and 8,280'.

**Remarks:** Originally described from lower to middle Oligocene sediments offshore Cameroon. Best observed through wetting the specimen with a small amount of water under reflected light.

Order TROCHAMMINIDA Saidova, 1981

Suborder TROCHAMMININA Brönnimann & Whittaker, 1988


Subfamily TROCHAMMINADAE Schwager, 1877 emend. Brönnimann & Whittaker, 1988

Genus PARATROCHAMMINA Brönnimann, 1979

Subgenus PARATROCHAMMINA (LEPIDOPARATROCHAMMINA) Brönnimann & Whittaker, 1986

*Paratrochammina (Lepidoparatrochammina)* sp. 1

Plate 50, figures 4a, 4b

**Description:** Large, semi-inflated test, pinched periphery. Low trochospire, slightly concave to flat ventral side. Five to six chambers visible on the ventral side, inflated, ‘square’ shape, gradually increase in size as added. Dorsal slightly convex. Wall of moderate grain size, high proportion of cement, smooth finish. Aperture not observed.

**Occurrence:** Found offshore Cabinda in CABGOC 128-3 at 10,100' and 10,160'.

*Paratrochammina (Lepidoparatrochammina)* sp. 2

Plate 50, figures 5a, 5b

**Description:** Distinctive large bulbous species, low trochospire. Always compressed and deformed obscuring arrangement of chambers which appear as irregular ‘blobs’. Chambers inflated, and rounded, sutures depressed and arcuate. Wall fine grained with high proportion of cement, smooth polished surface. Aperture not observed.

**Occurrence:** Found offshore Cabinda in CABGOC 115-1X between 8,400' and 10,020, frequent.
Genus TROCHAMMINA Parker and Jones, 1859 emend. Brönnimann & Whittaker, 1988

**Trochammina** sp. aff. *T. altiformis* Cushman & Renz

**Plate 14, figures 4a, 4b, 4c; Plate 50, figure 6**

*Trochammina globigeriniformis* (Parker & Jones) var. *altiformis* CUSHMAN & RENZ 1946, pl. 3, figs. 7 - 11

*Trochammina altiformis* Cushman & Renz. --WEBB 1975, pl. 3, figs. 7 - 9. --KAMINSKI et. al. 1988, pl. 8, figs. 1 - 2. --OSTERMAN & QVALE 1989, pl. 4, fig. 15

**Description:** High trochoid spire. Specimens tend to be large and coarsely agglutinated, often deformed or compressed in any plane.

**Occurrence:** Confined to *S. transversa* Zone, rare occurrence in Venezuela. Offshore Cabinda found infrequently in CABGOC 128-3 between 4,890' and 10,160', and in CABGOC 115-1X between 5,040' and 9,540'.

**Remarks:** First record of this taxon from the Agua Salada Formation. In African samples specimens become compressed and deformed.

**Trochammina** cf. *pacific* Cushman

**Plate 14, figure 5a, 5b; Plate 50, figure 7**

*Trochammina pacifica* CUSHMAN 1925, pl. 6, fig. 3

*Trochammina pacifica* Cushman. --CUSHMAN & MCCULLOCH 1939, pl. 11, fig. 3

*Trochammina cf. pacifica* Cushman. --RENZ 1948, pl. 3, figs. 4 - 5. --BLOW 1959, pl. 7, fig 6. --BOLLI, et. al. 1994, pl. 76, fig. 35

**Description:** Small low trochospiral test, medium grain size. Aperture ventral basal. 4 - 5 chambers in last whorl, periphery rounded, sutures distinct. Usually deformed.

**Occurrence:** Present in *V. herricki* and *S. transversa* Zones, acmes occur at samples 2610 and 2702 in Venezuela. Offshore Cabinda found infrequently in CABGOC 128-3 between 4,050' and 10,160', and in CABGOC 115-1X between 5,820' and 9,540'.

**Remarks:** Renz (1948) found the taxon scarce in the *T. panamaensis* zonule and common in the *M. superbus* zonule. He also notes poor preservation precluding absolute species identification. Blow (1959), noted that compressed specimens preclude unambiguous identification. He recorded specimens in his *G. menardii menardii / G. nepenthes* Zone, but finds they become common in his *S. seminulina* Zone. Originally described from the Recent sediments off British Columbia.

**Trochammina** cf. *squamata* (Jones & Parker)

**Plate 14, figures 6a, 6b, 6c**

*Trochammina squamata* (Jones & Parker 1860) emend. Hedley, Hurdle & Bardett 1964, tf. 1a - b, 3. figs. 1a - b, 3a - c (fide Ellis & Messina 1940, et. seq.)

*Trochammina squamata* (Jones & Parker). —CUSHMAN 1921, pl. 22, fig. 6 (not pl. 17, fig. 2). —MIKHALEVICH 1983, pl. 9, figs. 140 - 143

**Description:** Extremely flattened species, often appears translucent. Four to five chambers per whorl, gradually increasing in size. Very finely agglutinating with high proportion of cement. Specimens may begin to develop a slight spire, though not in all cases. Deformation of specimens common.
Occurrence: Rare specimens confined to V. herricki, S. transversa and L. wallacei Zones in Venezuela. Offshore Cabinda found in CABGOC 115-1X between 5,040' and 9,960', common. Found in low frequencies in the Chechis Marls and Sacel, Romania.


**Trochammina sp. 1**

**Plate 15, figure 1**

Description: Robust taxon. Bulbous chambers form a low spire, sutures depressed. Fine grained test with high proportion of cement. Aperture not visible.

Occurrence: Intermittent occurrence in V. herricki Zone in Venezuela.

Remarks: First record of this taxon from the Agua Salada Basin.

**Trochammina sp. 2**

**Plate 15, figures 2a, 2b, 2c**

Description: Highly compressed coarse grained taxon. Low spire. Chambers semi-inflated on ventral side, excavated appearance on dorsal side. Sutures indistinct on dorsal side, incised and curving on ventral side. Aperture an interiomarginal opening.


Remarks: First recording of this taxon from the Agua Salada Formation.

Family PROLIXOPLECTIDAE Loeblich & Tappan, 1985

Genus EOMARSSONELLA Levina, 1972

**Eomarssonella sp.**

Description: Small test, conical, inflated. Initially trochospiral, becoming triserial, last three chambers much enlarged giving lobulate appearance. Sutures in trochospiral portion indistinct, flush, become depressed in triserial part. Wall finely agglutinated with large proportion of cement, smooth. No evidence of canaliculae. Aperture a small interiomarginal arch, frequently obscured.

Occurrence: Offshore Cabinda found in CABGOC 115-1X between 4,370' and 7,200', infrequent.

Genus KARRERULINA Finlay, 1940

**Karrerulina apicularis** (Cushman)

**Plate 51, figures 1 - 2**

Gaudryina apicaulis CUSHMAN 1911, textfig. 110
Karreriella conversa (Grzybowski). --KAMINSKI, et. al. 1990, pl. 8, figs. 3 - 4
Karrerulina apicularis (Grzybowski). --PFLUM et. al. 1976, pl. 1, fig. 2
Karrerulina apicularis (Grzybowski). --MURRAY & ALVE 1994, pl. 1, fig. 13
**Description:** Elongate test, rounded periphery. Initial triserial chambers small and indistinct. Subsequent biserial growth inflated and distinct. Wall moderately coarsely grained, roughened. Last formed chamber extends to form elongated profile with terminal rounded aperture.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 at 6,080' and in CABGOC 115-1X between 6,360' and 9,460'.


*Karrerulina coniformis* (Grzybowski)

**Plate 51, figure 3**

*Gaudryina coniformis* GRZYBOWSKI 1898, pl. 12, fig. 7 *(fide* Kaminski & Geroch 1993)

*Plecanium potocense* GRZYBOWSKI 1898, pl. 12, fig. 5 *(fide* Kaminski & Geroch 1993)

*Karreriella coniformis* (Grzybowski). --MJATLIUK 1970, pl. 34, figs. 1 - 9

*Karrerulina coniformis* (Grzybowski). --KAMINSKI, et. al. 1989a, pl. 6, fig. 14. --CHARNOCK & JONES 1990, pl. 25, fig. 9. --KAMINSKI & GEROCH 1993, pl. 13, figs. 1 - 4, pl. 12, fig. 1

**Description:** Elongate, rounded test, tapering at either end. Broadest towards centre. Initial trochospiral chambers indistinct, subsequent quadrisserial and biserial portion of inflated chambers of uniform shape. Sutures flush to slightly depressed. Wall of moderate grain size with high proportion of cement. Roughened surface. Terminal aperture on a short neck.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 between 4,170' and 10,100', and in CABGOC 115-1X between 5,340' and 8,820'.

**Remarks:** Differs from *K. horrida* Mjatliuk in a shorter, 'stubbier' test, and a 'neater' chamber arrangement.

*Karrerulina conversa* (Grzybowski)

*Gaudryina conversa* GRZYBOWSKI 1901, pl. 7, figs. 15 - 16 *(fide* Kaminski & Geroch 1993)

*Gerochammina conversa* (Grzybowski). --KAMINSKI & GEROCH 1993, pl. 13, figs. 8 - 10 *(not* 5 - 7)

*Karrerulina conversa* (Grzybowski). --KAMINSKI, et. al. 1989a, pl. 6, fig. 13 *(not* 11 - 12). --KAMINSKI, et. al. 1989b, pl. 4, fig. 9. --CHARNOCK & JONES 1990, pl. 12, fig. 19, pl. 25, fig. 10. --KAMINSKI & HUANG 1991, pl. 3, fig. 14. --CICHA, et. al. 1998, pl. 7, fig. 4

**Description:** Small test, elongate, tapers to apical and apertural ends evenly. Periphery rounded. Initial triserial portion indistinct. Following biserial growth extended with semiinflated chambers. Sutures slightly depressed. Wall of moderate grain size with high proportion of non-calcareous cement. Aperture terminal on a short extension of the last formed chamber.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 at 5,890' and 10,100', and in CABGOC 115-1X between 7,020' and 9,480'.

**Remarks:** Originally described from the Upper Cretaceous / Lower Eocene of Poland. Differs from *K. apicularis* Cushman in the greater smoothness to the rounded profile. Known from Tertiary flysch deposits in Switzerland (Brouwer 1965).
**Karreruiina horrida** (Mjatliuk)

**Plate 15, figure 3**

*Karreriella horrida* MJATLIUK 1970, pl. 5, fig. 9, pl. 33, figs. 15 - 16

*Karreriella horrida* Mjatliuk. --KAMINSKI et. al. 1988, pl. 9, figs. 19 - 20. --KAMINSKI, et. al. 1990, pl. 8, figs. 7 - 8

*Plectina cf. apicularis* (Cushman). --GEROCH 1960, pl. 6, fig. 9

*Plectina cf. conversa* (Grzybowski). --POKORNY 1961, pl. 1, figs. 4, 6

*Karreruiina horrida* Mjatliuk. --KAMINSKI, et. al. 1989a, pl. 6, fig. 15. --KAMINSKI et. al. 1989b, pl. 8, figs. 7, 8. --KAMINSKI et. al. 1993, pl. 13, figs. 14 - 15

**Description:** Large species, tapered at base, initially coiled in a high trochospire, becoming triserial, with biserial final chambers. Sutures difficult to distinguish, aperture terminal, sometimes with short neck. Medium grain size, often roughened.

**Occurrence:** Rare occurrence in the *G. fohsi* and *S. transversa* Zones in Venezuela. Offshore Cabinda found in CABGOC 128-3 between 4,530’ and 10,160’, and in CABGOC 115-1X between 5,220’ and 10,020’, becoming more common down well.

**Remarks:** First record of this taxon from the Agua Salada Formation. Originally described from the Upper Palaeocene of the Carpathians. Cursory examination of faunal slides of Whittaker (1988) reveal comparable forms in the Cacelta Formation, Ecuador.

**Karrerulina indigena?** Mjatliuk

**Plate 16, figure 7**

*Karreriella indigena* MJATLIUK 1970, pl. 34, figs. 10 - 14

**Description:** Narrow test, rounded profile. Chambers become larger with growth, alter from rounded shape towards more angular profile. Aperture on short stout neck of last chamber. Test fairly coarsely grained and of robust nature.

**Occurrence:** Confined to *V. herricki* and *G. fohsi* Zones, comparatively uncommon in Venezuela.

**Remarks:** First report of this species from the Agua Salada Formation. Originally described from the Upper Eocene of the Ukraine. Differs from *K. pokornyi* Mjatliuk in a shorter, stubbier test and a coarser grained wall.

**Karrerulina pokornyi?** Mjatliuk

**Plate 16, figure 8**

*Karreriella pokornyi* MJATLIUK 1970, pl. 34, figs. 15 - 17

**Description:** Long narrow test, rounded profile. Chambers inflated and consist of approximately ten whorls. Chambers gradually increase in height, final chamber extended to form stout apertural neck and terminal aperture. Sutures depressed and oblique. Wall of medium grain size with high proportion of cement.

**Occurrence:** Confined to sample 2610 of *V. herricki* Zone in Venezuela.

**Remarks:** First report of this species from the Agua Salada Formation. Originally described from the Upper Eocene of the Eastern Carpathians and also found in Moravia, Czechoslovakia.
Differs from *K. indigena* Mjatliuk in a greater elongation and narrowing of the test and a finer agglutinated wall.

**Karrerulina sp. 1**

Plate 15, figures 4a, 4b  
**Description:** Tapering elongate test, may arch. Lobulate periphery. Initial triserial portion acute, rapidly becomes biserial with parallel sides. Numerous low chambers, semi-inflated, distinctly sloping downwards, of approximately equal size. Sutures depressed and distinct, straight. Medium grain size, high proportion of cement.  
**Occurrence:** Found in *R. spinulosa / E. poeyanum* zonule, *V. herricki*, and *G. fohsi* Zone, most common in *V. herricki* Zone in Venezuela.  
**Remarks:** First record of this taxon from the Agua Salada Basin.

**Karrerulina sp. 2**

Plate 51, figure 4  
**Description:** Tapering short test. Rounded periphery. Initial triserial portion acute, rapidly becomes biserial. Numerous low chambers, semi-inflated, low and broad, of approximately equal size. Sutures depressed but indistinct, straight. Fine grain size, high proportion of cement, smooth finish.  
**Occurrence:** Found offshore Cabinda in CABGOC 115-1X between 6,600' and 8,280'.  

Superfamily VERNEUILINACEA Cushman, 1911  
Family VERNEUILINIDAE Cushman, 1911  
Subfamily VERNEUILININAE Cushman, 1911  
Genus GAUDRYINA d'Orbigny, 1839  

**Gaudryina paalzowi** Cushman  
**Description:** Elongate test, tapered at initial end, rounded periphery. Majority of test with parallel sides, early portion may be slightly compressed. Early chambers indistinct, biserial chambers inflated, increasing in height as added. Sutures depressed. Wall coarse grained with a rough surface. Aperture an elongate slit in a slight re-entrant.  
**Occurrence:** Offshore Cabinda found in CABGOC 115-1X between 5,940' and 7,440', rare.  
**Remarks:** Originally described from the Miocene of Hungary.

**Gaudryina thalmanni** Cushman & Renz  
Plate 15, figure 5; Plate 51, figures 5a, 5b  
**Description:** Test elongate and tapering, slightly compressed. Periphery somewhat rounded. Chambers inflated and rapidly increase in size. Sutures distinct, slightly oblique. Test wall fine
grained with high proportion of cement. Aperture a narrow slit in depression of apertural face of last chamber.

**Occurrence:** Single specimen in *V. herricki* Zone in Venezuela. Offshore Cabinda found in CABGOC 128-3 at 10,040' and 10,160'.

**Remarks:** Cushman and Renz (1941) described the species from the Agua Salada Formation, but found it at the lower extremes. Renz (1948), subsequently found it restricted to the upper Acostian and extremely scarce. Blow (1959), only observed it restricted to his *G. insueta* / *G. bispherica* subzone.

Genus VERNEUILINA d'Orbigny, 1839

**Verneuilina** sp. 1

Plate 51, figure 6

**Description:** Moderate sized test, rounded periphery, tapering. Widest at apertural end, triserial chambers steadily increase in size as added, low and broad. Sutures distinct and depressed, slope toward the periphery. Triangular in apertural view, walls slightly concave in some specimens. Aperture obscured.

**Occurrence:** Offshore Cabinda found infrequently in CABGOC 128-3 between 6,140' and 9,440', rare.

**Remarks:** Poor preservation.

Superfamily ATAXOPHRAGMIACEA Schwager, 1877

Family GLOBOTEXTULARIIDAE Cushman, 1927

Subfamily GLOBOTEXTULARIINAE Cushman, 1927

Genus GRAVELLINA Brônnimann 1953

**Gravellina narivaensis** Brônnimann

Plate 15, figures 6a, 6b; Plate 70, figure 7

**Gravellina narivaensis** Brônnimann 1953 pl. 15, fig. 9, textfig. 1

**Gravellina narivaensis** Brônnimann. --BLOW 1959, pl. 6, fig. 5. --DIAZ de GAMERO 1985a, pl. 4, fig. 17. --THOMAS 1985, pl. 1, fig. 7. --BOLLI, et. al. 1994, pl. 64, figs. 4 - 7, pl. 81, fig. 1

**Description:** Usually deformed, laterally or axially compressed. Quadriserial spiral, elongate test, greatest diameter in last whorl. Inflated chambers, distinct longitudinal sutures. Medium grain size. Recognised by characteristic converging longitudinal sutural lines on both sides of test.

**Occurrence:** Scarce in *T. panamaensis* zonule and *M. basispinosus* Zone. More common through *V. herricki*, *G. fohsi* and *S. transversa* Zones, reaches acme at sample 2610 in the *V. herricki* Zone in Venezuela. Offshore Cabinda found in CABGOC 128-3 between 4,410' and 10,160', and in CABGOC 115-1X between 5,040' and 8,580', acme at 6,420'. Two specimens identified in the Chechis Marls, Romania.

**Remarks:** Diaz de Gamero (1985a) recorded this species in her 'lower arenaceous interval' of the Agua Salada Basin. Blow (1959) found the species to be scarce and only observed it within the arenaceous horizons of his *G. insueta* Zone. Originally described from the Miocene of Trinidad.
Subfamily LIEBUSELLINAE Saidova, 1981
Genus JARVISELLA Brônnimann, 1953

Jarvisella karamatensis Brônnimann

Plate 6, figures 2 - 3; Plate 15, figures 7a, 7b

Jarvisella karamatensis BRÖNNIMANN 1953, pl. 15, fig. 7, textfigs. 2, 3
Jarvisella karamatensis Brônnimann. -SEIGLIE, et. al. 1986, p 173. --BOLLI, et. al. 1994, pl. 64, figs.8 - 9

Description: Trochoid spiral, chambers increase rapidly in size, initial portion pointed. Later chambers form basal pockets. Finely arenaceous, smooth. Aperture arcuate with neck, situated at base of apertural face.

Occurrence: In Venezuela scarce through the R. spinulosa / E. poeyanum zonule to the M. basispinosus Zone. More frequent in the V. herricki, G. fohsi and S. transversa Zones. Acme occurrences in sample 2610 of the V. herricki Zone and sample 2702 of the S. transversa Zone.

Remarks: First record of this taxon from the Agua Salada Formation. Seiglie et. al. (1986) suggested Jarvisella is indicative of stressful conditions, its thick walled ancestor, Liebusella, more common in relatively stable environments. Originally described from Miocene of Trinidad. Found in association with V. flexilis, E. karamatensis an6 H. narivaensis (Brônnimann 1953).

Family ALVEOVALVULINIDAE Seiglie, et. al., 1986
Genus ALVEOVALVULINA Brônnimann, 1951

Alveovalvulina suteri Brônnimann

Plate 83, figure C

Alveovalvulina suteri BRÖNNIMANN 1951, pl. 11, fig. 5, textfigs 5 - 8
Alveovalvulina suteri Brônnimann 1951. -SEIGLIE, et. al. 1986. pl. 1, figs. 3 & 6. --BOLLI, et. al. 1994, pl. 64, figs. 10 - 14

Description: Usually compressed and deformed. Trochoid spiral, adult whori largest proportion of test, initial portion pointed. Sutures tend to be indistinct. Aperture in umbilical depression at base of apertural face of last chamber, always obscured. Medium grain size.

Occurrence: In Venezuela apparent throughout the section, but most common in the V. herricki Zone, reaching acme abundance in sample 2610. Offshore Cabinda found in CABGOC 128-3 between 4,530' and 10,160, and in CABGOC 115-1X between 4,920' and 9,960'.

Remarks: First record of this taxon from the Agua Salada Formation. Previously described from the Miocene of Trinidad. Seiglie, et. al. (1986) attributed it to sublittoral to abyssal depths and interturbidite conditions. Specimens in the Brônnimann collection (P41018) clearly display the alveolar nature of the wall through the test. This is not as evident in the individuals recovered in this study, especially African specimens, but is attributed to re-silification. Sectioning of these samples proved to be unsuccessful.
Genus ALVEOVALVULINELLA Brönnimann, 1953

Alveovalvulinella pozonensis (Cushman & Renz)

Plate 6, figure 4; Plate 7, figures 1 - 6; Plate 16, figures 1a, 1b; Plate 83, figures D - E

Liebusella pozonensis CUSHMAN & RENZ 1941, pl. 2, figs. 1, 2

Liebusella pozonensis Cushman & Renz. --RENZ 1948, pl. 2, figs. 19, 20. --SKINNER & GLASER 1972, pl. 1, fig. 12

Alveovalvulinella pozonensis (Cushman & Renz). --BRÔNNIMANN 1953, pl. 15, fig. 3, textfigs. 3e, 4a, b, 5a - d, 6g, h, 7. --BLOW 1959, pl. 6, fig. 4. --DIAZ de GAMERO 1985a, pl. 5, fig. 4. --BOLLI, et al. 1994, pl. 64, figs. 15 - 21, pl. 76, figs. 28 - 29, pl. 81, fig. 2

Description: Specimens often worn. Test of medium size, subcylindrical and tapering. Triserial initial portion followed by uniserial stage. Sutures tend to be indistinct. Wall finely arenaceous. Aperture rounded and terminal. Alveoles apparent as subcircular depressions on test surface, arranged normal to the wall.

Occurrence: Only known from the Venezuelan section between the M. basispinosus and S. transversa Zones, acme in sample 2610.

Remarks: The typical species was removed from Liebusella to Alveovalvulinella by Brönnimann (1953) creating a monotypic genus upon the basis of the 'alveolated' rather than 'labyrinthic' test wall. He made reference to the variety crassa as a synonymy to the typical species upon the basis of preservation. Here the variant species has been treated separately upon the diagnosis of its extreme wall thickness. Cushman & Renz (1941) found the species throughout the Agua Salada Basin, Renz (1948) reported it to be sporadic throughout the Acostian and Araguatian. Blow (1959) made reference to it in the arenaceous facies of his C. stainforthi and G. insueta Zones, occasional specimens were also present in his G. fohsi and G. mayeri Zones. Diaz de Gamero (1985a) recorded the species intermittently throughout the Agua Salada Basin. Specimens within the Brönnimann collection (P41020), labelled as G. miocenica Brönnimann appear to contain additional A. pozonensis (Cushman and Renz) and A. pozonensis crassa (Cushman and Renz), these species appear more punctate than G. miocenica Brönnimann, and show more distinct chambers and sutural indentations. This collection was deposited in 1951, two years before the creation of the genus Alveovalvulinella, clarifying this discrepancy to a certain extent. At present, the author is awaiting type material from the Smithsonian to clarify generic characteristics. Cursory examination of faunal slides of Whittaker (1988) reveal comparable forms in the Cacelta Formation, Ecuador.

Alveovalvulinella pozonensis crassa (Cushman & Renz)

Plate 8, figures 1a, 1b; Plate 16, figures 2a, 2b; Plate 83, figure F

Liebusella pozonensis var. crassa CUSHMAN & RENZ 1941, pl. 2, figs. 3, 4

Liebusella pozonensis var. crassa Cushman & Renz 1941. --RENZ 1948, pl. 2, figs. 21 & 22

Alveovalvulinella pozonensis var. crassa (Cushman & Renz). --BOLLI, et al. 1994, pl. 76, figs. 30 - 31

Description: Normally of medium grain size, roughened, trochospiral to uniserial. Aperture terminal. Alveolar nature of test very apparent as subcircicular depressions on test wall. Test often partially flattened longitudinally. Although robust, frequently fractured. Extreme thickness to test
wall. Differs from typical species in the inflated nature of the chambers, thicker wall and denser arrangement of alveoles.

**Occurrence:** In Venezuela scarce in *R. spinulosa / E. poeyanum* and *M. superbus* zonules. More common in *V. herricki, G. fohsi* and *S. transversa* Zones. Acme occurrence in sample 2610 of the *V. herricki* Zone.

**Remarks:** Brønnimann (1953) made reference to this variety as a synonym to the typical species upon the basis of preservation. Here the variant form has been treated separately upon the diagnosis of extreme wall thickness, more bulbous uniserial chambers, and a wider, more robust test. Previous studies of Cushman & Renz (1941) and Renz (1948) have found this taxon throughout the Agua Salada Formation.

**Genus TEXTULARIELLA Cushman, 1927**

**Textulariella barrettii?** (Jones & Parker)

**Plate 70, figure 8**

*Textularia barrettii* JONES & PARKER 1863, pp. 99 *(fide Ellis & Messina 1940, et. seq.)*

*Textulariella barrettii* (Jones & Parker). –CUSHMAN 1927, pl. 5, fig. 3. –HEDBERG 1937, pl. 90, fig. 11. –RENZ 1948, pl. 2, fig. 13. –AKERS & DOORMAN 1964, pl. 1, figs. 26 - 27. –MIKHALEVICH 1983, pl. 9, fig. 132. –KOHL 1985, pl. 4, fig. 3

**Description:** Subconical test, initially trochospiral, becoming biserial. Circular in transverse section. Labyrinthic interior. Chambers and sutures indistinct. Wall finely agglutinated and perforate. Aperture a low interiomarginal arch at the base of the apertural face.

**Occurrence:** Offshore Cabinda found infrequently in CABGOC 128-3 between 6,200’ and 9,440’. Single specimen recovered from Costei, Romania.

**Remarks:** Originally described from the Tertiary of Jamaica. Also known from Venezuela, Trinidad, Puerto Rico, Haiti, and Jamaica (Renz 1948). Specimens in the Bagg collection (NHM) and W. K. Parker collection (P48149 and P48159) display excellent preservation in comparison to those of this study but remain comparable. Cursory examination of faunal slides of Whittaker (1988) reveal comparable forms in the Tosagua Formation, Ecuador. In addition, comparable forms are evident in the J. Doreen collection.

**Textulariella miocenica** Cushman

**Plate 51, figures 7a, 7b**

*Textulariella miocenica* CUSHMAN 1936, pl. 6, figs. 17, 19

*Textulariella miocenica* Cushman. –RENZ 1948, pl. 2, fig. 14. –BOLLI, et. al. 1994, pl. 76, fig. 27

**Description:** Elongate, robust test, stout. Rounded periphery. Initial end bluntly pointed, rapidly expands to adult form with parallel sides. Early chambers indistinct, quadriserial, later chambers become triserial to biserial. Chambers numerous and small, slowly increase in size in adult stage, slightly inflated, uniform shape. Slightly embrace towards the apertural end. Sutures slightly raised and limbate in early portion, become slightly depressed in adult. Wall of moderate grain size, aperture a low arch at the inner margin.

**Occurrence:** Offshore Cabinda found in CABGOC 115-1X between 5,760’ and 7,440’.
Remarks: Originally described from the middle Miocene of Trinidad. Specimens all poorly preserved, re-silicified. Differs from *T. barrettii* (Jones & Parker) in slenderness of test and more numerous chambers.

*Textulariella miocenica brevis* Cushman & Renz  
*Textulariella miocenica var. brevis* CUSHMAN & RENZ 1941, pl. 1, fig. 15  
*Textulariella miocenica var. brevis* Cushman & Renz. --RENZ 1948, pl. 2, fig. 15. --BOLLI, et al. 1994, pl. 76, fig. 26  
Description: Differs from the typical in a stouter form and greater inflation of chambers. Fewer chambers, sutures more depressed.  
Occurrence: Offshore Cabinda found in CABGOC 115-1X at 7,140'.  
Remarks: Specimens poorly preserved, re-silicified.

Superfamily TEXTULARIACEA Ehrenberg, 1838  
Family EGGERELLIDAE Cushman, 1937  
Subfamily DOROTHININAE Balakhmatova, 1972  
Genus DOROTHIA Plummer, 1931  
*Dorothia cylindrica* (Nuttall)  
Plate 16, figures 3a, 3b; Plate 51, figure 8  
*Gaudryina cylindrica* NUTTALL 1932, pl. 2, fig. 7  
*Dorothia cylindrica* (Nuttall). --CUSHMAN & RENZ 1947, pl. 2, fig. 1. --DIAZ de GAMERO 1977, pl. 3, fig. 9. --BOLLI, et al. 1994, pl. 81, fig. 3  
Description: Elongate cylindrical test, inflated. Initial end blunt, parallel sides. Triserial portion indistinct, biserial portion shows greater inflation to chambers and increased chamber size. Sutures slightly depressed, sub-horizontal. Wall fine grained with a high proportion of cement. Aperture an oval opening near the base of the apertural face.  
Occurrence: Sporadic throughout the section apart from the *S. transversa* and *L. wallacei* Zones. Reaches acme occurrence at sample 2613. Offshore Cabinda found in CABGOC 115-1X between 6,900' and 8,820'.  
Remarks: Originally described from the Lower Oligocene of Mexico. First report of this species from the Agua Salada Formation, Venezuela. Differs from *K. microgranulosa* Graham, et al. in greater width of the test, fewer chambers and greater inflation of the chambers.

Subfamily EGGERELLINAE Cushman, 1937  
Genus EGGERELLA Cushman, 1935  
*Eggerella bradyi* (Cushman)  
Plate 51, figures 9a, 9b, 9c  
*Vemeuilina bradyi* CUSHMAN 1911, textfig. 87  
*Karreniella siphonella* Reuss. --GRAHAM, et al. 1965, pl. 2, fig. 10  
*Eggerella bradyi* (Cushman). --SOUYA 1965, pl. 1, fig. 5. --BOLTOVSKOY 1980, pl. 2, fig. 1. --WESTON 1984, pl. 1, figs. 2 - 3. --KOHL 1985, pl. 3, fig. 3. --BELANGER & BERGGREN 1986, pl. 1, fig. 1. --CLARK 1990, pl. 1, fig. 4. --SCHRÖDER-ADAMS 1990, pl. 3, fig. 12, pl. 6, figs. 20 - 21. --SPROVIERI &
**Eggerella ? bradyi** (Cushman). -HALLER 1980, pl. 2, fig. 1

**Description:** Robust distinctive test. Triserial, inflated chambers rapidly increase in size as added, last three formed constituting much of test. Sutures distinct and depressed. Wall finely agglutinating, smooth. Aperture an rounded slit toward the base of the inner margin of the last formed chamber.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 between 9,980' and 10,160', rare, and in CABGOC 115-1X between 6,120' and 9,840', infrequent.

**Remarks:** Originally described from Recent material from the North Pacific. Graham, *et al.* (1965), note *K. siphonella* Reuss from lower Miocene sediments of Gabon, this taxon shows less inflated chambers than those of *E. bradyi*, but in other aspects is extremely similar. Poor preservation apparent in some specimens. Cursory examination of faunal slides of Whittaker (1988) reveal comparable forms in the Tosagua Formation, Ecuador. In addition, comparable forms are evident in the J. Doreen collection. Known from the Miocene of Haiti (Coryell & Rivero 1940).

**Eggerella forestensis** Brönnimann

*Plate 16, figure 4; Plate 52, figures 1 - 2; Plate 70, figure 9*

**Eggerella forestensis** BRÖNNIMANN 1953, pl. 15, fig. 8, textfig. 15 a - g

**Description:** Extremely compressed small trochoid spiral. Chambers increase rapidly in size, widest breadth at apertural end. Sutures distinct, medium grain size. Aperture indistinct.

**Occurrence:** Infrequent occurrence through *V. herricki* to *S. transversa* Zones, reaches acme occurrence at sample 2609B in Venezuela. Offshore Cabinda found in CABGOC 128-3 between 4,770' and 9,080', and infrequently in CABGOC 15-1X between 4, 980' and 10,020'. Single specimen identified the Chechis Marls, Romania.

**Remarks:** First report of this species from the Agua Salada Formation. Originally described from the Miocene of Trinidad. Cursory examination of faunal slides of Whittaker (1988) reveal comparable forms in the Cacelta Formation, Ecuador.

**Eggerella** sp. aff. *E. jobei* Harris & Jobe

*Plate 52, figures 3 - 4*

**Eggerella jobei** HARRIS & JOBE 1951, pl. 2, fig. 11 (fide Ellis & Messina 1940, et. seq.)

**Description:** Free test, large and bulbous. Strongly tapering test, last formed chamber strongly embracing. Rounded periphery. Chambers distinct and high, enlarge gradually as added and strongly inflated. Sutures distinct, flush to slightly depressed, gently curving. Aperture a high arch at the base of the inner margin of the last formed chamber, slight lip. Wall very finely grained.

**Occurrence:** Observed in CABGOC 115-1X between 6,000' and 6,600', acme at 6,480'.

**Remarks:** Originally described from the Paleocene of Arkansas, USA. Differs from the typical species in a greater inflation of the chambers, wider apertural end, and greater test size.
**Eggerella karamatensis** Brönnimann

Plate 52, figures 5 - 6; Plate 70, figures 10a, 10b

*Eggerella karamatensis* BRÖNNIMANN 1953, pl. 15, fig. 2, textfig. 5 f-i

*Eggerella karamatensis* Brönnimann. --DÍAZ de GAMERO 1985a, pl. 4, fig. 21. --BOLLI, *et. al.* 1994, pl. 64, figs. 28 - 29

**Description:** Variable species, invariably deformed and compressed longitudinally. Elongate, tapering trochoid spiral. Subglobular chambers, show varying degrees of inflation. Sutures always distinct. Medium grain size. Aperture always obscured.

**Occurrence:** Sporadic occurrence throughout the Venezuelan section. Common offshore Cabinda in CABGOC 128-3 between 4,410' and 9,980', and in CABGOC 115-1X between 4,490' and 10,020'. Relatively abundant in the Chechis Marls, Romania.

**Remarks:** Díaz de Gamero (1985a) reported the species from her upper arenaceous interval. Originally described from the Miocene of Trinidad. Cursory examination of faunal slides of Whittaker (1988) reveal comparable forms in the Tosagua and Calceta Formations, Ecuador.

**Eggerella sp. 1**

Plate 16, figures 5a, 5b

**Description:** Distinctive taxon, elongate, gently tapering. Rounded periphery, inflated. Chambers and sutures obscured by coarse grained wall comprised of varietal shell debris. Wall thick, broken specimens show fine septa passing from the chamber lumina through two thirds its depth. Light coloured. Aperture unobserved.

**Occurrence:** Isolated to the *V. herricki* Zone in Venezuela.

**Remarks:** Skinner & Glaser (1972) refer to a *Eggerella* sp. from the Gulf Coast. Upon their description and illustration it is impossible to ascertain if these taxa are comparable.

Genus **KARRERIELLA** Cushman, 1933

*Karreriella bradyi* (Cushman)

Plate 52, figures 7a, 7b

*Gaudryina bradyi* CUSHMAN 1911, textfig. 107

*Karreriella bradyi* (Cushman). --CORYELL & RIVERO 1940, pl. 43, fig. 5. --CUSHMAN & RENZ 1947, pl. 2, fig. 6. --BOLTOVSKOY 1980, pl. 4, fig. 7. --W ESTON 1984, pl. 1, figs. 1, 4. --KOHL 1985, pl. 3, figs. 4 - 5. --BELANGER & BERGGREN 1986, pl. 1, fig. 2. --CHARNOCK & JONES 1990, pl. 12, fig. 15, pl. 25, fig. 5. --LUCZKOWSKA 1990, pl. 1, fig. 6. --SPROVIERI & HASEGAWA 1990, pl. 1, figs. 9 - 10. --NOMURA 1991, pl. 1, fig. 13. --KAIHO 1992a, pl. 1, fig. 12. --BORNMALM 1997, fig. 13G

**Description:** Elongate cylindrical test, rounded periphery. Trochospiral early chambers indistinct, subsequent biserial growth inflated and twisted. Sutures indistinct in early portion, depressed in later growth. Fine grained wall, smooth. Aperture an elongate ovoid with lip towards the base of the apertural face, parallel to suture.

**Occurrence:** Offshore Cabinda in CABGOC 115-1X between 6,240' and 7,560'.

**Karreriella chlostoma** (Reuss)

Plate 71, figures 1a, 1b

*Textularia chlostoma* REUSS 1852, p. 18, textfig. a - b (*fide* Ellis & Messina 1940, *et. seq.*)

*Karreriella chlostoma* (Reuss). —CUSHMAN & STAINFORTH 1945, pl. 2, figs. 6 - 7. —CUSHMAN & RENZ 1947, pl. 2, fig. 5. —POPESCU 1975, pl. 8, figs. 3 - 5, pl. 93, fig. 11. —DÍAZ de GAMERO 1985a, pl. 4, fig. 18. —BUCEFALO PALLANI, *et. al.* 1997, not pl. 4, figs. F1 - F2. —CICHA, *et. al.* 1998, pl. 9, figs. 1 - 3

**Description:** Moderate sized robust test. Rounded profile, tapering, widest at apertural end. Subacute initial end, chambers indistinct, rapidly increase in size as added, slightly inflated. Sutures distinct and depressed, sub-horizontal. Wall fine grained and smooth. Aperture at the base of the apertural face.

**Occurrence:** Offshore Cabinda found in CABGOC 115-1X at 5,700' and between 9,480' and 9,600'. Rare in the Chechis Marls and Sacel, Romania.

**Remarks:** Also known from Venezuela. Cursory examination of faunal slides of Whittaker (1988) reveal comparable forms in the Tosagua Formation, Ecuador. In addition, comparable forms are evident in the J. Doreen collection.

**Karreriella microgranulosa** Graham, *et. al.*

Plate 52, figures 8 - 9

*Karreriella microgranulosa* GRAHAM, *et. al.* 1965, pl. 2, fig. 1

**Description:** Elongate conical test, rounded in transverse section. Finely grained, white in colour. Initial trochospiral portion rapidly becomes triserial. Chambers increase in size as added, low and wide, slightly inflated in biserial portion. Sutures distinct and in the biserial portion, slightly depressed, sub-horizontal to the test wall. Aperture a small rounded opening toward the base of the inner margin of the last formed chamber.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 between 4,720' and 9,260, and frequently in CABGOC 115-1X between 5,820' and 8,220', acme at 6,540'.

**Remarks:** First described from the Miocene of Gabon.

**Karreriella cf. microgranulosa** Graham, *et. al.*

*Karreriella microgranulosa* GRAHAM, *et. al.* 1965, pl. 2, fig. 1

**Description:** Differs from the typical form in an increased inflation of the chambers.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 between 4,410' and 6,920'.

**Karreriella subcylindrica** Nuttall

Plate 16, figure 6

*Karreriella subcylindrica* NUTTALL 1928, pl. 3, figs. 17 - 18

**Description:** Partial specimens. Tapering test, rounded periphery. Small finely grained test. High proportion of cement. Bulbous inflated chambers, depressed, curving sutures.
Occurrence: Single specimen in sample 2715 of the *L. wallacei* Zone in Venezuela. Offshore Cabinda found in CABGOC 115-1X at 5,820'.


*Karreriella* sp. 1

Description: Elongate taxon, bulbous. Initial triserial chambers obscure and small, later growth of four to five distinctive bulbous chambers, giving lobulate profile, chambers may overlap slightly. Sutures distinct and depressed. Fine grained, smooth wall. Aperture a simple opening.

Occurrence: Offshore Cabinda found in CABGOC 128-3 at 10,160'.

Remarks: Single specimen.

*Karreriella* sp. 2

Description: Short tapering test, triangular profile. Rounded periphery, widest at apertural end. Initial chambers indistinct, later become inflated and increase in size as added, low and broad. Sutures distinct and depressed. Aperture a simple interiomarginal opening.

Occurrence: Offshore Cabinda found in CABGOC 128-3 at 5,240' and 6,140'.

*Karreriella* sp. 3

Description: Poorly preserved individual tentatively placed in the genus.

Occurrence: Offshore Cabinda found in CABGOC 115-1X at 6,780'.

Remarks: Single specimen.

Genus MARTINOTTIELLA Cushman, 1933

*Martinottiella communis* (d'Orbigny)

Plate 16, figure 9; Plate 71, figures 2 - 3

*Clavulina communis* d'Orbigny 1846, pl. 12, figs. 1 - 2

*Clavulina communis* d'Orbigny. --CUSHMAN 1921, pl. 31, fig. 1. --CUSHMAN & JARVIS 1930, pl. 32, fig. 4. --MACFADYEN 1930, pl. 1, fig. 9

*Listerella communis* (d'Orbigny). --CUSHMAN 1937, pl. 17, figs. 4 - 9

*Schenckiella communis* (d'Orbigny). --LE ROY 1964, pl. 1, fig. 17

*Martnottiella communis* (d'Orbigny). --ASANO 1950, p. 3, figs. 16 - 17--SOYUA 1965, pl. 1, fig. 25. --POPESCU 1975, pl. 10, figs. 5 - 6. --RÖGL 1976, pl. 4, fig. 13. --KELLER 1980, pl. 1, fig. 12. --THOMPSON 1980, pl. 8, fig. 9. --PAPP & SCHMID 1985, pl. 66, figs. 1 - 8. --BELANGER & BERGGREN 1986, pl. 1, figs. 3 - 4. --BOERSMA 1986, pl. 3, fig. 5. --OSTERMAN & QVALE 1989, pl. 5, fig. 3. --CHARNOCK & JONES 1990, pl. 12, figs. 10 - 11, pl. 25, fig. 2. --SPROVIERI & HASEGAWA 1990, pl. 1, fig. 5. --KAIHO 1992, pl. 1, fig. 17. --KATO 1992, pl. 1, fig. 5. --NOMURA 1992, pl. 1, figs. 5 - 9. --BORNMALM 1997, fig. 13H. --FORESI, et. al. 1997, pl. 3, figs. 6 - 8. --CICHA, et. al. 1998, pl. 9, figs. 6 - 7
**Description:** Test free, elongate, circular in cross section. Early chambers trochospiral, reducing to triserial and uniserial in the adult form. Initial portion tapered. Sutures indistinct in early portion, depressed in uniserial part. Uniserial chambers increase gradually in size as added, slightly inflated. Sutures distinct and slightly depressed. Wall finely grained, although occasional coarser adventitious material occurs in some specimens. Wall perforate. Aperture terminal, a small round opening with produced lip in centre of last formed chamber.

**Occurrence:** In Venezuela occurs intermittently throughout the section. Acme occurrences at sample 2618 of the *G. fohsi* Zone and sample 2710 of the *S. transversa* Zone. Offshore Cabinda found in CABGOC 115-1X between 7,080' and 10,020', becoming more frequent down well. Found in Costei, the Chechis Marls, and Sacel, Romania.


**Martinottiella cf. cyclostomata** (Galloway & Morrey)

**Vermeuilina cyclostomata** GALLOWAY & MORREY 1929, pl. 5, fig. 2

**Schenckiella cf. cyclostomata** (Galloway & Morrey). --RENZ 1948, pl. 2, fig. 16

**Martinottiella cyclostomata** (Galloway & Morrey). --DIAZ de GAMERO 1985a, pl. 5, fig. 1

**Description:** Small conical test. Strongly tapering, rounded periphery. Initial chambers indistinct, Subsequent uniserial chambers increase rapidly in size as added, invariably deformed. Sutures depressed to flush. Wall fine grained and smooth, high proportion of cement. Aperture unobserved.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 between 4,770' and 10,040'.

**Remarks:** Originally described from the Oligocene of Ecuador.

**Martinottiella pallida** (Cushman)

**Clavulina communis var. pallida** CUSHMAN 1927, pl. 2, fig. 1

**Schenckiella pallida** (Cushman). --RENZ 1948, pl. 2, figs. 17 - 18

**Martinottiella pallida** (Cushman). --DIAZ de GAMERO 1985a, pl. 5, fig. 2. --BOLLI, *et. al.* 1994, pl. 76, figs. 19 - 20

**Description:** Test, elongate, circular in cross section. Early chambers trochospiral, reducing to triserial and uniserial in the adult form. Initial portion tapered to blunt point. Sutures indistinct, depressed in uniserial part. Uniserial chambers slightly inflated. Wall fine grained and smooth, normally of a light coloured material. Aperture terminal, a small round opening in centre of last formed chamber.

**Occurrence:** Offshore Cabinda in CABGOC 115-1X between 8,640' and 9,950'.

**Martinottiella sp. 1**

Plate 52, figure 10

**Description:** Similar to *M. pallida* (Cushman), but greater inflation of the uniserial chambers, and a much reduced triserial and biserial portion.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 at 9,080’ and in CABGOC 115-1X at 3,050’.

**Remarks:** Single specimens.

Family TEXTULARIIDAE Ehrenberg, 1838
Subfamily TEXTULARIINAE Ehrenberg, 1838
Genus BIGENERINA d’Orbigny, 1826

**Bigenerina directa** Cushman & Ellisor

Plate 53, figure 1; Plate 71, figures 4a, 4b

**Bigenerina nodosarida** var. directa CUSHAMAN & ELLISOR 1939, pl. 1, fig. 5

**Bigenerina nodosarida** var. directa Cushman & Ellisor. --SKINNER & GLASER 1972, pl. 1, fig. 10. --SKINNER & STEINKRAUS 1972. --POPECSCU 1975, pl. 6. figs. 5 - 6

**Description:** Elongate slender test, moderately compressed. Uniserial portion forms majority of test, chambers inflated and distinct. Sutures depressed, aperture a terminal rounded opening with a slight neck. Differs from the typical taxon in rougher surface to the test.

**Occurrence:** Offshore Cabinda found in CABGOC 115-1X at 6,780’. Observed in Sacel, Romania.


**Bigenerina hollandaninae** van Voorthuysen

**Bigenerina nodosarida** var. hollandaninae VAN VOORTHUYSEN 1950, pl. 1, fig. 5. textfig. 1 (*fide* Ellis & Messina 1940, et seq.)

**Description:** Test elongate and slender. Biserial portion somewhat compressed, uniserial portion rounded profile. Chambers increase in size as added, sutures depressed and distinct. Wall finely agglutinating with large proportion of cement giving smooth appearance. Aperture terminal.

**Occurrence:** Single occurrence in *V. herricki* Zone in Venezuela.

**Remarks:** First report of this species from the Agua Salada Formation. Previously described from the Pliocene of the Netherlands.
**Bigenerina** cf. *lindae* Schroeder

*Bigenerina lindae* SCHROEDER 1968, pl. 1, figs. 18 - 23 (fide Ellis & Messina 1940, et. seq.)

**Description:** Small, elongate test. Initial biserial portion of rapidly increasing chamber size, blunt apical end. Subsequent uniserial growth may show winding chamber arrangement. Chambers larger and bulbous. Sutures in initial growth indistinct, uniserial growth sutures depressed. Fine grained wall with high proportion of cement. Aperture a simple terminal opening.

**Occurrence:** Offshore Cabinda found in CABGOC 115-1X at 9,180'.

**Remarks:** Originally described from the Triassic of Idaho.

**Bigenerina** sp. 1

**Description:** Poorly preserved individual tentatively ascribed to the genus.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 at 6,920'.

**Remarks:** Single specimen.

Genus *TEXTULARIA* Defrance, 1824

*Textularia abbreviata* (d'Orbigny)

**Plate 16, figures 10a, 10b; Plate 53, figures 2 - 3**

*Textularia abbreviata* d'ORBIGNY 1846, pl. 15, figs. 7 - 12

*Nautilus amphorinus* (d'Orbigny). --SOLDANI 1780, pl. 7, fig. c (fide Ellis & Messina 1940, et. seq.)

*Textularia abbreviata* (d'Orbigny). --CUSHMAN 1921, pl. 21, fig. 2. --RENZ 1948, pl. 1, figs. 10 - 11. --SOUYA 1965, pl. 1, fig. 23. --BOLLI, et. al. 1994, pl. 76, figs. 9 - 10. --FORESI, et. al 1997, pl. 3, fig 10 - 11 (not 10a)

*Textularia gramen* (d'Orbigny). --PAPP & SCHMID 1985, pl. 81, figs. 4 - 6

**Description:** Large test, finely grained and smooth. Rhomboid in transverse section, chambers partially inflated and sutures distinct. Aperture wide intermarginal ovoid, periphery acute.

**Occurrence:** Infrequent occurrence in *M. basispinosus* and *V. herricki* Zones in Venezuela. Offshore Cabinda rare, found in CABGOC 128-3 between 5,000' and 10,160', and in CABGOC 115-1X between 6,360' and 8,760'.

**Remarks:** Renz noted the taxon from the Araguatian and Lucian of the Agua Salada Basin. The species was originally described from the Tertiary of the Vienna Basin. Recognised in the Miocene of the Gulf of Suez region (Souya 1965). Specimens compare well with those of the Burrow and Holland collection (slide G, NHM), and to those labelled *Plecanium abbreviata* of the Brady collection (NHM). Cursory examination of faunal slides of Whittaker (1988) reveal comparable forms in the Cacelta Formation, Ecuador.

*Textularia agglutinans* d'Orbigny

**Plate 71, figures 5 - 6**

*Textularia agglutinans* d'ORBIGNY 1839, pl. 1, figs. 17 - 18, 32 - 34 (fide Ellis & Messina 1940, et. seq.)

*Textularia agglutinans* d'Orbigny. --CUSHMAN 1921, pl. 20, fig. 8. --CUSHMAN 1930, pl. 1, fig. 4. --CUSHMAN & CAHILL 1933, pl. 1, fig. 8. --MIKHALEVICH 1983 pl. 3, figs. 43 - 44. --SNYDER, et. al. 1988, pl. 1, figs. 4 - 5. --CIMERMAN & LANGER 1991, pl. 10, figs. 1 - 2. --HOTTINGER, et. al. 1993, pl. 13, figs. 1 - 9
Description: Elongate conical test, chambers increasing in size as added to give tapering appearance. Lobate periphery. Initial end subacute. Chambers inflated and rounded. Sutures depressed and sub-horizontal to the test wall. Aperture an arched opening at the base of the apertural face.

Occurrence: Common in Costei, Romania.

Remarks: Originally described from Recent material from Cuba, Martinique, and Jamaica. Known from Trinidad (Nuttall 1927) and the Miocene of Venezuela (Bermúdez and Fuenmayor 1966). Specimens compare well with those of the Heron-Allen and Earland collection (P32322-32355, P32399-32450, P32472-32499, P32546-32595) and the Burrow and Holland collection (slide G, NHM). Specimens in the W. K. Parker collection (P47826) are mixed with examples of T. saggitulla and (P47827) mixed with T. parisiensis.

Textularia agglutinans nalinnesensis Kaasschieter

Plate 17, figures 1a, 1b, 2a, 2b

Textularia agglutinans var. nalinnesensis KAASSCHIETER 1961, pl. 1, figs. 17 - 18 (fide Ellis & Messina 1940, et. seq.)

Description: This variety is larger than the typical form with a coarser test wall and less compressed. The proloculus tends to be finer grained and somewhat compressed than the adult stage of growth. Chambers steadily increase in size uniformly producing a tapering outline. Sutures are straight and slope slightly downwards. The aperture is a low slit.

Occurrence: Single specimens in the T. panamaensis zonule and V. herricki Zones in Venezuela.

Remarks: First report of this species from the Agua Salada Formation. Previously reported from Mid Eocene sands of Belgium. Specimen from the T. panamaensis zonule shows a distinctive test structure and is tentatively placed in this taxon.

Textularia angularis? d’Orbigny

Plate 71, figures 7a, 7b

Textularia angularis d’ORBIGNY 1887, text fig. 7 (fide Ellis & Messina 1940, et. seq.)

Description: Test of moderate size, strongly tapered, acute periphery, flattened. Initial end acute, chambers rapidly increase in size as added, maintain slanting oblong shape. Sutures flush to slightly depressed, straight and angled. Wall finely grained with high proportion of cement. Aperture a low slit at the base of the apertural face in a slight re-entrant.

Occurrence: Single specimen identified in Costei, Romania.

Remarks: Originally described from 'Recent and fossil' material from the Adriatic Sea and Bordeaux, France.

Textularia sp. aff. T. articulata d’Orbigny

Plate 17, figures 3a, 3b

Textularia articulata d’ORBIGNY 1826, pl. 11, figs. 1 - 4 (fide Ellis & Messina 1940, et. seq.)

Textularia aff. T. articulata d’Orbigny. –SKINNER & GLASER 1972, pl. 1, fig. 4
**Textularia articulata** d'Orbigny. --D'ORBIGNY 1846, pl. 15, figs. 16 - 18. --PAPP & SCHMID 1985, pl. 82, figs. 1 - 3. --SNYDER, et. al. 1988, pl. 1, figs. 6 - 7. --FORESI, et. al 1997, pl. 3, fig. 4 - 5

**Description:** Fine grained test, extreme tapering profile. Chambers dramatically increase in size as added. Sutures oblique, sloping downwards notably and raised. Periphery acute. Aperture small arched slit.

**Occurrence:** Single specimen in the *V. herricki* Zone in Venezuela.

**Remarks:** First report of this species from the Agua Salada Formation. Originally described from Recent material of the Adriatic Sea, previously reported from the Gulf Coast Miocene. Papp & Schmid (1985) consider the species to be a ecologic variant of *T. mariae* d'Orbigny indicative of 'calm sea bottoms'.

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**Textularia barnwelli** Kennett

Plate 17, figures 4a, 4b; Plate 71, figures 8a, 8b

**Textularia barnwelli** KENNETT1966, pl. 1, figs. 1 - 5 (fide Ellis & Messina 1940, et. seq.)

**Description:** Small test, rapidly increases in size. Rounded profile. Inflated chambers slope gently downwards. Sutures indented and gently curving. Moderate grain size with fairly high proportion of cement. Terminal face broad and rounded, curving downwards margins. Aperture a narrow slit in a depression on the inner margin of the last chamber.

**Occurrence:** Single specimen in the *V. herricki* Zone in Venezuela. Identified in Costei, Romania.

**Remarks:** First report of this species from the Agua Salada Formation. Previously reported from upper Miocene and lower Pliocene of New Zealand.

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**Textularia crassisepta** Cushman

Plate 17, figures 5a, 5b; Plate 53, figure 4

**Textularia crassisepta** CUSHMAN 1911, textfig. 41

**Textularia crassisepta** Cushman. --CUSHMAN 1921, pl. 23, fig. 1. --RENZ 1948, pl. 1, fig. 12. --BLOW 1959, p. 112 - 113. --BOLLI, et. al. 1994, pl. 76, fig. 5

**Description:** Broad test. Initial end wide, tapering towards aperture to form quadrangular profile in end view. Early chambers low and broad, later chambers become higher. Wall of moderate grain size, sutures conspicuously curved and raised. Aperture an arched slit on inner border of last formed chamber.

**Occurrence:** Intermittent occurrence throughout Venezuela section, most common in *V. herricki* and *G. fohsi* Zones. Acme occurrence in sample 2613 of *V. herricki* Zone. Offshore Cabinda found in CABGOC 128-3 between 6,500' and 10,160' and in CABGOC 115-1X between 6,300' and 9,960'.

**Remarks:** Renz (1948) noted the taxon as scarce through the Acostian, Araguatian and Lucian of the Agua Salada Formation. Blow (1959), found isolated individuals in the *G. insueta*, *G. fohsi* and *S. seminulina* Zones. Known from additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966). Cursory examination of faunal slides of Whittaker (1988) reveal comparable forms in the Tosagua, Cacelta, and Viche Formations, Ecuador. In addition, comparable forms are evident in the J. Doreen collection.
Textularia cubensis nipensis Keijzer

Plate 17, figure 6a, 6b; Plate 53, figure 5

Textularia cubensis var. nipensis KEIJZER 1945, pl. 1, fig. 7 (fide Ellis & Messina 1940, et. seq.)

Textularia nipensis Keijzer. -DIAZ de GAMERO 1985a, pl. 4, fig. 13

Description: Wedge shape given by rapid increase in chamber size as added. Broadest towards centre, tapering to acute margins. Chambers alternate distinctly and overhang previous portion. Thickened margins curve downwards characteristically. Fine grained giving smooth appearance to test. Low broad aperture in depression on the inner margin of the convex upper surface of the last formed chamber. This variety tends to be longer than the typical species, the aperture broader and lower.

Occurrence: Isolated occurrences in the R. spinulosa / E. poeyanum and T. panamaensis zonules in Venezuela. Offshore Cabinda found in CABGOC 115-1X at 7,080'.

Remarks: Diaz de Gamero (1985a) recorded the species in the younger sediments of the Agua Salada Basin. Previously described from the middle to Upper Oligocene of Cuba.

Textularia deltoidea Reuss

Plate 71, figures 9a, 9b

Textularia deltoidea REUSS 1850, pl. 49, fig. 4 (fide Ellis & Messina 1940, et. seq.)

Textularia deltoidea Reuss. -POPESCU 1975, pl. 9, fig. 6

Description: Tapering compressed test. Finely agglutinating. Initial end semiacute, rapidly tapers to widest portion at apertural end. Five to six pairs of chambers, large, sloping and semiinflated. Sutures slightly depressed and sloping, slightly limbate. Aperture a wide low opening at the base of the apertural face.

Occurrence: Common in Sacel, Romania.

Remarks: Originally described from the Tertiary of Germany.

Textularia earlandi Parker

Plate 53, figures 6 - 7

Textularia earlandi PARKER 1952

Textularia tenuissima EARLAND 1933, pl. 3, figs. 21 - 30 (fide Ellis & Messina 1940, et. seq.)

Description: Small, elongate tapering test, subacute periphery, compressed, widest at apertural end. Initial end acute, chambers difficult to discern. Chambers increase in size steadily as added, adult growth with sub-parallel sides and chambers of similar size. Chambers numerous, distinct, slightly inflated, overlapping ovoids. Sutures distinct, depressed. Aperture unobserved.

Occurrence: Offshore Cabinda found in CABGOC 128-3 between 6,140' and 10,100', rare. In CABGOC 115-1X found frequently between 4,370' and 10,020', acmes at 4,970' to 6,360', 7,740' to 6,360', and 9,950'.

Remarks: Originally described from the Recent of South Georgia. Recognised as a constituent of a diverse bathyal benthonic association offshore West Africa (Haman, et. al. 1993). Some of the type illustrations depict a coiledjuvenarium, this is not apparent in any of the specimens of this study. Differs from T. elegans Lacroix in the ovoid shape to the chambers which overlap to a greater extent in T. earlandi Parker. Specimens of this study tend to be shorter than the figured

**Textularia excavata** Cushman

*Textularia excavata* CUSHMAN 1913, pl. 79, fig. 5

*Textularia excavata* Cushman. –RENZ 1948, pl. 1, fig. 15

**Description**: Large robust test. Rhomboid, rounded periphery. Initial end rounded and indistinct. Later growth of rapidly enlarging chambers, sloping, and inflated towards the margin. Last formed chamber greatly inflated and bulbous. Wall fine grained with a high proportion of cement, smooth. Aperture a low arch at the base of the apertural face.

**Occurrence**: Offshore Cabinda found in CABGOC 115-1X at 5,040'.

**Remarks**: Originally described from Recent material from the Pacific. Single specimen.

**Textularia falconensis** Cushman & Renz

*Textularia falconensis* CUSHMAN & RENZ 1941, pl. 1, fig. 3

*Textularia falconensis* Cushman & Renz. –RENZ 1948, pl. 1, fig. 14. –BOLLI, et. al. 1994, pl. 76, fig. 13

**Description**: Test medium sized, moderately compressed, elongate, with broadly parallel sides. Slightly narrower at apertural end, subacute periphery. Numerous chambers increase slightly in size as added. Sutures slightly limbate and depressed. Wall fine grained and polished, with high proportion of cement. Aperture not apparent in specimen observed, but described as ‘rounded ... with slight, broadly rounded lip’.

**Occurrence**: Single specimen in *G. fohsi* Zone in Venezuela.

**Remarks**: Cushman and Renz (1941) first described the species from the lower Agua Salada Formation, Renz (1948) found the species scarce in the upper Acostian.

**Textularia farafraensis** Le Roy

*Textularia farafraensis* LE ROY 1953, pl. 2. figs. 3 - 4

**Description**: Elongate tapered test, rounded periphery, bulbous. Initial end rounded, test expands uniformly as successive larger chambers added. Chambers numerous, inflated, sutures distinct and depressed. Wall of moderate grain size with roughened surface. Aperture a low arch at the base of the apertural face in a slight re-entrant.

**Occurrence**: Offshore Cabinda found in CABGOC 115-1X at 6,060’ and 6,540’.

**Remarks**: Originally described from the Paleocene / Lower Eocene of Egypt.

**Textularia isidroensis** Cushman & Renz

*Textularia isidroensis* CUSHMAN & RENZ 1941, pl. 1, fig. 7

*Textularia isidroensis* Cushman & Renz. –RENZ 1948, pl. 1, fig. 13. –BOLLI, et. al. 1994, pl. 76, fig. 6

**Description**: Small test, compressed, rhomboid and tapering. Periphery acute. Greatest breadth towards the apertural end, numerous chambers of same shape increase in size rapidly as
added, partially inflated. Sutures slightly limbate, flush to slightly depressed. Wall fine grained with high proportion of cement, smooth. Aperture a broad low slit at the base of the apertural face on the medial line.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 at 4,770'.

**Remarks:** Known from the Miocene of Venezuela (Bermúdez and Fuenmayor 1966).

**Textularia kugleri** Cushman & Renz

**Plate 54, figure 1**

*Textularia kugleri* CUSHMAN & RENZ 1941, pl. 1, figs. 8 - 9

*Textularia kugleri* Cushman & Renz. —RENZ 1948, pl. 1, figs. 16 - 17. —BOLLI, et. al. 1994, pl. 76, figs. 14 - 15

**Description:** Medium sized test, compressed and rhomboid, periphery lobulate. Greatest breadth towards the apertural end. Numerous sloping chambers steadily increase in size as added, slightly inflated. Sutures distinct, oblique, and slightly depressed, gently curving. Fine grained test, smooth. Semicircular aperture at base of apertural face on medial line.

**Occurrence:** Offshore Cabinda found frequently in CABGOC 128-3 between 3,630' and 4,790', acme at 3,870'. Found in CABGOC 115-1X between 4,920' and 9,600'.

**Textularia leuzingeri** Cushman & Renz

**Plate 17, figures 8a, 8b**

*Textularia leuzingeri* CUSHMAN & RENZ 1941, pl. 1, fig. 2

*Textularia leuzingeri* Cushman & Renz. —CUSHMAN & STAINFORTH 1945, pl. 1, figs. 19 - 20. —CUSHMAN & RENZ 1947, pl. 1, fig. 7. —RENZ 1948, pl. 1, fig. 18. —BLOW 1959, p. 113. —DOUGLAS 1973, pl. 2, figs. 7 - 9. —BOLLI, et. al. 1994, pl. 62, fig. 12, pl. 76, fig. 3

**Description:** Large species, rounded initial end, parallel sides, compressed, periphery subacute. Chambers numerous and indistinct, sutures indistinct, oblique. Medium grain size, roughened. Aperture a narrow ovoid opening at base of the apertural face on the median line.

**Occurrence:** Confined to the G. fohsi Zone in Venezuela.

**Remarks:** Cushman and Renz (1941) described the taxon from the lower and upper Agua Salada Formation, Renz (1948) subsequently noted the species as scarce in the 'Uvigerinella' sparsicostata Zone, Acostian, Araguatian, and Lucian. Blow (1959) reported isolated specimens from his G. insueta and G. fohsi Zones.

**Textularia cf. mexicana** Cushman

*Textularia mexicana* CUSHMAN 1922, pl. 2, fig. 9

*Textularia cf. mexicana* Cushman. —RENZ 1948, pl. 12, fig. 2. —BOLLI, et. al. 1994, pl. 76, fig. 2

**Description:** Small compressed test, broadly triangular in shape, periphery acute. Greatest breadth towards the apertural end. Apical end rounded, chambers indistinct, following chambers increase in size gradually as added, sloping. Sutures indistinct, flush and limbate, occasionally raised with coarse grained material. Wall coarse grained, roughened surface. Aperture a semicircular opening at the base of the apertural face.

**Occurrence:** Offshore Cabinda found in CABGOC 115-1X at 7,200' and 7,260'.
Remarks: Originally described from Recent material from the Gulf of Mexico. The specimens from Cabinda are more compressed than the holotype figure.

*Textularia michai* Popescu

Plate 71, figures 10a, 10b

*Textularia michai* POPESCU 1979, pl. 2, fig. 3 *(fide* Ellis & Messina 1940, *et. seq.)*

**Description:** Large test, elongate and compressed at its initial end, becoming ovoid in subsequent growth. Ten to twelve chambers alternate, acute margin, carinate in the early portion. Sutures distinct and depressed. Aperture a low slit towards the base of the last formed chamber. Wall finely agglutinating with a smooth finish.

**Occurrence:** Single specimen identified in Costei, Romania.

Remarks: Originally described from the upper mid Miocene of south-western Romania.

*Textularia miozea* Finlay

Plate 54, figures 2a, 2b

*Textularia miozea* FINLAY 1939 *(fide* Ellis & Messina 1940, *et. seq.)*

*Textularia miozea* Finlay. --FINLAY 1947, pl. 2, figs. 18 - 20 *(fide* Ellis & Messina 1940, *et. seq.)*

**Description:** Moderate sized test, gently tapering, slightly compressed. Subacute keels. Chambers increase in size gradually as added initially, becoming uniform in size and shape in adult growth. Chambers slope distinctively, sutures are depressed and slope toward the periphery. Wall coarse grained. Aperture a low arch at the base of the final chamber.

**Occurrence:** Found offshore Cabinda in CABGOC 128-3 between 630' and 1,620'.

Remarks: Originally described from the Lower Miocene of New Zealand. These specimens show a closer resemblance to Finlay's figure 19, the coarse grained 'espinose' form.

*Textularia mississippiensis* Cushman

*Textularia mississippiensis* CUSHMAN 1922, pl. 14, fig. 4

**Description:** Elongate, broad, compressed test. Greatest breadth towards the centre, periphery acute and irregular. Often broken. Chambers low and broad, indistinct at initial end, become higher with growth, sloping. Sutures sloping, raised by accumulation of coarser grained material. Chamber walls fine grained and smooth. Aperture not observed.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 between 5,180' and 10,100', and in CABGOC 115-1X between 1,790' and 2,930'.

Remarks: Originally described from the Oligocene of Mississippi.
Textularia mississippiensis alazanensis Nuttall
Plate 54, figure 3
Textularia mississippiensis var. alazanensis NUTTALL 1932, pl. 1, fig. 1
Textularia mississippiensis var. alazanensis Nuttall. --RENZ 1948, pl. 12, fig. 1. --BOLLI, et. al. 1994, pl. 76, fig. 1
Description: Differs from the typical in the strongly limbate nature of the sutures and presence of a narrow central ridge running the length of the test where the raised sutures fuse. Periphery may develop a narrow serrate flange.
Occurrence: Offshore Cabinda found in CABGOC 115-1X between 6,000' and 8,220'.
Remarks: Originally described from the Lower Oligocene of Mexico. Comparable forms are evident in the J. Doreen collection.

Textularia obliqua Dorsey
Plate 54, figure 4
Textularia obliqua DORSEY 1948, pl. 28, figs. 6 - 7 (fide Ellis & Messina 1940, et. seq.)
Textularia sp. PETTERS 1979, pl. 2, fig. 8
Description: Medium sized test, gently tapered, rounded periphery, greatest breadth towards the apertural end. Initial end bluntly pointed, chambers elongate and oblique, overlapping slightly at the medial line, gradually increase in size as added. Sutures indistinct, depressed and straight, sloping. Wall of moderate grain size with proportion of cement. Aperture a low arch at the base of the apertural face in a re-entrant.
Occurrence: Offshore Cabinda found in CABGOC 128-3 at 4,650' and 10,100', and in CABGOC 115-1X at 1,850' and 5,940'.
Remarks: Originally described from the Miocene of Maryland.

Textularia panamensis Cushman
Plate 18, figures 1a, 1b; Plate 54, figures 5a, 5b
Textularia panamensis CUSHMAN 1918, pl. 20, fig. 1
Textularia panamensis Cushman. --RENZ 1948, pl. 1, figs. 21 - 22. --BLOW 1959, pl. 7, fig. 3. --PETTERS 1982, pl. 3, fig. 4. --BOLLI, et. al. 1994, pl. 76, figs. 11 - 12
Occurrence: Confined to M. superbus zonule in Venezuela. Offshore Cabinda found in CABGOC 128-3 at 5,240' and 9,260', and in CABGOC 115-1X at 6,900'.
Remarks: Renz (1948) found the species scarce in his M. superbus-T. cf. pacifica zonule but common in his T. panamaensis zonule. Blow (1959) reported the taxon as scarce in the lower portion of his S. seminulina Zone becoming more common towards its mid and upper regions and the lower portion of the G. bulloides Zone. Comparable forms are evident in the J. Doreen collection. Cursory examination of faunal slides of Whittaker (1988) reveal comparable forms in the Tosagua Formation, Ecuador.
Textularia pozonensis Cushman & Renz
Plate 18, figures 2a, 2b; Plate 54, figure 6

Textularia pozonensis CUSHMAN & RENZ 1941, pl. 1, fig. 6
Textularia pozonensis Cushman & Renz. --RENZ 1948, pl. 1, fig. 23. --BLOW 1959, p. 114. --BOLLI, et al. 1994, pl. 76, fig. 16

Description: Small species, compressed, periphery rounded. Chambers inflated and increasing in size. Sutures depressed and oblique. Coarsely arenaceous, roughened. Aperture at base of last formed chamber, but invariably obscured.

Occurrence: Single specimen in G. fohsi Zone in Venezuela. Offshore Cabinda found in CABGOC 128-3 between 3,630' and 10,100', and in CABGOC 115-1X between 4,970', and 9,060', in both wells the taxon becomes less common down well.

Remarks: Cushman and Renz (1941) described the species from the upper Agua Salada Formation. Renz (1948) finds the species associated with T. panamaensis in the M. superbus-T. cf. pacifica and R. spinulosa / E. poeyanum zonules and common in the T. panamaensis zonule. Blow (1959) notes the taxon as scarce in the lower extremes of his S. seminulina Zone, becoming more common towards its middle and upper ranges and into the lower reaches of his G. bulloides Zone.

Textularia tatumi Cushman & Ellisor
Plate 18, figures 3a, 3b; Plate 54, figure 7

Textularia tatumi CUSHMAN & ELLSJOR 1939, pl. 1, fig. 2
Textularia tatumi Cushman & Ellisor. --SKINNER & GLASER 1972, pl. 1, fig 7

Description: Short broad test, almost equidimensional. Subacute periphery, broadest towards the median line gently tapering towards the margins. Chambers increase rapidly in size, becoming broader and curved towards the periphery. Medium grain size with high proportion of cement, smoothly finished. Apertural face truncate, aperture a broad low opening at the base of the apertural face on the median line.

Occurrence: Infrequent occurrence between the M. basispinosus and S. transversa Zones in Venezuela. Offshore Cabinda found in CABGOC 128-3 at 4,440' and 5,180'.

Remarks: First record of this species from the Agua Salada Formation.

Textularia teasi Cushman & Ellisor
Plate 54, figure 8

Textularia teasi CUSHMAN & ELLISOR 1939, pl. 1, fig. 3

Description: Elongate tapering test, periphery subacute becoming rounded with growth. Initial end subacute, tapering to greatest breadth towards the apertural end. Chambers distinct and inflated, gradually increasing in size as added, become more bulbous with growth. Sutures depressed, initially oblique, becoming horizontal. Wall fine grained and smooth in the initial portion, becoming coarser grained and roughened. Aperture a semicircular opening at the base of the apertural face on the medial line.

Occurrence: Offshore Cabinda found in CABGOC 128-3 at 4,770' and in CABGOC 115-1X at 7,380'.

125
Remarks: Originally described from the Oligocene of Louisiana.

**Textularia tumidulum** Cushman

**Plate 18, figures 4a, 4b**

*Textularia tumidulum* CUSHMAN 1922, pl. 15, figs. 1-2

*Textularia tumidulum* Cushman. --SKINNER & STEINKRAUS 1972

**Description:** Large, elongate, test. Slightly compressed towards periphery producing a subacute margin. Central portion thick. Sides almost parallel, chambers numerous. Last formed chamber may be distinctly offset from earlier growth. Fine grained test, with high proportion of cement. Sutures indistinct, but may show characteristic curved indentation towards central region. Aperture a low slit at base of apertural face.

**Occurrence:** Confined to single sample in the *V. herricki* Zone in Venezuela.

**Remarks:** First record of this species from the Agua Salada Formation. Previously described from the Oligocene of Mississippi.

**Textularia** sp. 1

**Plate 18, figures 5a, 5b**

**Description:** Strongly tapering finely grained test, flattened towards the initial end. Rhombic in cross section. Subacute margin. Finely grained, high proportion of cement. Chambers steadily increase in size as added, arcuate. Sutures composed of slightly coarser material and slightly raised, limbate and overlapping in the medial portion. Aperture a small rounded opening at the base of the apertural face.

**Occurrence:** Intermittent occurrence throughout the Venezuelan section. Acme occurrence in sample 2615 of the *G. fohsi* Zone.

**Remarks:** First record of this taxon from the Agua Salada Formation.

**Textularia** sp. 2

**Plate 18, figures 6a, 6b**

**Description:** Large robust test, semicompressed. Strongly tapering, acute margin. Fine grained test, smooth, large portion of cement. Eight pairs of chambers, steadily increase in size as added. Sutures strongly limbate and downward sloping, flush with surface and filled with extra wall material. Aperture not recovered.

**Occurrence:** Confined to single sample in the *V. herricki* Zone in Venezuela.

**Remarks:** First recording of this taxon from the Agua Salada Formation.

Subfamily SIPHOTEXTULARIINAE Loeblich & Tappan, 1985

Genus SIPHOTEXTULARIA Finlay, 1939

*Siphotextularia* sp.

**Plate 72, figures 1a, 1b**

**Description:** Medium sized test, tapering, acute margins. Oblong in cross section. Biserial chambers increase gradually in size as added, oblong and truncate, sloping. Sutures slightly
depressed, straight and sloping. Wall finely grained, smooth. Aperture an ovoid opening on a short neck towards the base of the apertural face.

**Occurrence:** Single specimen recovered from Costei, Romania.

**Remarks:** Taxon similar to *S. concava* but the aperture in this taxon has an extended neck and more slender test than *S. concava*.

Family PSEUDOOGAUDRYINIDAE Loeblich & Tappan, 1985
Subfamily PSEUDOOGAUDRYININAE Loeblich & Tappan, 1985
Genus CLAVULINOIDES Cushman, 1936

**Clavulinoides sp. 1**
Plate 19, figures 1a, 1b

**Description:** Initial triserial chambers rapidly reduce to biserial and finally uniserial growth. Fine grained wall with high proportion of cement. Chambers bulbous and inflated, increase in size as added. Sutures strongly incised and filled with agglutinating material in the earlier portion of the test. Aperture not observed.

**Occurrence:** Intermittent throughout the Venezuelan section, acme occurrence in sample 2725 of the *L. wallacei* Zone.

**Remarks:** First record of this taxon from the Agua Salada Formation.

**Clavulinoides sp. 2**

**Description:** Partial specimen, moderate grain size, robust.

**Occurrence:** Single specimen found at Lapugiu du Sus, Romania.

Genus PSEUDOOGAUDRYINA Cushman, 1936

**Pseudogaudryina alazanensis** (Cushman)

*Gaudryina (Pseudogaudryina) alazanensis* CUSHMAN 1936, pl. 2, fig. 17

**Description:** Large elongate test. Early triserial portion triangular in cross section, flat sides, margins subacute, chambers indistinct. Subsequent biserial growth of inflated chambers, bulbous. Sutures indistinct in early portion, depressed in biserial portion and horizontal. Coarse grained wall, rough surface. Aperture an oval opening in re-entrant.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 at 6,440'.

**Remarks:** Originally described from the Oligocene of Mexico. Noted in northern Venezuela (Renz 1948).

**Pseudogaudryina bullbrooki** Cushman

Plate 19, figure 2; Plate 55, figure 1

*Pseudogaudryina bullbrooki* CUSHMAN 1936, pl. 2, fig. 16

*Gaudryina (Pseudogaudryina) bullbrooki* (Cushman). CUSHMAN 1937, pl. 14, figs. 1 - 2

*Pseudogaudryina bullbrooki* Cushman. --CUSHMAN & RENZ 1947, pl. 1, fig. 18. --RENZ 1948, pl. 2, fig 6.

--BLOW 1959, p. 115

*Gaudryina bullbrooki* (Cushman). --BOLLI, et. al. 1994, pl. 76, fig. 24
Description: Test tapering, triangular with blunt keels. Chambers rapidly increase in width towards the apertural end. Sutures not heavily depressed, but distinct, become indistinct with growth, oblique and slightly curved. Wall of moderate grain size and may become roughly finished, though some specimens are smoother than others. Aperture a low slit in a re-entrant at the base of the last formed chamber, frequently obscured.

Occurrence: Scarce between the M. basispinosus and V. herricki Zones in Venezuela. Offshore Cabinda found in CABGOC 115-1X between 6,540' and 8,940'.

Remarks: Renz (1948) noted this species in the Acostian, upper Araguatian, and Lucian. Previously recorded from the Miocene of Trinidad (Cushman 1936). Blow note the species as generally scarce but ranging from his C. stainforthi to G. menardii menardii / G. nepenthes Zones. Specimens of Gaudryina sp. of the Heron-Allen and Earland collection (P32322-32355) compare well with those of this study. Cursory examination of faunal slides of Whittaker (1988) reveal comparable forms in the Tosagua Formation, Ecuador. In addition, comparable forms are evident in the J. Doreen collection. Known from additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966).

Pseudogaudryina jacksonensis abnormis Cushman & Renz
Plate 19, figure 3; Plate 55, figure 2
Pseudogaudryina jacksonensis var. irregularis CUSHMAN & RENZ 1941, pl. 1, figs. 11 - 12
Pseudogaudryina jacksonensis var. abnormis CUSHMAN & RENZ 1944, p. 78.
Gaudryina (Pseudogaudryina) jacksonensis var. abnormis Cushman & Renz. --CUSHMAN & RENZ 1947, pl. 1, fig. 15
Pseudogaudryina jacksonensis var. abnormis Cushman & Renz. --RENZ 1942, pl. 2, figs. 4 - 5. --BLOW 1959, p. 115.
Gaudryina jacksonensis var. abnormis Cushman & Renz. --BOLLI, et. al. 1994, pl. 76, figs. 22 - 23
Description: Differs from the typical species in the deeply excavated chamber walls and sutures, and acute periphery.

Occurrence: Single specimen in G. fohsi Zone in Venezuela. Offshore Cabinda found in CABGOC 115-1X between 7,440' and 10,020'.

Remarks: Cushman and Renz (1941) originally described the species from the lower Agua Salada Formation. Renz (1948), subsequently found the species to be restricted to the Acoastian of the Agua Salada Basin, but also found it in Upper and Oligocene sediments of other areas of Venezuela, Barbados, Trinidad and Mexico. Blow (1959) notes the species as common in his C. stainforthi Zone and scarce in his G. insueta Zone. Recognised along the Gulf Coast (Garret 1938). Cursory examination of faunal slides of Whittaker (1988) reveal comparable forms in the Viche Formation, Ecuador.
Family VALVULINIDAE Berthelin, 1880
Subfamily VALVULININAE Berthelin, 1880
Genus CLAVULINA d'Orbigny, 1826

Clavulina carinata Cushman & Renz

Plate 19, figures 4a, 4b

Clavulina carinata CUSHMAN & RENZ 1941, pl. 1, fig. 18

Clavulina carinata Cushman & Renz. --RENZ 1948, pl. 1, fig. 25. --BOLLI, et. al. 1994, pl. 76, fig. 21

Pseudoclavulina carinata (Cushman & Renz). --BLOW 1959, p. 115 - 116

Description: Triserual portion of test constitutes majority of growth. Uniserual stage short. Walls slightly concave with subacute periphery. Triserual stage chambers indistinct, becoming more distinct in uniserual stage, chambers uninflated. Sutures indistinct. Moderate grain size. Aperture terminal rounded opening in last formed chamber.

Occurrence: Intermittent occurrence throughout the Venezuelan section.

Remarks: Always poorly preserved. Cushman and Renz (1941) found this species throughout the Agua Salada Formation, Renz (1948) subsequently noted it as scarce in the Acostian and common in the Araguatian and Lucian. He also noted its presence in Colombia and Mexico. Blow (1959) found the species to be scarce.

Clavulina sp. 1

Description: Poorly preserved individuals tentatively assigned to the genus.


Remarks: First record of this taxon in the Agua Salada Formation

Genus CYLINDROCLAVULINA Bermúdez & Key, 1952

Cylindroclavulina rudis (Costa)

Plate 72, figures 2 - 5

Glandulina rudis COSTA 1855, pl. 1, figs. 12 - 13 (fide Ellis & Messina 1940 et. seq.)

Cylindroclavulina rudis (Costa). --POPESCU 1975, pl. 8, figs. 1 - 2, pl. 10, figs. 3 - 4, textfig. 7. --LUCZKOWSKA 1990, pl. 1, fig. 1. --SPROVIERI & HASEGAWA 1990, pl. 1, figs. 3 - 4. --CICHA, et. al. 1998, pl. 10, figs. 9 - 10

Description: Thick walled uniserial taxon. Rounded in apertural view, tapers slightly away from initial rounded chambers to apertural chamber. Coarse grained, sutures slightly depressed, chambers slightly inflated. Aperture a terminal opening with slight lip. Ontogenetically aperture develops from simple round opening to ovoid orifice with bifid tooth.

Occurrence: Common in Sacel, Romania.

Remarks: Specimens compare well with those of the Heron-Allen and Earland collection (P32399-32450, P32472-32499), the Brady collection (NHM), and with examples of Clavulina rostrata of the Brady collection (NHM). Known from the Miocene of the Gulf of Suez region (Souya 1965).
Genus VALVULINA d'Orbigny, 1826

Valvulina cf. chapmani Cushman

Valvulina chapmani Cushman 1937, pl. 2, figs. 1 - 2
Valvulina cf. chapmani CUSHMAN 1937. -RENZ 1948, pl. 2, figs. 9 - 10

Description: Test elongate and inflated although often deformed and compressed. Chambers and sutures distinct. Test wall finely grained and smoothly finished, occasional larger fragments may be incorporated. Aperture a large opening in a re-entrant on the inner margin. Valvular tooth obscured.

Occurrence: Only found in the G. fohsi Zone, scarce in Venezuela. Offshore Cabinda found in CABGOC 115-1X between 6,600' and 8,940'.

Remarks: Renz (1948) found a questionably identified form of this species in the upper Acostian and lower Araguatian of the Agua Salada Basin. The form is much shortened and may represent juvenile individuals. He also noted its occurrence in Trinidad. Cursory examination of faunal slides of Whittaker (1988) reveal comparable forms in the Tosagua and Viche Formations, Ecuador. In addition, comparable forms are evident in the J. Doreen collection.

Valvulina flexills Cushman & Renz

Plate 8, figures 2 - 3; Plate 19, figures 5a, 5b; Plate 55, figure 3; Plate 72, figures 6a, 6b

Valvulina flexills CUSHMAN & RENZ 1941, figs. 16 - 17
Valvulina flexills Cushman & Renz. --CUSHMAN & STAINFORTH 1945, pl. 2, fig. 4. --CUSHMAN 1947, pl. 1, fig. 8. --CUSHMAN & RENZ 1947, pl. 1, fig. 19. --CUSHMAN & RENZ 1948, pl. 3, fig. 9. --RENZ 1948, pl. 2, figs. 11 - 12. --BRÖNNIMANN 1953, textfig. 15. --BLOW 1959, p. 118. --DIAZ de GAMERO 1977, pl. 3, fig. 13. --PETTERS 1982, pl. 1, fig. 27. --DIAZ de GAMERO 1985a, pl. 4, fig. 20. --BOLLI, et al. 1994, pl. 64, figs. 30 - 32, pl. 76, figs. 17 - 18, pl. 81, fig. 6
Dorothia flexills (Cushman & Renz). --POPESCU 1975, pl. 6, figs. 2 - 4, pl. 7, figs. 3 - 5

Description: Large species, compressed, triserial. Periphery lobate, chambers rounded and inflated, increasing in size. Sutures depressed. Medium grain size, much cement. Aperture arched at base of apertural face with tooth. Often deformed, valvular tooth obscured.

Occurrence: Occurs commonly throughout the Venezuelan section. Acme occurrences at sample 2610 of the V. herricki Zone and sample 2702 of the S. transversa Zone. Offshore Cabinda found in CABGOC 128-3 between 4,350' and 10,160', and in CABGOC 115-1X between 4,970' and 10,020', becoming more common down well. Recovered from the Chechis Maris and Sacel, Romania.

Remarks: This is the index species for the Agua Salada Fauna (Renz 1948). Cushman and Renz (1941) found the form throughout the Agua Salada Formation. Renz (1948) found the species to be locally common to abundant in non-calcareous clays, but scarce on the whole. Brönnimann (1953), noted the obscure nature of the valvular tooth and also recorded the species occurrence in Trinidad. He noted the species to be confined to the Agua Salada Formation in Venezuela. Blow (1959) only observed the species in his arenaceous facies. Diaz de Gamero (1985a) reported the taxon from her upper arenaceous interval. Cursory examination of faunal slides of Whittaker (1988) reveal comparable forms in the Tosagua Formation, Ecuador.
Superfamily MILIOLACEA Ehrenberg, 1839
Family SPIROLOCULINIDAE Wiesner, 1920
Genus ADESLOSINA d'Orbigny, 1826

_Adeslosina longirostra_ (d'Orbigny)

_Plate 73, figure 1_

Quinqueloculina longirostra d'ORBIGNY 1846, pl. 18, figs. 25 - 27
Adeslosina longirostra (d'Orbigny). --PAPP & SCHMID 1985, pl. 95, figs. 9 - 12. --FILIPESCU 1996, pl. 1, fig. 8. --CICHA, et. al. 1998, pl. 12, figs. 7 - 8

Description: Compressed test, last two chambers enlarged, partially embracing, and keeled. Angular in cross section. Aperture circular with bifid tooth.

Occurrence: In Costei occurs at a fairly high frequency, single specimens found in Lapugiu du Sus and Vâlcele, Romania.

Remarks: Originally described from the Tertiary of the Vienna Basin. Specimens are comparable to those of the Burrow and Holland collection (slide G, NHM).

_Adeslosina schreibersii_ (d'Orbigny)

_Plate 73, figures 2a, 2b_

Quinqueloculina schreibersii d'ORBIGNY 1846, pl. 19, figs. 22 - 24
Adeslosina schreibersii (d'Orbigny). --PAPP & SCHMID 1985, pl. 98, figs. 6 - 8, pl. 99, figs. 1 - 10, 13. --CICHA, et. al. 1998, pl. 12, figs. 9 - 11

Description: Large test, rounded in cross-section. Characteristic ornamentation of longitudinal striae on latter formed chambers. Aperture rounded with bifid tooth. Specimens slightly abraded.

Occurrence: Observed in Costei, Romania.

Remarks: Originally described from the Tertiary of the Vienna Basin.

Genus SPIROLOCULINA d'Orbigny, 1826

_Spiroloculina excavata_ d'Orbigny

_Plate 73, figures 3 - 4_

_Spiroloculina excavata_ d'ORBIGNY 1846, pl. 16, figs. 19 - 27
_Spiroloculina excavata_ d'Orbigny. --PAPP & SCHMID 1985, pl. 85, figs. 4 - 6. --FILIPESCU 1996, pl. 2, fig. 3. --CICHA, et. al. 1998, pl. 12, figs. 16 - 17
_Spiroloculina depressa_ d'Orbigny. --CUSHMAN & CAHILL 1933, pl. 2, fig. 7. --CIMERMAN & LANGER 1991, pl. 23, figs. 1 - 3

Description: Large spiroloculine test, robust. Oval periphery and oblong in cross-section. Successive chambers increase in size to partially embrace earlier chambers and produce a slightly concave profile to each face. Aperture a large ovoid opening with prominent bifid tooth.

Occurrence: Observed in Costei, Romania.

Remarks: Originally described from the Tertiary of the Vienna Basin. Specimens of the Gubler collection (P33221) tend to be much smaller, thinner, and more elongate than those of this study. Specimens in the Burrow and Holland collection (slide G, NHM) and the Brady collection (NHM) are comparable.
Family HAUERINIDAE Schwager, 1876
Subfamily HAUERINIAE Schwager, 1876
Genus CYCLOFORINA Luczkowska, 1972

*Cycloforina serovae* (Bogdanowicz)

*Miliola serovae* BOGDANOWICZ 1952, pl. 9, fig. 2 (*fide* Ellis & Messina 1940, *et. seq.*)


**Description:** Large test. Milionid chambers obscured by thick wall and distinct longitudinal costae. Costae continuous, strong, approximately five to six per specimen. Aperture a large round opening with prominent bifid tooth.

**Occurrence:** Two specimens found in Lapugiu du Sus, Romania.

Genus LACHLANELLA Vella, 1957

*Lachlanella bicornis* (Walker & Jacob emend. Haynes)

**Plate 73, figures 5a, 5b**

*Serpula bicornis* WALKER & JACOB 1798 (*fide* Cimerman & Langer 1991)

*Quinqueloculina bicornis* (Walker & Jacob). –HAYNES 1973, pl. 7, fig. 18, textfigs. 16, 1 - 3

*Quinqueloculina bicornis* (Walker & Jacob). –CIMERMAN & LANGER 1991, pl. 29, figs. 1 - 3

**Description:** Ovate test, rounded periphery, triangular in apertural view. Chambers one-half coil in length, five visible, inflated. Sutures slightly depressed. Wall ornamented with thick longitudinal costae. Aperture a rounded opening with distinct long tooth and thickened lip.

**Occurrence:** Common in Lapugiu du Sus, Romania.

**Remarks:** Redescribed from Recent material from Cardigan Bay. Known from Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966).

Genus MASSILINA Schlumberger, 1893

*Massilina* sp.

**Plate 56, figure 1**

**Description:** Small test, compressed, rounded periphery. Elongate chambers steadily increase in width and height as added. Sutures broad and sweeping, flush, emphasised through darkening of the test. Aperture a simple round to ovate opening without tooth. Specimens commonly broken.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 between 4,890’ and 9,260’, and in CABGOC 115-1X between 6,600’ and 7,560’.

Genus QUINQUELOCULINA d'Orbigny, 1826

*Quinqueloculina buchiana* d'Orbigny

**Plate 73, figures 6a, 6b**

*Quinqueloculina buchiana* d'ORBIGNY 1846, pl. 18, figs. 10 - 12

*Quinqueloculina buchiana* d'Orbigny. –CICHA, *et. al.* 1998, pl. 15, figs. 11 - 12

**Description:** Large inflated test, triangular in cross section. Last three chambers clearly visible, elongate with distinct outer acute margin giving triangular appearance. Wall smooth. Aperture a subrounded opening with slender bifid tooth.
Occurrence: Single specimen recovered in Costei, Romania.
Remarks: Originally described from the mid Miocene of the Vienna Basin.

Quinqueloculina haidingeri d'Orbigny
Quinqueloculina haidingeri d'ORBIGNY 1846, pl. 18, figs. 13 - 15
Quinqueloculina haidingeri d'Orbigny. —PAPP & SCHMID 1985, pl. 94, figs. 1 - 5. —CICHA, et. al. 1998, pl. 16, figs. 3 - 4
Description: Test large, compressed. Broad and sub-circular in profile. Chambers are broad, the last two embracing earlier chambers. Aperture an ovoid opening with elongate bifid tooth.
Occurrence: One specimen recovered in Lapugiu du Sus, Romania.
Remarks: Originally described from the Tertiary of the Vienna Basin. Considered to be an indicator of 'optimal conditions' (Papp & Schmid 1985). Specimen is comparable to that of the Burrow and Holland collection (slide G, NHM).

Quinqueloculina seminula (Linné)
Plate 20, figure 1; Plate 56, figure 2
Serpula seminulum LINNE 1758, p. 786 (fide Ellis & Messina 1940, et. seq.)
Quinqueloculina seminulum (Linné).—CUSHMAN 1929, pl. 9, figs. 16 - 18. —CUSHMAN 1930, pl. 2, figs. 1 - 2. —CUSHMAN & CAHILL 1933, pl. 2, fig. 2. —RENZ 1948, pl. 3, fig. 1. —PETERS 1982, pl. 4, fig. 17. —LECKIE & WEBB 1986, pl. 2, figs. 1 - 3; pl. 17, figs. 2 - 5. —CIMERMAN & LANGER 1991, pl. 34, figs. 9 - 12. —FINGER 1992, pl. 1, fig. 29. —AKIMOTO 1994, pl. 4, fig. 12
Description: Test longer than wide, greatest width towards the centre. Small species, three chambers visible in front and rear view. Rounded periphery, sutures slightly depressed. Aperture (when present) oval, with bifid tooth.
Occurrence: Single specimen in M. superbus zonule in Venezuela. Offshore Cabinda found in CABGOC 128-3 between 3,210' and 10,160', and in CABGOC 115-1X between 4,430' and 8,040'.
Remarks: Originally described from Recent sediments of the Adriatic. Renz (1948) found the species intermittently throughout the section. Also known from Trinidad, Puerto Rico, and California. Recognised in the Miocene of Gulf of Suez region (Souya 1965), the Miocene of Egypt (Macfadyen 1930), and additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966). Specimens are comparable to those of the Bhabia collection (NHM).

Quinqueloculina sp. 1
Description: Partial abraded specimen, possibly a worn T. austriaca d'Orbigny.
Occurrence: Single specimen recovered in Vâlcele, Romania.

Quinqueloculina sp. 2
Description: An elongate Milionid taxon.
Occurrence: Two specimens recovered in Lapugiu du Sus, Romania.
**Quinqueloculina sp. 3**  
Plate 56, figure 3  
**Description:** Small flattened taxon. Rounded profile. Last two chambers visible, embracing. Aperture a simple opening without a tooth.  
**Occurrence:** Offshore Cabinda found in CABGOC 128-3 between 4,650' and 10,100', and in CABGOC 115-1X between 3,410' and 9,660'.  
**Remarks:** Poor preservation.

**Quinqueloculina sp. 4**  
Plate 56, figure 4  
**Description:** Large taxon, robust, inflated. Last two embracing chambers visible. Aperture unobserved.  
**Occurrence:** Offshore Cabinda found in CABGOC 128-3 between 4,530' and 9,400', and in CABGOC 115-1X between 3,350' and 8,820'.  
**Remarks:** Poor preservation.

Subfamily MILIOLINELLINAE Vella, 1957  
Genus Biloculinella Wiesner, 1931  
*Biloculinella depressa* (d'Orbigny)  
Plate 74, figures 1a, 1b  
*Biloculinella depressa* d'ORBIGNY 1826, p. 298 (fide Ellis & Messina 1940 et. Seq.)  
*Biloculinella depressa* d'Orbigny. --PARKER, et. al. 1871, pl. 8, fig. 5 (fide Ellis & Messina 1940 et. Seq.). --NUTTALL 1927, pl. 8, fig. 1  
*Biloculinella depressa* (d'Orbigny). --POPE 1975, pl. 13, figs. 1 - 2  
**Description:** Bulbous, small test. Smaller chamber wider and more inflated than the larger embracing chamber. Large aperture, long and wide, with a thickened rim and a wide knob-like tooth.  
**Occurrence:** Single specimen found in Vâlcele, Romania.  
**Remarks:** Originally described from 'fossil and Recent' material of Italy. Specimens compare well with those of the Brady collection, and Heron-Allen and Earland collection (NHM). Of same dimensions and appearance as *P. cf. magnacaudata*, differing in lack of basal appendage.

Genus *Pyrgo* Defrance, 1824  
*Pyrgo anomala* (Schlumberger)  
*Biloculinina anomala* SCHLUMBERGER 1891, pl. 11, figs. 84 - 86, pl. 12, fig. 101, textfig. 32 - 34  
**Description:** Biloculine inflated test. Rounded periphery. Dorsal chamber semi-embracing earlier ventral portion. Radical suture depressed and distinct. Wall smooth. Aperture an ovate opening on the periphery with large bifid tooth.  
**Occurrence:** Observed in Costei, Romania.  
**Remarks:** Originally described from Recent material of the Mediterranean.
**Pyrgo cf. magnacaudata** Smith

Plate 73, figures 7 - 8

*Pyrgo magnacaudata* SMITH 1948, pl. 11, figs. 14 - 16 (fide Ellis & Messina 1940 et seq.)

*Pyrgo vespertilio* (Schlumberger). —AKERS & DOORMAN 1964, pl. 2, figs. 29 - 32. —HALLER 1980, pl. 3, fig. 3

*Fissurina* sp. Osterman & Ovane. —OSTERMAN & OVALE 1989, pl. 1, fig. 5

**Description:** Bulbous, small test. Dorsal chamber wider and more inflated than the ventral. Large aperture, long and wide, with a thickened rim and a wide tooth. Distinctive flaring basal appendage projects from the suture beyond the periphery. This may project slightly dorsally or ventrally.

**Occurrence:** Observed in Costei, Romania.

**Remarks:** Originally described from the early mid Miocene of Louisiana. These specimens differ from Smith (1948) in the nature of the basal projection. Smith's specimens possess a 'squarely truncate' projection with 'parallel sides'. The projection on the Romanian specimens is distinctively flaring. These specimens compare well with Oligocene *P. depressa* specimens of the E. O. Teale collection, Victoria, Australia (NHM reference number P26389-P26427 inclusive and P27096-P27101), which similarly display a distinctive basal flaring projection. Specimens of *Biloculina lucemula* of the M. S. Srinivasan collection, although abraded, show remnants of a basal projection (P48527).

**Pyrgo simplex** d'Orbigny

Plate 73, figure 9

*Pyrgo simplex* d'ORBIGNY 1846, pl. 15, figs. 25 - 27

*Biloculina simplex* (d'Orbigny). —PAPP & SCHMID 1985, pl. 83, figs. 1 - 6

*Pyrgo simplex* d'Orbigny. —CICHA, et. al. 1998, pl. 17, figs. 3 - 4

**Description:** Large globular test, ultimate and penultimate chambers greatly inflated. Aperture a short narrow opening at the margin with a large bifid tooth.

**Occurrence:** Offshore Cabinda found in CABGOC 115-1X between 6,540' and 9,840'. Observed in Costei, Romania.

**Remarks:** Originally described from the Tertiary of the Vienna Basin.

**Pyrgo sp.**

**Description:** Small internal mould. Rounded profile. Ultimate chamber embracing penultimate. Aperture an elongate ovoid on the periphery, no tooth apparent.

**Occurrence:** Offshore Cabinda found in CABGOC 115-1X between 3,470' and 8,700', rare.

**Remarks:** Poor preservation. Possibly an internal mould of *P. simplex* d'Orbigny.
Genus TRILOCULINA d'Orbigny

*Triloculina austriaca* d'Orbigny

**Plate 74, figures 2a, 2b**

*Triloculina austriaca* d'ORBIGNY 1846, pl. 16, figs. 25 - 27

*Triloculina austriaca* d'Orbigny. --POPESCU 1975, pl. 13, fig. 3, pl. 14, figs. 1 - 2

**Description:** Ovate inflated test, rotund. Triangular in cross section. Last three chambers visible, inflated, broad and low. Rounded angular margins. Longitudinal sutures distinct and depressed. Wall smooth. Aperture an ovate opening in the foreshortening of the ultimate chamber, small tooth.

**Occurrence:** In Romania found in Costei.

**Remarks:** Originally described from the mid Miocene of the Vienna Basin. Specimens compare well those of the Burrow and Holland collection (slide G, NHM).

*Triloculina tenuidomus* (Popescu)

**Plate 74, figures 3 - 4**

*Triloculinopsis tenuidomus* POPESCU 1975, pl. 14, figs. 3 - 5

**Description:** An elongate taxon, robust test, ovoid in outline. Periphery rounded and inflated. Chambers inflated and embracing, elongate. Sutures indistinct. Aperture a wide ovate opening in the ultimate chamber with small tooth. Specimens always abraded.

**Occurrence:** Recovered from Vâlcele, Costei, Lapugiu du Sus, and Sacel, Romania.

**Remarks:** Specimens are comparable to those of the Burrow and Holland collection (slide G, NHM).

*Triloculina sp.1*

**Plate 20, figure 2**

**Description:** Partial pyrite internal mould recovered. Possibly *Triloculina tricarinata*, but insufficient recovery for absolute identification.

**Occurrence:** Single occurrence in *G. fohsi* Zone in Venezuela.

**Remarks:** First record of this taxon from the Agua Salada Formation.

Subfamily SIGMOILINITINAE Luczkowska, 1974

Genus SIGMOILINA Schlumberger, 1887

*Sigmoilina ?* sp

**Description:** Single poorly preserved specimen tentatively placed in this genus.

**Occurrence:** Single specimen recovered from Vâlcele, Romania.
Genus SIGMOILINITA Seiglie, 1965

**Sigmoilinita tenuis** (Czjzek)

Plate 20, figure 3; Plate 56, figure 5; Plate 74, figures 6a, 6b

**Quinqueloculina tenuis** CZJZEK 1847, pl. 13, figs. 31 - 34 (fide Ellis & Messina 1940, et. seq.)

**Sigmoilina tenuis** (Czjzek). --CUSHMAN 1918, pl. 31, figs. 4a - c. --CUSHMAN 1930, pl. 2, fig. 8. --NUTTALL 1932, pl. 1, fig. 4. --CUSHMAN & CAHILL 1933, pl. 3, fig. 1. --RENZ 1948, pl. 2, fig. 23. --POPESCU 1975, pl. 12, fig. 2. --WRIGHT 1978, pl. 7, fig. 18. --SKINNER & GLASER 1972, pl. 2, fig. 1. --BORNMALM 1997, fig. 14E

**Spiroloculina tenuis** (Czjzek). --MACFADYEN 1930, pl. 1, fig. 1. --PETTERS 1982, pl. 4, figs. 13, 22

'Sigmoilina' tenuis (Czjzek). --HALLER 1980, pl. 2, fig. 9

**Sigmoilinita tenuis** (Czjzek). --KOHL 1985, pl. 5, fig. 5. --HASEGAWA, et. al. 1990, pl. 2, figs. 8 - 9. --CIMERMAN & LANGER 1991, pl. 45, figs. 7 - 10. --CICHA, et. al. 1998, pl. 17, figs. 15 - 16

**Massilina tenuis** (Czjzek). --DIAZ de GAMERO 1985a, pl. 5, fig. 2

**Description:** Small species, test longer than broad and compressed. 4 - 5 chambers visible on either side forming a sigmoidal curve, sutures always indistinct as specimens always worn. Wall, when preserved, smooth, aperture terminal, circular, with short neck.

**Occurrence:** Rare in Venezuela, occurs intermittently throughout the section. Offshore Cabinda found in CABGOC 128-3 between 9,260' and 10,160', and in CABGOC 115-1X between 7,440' and 8,400'. Single specimen recovered in Sacel, Romania.

**Remarks:** Originally described from the Tertiary of the Vienna Basin. Renz (1948) found the species scarce through most of the basin and not apparent in the Lucian. Also known from Ecuador, Trinidad, Cuba, Jamaica, Mexico, California, and the Gulf Coast. Recognised in the Miocene of the Gulf of Suez region (Souya 1965), along the Gulf Coast (Garret 1938), and found to be well preserved compared to other Miliolininae in the Miocene of Egypt (Macfadyen 1930). Known from Recent sediments of the Côte d'Ivoire (Calvez 1963) and additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966). Specimens compare well with *Spiroloculina tenuis* of the T. R. Jones collection (P32969) and *Sigmoilina tenuis* of the Burrow and Holland collection (slide F, NHM).

Subfamily SIGMOILOPSINAE Vella, 1957

Genus SIGMOILOPSIS Finlay, 1947

**Sigmoilopsis celata** (Costa)

Plate 74, figure 7

**Spiroloculina celata** COSTA 1855, pl. 1, fig. 14 (fide Ellis & Messina 1940, et. seq.)

**Sigmoilopsis celata** (Costa). --POPESCU 1975, pl. 11, figs. 7 - 8

**Description:** Ovate compressed test, inflated, rounded periphery. Finely agglutinating. Last 2 - 3 chambers visible, inflated, sutures indistinct. Aperture a rounded opening at the terminal end of the ultimate chamber.

**Occurrence:** Recovered from Vâlcele and Costei, Romania.

**Remarks:** Originally described from the Tertiary of Italy. Specimens compare well with those of the Gubler collection (P33222) and the Burrow and Holland collection (slide G, NHM). Known from the Miocene of the Gulf of Suez region (Souya 1965), and the Miocene of Haiti (Coryell & Rivero 1940).
**Sigmoilopsis colomi** (Glàçon & Mangé)

**Plate 74, figures 8a, 8b**

*Sigmoilina colomi* GLAÇON & MANGÉ 1953, textfig. 1 - 5 (*fide* Ellis & Messina 1940, *et. seq.*)

*Sigmoilopsis colomi* (Glàçon & Mangé). — POPESCU 1975, pl. 11, figs. 1 - 2

**Description:** Robust test, compressed. Rounded periphery, oval outline. Finely glutting test. Last 3 - 4 chambers visible, increasing in size as added, inflated. Sutures depressed. Aperture an oval opening in the terminal end of the last chamber, varies in size.

**Occurrence:** Offshore Cabinda found in CABGOC 115-1X at 7,140'. Observed in the Chechis Marls, Romania.

**Remarks:** Originally described from the lower Miocene of Algeria.

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**Sigmoilopsis schiumbergeri** (Silvestri)

**Plate 74, figures 9 - 11**

*Sigmoilina schiumbergeri* SILVESTRI 1904, figs. 6 - 7, 12 - 14 (*fide* Ellis & Messina 1940, *et. seq.*)

*Sigmoilina schiumbergeri* Silvestri. — CUSHMAN & STAINFORTH 1945, pl. 2, fig. 20

*Sigmoilopsis schiumbergeri* (Silvestri). — AKERS & DOORMAN 1964, pl. 2, figs. 16 - 18. — POPESCU 1975, pl. 10, fig. 1, pl. 11, figs. 9 - 10. — DIAZ de GAMERO 1985a, pl. 5, fig. 7. — KOHL 1985, pl. 5, fig. 6. — BELANGER & BERGGREN 1986, pl. 1, fig. 5. — HASEGAWA, *et. al.* 1990, pl. 1, figs. 16 - 17. — VAN MORKHOVEN, *et. al.* 1986, pl. 18, fig. 1. — CIMERMAN & LANGER 1991, pl. 46, figs. 10 - 14. — KAIHO 1992a, pl. 2, fig. 7. — AKIMOTO 1994, pl. 4, fig. 15. — BORNMALM 1997, fig. 14F

**Description:** Ovate test, sub-triangular in transverse section. Indistinct chambers and sutures. Chambers inflated. Wall can be finely to coarsely agglutinating. Aperture a rounded terminal opening on a short neck with a small bifid tooth, slight lip.

**Occurrence:** Offshore Cabinda found intermittently in CABGOC 128-3 between 630' and 10,160'. Recovered from Vâlcele, Lapugiu du Sus, the Chechis Marls, and Sacel Romania.

**Remarks:** Originally described from modern sediments of the Atlantic. Cursory examination of faunal slides of Whittaker (1988) reveal comparable forms in the Tosagua and Cacelta Formations, Ecuador. In addition, comparable forms are evident in the J. Doreen collection. Known from the Miocene of the Gulf of Suez region (Souya 1965) and additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966).

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**Family ALVEOLINIDAE** Ehrenberg, 1839

**Genus BORELIS** de Montfort, 1808

**Borelis mello** (Fitchel & Moll)

**Plate 75, figure 1**

*Nautilus mello* var. L. FITCHEL & MOLL 1798, pl. 24, figs. a - f (*fide* Ellis & Messina 1940, *et. seq.*)

*Alveolina mello* d'Orbigny. — d'ORBIGNY 1846, pl. 7, figs. 15 - 16

*Borelis mello* (Fitchel & Moll). — PAPP & SCHMID 1985, pl. 47, figs. 1 - 12, textfig. 7. — FILIPESCU 1996, pl. 2, fig. 1


**Description:** Globular test, may become oval to fusiform on rare occasions. Longitudinal sutures on the exterior. Apertures of last whorl may be linear or uniserial. Always recovered as worn specimens.
Occurrence: Common to Costei and Lapugiu du Sus in Romania.
Remarks: Originally described from the Tertiary of the Vienna Basin. Considered to be an inshore, shallow water, 'ecologically sensitive' taxon (Papp & Schmid 1985). Para-neotypes of the Hasen and Rögl collection (NHM) tend to be larger than the specimens of this study, but otherwise show a good comparison. Specimens show a good comparison to examples in the Adams collection (P43888).

Order LAGENIDA Lankester, 1885
Suborder LAGENINA Delage & Herouard, 1896
Superfamily NODOSARIACEA Ehrenberg, 1836
Family NODOSARIIDAE Ehrenberg, 1838
Subfamily NODOSARIINAE Ehrenberg, 1838
Genus DENTALINA Risso, 1826

*Dentalina advena* (Cushman)

Plate 20, figure 4

*Nodosaria advena* CUSHMAN 1923, pl. 14, fig. 12
*Dentalina advena* (Cushman). –RENZ 1948, pl. 9, fig 27. –BERGGREN 1972, pl. 9, fig. 2. –LECKIE & WEBB 1986, pl. 19, figs. 13 - 15

Description: Elongate test, slightly tapering. Few chambers, apertural end slightly drawn out and wider. Sutures oblique and depressed. Wall smooth, aperture radiate, though rarely found intact. Normally found as fragments.

Occurrence: Confined to *M. basispinosus, V. herricki* and *G. fohsi* Zones, isolated occurrence in *L. wallacei* Zone in Venezuela. Offshore Cabinda found in CABGOC 115-1X between 3,140' and 8,880'.

Remarks: No quantitative study was made of this species as a result of its fragmented recovery. Originally described from Recent sediments offshore the north-eastern American coast. Renz (1948) found the species very scarce in the upper Acostian and Lucian. Blow (1959) only recovered isolated samples. These specimens compare well with those of the Burrow and Holland collection (slide B, NHM).

*Dentalina cf. advena* (Cushman)

Plate 56, figure 6

*Nodosaria advena* CUSHMAN 1923, pl. 14, fig. 12
*Dentalina cf. advena* (Cushman). –BLOW 1959, p. 120

Description: Differs from the typical in having fewer chambers and a greater angle to the sutures.

Occurrence: Offshore Cabinda found in CABGOC 128-3 between 6,380' and 10,100'.

Remarks: Fragmentary recovery.
**Dentalina consorbrina** d'Orbigny

*Plate 56, figure 7; Plate 75, figure 2*

*Dentalina consorbrina* d'Orbigny 1846, pl. 2, figs. 1 - 3

*Stilostomella* sp. PETTERS 1979, pl. 2, fig. 7

*Dentalina consorbrina* d'Orbigny. --CUSHMAN 1929, pl. 12, fig. 27. --CORYELL & RIVERO 1940, pl. 41, figs. 17, 23

*Nodosaria consorbrina* (d'Orbigny). --MACFADYEN 1930, pl. 2, fig. 20. --CORYELL & RIVERO 1940, pl. 41, figs. 17, 23

*Dentalina cf. consorbrina* d'Orbigny. --LE ROY 1939, pl. 7, figs. 31 - 32

*Dentalina sp. aff. consorbrina* d'Orbigny. --RENZ 1948, pl. 9, fig. 30

*Siphonodosaria consorbrina* (d'Orbigny). --THOMPSON 1980, pl. 8, fig. 7. --BORNMALM 1997, fig. 18H. -- BOLLI, et. al. 1994, pl. 87, fig. 41

*Stilostomella consorbrina* (d'Orbigny). --PAPP & SCHMID 1985, pl. 11, figs. 1 - 5. --THOMAS 1985, pl. 14, figs. 6 - 7

*Stilostomella cf. consorbrina* (d'Orbigny). --SCHÖFELD & SPIEGLER 1995, pl. 2, fig. 2

*Description:* Always found broken. Smooth wall, aperture distinct and slightly oblique. Chambers bulbous and slightly offset from one another. Aperture and embryonic chambers not recovered.

*Occurrence:* Intermittent recovery throughout Venezuelan section. Offshore Cabinda found infrequently in CABGOC 128-3 between 4,650' and 10,100', and in CABGOC 115-1X between 3,350' and 8,400'. Observed in the Chechis Marls, Romania.

*Remarks:* Originally described from the Miocene (Badenian) of the Vienna Basin. No quantitative study was made of this species as a result of its fragmented recovery. Renz (1948) noted a similar species in the upper Acostian and lower Araguatian. Recognised in the Miocene of the Gulf of Suez region (Souya 1965) and as fragmentary pieces in Haiti (Coryell and Rivero 1940). Known from additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966). Specimens compare well with those of the Heron-Alien and Earland collection (P32399-32450).

**Dentalina isldroensis** Cushman & Renz

*Plate 20, figure 5*

*Dentalina isldroensis* CUSHMAN & RENZ 1941, pl. 3, figs. 2 - 3

*Pyramidulina isldroensis* (Cushman & Renz). --BOLLI, et. al. 1994, pl. 77, figs. 43 - 44

*Description:* Always found as chamber fragments and always well worn. Chambers inflated and sutures distinct. Characteristic ornament of longitudinal costae.

*Occurrence:* Sporadic occurrence throughout Venezuelan section. Offshore Cabinda found in CABGOC 128-3 between 5,060' and 10,040', and in CABGOC 115-1X at 6,050' and 6,360'.

*Remarks:* No quantitative study was made of this species as a result of its fragmented recovery. Cushman and Renz (1941) found this species throughout the Agua Salada Basin, Renz (1948), found the species a comparatively scarce form in the Acostian and Araguatian.
**Dentalina pauperata** d'Orbigny

**Plate 20, figure 6**

_Dentalina pauperata_ d'ORBIGNY 1846, pl. 1, figs. 57 - 58

*Dentalina pauperata* d'Orbigny. --CUSHMAN 1929, pl. 12, figs. 23, 24. --CUSHMAN & LAIMING 1931, pl. 10, figs. 11 - 12. --CORYELL & RIVERO 1940, pl. 41, figs. 20 - 21. --RENZ 1948, pl. 9. fig. 26. --BERMÜDEZ & FUENMAYOR 1966, pl. 3, fig. 24

_Dentalina elegans_ (d'Orbigny). --PAPP & SCHMID 1985, pl. 10, figs. 6 - 8

**Description:** Always found as fragmented chambers. Chambers inflated, sutures distinct and depressed. Test un-ornamented and smooth. Embryonic chambers and aperture not observed.

**Occurrence:** Occurs sporadically throughout Venezuelan section. Most common towards the base of the _L. wallacei_ Zone. Offshore Cabinda found in CABGOC 128-3 between 4,650' and 10,160', and in CABGOC 115-1X between 3,200' and 9,600'.

**Remarks:** Originally described from the Tertiary of the Vienna Basin. No quantitative study was made of this species as a result of its fragmented recovery. Renz (1948) found the species scarce throughout the Agua Salada Basin, but noted its presence at Ecuador, Trinidad, Haiti, Mexico, and California. Known from additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966). Coryell and Rivero (1940) note the lack of an initial spine in their Haitian specimens. Specimens compare well with that of the Helvetian Gubler collection (P33225).

**Dentalina schwartzii** Karrer

**Plate 75, figure 3**

_Dentalina schwartzii_ KARRER 1865, pl. 1, fig. 5 (fide Ellis & Messina 1940, et. seq.)

_Dentalina schwartzii_ Karrer. --POPEȘCU 1975, pl. 16, fig. 4

**Description:** Distinctive species. Elongate chambers increase in size as added, slightly inflated. Sutures slightly depressed, indistinct. Test covered in 12 - 14 continuous parallel longitudinal striae. Ultimate chamber un-ornamented. Aperture terminal rounded opening with slight neck.

**Occurrence:** Single specimen recovered from Sacel, Romania.

**Remarks:** Originally described from the Tertiary of Austria.

Genus _LAEVIDENTALINA_ Loeblich & Tappan, 1986

**Laevidentalina elegans** (d'Orbigny)

**Plate 75, figures 4 - 5**

_Dentalina elegans_ d'ORBIGNY 1846, pl. 1, figs. 52 - 56

_Laevidentalina elegans_ (d'Orbigny). --FILIPESCU 1996, pl. 2, fig. 4. --CICHA, et. al. 1998, pl. 21, figs. 6 - 7

**Description:** Elongate, slender, uniserial test. Chambers slightly inflated, sutures slightly oblique. Wall smooth. Aperture terminal and radiate, closed at the apex.

**Occurrence:** Found in Lapugiu du Sus and Sacel in Romania.

**Remarks:** Originally described from the Tertiary of the Vienna Basin.
Genus NODOSARIA Lamarck, 1812

**Nodosaria bacillum** Defrance

*Nodosaria bacillum* DEFRAENCE 1846, pl. 1, figs. 40 - 47

*Nodosaria bacillum* Defrance. —d’ORBIGNY 1846, pl. 1, figs. 40 - 47. —POPESCU 1975, pl. 16, fig. 1. —PAPP & SCHMID 1985, pl. 8, figs. 4 - 6, pl. 9, fig. 12

**Description:** Large elongate test, thick walled. Longitudinal continuous costae along the length of the test. Perforate. When present aperture a circular opening.

**Occurrence:** Single specimen identified in Lapugiu du Sus, Romania.

**Remarks:** Originally described from the Vienna basin. Considered to require ‘optimal living conditions’ (Papp & Schmid 1985). Known from the Miocene of the Gulf of Suez region (Souya 1965).

**Nodosaria longiscata** d’Orbigny

Plate 20, figure 7

*Nodosaria longiscata* d’ORBIGNY 1846, pl. 1, figs. 10 - 12

*Nodosaria longiscata* d’Orbigny. —NUTTALL 1927, pl. 4, fig. 13. —CUSHMAN & JARVIS 1930, pl. 32, figs. 15 - 16. —MACFADYEN 1930, pl. 2, fig. 17. —HEDBERG 1937, pl. 91, figs. 3 - 4. —LE ROY 1939, pl. 2, fig. 11. —CUSHMAN & STAINFORTH 1945, pl. 3, figs. 19 - 21. —CUSHMAN & RENZ 1947, pl. 4, figs. 17 - 18.-RENZ 1948, pl. 5, figs. 1 - 4. —KOHL 1985, pl. 6, fig. 3. —PAPP & SCHMID 1985, pl. 3, figs. 1 - 5. —SNYDER, et. al. 1988, pl. 1, fig. 11. —KAIHO 1992, pl. 2, fig. 12. —BOLLI, et. al. 1994, pl. 63, fig. 17, pl. 77, figs. 31 - 32

*Nodosaria? longiscata* d’Orbigny. —BLOW 1959, p. 126 - 127

‘*Nodosaria* longiscata’ d’Orbigny. —BUCFALO, et. al. 1997, pl. 4, fig I (not H)

**Neugeborinia longiscata** (d’Orbigny). —CICHA, et al. 1998, pl. 21, fig. 12

**Description:** Only recovered as partial fragments. Test long and slender, circular in cross section. May occasionally show horizontal constriction of sutures dividing long individual chambers. Parallel sides. Embryonic chambers and aperture not recovered.

**Occurrence:** Infrequent throughout the Venezuelan section. Common in the *G. fohsi* Zone. Offshore Cabinda found in CABGOC 115-1X between 2,630’ and 10,020’, acme at 9,900’.

**Remarks:** Fragmentary recovery precludes quantitative analysis. Renz (1948) found the taxon common in the lower Acostian and scarce in the upper Acostian, Araguatian, and Lucian. Blow (1959) found specimens he doubtfully assigned to the species. Originally described from the Tertiary (Badenian) of the Vienna Basin, where it shows a wide distribution form the Oligocene. Recognised in the Miocene of the Gulf of Suez region (Souya 1965) and the Oligocene of Mexico (Nuttall 1932). Specimens in the M. S. Srinivasan collection are better preserved than those of this study and compare well (P48584), as do those of the Burrow and Holland collection (slide A, NHM), and the Brady collection (NHM). Known from throughout tropical America. Recognised along the Gulf Coast (Garret 1938).
**Nodosaria pyrula** d'Orbigny

Plate 20, figure 8; Plate 75, figure 6

_Nodosaria pyrula_ d'ORBIGNY 1826, p. 253 (fide Ellis & Messina 1940, et. seq.)

_Nodosaria pyrula_ d'Orbigny. --MACFADYEN 1930, pl. 2, fig. 16. --AKERS & DOORMAN 1964, pl. 6, figs. 19. --PAPP & SCHMID 1985, pl. 4, figs. 2 - 3. --KOHL 1985, pl. 6, fig. 4. --FILIPESCU 1996, pl. 1, fig. 5

_Nodosaria cf. pyrula_ d'Orbigny. --CUSHMAN & STAINFORTH 1945, pl. 3, fig. 22

*Grigelis pyrula* (d'Orbigny). --CICHA, et. al. 1998, pl. 21, fig. 9

**Description:** Elongate uniserial test. Chambers elongate and ovoid, separated by slender tubular constrictions. Wall smooth.

**Occurrence:** Restricted to the _G. fohsi_ and _L. wallacei_ Zones in Venezuela, rare. Observed in Sacel and the Chechis Marls, Romania.

**Remarks:** Originally described from the Tertiary of the Vienna Basin. First record of this form from the Agua Salada Formation. Fragmentary nature of recovery precludes faunal analysis.

Specimens of the M. S. Srinivasan collection (P48586) are much more robust than the specimens of this study. The Car Nicobar examples showing a greater inflation of the chambers and less constricted necks. Specimens compare well with those of the Heron-Allen and Earland collection (P32399-32450) and the Burrow and Holland collection (slide A & B, NHM). Known from the Miocene of the Gulf of Suez region (Souya 1965) and additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966).

**Nodosaria raphanistrum caribbeana** Hedberg

Plate 20, figure 9

_Nodosaria raphanistrum var. caribbeana_ HEDBERG 1937, pl. 91, fig. 1

_Nodosaria raphanistrum var. caribbeana_ Hedberg. --RENZ 1948, pl. 5, figs. 6 - 7. --SNYDER, et. al. 1988, pl. 1, fig. 12

*Pyramidulina raphanistrum caribbeana* (Hedberg). --BOLLI, et. al. 1994, pl. 77, figs. 38, 41 - 42

**Description:** Fragmentary sections recovered. Large thick walled species, with 10 - 12 prominent longitudinal costae crossing sutures with minimal diminution. Sutures distinct constrictions, chambers 'subglobular'.

**Occurrence:** Rare occurrence in Venezuela. Found in _M. basispinosus, G. fohsi_ and _V. herricki_ Zones. Offshore Cabinda in CABSOC 115-1X between 3,350' and 8,700'.

**Remarks:** Hedberg erected the subspecies due to the uncertainty of the characters of Linné's typical species. It is common to the Tertiary of the Caribbean region. Renz (1948) found it common in the Acostian, and scarce in the Araguatian and Lucian. Fragmentary nature of recovery prevents quantitative analysis.

**Nodosaria schlichti** Reuss

_Nodosaria schlichti_ REUSS 1870, pl. 6, figs. 29 - 31 (fide Ellis & Messina 1940, et. seq.)

_Nodosaria schlichti_ Reuss. --NUTTALL 1927, pl. 4, figs. 18 - 19. --RENZ 1948, pl. 4, fig. 25, pl. 5, fig 5. --BLOW 1959, p. 127 - 128. --BOLLI, et. al. 1994, pl. 77, fig. 33 - 34

*Lagenonodosaria schlichti* (Reuss). --CORYELL & RIVERO 1940, pl. 43, fig. 8
**Description:** Recovered as fragments. Normally one or two chambers recovered as small bulbous test covered with small hispid spines, quite often subject to dissolution and abrasion. Sutures when present acute constriction of test.

**Occurrence:** Confined to *V. herricki* and *G. fohsi* Zones, spurious occurrence in *L. wallacei* Zone in Venezuela.

**Remarks:** Renz (1948) found the taxon scarce throughout the Agua Salada Formation. Blow (1959) found the taxon scarce, but similarly in all zones. Originally described from the Oligocene of Germany. Fragmentary nature of recovery prevents quantitative analysis.

*Nodosarida spirostriolata* Cushman

**Plate 75, figure 7**

*Nodosarida spirostriolata* CUSHMAN 1917, pl. 38, fig. 4 (fide Ellis & Messina 1940, et. seq.)

*Nodosarida spirostriolata* Cushman. --POPESECU 1975, pl. 15, fig. 1

**Description:** Elongate test, tapering slightly to the initial end. Initial chamber rounded. Numerous chambers, gradually increase in size as added, foreshortened. Sutures gently depressed. Characteristic fine longitudinal striae slowly spiral up test.

**Occurrence:** Two specimens identified in the Chechis Marls, Romania.

**Remarks:** Originally described from Recent material from the Philippines.

*Nodosaria vertebralis* (Batsch)

**Plate 20, figure 10**

*Nautilus (Orthoceras) vertebralis* BATSCH 1791, pl. 2, fig. 6 (fide Ellis & Messina 1940, et. seq.)

*Dentalina vertebralis* (Batsch). --CUSHMAN 1931, p. 66. --CORYELL & RIVERO 1940, pl. 42, fig 1 (not 3). --CUSHMAN & RENZ 1947, pl. 4, fig. 14

*Nodosaria vertebralis* (Batsch). --HEDBERG 1937, pl. 91, fig. 2. --CUSHMAN & RENZ 1947, pl. 4, fig. 14. --RENZ 1948, pl. 5, figs. 8 - 11. --BLOW 1959, p. 128. --KELLER 1980, pl. 1, fig. 1. --KOHL 1985, pl. 6, figs. 8 - 9

Pyramidulina vértebralis (Batsch). --BOLLI, et. al. 1994, pl. 77, figs. 36 - 37

**Description:** Elongate test, always recovered as fragments. Bulbous chambers separated by distinct constrictions at the sutures. Numerous longitudinal costae extend over the chambers and sutures. Aperture not recovered.

**Occurrence:** Confined to *V. herricki* and *G. fohsi* Zones in Venezuela. Offshore Cabinda in CABGOC 115-1X found in CABGOC 115-1X between 3,350’ and 8,700’. Found in the Chechis Marls, Romania.

**Remarks:** Fragmentary nature of recovery prevents quantitative analysis. Originally described from the Recent (?) of the Adriatic. Renz (1948) found the taxon common in the Acostian, but rare in the Araguatian and Lucian. Blow (1959) found the taxon in association with *A. stainforthi*. Also known from Colombia, Ecuador, Trinidad, Cuba, Haiti, Jamaica, Mexico, and additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966). Recognised in the Miocene of the Gulf of Suez region (Souya 1965). Known from Recent sediments of the Côte d’Ivoire (Calvez 1963). These specimens compare well with some examples of Dentalina vertebralis of the Burrow and Holland collection (slide B, NHM).
**Nodosarida sp.**

**Description:** Broken unilocular fragment.

**Occurrence:** Single specimen identified in Lapugiu du Sus, Romania.

**Genus** PSEUDONODOSARIA Broomgaart 1949

**Pseudonodosaria comatula** (Cushman)

**Plate 20, figure 11**

*Nodosaria comata* BRADY 1884, pl. 64, figs. 1 - 5

*Nodosaria comatula* CUSHMAN 1923, pl. 14, fig. 5

*Pseudogludulina comatula* (Cushman). --NUTTALL 1932, p. 16. --HEDBERG 1937, pl. 91, figs. 9 - 10. --RENZ 1948, pl. 5, fig. 12. --SKINNER & GLASER 1972, pl. 2, fig. 4. --BOLLI, et. al. 1994, pl. 80, fig. 21

*Glandulina comatula* (Cushman). --HALLER 1980, pl. 4, fig. 14

*Pseudonodosaria comatula* (Cushman). --AKERS & DOORMAN 1964, pl. 5, fig. 28. --KOHL 1985, pl. 7, fig. 10

**Description:** Robust test, medium size, inflated. Circular in transverse section. Finely costate, indistinct chambers and sutures, although definite constrictions along length. Aperture invariably missing. Ontogenetic variation prevalent.

**Occurrence:** Confined to G. *fohsi* & L. *wallacei* Zones in Venezuela. Offshore Cabinda found in CABGOC 128-3 at 6,440'.

**Remarks:** Originally described from Recent (?) sediments of the Gulf of Mexico. Renz (1948) found the species a good marker for the Acostian. Also known from Ecuador, Barbados, Trinidad, Puerto Rico, Cuba, Jamaica, Haiti, and Mexico. Recognised along the Gulf Coast (Garret 1938), and as a constituent of a diverse bathyal benthonic association offshore West Africa (Hamann, et. al. 1993). Known from additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966).

**Genus** PYRAMIDULINA Fornasini, 1894

**Pyramidulina paucicostata** (Cushman & Renz)

**Plate 20, figure 12**

*Pseudogludulina gallowayi* var. *paucicostata* CUSHMAN & RENZ 1941, pl. 3, fig. 5

*Pseudogludulina gallowayi* var. *paucicostata* Cushman & Renz. --RENZ 1948, pl. 5, fig 13

*Pseudogludulina gallowayi* *paucicostata* Cushman & Renz. --BOLLI, et. al. 1994, pl. 80, fig. 20

**Description:** Robust species. Bulbous, with highly tapered terminal and initial chambers. Sutures indistinct. Approximately 18 distinct striae originate at base of initial camber and terminate below radiate aperture.

**Occurrence:** Found in the *T. panamaensis* zonule and the *M. basispinosus* and *V. herricki* Zones in Venezuela.

**Remarks:** Differs from the typical in the fewer and higher costae and less tapering form. Cushman & Renz (1941) found the species throughout the Agua Salada Formation. Renz (1948), found it scarce in the upper Acostian and Araguatian, but with occasional localised acmes. Also known from Ecuador, Carriacou, Trinidad, and California.
**Pyramidulina incisa** (Neugeboren)

*Plate 20, figure 13; Plate 56, figure 8*

*Glandulina incisa* NEUGEBOREN 1850, pl. 1, figs. 7a - b *(fide* Ellis & Messina 1940, *et. seq.)*

*Pseudoglandulina incisa* (Neugeboren). --RENZ 1948, pl. 5, fig. 16. --BLOW 1959, pl. 7, fig. 13. --PETTERS 1982, pl. 6, fig. 30. --BOLLI, *et. al.* 1994, pl. 80, fig. 27

*Pseudonodosaria discrete* (Reuss). --FORESI, *et. al.* 1997, pl. 1, fig. 10

**Description:** Smooth walled, large species. Wall unornamented, initial end acute, widely tapering to distinct constriction approximately two thirds up the length. Final uniserial inflated chamber narrows to terminal aperture.

**Occurrence:** Scarce in the *V. herricki*, *G. fohsi*, *S. transversa*, and *L. wallacei* Zones in Venezuela. Offshore Cabinda found in CABGOC 128-3 between 3,930' and 10,040', and in CABGOC 115-1X between 8,280' and 8,940'. Relatively rare.

**Remarks:** Originally described from the Tertiary of Transylvania. Renz (1948) and Blow (1959) found the species scarce throughout the Agua Salada Formation. Also known from Trinidad.

**Pyramidulina laevigata** (d'Orbigny)

*Plate 20, figure 14; Plate 75, figures 8 - 9*

*Nodosaria (Glandulina) laevigata* d'ORBIGNY 1826, pl. 10, figs. 1 - 3 *(fide* Renz 1948)

*Nodosaria (Glandulina) laevigata* d'Orbigny. --MACFADYEN 1930, pl. 2, fig. 13

*Pseudoglandulina laevigata* (d'Orbigny). --RENZ 1948, pl. 5, figs. 14 - 15

*Glandulina laevigata* d'Orbigny. --d'ORBIGNY 1846, pl. 1, figs. 4 - 5. --CUSHMAN & LAIMING 1931, pl. 11, fig. 8. --HALLER 1980, pl. 4, fig. 13. --KOHL 1985, pl. 14, fig. 2. --HOTTINGER, *et. al.* 1993, pl. 96, figs. 1 - 5, 8. --OSTERMAN 1996, pl. 2, fig. 2. --BORNMALM 1997, fig. 16H

*Pseudoglandulina conica* (Neugeboren). --LE ROY 1939, pl. 8, fig. 4

**Description:** Elongate bulbous test, tapering acutely to initial end, more rounded at apertural end. Normally two to three visible chambers, increasing rapidly in size, the last formed chamber comprising the majority of the test. Sutures gently depressed and straight. Radial terminal aperture.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 between 1,200' and 10,100', and in CABGOC 115-1X between 3,350' and 8,640'. Found in the Chechis Marls and Sacel, Romania.

**Remarks:** Originally described from Recent and Tertiary sediments of the Adriatic Sea and Italy. Known from additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966). Specimens compare well with *G. laevigata* examples of the Heron-Allen and Earland collection (P32472-32499), the Brady collection (NHM), and that of the Helvetian Gubler collection (P33240), although these are slightly dwarfed in comparison to those of this study. Specimens labelled *Glandulina* sp. in the Brady collection (P30282) are also comparable. Known from the Miocene of the Gulf of Suez region (Souya 1965).
Subfamily LINGULININAE Loeblich & Tappan, 1961
Genus LINGULINA d'Orbigny, 1826

**Lingulina grimsdalei** Cushman & Renz

*Lingulina grimsdalei* CUSHMAN & RENZ 1941, pl. 3, fig. 1

*Lingulina grimsdalei* Cushman & Renz. --RENZ 1948, pl. 5, fig. 23. --BLOW 1959, p. 123

*Thollmannia grimsdalei* (Cushman & Renz). --BOLLI, et. al. 1994, pl. 80, fig. 19

**Description:** Slightly compressed test, tapers gradually. Rounded periphery. Chambers inflated and overlapping, increase in size as added. Sutures depressed. Longitudinal costae ornament wall. Aperture terminal, elongate slit with slight lip.

**Occurrence:** Only recovered from the *M. basispinosus* and *G. fohsi* Zones in Venezuela.

**Remarks:** Cushman and Renz (1941) found the taxon in the lower Agua Salada Formation. Renz (1948) found the species scarce, but 'a good marker for the lower Acostian'. Blow (1959) found the taxon scarce.

Genus DAUCINOIDES de Klasz & Rérat, 1962

**Daucinoides circumtegens** de Klasz & Rérat

*Daucinoides circumtegens* de KLASZ & RÉRAT 1962, pl. 2, figs. 7-11

*Daucinoides circumtegens* de Klasz & Rérat. --KOGBE & MEHES 1986, fig. 6

**Description:** Elongate test, ovate in outline. Tapers strongly to the base. Chambers uniserial, subsequent chambers completely embracing earlier growth. Wall not observed, faint striae toward the base and apertural ends. Aperture a terminal elliptical slit.

**Occurrence:** Found in CABGOC 115-1X at 6,480' and 7,380'.

**Remarks:** Originally described from the Lower Miocene from offshore Cameroon. Always occurs as pyrite internal moulds. Possible fragments recovered from CABGOC 128-3.

Subfamily FRONDICULARIINAE Reuss, 1869
Genus FRONDICULARIA Defrance, 1860

**Frondicularia inaequalis** Costa

*Frondicularia inaequalis* COSTA 1855, pl. 3, fig. 3 (fide Ellis & Messina 1940, et. seq.)

*Frondicularia inaequalis* Costa. --CUSHMAN 1921, pl. 40, figs. 5 - 6. --MACFADYEN 1930, pl. 3, fig. 1. --RENZ 1948, pl. 5, fig. 29. --BLOW 1959, p. 120 - 121

**Description:** Always preserved as partial internal pyrite moulds. Test extremely compressed. Chambers overlap one another in alternating sequence to produce crude herring bone pattern along central ridge. Aperture missing.

**Occurrence:** Confined to *S. transversa* Zone in Venezuela.

**Remarks:** Originally described from the Tertiary of Sicily. Renz (1948) found the species restricted to the upper Araguatian. Blow (1959) only recovered isolated specimens. Specimens compare well with *P. inaequalis* examples of the Heron-Allen and Earland collection (P32472-32499). Known from the Miocene of the Gulf of Suez region (Souya 1965).
Subfamily PLECTOFRONDICULARIAE Cushman, 1927
Genus AMPHIMORPHINA Neugeboren, 1850

**Amphimorphina stainforthi** (Cushman & Renz)

*Plate 20, figure 16; Plate 56, figure 10 - 11*

*Nodosaria stainforthi* Cushman & Renz. --CUSHMAN & RENZ 1941, pl. 3, fig. 4

*Nodosaria stainforthi* Cushman & Renz. --CUSHMAN & RENZ 1947, pl. 4, fig. 20. --RENZ 1948, pl. 4, fig. 31. --BLOW 1959, p. 128. --PETTERS 1982, pl. 5, fig. 34

*Amphimorphina stainforthi* (Cushman & Renz). --KOHL 1985, pl. 9, figs. 4 - 5

*Pyramidulina stainforthi* (Cushman & Renz). --BOLLI, et al. 1994, pl. 63, fig. 18, pl. 77, figs. 39 - 40

**Description:** Elongate, uniserial test, slender and tapering. Initial end acute in most specimens, but more rounded in some. Never found complete, apertural end always missing. Wall characteristically ornamented by six longitudinal continuous costae. Chambers and sutures indistinct. Aperture not recovered, originally described as radiate.

**Occurrence:** Rare species in *V. herricki* and *G. fohsi* Zones in Venezuela. Offshore Cabinda found in CABGOC 128-3 between 5,000' and 9,440'.

**Remarks:** Fragmentary nature of recovery prevents quantitative analysis. Cushman and Renz (1941) found the species in the upper and mid Agua Salada Formation. Renz (1948) found the taxon throughout the basin but most common in the upper Acostian, this is supported by the data of Blow (1959). Fragmentary recovery.

Genus PLECTOFRONDICULARIA Liebus, 1902

**Plectofrondicularia advena** (Cushman)

*Plate 21, figure 1*

*Frondicularia inaequalis* BRADY 1884, pl. 66, figs. 8 - 12

*Frondicularia advena* CUSHMAN 1923, pl. 20, figs. 1 - 2

*Frondicularia advena* Cushman. --GALLOWAY & WISSLER 1927, pl. 8, figs. 7 - 8. --NUTTALL 1927, pl. 6, fig. 8. --RENZ 1948, pl. 12, fig. 5. --BLOW 1959, p. 120

*Parafrondicularia advena* (Cushman). --LUTZE 1979, pl. 3, fig. 5

*Plectofrondicularia advena* (Cushman). --HALLER 1980, pl. 6, figs. 5 - 6 (not 7). --KELLER 1980, pl. 1, fig. 13. --THOMPSON 1980, pl. 8, fig. 1. --KOHL 1985, pl. 9, figs. 8 - 9


**Description:** Specimen poorly preserved, battered. Test compressed, initial end narrow, typical 'V' shaped chambers comprise most of test. Peripheral keel lost. Sutures slightly depressed, aperture missing. Wall thin and translucent, surface usually roughened through abrasion. Partially preserved as pyrite internal mould.

**Occurrence:** Single specimen in *G. fohsi* Zone in Venezuela.

**Remarks:** Originally described from Recent sediments from offshore the north-eastern United States. Renz (1948) found the species very scarce in the Araguatian. Blow (1959) only recovered isolated specimens. Also found in California. *P. vaughani* Cushman differs from *P. advena* (Cushman) in its more elliptical profile.
**Plectofrondicularia californica** Cushman & Stewart

**Plate 21, figure 2**

*Plectofrondicularia californica* CUSHMAN & STEWART 1926, pl. 6, figs. 9 - 11

*Plectofrondicularia californica* Cushman & Stewart. --NUTTALL 1927, pl. 6, fig. 9. --CUSHMAN 1929, pl. 13, figs. 18 - 19. --HEDBERG 1937, pl. 91, fig. 7. --RENZ 1942, pp. 554, 556. --RENZ 1948, pl. 12, fig. 10. --BLOW 1959, p. 142. --HALLER 1980, pl. 6, fig. 9. --KLEINPELL 1980, pl. 5, figs. 2, 4. --FINGER 1990, p. 190 - 191. --FINGER et. al. 1990, pl. 9, fig. 23. --RESIG 1990, pl. 3, fig. 7. --FINGER 1992, pl. 3, figs. 18 - 19

*Plectofrondicularia cf. californica* Cushman & Stewart. --BOLLI, et. al. 1994, pl. 80, fig. 15

**Description:** Compressed elongate test. Bilaterally asymmetrical, though occasionally symmetrical. Broad faces concave, lateral sides slightly flaring, initial end rounded. Periphery with three distinct short carinae. Chambers numerous, biserial in juvenile stage, uniserial in adult. Sutures slightly limbate but indistinct. Wall smooth.

**Occurrence:** Occurs intermittently throughout the Venezuelan section.

**Remarks:** First described from the Pliocene of California. Renz (1948) found the specimens tentatively referred to as the species in the Acostian. Blow (1959) found the taxon generally scarce. Also known from Costa Rica, Ecuador, Trinidad, Cuba, and California.

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**Plectofrondicularia floridana** Cushman

**Plate 21, figure 3; Plate 75, figure 10**

*Plectofrondicularia floridana* CUSHMAN 1930, pl. 8, fig. 1

*Plectofrondicularia floridana* Cushman. --CUSHMAN & CAHILL 1933, pl. 7, fig. 11. --RENZ 1948, pl. 6, fig. 19. --BLOW 1959, p. 142 - 143. --AKERS & DOORMAN 1964, pl. 7, figs. 23 - 24. --KOHL 1985, pl. 9, figs. 6 - 7. --DIAZ de GAMERO 1985a, pl. 5, fig. 10. --SNYDER, et. al. 1988, pl. 3, figs. 3 - 4. --BOLLI, et. al. 1994, pl. 80, fig. 17

**Description:** Elongate tapering test, greatest width towards aperture. Strongly compressed, with tricarinate keel. Early portion has single median costae. Chambers numerous and distinct, of a sigmoid shape. Wall smooth.

**Occurrence:** Occurs intermittently throughout the Venezuelan section. Acme in sample 2601 of the *M. basispinosus* Zone. Single specimen identified in the Chechis Maris, Romania.

**Remarks:** Originally described from the Miocene of Florida. Renz (1948) found the species scarce in the Agua Salada Formation. However, Blow (1959) found the taxon 'fairly common' in all zones below his *S. seminulina* Zone. Diaz de Gamero (1985a) found the species intermittently in calcareous dominated assemblages. *P. floridana* Cushman differs from *P. californica* Cushman & Stewart in its wider sutures which tend to be more perpendicular to the test wall. Known from the Miocene of Trinidad (Cushman and Renz 1947) and additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966).
Plectofrondicularia cf. longistriata Le Roy
Plate 56, figure 12

Plectofrondicularia longistriata LE ROY 1939, pl. 5, figs. 4 - 6
Plectofrondicularia cf. longistriata Le Roy. --RENZ 1948, pl. 6, fig. 21


Occurrence: Offshore Cabinda found in CABGOC 128-3 between 6,080' and 10,040', and in CABGOC 115-1X at 4,310'.

Remarks: Originally described from the Miocene of Sumatra.

Plectofrondicularia mansfieldi Cushman & Ponton
Plate 21, figure 4

Plectofrondicularia mansfieldi CUSHMAN & PONTON 1931, pl. 8, fig 1
Plectofrondicularia mansfieldi Cushman & Ponton. --CUSHMAN & CAHILL 1933, pl. 7, fig.12. --RENZ 1948, pl. 12, fig. 11. --BLOW 1959, p. 143. --BOLLI, et al. 1994, pl. 80, fig. 16

Description: Compressed test, elongate and tapering. Periphery sharply truncate with distinct keels. Chambers numerous, biserial in the juvenile portion, becoming uniserial in the adult. Slightly inflated. Sutures distinct, depressed, convexly curved. Wall smooth, basal end may show one or two costae.


Remarks: Originally described from the Miocene of Florida. Renz (1948) found the species a useful marker for the Araguatian and Lucian.

Plectofrondicularia vaughani Cushman
Plate 21, figure 5; Plate 56, figure 13

Plectofrondicularia vaughani CUSHMAN 1927, pl. 23, fig. 3
Plectofrondicularia vaughani Cushman. --HEDBERG 1937, pl. 91, figs. 12 - 13. --CORYELL & RIVERO 1940, pl. 2, fig. 28. --CUSHMAN & STAINFORTH 1945, pl. 5, fig. 13. --RENZ 1948, pl. 6, fig 20. --VAN MORKHOVEN, et al. 1986, pl. 42, figs. 1 - 2. --BOLLI, et al. 1994, pl. 62, fig. 20, pl. 87, fig. 24
Proxifrons vaughani (Cushman). --FINGER 1992, pl. 3, fig. 23

Description: Compressed test, slightly elliptical. Initial end rounded. Chambers distinct, coiled in juvenile portion and biserial in adult, characteristically alternating. Sutures distinct, slightly depressed, curved. Wall smooth and finely perforate.

Occurrence: Found in the M. basispinosus, V. herricki, and L. wallacei Zones in Venezuela. Offshore Cabinda found in CABGOC 128-3 between 5,840' and 9,260', and in CABGOC 115-1X between 6,720' and 9,420'.

Remarks: Originally described from the Eocene of Mexico. Renz (1948) found the taxon scarce in the 'Uvigerinella' sparsicostata Zone and Acostian, but common throughout in the Tertiary of tropical America. Haitian specimens display a slight biserial character in the early chambers and little variation in the alignment of the aperture (Coryell and Rivero 1940). Recognised along the
Gulf Coast (Garret 1938), the Miocene of Trinidad (Cushman and Renz 1947) and in the Oligocene of Mexico (Nuttall 1932).

Family VAGINULINIDAE Reuss, 1860
Subfamily LENTICULININAE Chapman, Parr & Collins, 1934
Genus DIMORPHINA d’Orbigny, 1826

**Dimorphina ackneriana** (Neugeboren)

Plate 75, figure 11

*Marginulina ackneriana* NEUGEBOREN 1851, pl. 5, figs. 15 - 16 (*fide* Ellis & Messina 1940, *et. seq.*)
*Dimorphina ackneriana* (Neugeboren). —POPESCU 1975, textfig. 11. —CICHA, *et. al.* 1998, pl. 22, fig. 16

**Description:** Large robust test, inflated, rounded periphery. Initial planispiral chambers followed by uniserial growth. Chambers increase in size as added, inflated. Initial sutures indistinct, those of the uniserial portion limbate and depressed. Wall smooth. Aperture terminal and radiate.

**Occurrence:** Single specimen recovered from the Chechis Marls, Romania.

**Remarks:** Originally described from the Tertiary of Romania. Popescu (1975) adopts a synonymised approach to *Marginulina variabilis* Neugeboren, using *Dimorphina ackneriana* (Neugeboren) as the senior synonym.

**Dimorphina sp. 1**

Plate 75, figures 12a, 12b

**Description:** Small indistinct specimen, subacute periphery, becoming 'pinched' towards apertural region. Ovate profile, slightly compressed. Chambers and sutures indistinct throughout growth. Aperture terminal and radiate.

**Occurrence:** Recovered from the Chechis Marls, Romania.

**Remarks:** Possibly juvenile.

Genus LENTICULINA Lamarck, 1804

**Lenticulina americanus** (Cushman)

Plate 21, figure 6; Plate 56, figure 14

*Cristellaria americana* CUSHMAN 1918, pl. 10, figs. 5 - 6
*Robulus americanus* (Cushman). —CUSHMAN 1930, pl. 3, fig. 7. —CUSHMAN and CAHILL 1933, pl. 3, fig. 6. —RENZ 1948, pl. 12, fig 3. —BLOW 1959, p. 130 - 131
*Lenticulina americana americana* (Cushman). —SNYDER, *et. al.* 1988, pl. 2, figs. 6 - 7
*Lenticulina (Robulus) americanus* (Cushman). —WHITTAKE 1988, pl. 5, figs. 1 - 2

**Description:** Involute test, slightly keeled, six to seven chambers in the last whorl. Sutures distinct and raised, limbate. Definite raised umbilical area joining sutures. Surface smooth but specimens often fragmented. Aperture radiate.

**Occurrence:** Common throughout the Venezuelan section. Acme in sample 2605 of the *V. herricki* Zone. Offshore Cabinda found in CABGOC 128-3 between 1,140' and 10,160', and in CABGOC 115-1X between 2,210' and 9,840', common.
Remarks: Originally described from the Miocene of Florida. Renz (1948) found the species scarce in the 'Uvigerinella' sparsicostata Zone, but common throughout the rest of the basin; this data is supported by Blow (1959). Also known from Barbados, Trinidad, Jamaica, and California. Specimens compare well with Cristellaria sp. of the Parker and Jones collection (P10842). The specimens of Whittaker (1988) show a greater elevation of the sutures and in general more chambers (P519335).

**Lenticulina arcuatostriatus carolinianus** (Cushman)

**Plate 57, figure 1**

Robulus arcuato-striatus (Hantken) var. carolinianus CUSHMAN 1933, pl. 1, fig. 9

Robulus arcuato-striatus var. carolinianus Cushman. --CUSHMAN 1953, pl. 6, fig. 6. --RENZ 1948, p. 157

Cristellaria arcuato-striatus var. carolinianus (Cushman). --PARKER & BERMÚDEZ 1936, p. 249

Lenticulina arcuato-striatus var. caroliniana (Cushman). --PALMER 1940, p. 126

Robulus arcuato-striatus carolinianus (Cushman). --BLOW 1959, p. 131 - 132

**Description:** Involute, strongly umbonate, peripheral keel usually missing through abrasion. Chambers distinct with strongly curved sutures ending in a clear umbo. Eight to nine chambers in last whorl. Surface roughened through abrasion, aperture often missing but when present protruding and radiate.

**Occurrence:** Less common species. Intermittent occurrence throughout the Venezuelan section. Acme in sample 2611 of the V. herricki Zone. Offshore Cabinda in CABGOC 128-3 between 1,080' and 10,100', and in CABGOC 115-1X at 7,380'. Two specimens tentatively referred to as this taxon in Sacel, Romania.

**Remarks:** Originally described from the Eocene of Alabama. Renz (1948) and Blow (1959) found the species scarce in the Acostian and Araguatian. Also known from Barbados, Trinidad, and Cuba.

**Lenticulina calcar** (Linné)

**Plate 21, figure 7; Plate 57, figures 2a, 2b; Plate 75, figures 13a, 13b**

*Nautilus calcar* LINNÉ 1767, p. 1162 (fide Ellis & Messina 1940, et. seq.)

*Cristellaria calcar* (Linné). --NUTTALL 1927, pl. 5, fig. 8

*Robulus calcar* (Linné). --d'ORBIGNY 1846, pl. 4, figs. 18 - 20. --GALLOWAY & MORREY 1929, pl. 2, fig. 10. --LE ROY 1939, pl. 2, fig. 20. --CORYELL & RIVERO 1940, pl. 41, fig. 9. --CUSHMAN & RENZ 1947, pl. 3, fig. 3. --RENZ 1948, pl. 3, fig. 6. --BLOW 1959, p. 132. --KOHL 1985, pl. 10, figs. 4 - 5. --PAPP & SCHMID 1985, pl. 30, figs. 1 - 3

*Cristellaria calcar* (Linné). --MACFADYEN 1930, pl. 3, fig. 17

*Lenticulina calcar* (Linné). --AKERS & DOORMAN 1964, pl. 4, fig. 8. --BERMÚDEZ & FUENMAYOR 1966, pl. 3, figs. 15 - 16. --POPEȘCU 1975, pl. 34, fig. 3. --HALLER 1980, pl. 3, fig. 4. --CIMERMAN & LANGER 1991, pl. 53, figs. 1 - 4. --BOLLI, et al. 1994, pl. 77, fig. 8. --FORESI, et. al 1997, pl. 1, fig. 3. --CICHA, et. al. 1998, pl. 24, fig. 6

*Lenticulina (Robulus) calcar* (Linné). --WHITTAKER 1988, pl. 5, figs. 3 - 4


**Description:** Small robust species although always fragmented. Walls roughened through abrasion. Four to five chambers in final whorl, sutures straight, raised and distinct, meeting in
central raised clear umbo. Slightly thickened keel, remnants of spines protruding from the keel often apparent. Aperture rarely preserved.

**Occurrence:** Intermittent occurrence throughout the Venezuelan section. Most common the V. herricki and G. fohsi Zones. Offshore Cabinda found in CABGOC 128-3 between 4,890' and 10,100, and in CABGOC 115-1X at 8,520' and 10,020'. Also identified in Lapugiu du Sus, the Chechis Marls, and Sacel, Romania.

**Remarks:** Originally described from Recent sediments of the Adriatic. Renz (1948) and Blow (1959) found the species commonly throughout the Agua Salada Basin, although Blow (1959) refers to a sporadic distribution. Widespread in the Tertiary of tropical America. Also known from the Badenian of the Vienna Basin and mid Miocene to Recent of Italy. Recognised in the Miocene of the Gulf of Suez Region (Souya 1965), along the Gulf Coast (Garret 1938), and Haiti (Coryell and Rivero 1940). Finger (1990) notes a variability in the nature of the peripheral spines, the type illustration of Linné (1758) shows individuals both with and without spines, hence all individuals are included in *L. calcar* s.s. in this study. Specimens of the Heron-Alien and Earland collection (P32399-32450, P32500-32545) and those of the Gubler collection (P33228) tend to have much more prominent spines than those of this study. Specimens compare well with those of the Burrow and Holland collection (slide C, NHM), the Brady collection (NHM), and *Cristellaria* sp. of the Parker and Jones collection (P10840).

**Lenticulina cf. cassis** (Fitchel & Moll)

**Plate 75, figure 14**

*Nautilus cassis* FITCHEL & MOLL 1798, figs. 3 - 6, textfig. 23 - 24 (fide Ellis & Messina 1940, et. seq.)

**Description:** Planispiral large test, compressed. Numerous low, comma shaped chambers, increase in size considerably as added. Sutures flush with the surface and wide, indistinct. Boss region covered by pustulose ornament, extends along earlier sutures as raised intermittent ornament. Wall smooth. Periphery acute with slight keel, abraded. Aperture radiate with lip about extension of downward projecting opening.

**Occurrence:** Single specimen identified in Sacel, Romania.

**Remarks:** Originally described from the Pliocene of Italy.

**Lenticulina clericii** (Fornasini)

**Plate 21, figure 8**

*Robulus clericii* (Fornasini). --CUSHMAN 1929, pl. 12, figs. 16 - 17

*Cristellaria clericii* (Fornasini). --NUTTALL 1927, pl. 5, fig. 10

*Robulus clericii* (Fornasini). --CUSHMAN & STAINFORTH 1945, pl. 2, fig. 23. --CUSHMAN & RENZ 1947, pl. 3, fig. 1. --CORYELL & RIVERO 1940, pl. 43, fig. 7. --RENZ 1948, pl. 3, fig. 8. --BLOW 1959, p. 132

**Description:** Less common species. Limbate sutures, flush with the chambers. Prominent umbo forming clear boss in most specimens though may be reduced in individuals. 'Comma shaped' chambers. Always roughened surface through abrasion and aperture always absent.
Occurrence: Occurs commonly throughout the Venezuelan section. Acme in sample 2608 of the V. herricki Zone. Offshore Cabinda found in CABGOC 128-3 between 6,380' and 9,260', and in CABGOC 115-1X between 3,770' and 8,400'.

Remarks: Originally described from the Tertiary of Italy. Renz (1948) noted the inter-variability of L. clericii and L. chambersi Garret in the Agua Salada Basin. This study has followed Renz, using L. clericii rather L. chambersi. Renz (1948) and Blow (1959) found the species throughout the basin. Coryell and Rivero (1940) note their Haitian specimens vary in their degree of involution, occasionally showing earlier chambers through the umbo, the umbo occasionally appears as a central rosette. Known commonly throughout Tertiary tropical America. Specimens compare well with those the Gubler collection (P33226) and the Whittaker collection (P51938).

*Lenticulina cultrata* (Montfort)

Plate 75, figures 15a, 15b

*Robulus culratus* MONTFORT 1808, textfig. q (fide Ellis & Messina 1940, et. seq.)

*Lenticulina cultrata* (Montfort). -d'ORBIGNY 1846, pl. 4, figs. 10 - 13. --POPESCU 1975, pl. 30, fig. 2, pl. 33, fig. 3. --PAPP & SCHMID 1985, pl. 28, figs. 4 - 7, pl. 29, figs. 1 - 5

Description: Planispiral involute test, smooth wall. Biumbilicate with distinct boss. Five to seven chambers in the final whorl of similar size and shape. Sutures distinct, flush and straight. Periphery keeled. Radiate aperture with slit projecting downward.

Occurrence: Found offshore Cabinda in CABGOC 115-1X between 3,410' and 7,800'. Single specimen identified in Sacel, Romania.

Remarks: Originally described from the Tertiary of the Vienna Basin. Known from the Miocene of Egypt (Macfadyen 1930). Specimens compare well with examples of *Cristellaria calcar* var. *cultrata* of the Brady collection (NHM).

*Lenticulina depauperata* (Reuss)

Plate 75, figure 16

*Robulina depauperata* REUSS 1851, pl. 4, fig. 29 (fide Ellis & Messina 1940, et. seq.)

*Lenticulina depauperata* (Reuss). --POPESCU 1975, pl. 31, figs. 2, 4. --CICHA, et. al. 1998, pl. 23, figs. 4 - 5

Description: Biumbilicate inflated test. Periphery subrounded. Five to six chambers in the last whorl, gradually increasing in size as added, uninflated. Sutures flush with the surface and curved. Wall smooth. Aperture radiate.

Occurrence: Offshore Cabinda single specimen found in CABGOC 115-1X at 9,120'. Found in the Chechis Marls and Sacel, Romania.

Remarks: Originally described from the Eocene of Germany.
**Lenticulina formosus** (Cushman)

Plate 57, figure 3; Plate 75, figures 17a, 17b

*Cristellaria formosa* CUSHMAN 1923, pl. 29, fig. 1; pl. 30, fig. 6

*Cristellaria formosa* (Cushman). --NUTTALL 1927, pl. 5, fig. 5. --NUTTALL 1932, pl. 1, fig. 10

*Robulus formosus* (Cushman). --CUSHMAN & JARVIS 1930, pl. 32, fig. 10. --RENZ 1948, pl. 3, fig. 9. --BLOW 1959, p. 132 - 133

*Lenticulina formosa* (Cushman). --POPESCU 1975 pl. 31, fig. 5, pl. 34, fig. 2. --KOHL 1985, pl. 10, fig. 9. --BOLLI, et. al. 1994, pl. 77, fig. 9

**Description:** Large test often confused with *L. grandis*. However, this species has strong keel with flattened spines. Nine to ten chambers in the last whorl, sutures distinct and raised, large raised boss over umbilical area. Specimens always roughened through abrasion, aperture frequently missing.

**Occurrence:** Occurs intermittently throughout the Venezuelan section. Offshore Cabinda in CABGOC 128-3 between 5,600' and 10,100', and in CABGOC 115-1X between 4,490' and 8,520', acme at 4,490'. Single specimen identified in Sacel, Romania.

**Remarks:** Originally described from Recent sediments from the Gulf of Mexico and the Caribbean. Renz (1948) and Blow (1959) found the taxon scarce throughout the basin. Also known from Trinidad, Cuba, Jamaica, and Mexico. Recovered from the Miocene of Egypt (Macfadyen 1930), along the Gulf Coast (Garret 1938), and additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966).

**Lenticulina gibba** (d'Orbigny)

Plate 76, figures 1a, 1b

*Cristellaria gibba* d'ORBIGNY 1839, pl. 7, figs. 20 - 21 (fide Ellis & Messina 1940, et. seq.)

*Lenticulina gibba* (d'Orbigny). --POPESCU 1975, pl. 34, fig. 7. --CIMERMAN & LANGER 1991, pl. 53, figs. 7 - 11

**Description:** Rotund test, biumbilicate. Chambers increase in size as added, sutures distinct, curved and slightly depressed. Periphery sub-acute. Wall smooth. Aperture radiate.

**Occurrence:** Observed in Sacel, Romania.

**Remarks:** Originally described from Recent material of the Mediterranean. Known from the Miocene of Trinidad (Nuttall 1927), and the Miocene of the Gulf of Suez region (Souya 1965). The specimens of this study are worn, however, they compare well with those of the Heron-Allen and Earland collection (P32546-32595).

**Lenticulina grandis** (Cushman)

Plate 21, figure 9; Plate 57, figure 4

*Cristellaria americana* CUSHMAN var. *grandis* CUSHMAN 1920, pl. 11, fig. 2

*Robulus americanus* var. *grandis* Cushman. --RENZ 1948, pl. 3, fig. 7

*Robulus americanus grandis* Cushman. --BLOW 1959, p. 131

*Robulus americanus grandis* (Cushman). --BOLLI, et. al. 1994, pl. 77, fig. 10

**Description:** Larger species than the typical, tends to have more chambers in final whorl, sutures may be raised with costae.
Occurrence: Single specimen in V. herricki Zone in Venezuela. Offshore Cabinda infrequent recovery in CABGOC 128-3 between 3,990' and 10'160', and in CABGOC 115-1X between 3,200' and 7,500'. Single specimen identified in the Chechis Marls, Romania.

Remarks: Originally described from the Miocene of Florida. Renz (1948) found the species throughout the Agua Salada Formation, however, Blow (1959) only recorded the taxon below his G. bulloides Zone, where it fluctuated greatly in abundance. Also known from Costa Rica, Barbados, Carriacou, Trinidad, and Jamaica.

*Lenticulina inornata* (d'Orbigny)

Plate 76, figures 2a, 2b

Robulina inornata d'ORBIGNY 1846, pl. 4, figs. 25 - 26

*Lenticulina inornata* (d'Orbigny). --POPE 1975, pl. 34, fig. 6. --PAPP & SCHMID 1985, pl. 31, figs. 6 - 8, pl. 32, figs. 1 - 8, pl. 33, figs. 1 - 3. --FILIPESCU 1996, pl. 2, fig. 10. --CICHA, et. al. 1998, pl. 23, fig. 1

Description: Test similar to *L. cuitrata* (Montfort) but minus the keel. Chambers tend to show greater inflation and sutures begin to curve.

Occurrence: Observed in the Chechis Marls, Romania.

Remarks: Originally described from the Tertiary of the Vienna Basin. Known from the Oligocene of Mexico (Nuttall 1932) and the Miocene of the Gulf of Suez region (Souya 1965). Specimens compare well with those the Gubler collection (P33232) and the Brady collection (NHM).

*Lenticulina lotus* (Cushman)

Plate 21, figure 10

*Cristellaria cuitrata* BRADY 1884, pl. 70, figs. 4 - 6

*Cristellaria iota* CUSHMAN 1923, pl. 29, fig. 2: pl. 30. fig. 1

Robulus iota (Cushman). --CUSHMAN 1930, pl. 4, fig. 1. --CUSHMAN & CAHILL 1933, pl. 4, fig. 1. --RENZ 1948, pl. 3, fig. 14. --BLOW 1959, p. 133

Robulus iota (Cushman). --GALLOWAY & HEMINWAY 1941, pl. 12, figs. 7a - b. --SOUYA 1965, pl. 1, fig. 22. --BERMUDEZ & FUENMAJOR 1966, pl. 3, figs. 11 - 14

*Lenticulina iota* (Cushman). --HERMELIN 1990, pl. 3, fig. 3. --BOLLI, et. al. 1994, pl. 77, fig. 3

Description: Uncommon species, never found complete. Compressed umbonate test, periphery with broad keel. Sutures curved and limbate, not raised. Boss of clear material over umbo. Wall smooth, aperture radiate with peripheral slit at the peripheral angle of the last formed chamber.

Occurrence: Intermittent occurrence in Venezuela. Acme in sample 2725 of the *L. wallacei* Zone. Offshore Cabinda found in CABGOC 128-3 between 4,410' and 10'100', and in CABGOC 115-1X between 7,380' and 8,880'.

Remarks: Originally described from Recent sediments of the Gulf of Mexico. Renz (1948) and Blow (1959) found the species scarce in the Acostian and Lucian. Also known from Trinidad, Puerto Rico, Jamaica, and Mexico. Recognised in the Miocene of the Gulf of Suez region (Souya 1965). Specimens compare well with examples in the Burrow and Holland collection (slide C, NHM), although these have an exaggerated keel.
**Lenticulina mayeri** (Cushman & Ellisor)

*Robulus mayeri* CUSHMAN & ELLISOR 1939, pl. 1, fig. 6

**Description**: Broad robust test, thickest at the umbo in apertural view. Rounded periphery with acute margin developed into slight keel. Distinct chambers of uniform shape, increase gradually in size as added. Sutures distinct and raised, intermittent knob-like ornament along some. Umbo raised and covered in dense knob-like ornamentation. Radiate aperture.

**Occurrence**: Offshore Cabinda single specimen found in CABGOC 115-1X at 7,980'.

**Remarks**: Originally described from the Miocene of Louisiana.

**Lenticulina melvilli** Cushman & Renz

**Plate 21, figure 11; Plate 57, figure 5**

*Robulus melvilli* CUSHMAN & RENZ 1941, pl. 2, fig. 12

*Robulus melvilli* Cushman & Renz. --RENZ 1948, pl.3, fig. 11. --BLOW 1959, p. 133

*Lenticulina melvilli* (Cushman & Renz). --AKERS & DOORMAN 1964, pl. 4, figs. 15 - 16. --BOLLI, et. al. 1994, pl. 77, fig. 6. --CICHA, et. al. 1998, pl. 23, figs. 10 - 11

**Description**: Distinctive species. Small involute compressed test, narrow rounded keel, only five chambers in the last whorl. Sutures distinct and slightly curved. Aperture terminal peripheral radiate.

**Occurrence**: Occurs intermittently throughout the Formation in Venezuela. Offshore Cabinda found in CABGOC 128-3 between 6,080' and 6,380', rare. In CABGOC 115-1X recovered between 3,410' and 9,940', common.

**Remarks**: Cushman and Renz (1941) found the species in the upper Agua Salada Formation. Renz (1948) subsequently found it throughout the formation. Blow (1959) noted its scarcity. Also noted from Trinidad. Specimens of the Heron-Alien and Earland collection (P32500-32545) tend to have an enlarged boss in comparison to those of this study. Specimens compare well with those of the Burrow and Holland collection (slide C, NHM) and Cristellaria sp. of the Parker and Jones collection (P10836, 10841).

**Lenticulina occidentalis?** (Cushman)

**Plate 22, figure 1**

*Cristellaria occidentalis* CUSHMAN 1923, pl. 25, fig. 2; pl. 26, figs. 1 - 2

**Description**: Close coiled test, compressed, few chambers. Periphery carinate. Apertural face of last formed chamber truncate, the apertural end projecting away from the test. Sutures distinct, almost straight. Aperture radiate at the end of the peripheral projection.

**Occurrence**: Confined to *V. herricki* and *G. fohsi* Zones in Venezuela. Infrequent.

**Remarks**: First record of this taxon from the Agua Salada Formation. Originally described from Recent sediments offshore the north-eastern USA. Known from Recent sediments of the Côte d'Ivoire (Calvez 1963).
**Lenticulina occidentalis torridus** (Cushman)

Plate 22, figure 2; Plate 57, figure 6; Plate 76, figures 4a, 4b

*Cristellaria occidentalis* var. *torrida* CUSHMAN 1923, pl. 25, fig. 1

*Robulus occidentalis* var. *torridus* (Cushman). --CUSHMAN & STAINFORTH 1945, pl. 2, fig. 25. --CUSHMAN & JARVIS 1930, pl. 32, fig. 8. --RENZ 1948, pl. 3, fig. 17

*Robulus occidentalis torridus* (Cushman). --BLOW 1959, p. 134

*Lenticulina occidentalis* var. *torrida* (Cushman). --BOLLI, et. al. 1994, pl. 77, fig. 2

**Description:** Specimen fragmented. Test compressed, six to eight chambers in last whorl. Periphery carinate, aperture projecting away from apertural face. Sutures distinct and raised, slightly limbate.

**Occurrence:** Single specimen in sample 2605 of the *V. herricki* Zone in Venezuela. Offshore Cabinda found in CABGOC 128-3 at 5,060' and 6,380, in CABGOC 115-1X recovered between 6,720' and 9,600'. Found in the Chechis Marls and Sacel, Romania.

**Remarks:** Differs from the typical in the development of an acute peripheral keel. Renz (1948) found this variety common throughout the Agua Salada Formation, as did Blow (1959). Common to much of tropical Tertiary America, known from the Miocene of Trinidad (Cushman and Renz 1947).

**Lenticulina protruberans** (Cushman)

Plate 22, figure 3; Plate 57, figure 7

*Cristellaria protruberans* CUSHMAN 1918, pl. 22, fig. 2

*Robulus protruberans* (Cushman). --GALLOWAY & HEMINWAY 1941, pl. 11, figs. 13a - b. --RENZ 1948, p. 160. --BLOW 1959, p. 134

**Description:** Distinctive rare species. Always fragmented. Compressed, seven chambers in last whorl, raised boss over umbo region, aperture frequently missing.

**Occurrence:** Intermittent occurrence throughout the Venezuelan section. Acme in sample 2601 of the *M. basispinosus* Zone. Offshore Cabinda found infrequently in CABGOC 128-3 between 5,480' and 10,100', and in CABGOC 115-1X between 2,690' and 9,660'.

**Remarks:** Originally described from the Oligocene of Panama. Renz (1948) found the species restricted to the upper Acostian. Blow (1959) only noted the taxon in isolated samples of his *G. insueta / G. triloba* subzone.

**Lenticulina spinosus** (Cushman)

Plate 22, figure 4; Plate 57, figure 8

*Cristellaria americana* var. *spinosa* CUSHMAN 1918, pl. 10, fig. 7

*Robulus americanus* var. *spinosus* (Cushman). --CUSHMAN 1930, pl. 3, fig. 8. --CUSHMAN & CAHILL 1933, pl. 3, fig. 7. --RENZ 1948, pl. 12, fig 4

*Cristellaria americana* var. *spinosa* (Cushman). --CUSHMAN & CAHILL 1933, pl. 3, fig. 7

*Robulus americanus spinosus* (Cushman). --BLOW 1959, p. 131

*Lenticulina americana spinosa* (Cushman). --SNYDER, et. al. 1988, pl. 2, fig. 8

**Description:** Identical to typical form but with addition of short spines to peripheral margin extending from sutures.
Occurrence: Occurs intermittently throughout the Venezuelan section. Acme in sample 2608 of the V. herricki Zone. Offshore Cabinda frequent in CABGOC 128-3 between 4,410’ and 9,260’. Rare in CABGOC 115-1X between 3,470’ and 7,200’.

Remarks: Originally described from the Miocene of Florida. Differs from L. calcar (Linne) in a rounder profile and more inflated test. Renz (1948) found the form throughout the basin, but most common in the Lucian. Blow (1959) similarly found the taxon throughout the section, but found its abundance fluctuated greatly. Also known from Carriacou, Trinidad, Cuba, California, and additional Miocene Venezuelan localities (Bermudez and Fuenmayor 1966).

**Lenticulina subaculeatus glabratus** (Cushman)

Plate 22, figure 5

*Cristellaria subaculeata* Cushman var. *glabrata* Cushman 1923, pl. 32, fig. 4

*Cristellaria subaculeata* var. *glabrata* Cushman. —Nuttall 1927, pl. 6, figs. 1 & 5

*Robulus subaculeatus* (Cushman) var. *glabratus* (Cushman). —Renz 1948, pl. 3, figs. 20 - 21

*Robulus subaculeatus glabratus* (Cushman). —Blow 1959, p. 135

*Lenticulina subaculeata glabrata* (Cushman). —Diaz de Gamero 1985a, pl. 5, fig. 8. —Bolli, et al. 1994, pl. 77, fig. 13

**Description:** Tentative species name given to partial specimens. Smooth wall, inflated chambers, strong peripheral margin. Specimens crossed by series of thick horizontal striae.  

**Occurrence:** Occurs throughout the Venezuelan section. Most common in the *M. basispinosus* and *V. herricki* Zones.  

**Remarks:** Originally described from Recent sediments from the Gulf of Mexico. Renz (1948) found the species morphologically extremely variable, but identified scarce specimens in the 'Uvigerina' sparsicostata Zone, the taxon becoming common in the Acostian and Araguatian. The top occurrence marks the top Araguatian in the Agua Salada Basin. Also known from Costa Rica, Barbados, Carriacou, Trinidad, and Cuba. Diaz de Gamero (1985a) found the species intermittently in her study.

**Lenticulina subkubinyii?** (Nuttall)

Plate 22, figure 6

*Cristellaria subkubinyii* Nuttall 1932, pl. 1, fig. 16

*Darbyella subkubinyii* (Nuttall). —Renz 1948, pl. 4, fig. 3. —Bolli, et al. 1994, pl. 80, fig. 22

**Description:** Compressed, close coiled test. Wide, thin keel, central boss. Sutures thick, gently curving. Smooth, glassy test wall. Aperture not recovered, described as radiate.

**Occurrence:** Single specimen in S. transversa Zone in Venezuela.

**Remarks:** Originally described from the Tertiary of Mexico. Renz (1948) found the species restricted to the Acostian, but also noted its presence in Trinidad and Cuba.

**Lenticulina cf. subkubinyii?** (Nuttall)

*Cristellaria subkubinyii* Nuttall 1932, pl. 1, fig. 16

**Description:** Differs from the typical taxon in greater inflation of the test.

**Occurrence:** Single specimen offshore Cabinda in CABGOC 115-1X at 7,260’.
**Lenticulina subumbonata** (Cushman)

*Lenticulina subumbonata* (Cushman). —POPESCU 1975, pl. 24, fig. 5, pl. 30, fig. 4

**Description:** Large, biumbilicate, acute periphery, keeled. Eight to ten chambers in the last whorl, sweeping, indistinct. Sutures broad and flush. Umbilical area pronounced and raised, comprised of clear shell material. Wall smooth, un-ornamented. Aperture not recovered.

**Occurrence:** Single specimen identified in Lapugiu du Sus, Romania.

**Lenticulina thaimanni** (Hessland)

*Plate 76, figures 3a, 3b*

Robulus thaimanni HESSLAND 1943, pl. 2, fig. 16 (*fide* Ellis & Messina 1940, *et. seq.*)

*Lenticulina thaimanni* (Hessland). —POPESCU 1975, pl. 29, fig. 2

**Description:** Rounded test, rounded periphery, biumbilicate, ovate in cross section. Ten to fifteen chambers in the last whorl, narrow and elongate. Sutures flush with the surface and limbate. Margin with rounded extension of clear shell material. Wall smooth. Aperture radiate.

**Occurrence:** Observed in Sacel, Romania.

**Remarks:** Originally described from the Pleistocene of Sweden.

**Lenticulina vittrea** (Seguenza)

*Lenticulina vittrea* (Seguenza). —POPESCU 1975, pl. 31, fig. 3

**Description:** Large test, acute periphery, keeled, compressed. Keel serrated and broken. Ten to twelve chambers in the last whorl, sweeping, indistinct. Sutures broad and flush. Wall smooth, un-ornamented. Aperture not recovered.

**Occurrence:** Single specimen tentatively identified in Costei, Romania.

**Lenticulina vortex** (Fichtel & Moll)

Nautilus vortex FICHTEL & MOLL 1798, pl. 2, figs. d - l

*Cristellaria vortex* (Fichtel & Moll). —MACFADYEN 1930, pl. 3, fig. 15. —PAPP & SCHMID 1985, pl. 33, figs. 4 - 8. —CICHA, *et. al.* 1998, pl. 23, fig. 2

*Cristellaria aff. vortex* (Fichtel & Moll). —NUTTALL 1927, pl. 5, fig. 7

**Description:** Close coiled test, rounded periphery, strongly lenticular in apertural view. Chambers of similar size and shape, narrow and strongly sweeping toward the periphery. Sutures flush and strongly curved toward the periphery. Central pillar. Smooth wall. Aperture radiate.

**Occurrence:** Offshore Cabinda single specimen found in CABGOC 115-1X at 9,720'.

**Remarks:** Originally described from the Tertiary of Italy. Noted in the Miocene of northern Venezuela (Renz 1948; Bermúdez and Fuenmayor 1966) and the Gulf of Suez region (Souya 1965). Specimens compare well with those of the Heron-Allen and Earland collection (P32500-22545) and the Burrow and Holland collection compare well (slide C, NHM). Specimens in the Gubler collection (P33224) tend to be somewhat more inflated.
**Lenticulina sp. 1**

Plate 22, figure 7

Description: Poor preservation obliterates distinguishing features.

Occurrence: Single specimen in *G. fohsi* Zone in Venezuela.


**Lenticulina sp. 2**

Plate 22, figures 8a, 8b

Description: Small bulbous taxa, inflated. Rounded periphery. Three to four chambers in the last whorl, of similar size and shape. Sutures straight and flush. In apertural view umbilical region widest portion of the test. Wall smooth and un-ornamented. Aperture radiate.

Occurrence: Intermittent occurrence throughout the Venezuelan section. Most common in the *M. basispinosus* and *V. herricki* Zones. Found offshore Cabinda in CABGOC 115-1X at 4,430'.

Remarks: First record of this taxon in the Agua Salada Formation.


**Lenticulina sp. 3**

Plate 22, figure 9

Description: Small poorly preserved specimens. Subacute periphery, semi-inflated. Three to four chambers in the last whorl, increase in size steadily as added. Sutures straight. High apertural face, radiate aperture.

Occurrence: Confined to *G. fohsi* and *L. wallacei* Zones in Venezuela.

Remarks: First record of this taxon in the Agua Salada Formation.


**Lenticulina spp.**

Description: Poor preservation obliterates distinguishing features.

Occurrence: Present in the Chechis Marls and Sacel, Romania.


**Genus MARGINULINOPSIS Silvestri, 1904**

**Marginulinopsis tenuis** (Bornemann)

Plate 76, figure 7

*Marginulina tenuis* BORNEMANN 1855, pl. 13, fig. 14 (fide Ellis & Messina 1940, et seq.)

*Marginulinopsis tenuis* (Bornemann). --POPESCU 1975, pl. 20, fig. 1

Description: Elongate slender test, rounded in cross section. Chambers inflated and increase in size as added. Sutures distinct and depressed, sloping. Wall smooth. Aperture terminal and radiate.

Occurrence: Single juvenile specimen found in the Chechis Marls, Romania.

Remarks: Originally described from the Oligocene of Germany. Known from the Miocene of the Gulf of Suez region (Souya 1965).
**Marginulinopsis sp.**

Plate 58, figures 1a, 1b

**Description:** Uniserial test. Initially arcuate, becomes straight. Chambers low and broad, sutures straight and horizontal. Distinctive parallel longitudinal costae. Aperture not recovered.

**Occurrence:** Offshore Cabinda single specimen found in CABGOC 115-1X at 4,610'.

**Remarks:** Poor preservation, fragment recovered.

Genus SARACENARIA Defrance, 1824

**Saracenaria italica acutocarinata** (Cushman)

Plate 23, figures 1a, 1b

*Cristellaria italica* var. *acutocarinata* CUSHMAN 1917, p. 661

*Cristellaria italica* var. *acutocarinata* Cushman. --CUSHMAN 1921, pl. 51, fig. 3

*Saracenaria italica* var. *acutocarinata* (Cushman). --RENZ 1948, pl. 5, fig. 19

*Saracenaria italica* *acutocarinata* (Cushman). --BLOW 1959, p. 137. --BOLLI, et. al. 1994, pl. 77, fig. 30

**Description:** Always preserved as partial internal moulds. Small species, four to five visible chambers. Margins distinctive and raised, sutures depressed. Differs from the typical species in greatly extended angles to form thin carinae from apex to aperture, the lines of growth being apparent in the carinae.

**Occurrence:** Two specimens recovered in the *V. herricki* and *G. fohsi* Zones in Venezuela.

**Remarks:** Originally described from Recent sediments from offshore the Philippines. Renz (1948) and Blow (1959) found the species scarce and confined to the Acostian and lower Araguatian. Specimens compare well with examples in the Burrow and collection (slide C, NHM).

**Saracenaria italica carapitana** Franklin

Plate 23, figures 2a, 2b; Plate 58, figure 2

*Saracenaria italica* CUSHMAN 1929, pl. 13, fig 14

*Saracenaria italica* *carapitana* FRANKLIN 1944, pl. 45, fig. 14

*Saracenaria italica* RENZ 1942, p. 554

*Saracenaria italica* var. *carapitana* Franklin. --RENZ 1948, pl. 5, fig. 17, 18

*Saracenaria italica* *carapitana* Franklin. --BLOW 1959, p. 137. --BOLLI, et. al. 1994, pl. 77, fig. 28

*Lenticulina* (*Saracenaria* *carapitana* Franklin. --WHITTMER 1988, pl. 5, figs. 19 - 20

**Description:** Small test, early portion close coiled. Periphery acute and keeled. Early portion closely coiled, becoming uncoiled. Test triangular in cross section, sutures narrow and gently curving, flush. Wall smooth. Aperture a slit at the peripheral angle.

**Occurrence:** Few specimens in Venezuela. Confined to *G. fohsi* Zone. Found offshore Cabinda in CABGOC 128-3 between 4'890' and 6'380', rare.

**Remarks:** Originally described from the Oligocene of the Carapitana Formation, north-eastern Venezuela. Similar to *S. senni* Hedberg, but lacks the spinose initial end. Renz (1948) found some specimens in the upper Araguatian tentatively called this species. Specimens conforming more strongly to his definition of the species occur throughout the Agua Salada Basin. The
specimens of Whittaker (1988) tend to be larger than those of this study. Specimens also known from Barbados, Trinidad, Cuba, Jamaica, and Mexico.

**Saracenaria latifrons** (Brady)

**Plate 23, figure 3; Plate 58, figure 3**

*Cristellaria latifrons* BRADY 1884, pl. 113, fig 11

*Saracenaria latifrons* (Brady). --RENZ 1948, pl. 5, fig. 22. --BLOW 1959, p. 137. --KOHL 1985, pl. 11, figs. 5 -6. --SNYDER, et. al. 1988, pl. 2, fig. 11. --BOLLI, et. al. 1994, pl. 77, fig. 29. --BORNMALM 1997, fig. 16E

**Description:** Distinctive species. Elongate free test, planispiral, broadest towards the centre and tapering to either end. Early portion coiled, later uncoiling and flaring. Ventral face broad and oval, dorsal margin angular, lateral edges rounded, triangular in cross section. Early chambers small and involute, adult chambers long, narrow and slightly curved. Sutures distinct and flush. Aperture radiate on the peripheral margin.

**Occurrence:** Occurs rarely in the *M. basispinosus, V. herricki, G. fohsi, and S. transversa* Zones in Venezuela.

**Remarks:** Originally described from Recent sediments offshore the West Indies. Renz (1948) and Blow (1959) found the taxon scarce in the Araguatian and Lucian. Also known from Jamaica. Recognised in the Miocene of the Gulf of Suez region (Souya 1965). Uncertain recovery from the Miocene of Egypt (Macfadyen 1930).

**Saracenaria cf. schencki** Cushman & Hobson

**Plate 23, figures 4a, 4b**

*Saracenaria schencki* CUSHMAN & HOBSON 1935, pl. 8, fig. 11

*Saracenaria schencki* Cushman & Hobson. --RENZ 1948, pl. 5, fig. 20. --BLOW 1959, p. 137 - 138

*Saracenaria cf. schencki* Cushman & Hobson. --CUSHMAN & STAINFORTH 1945, pl. 4, fig. 4

**Description:** Small species preserved as internal moulds. Early chambers closely coiled, adult chambers elongate slightly and increase in size as added. Periphery acute, with slight keel. Aperture radiate on the peripheral margin.

**Occurrence:** Occurs intermittently throughout the Venezuelan section. Scarce. Offshore Cabinda found in CABGOC 128-3 between 4,890' and 10,160', and in CABGOC 115-1X between 3,950' and 7,500'.

**Remarks:** Originally described from the Tertiary of California. Renz (1948) found similar specimens scarcely throughout the Agua Salada Basin. Blow (1959) noted the sporadic occurrence of the taxon. Also known from Barbados, Trinidad, Cuba, Jamaica, and Mexico. Preservation variable.

**Saracenaria senni** Hedberg

**Plate 23, figures 5a, 5b**

*Saracenaria senni* HEDBERG 1937, pl. 90, fig. 18

*Saracenaria senni* Hedberg. --RENZ 1948, pl. 5, fig. 21. --BLOW 1959, p. 138. --BOLLI, et. al. 1994, pl. 77, fig. 27
Description: Small test, early portion closely coiled, later chambers increasing rapidly in size and uncoiling. Chambers curved, periphery keeled. Inner margins of each chamber support short projection, though often abraded and not apparent. Apertural face inflated and triangular in shape. Sutures distinct and curved. Aperture radiate.

Occurrence: Single specimen in G. fohsi Zone in Venezuela.

Remarks: Renz (1948) found the taxon an excellent marker for the Oligocene in the Caribbean region. In the Agua Salada Basin he recovered it scarcely in the 'Uvigerinella' sparsicostata Zone, and more commonly in the Acostian. He regarded the top occurrence to mark the upper boundary of the L. wallacei Zone. Blow (1959) only recovered the taxon in isolated samples. Also noted in Trinidad and Barbados.

Subfamily MARGINULININAE Wedekind, 1937
Genus AMPHICORYNA Schlumberger, 1881

Amphicoryna armata (Neugeboren)
Plate 76, figure 8

Nodosaria armata NEUGEBOREN 1852, pl. 1, fig. 44 (fide Ellis & Messina 1940, et. seq.)
Amphicoryna armata (Neugeboren). --POPESCU 1975, pl. 19, figs. 6 - 8

Description: Distinctive slender species. Uniserial bulbous chambers separated by constrictions of the test. Initial chamber rounded with apical spine, following chamber becoming extended, slight suture separating the two. Subsequent chambers become ovoid. Test covered with short hispid ornamentation. Aperture a rounded opening at the end of the extended last chamber with phialine lip.

Occurrence: Found in Lapugiu du Sus, the Chechis Marls, and Sacel, Romania.

Remarks: Originally described from the Tertiary of Romania.

Amphicoryna imperfectecostata (Silvestri)
Plate 76, figure 9

Nodosaria longicauda d'Orbigny var. imperfecte-costata SILVESTRI 1872, pl. 6, figs. 127 - 137 (fide Ellis & Messina 1940, et. seq.)
Amphicoryna imperfectecostata (Silvestri). --POPESCU 1975, pl. 19, fig. 3

Description: Elongate uniserial test. Bulbous inflated chambers gradually increase in size as added. Initial end with short apical spine, last chamber extended into apertural neck. Sutures distinct and depressed. Distinctive longitudinal parallel striae cover test, less prominent on last chamber. Aperture a rounded opening with phialine lip.

Occurrence: Observed in Sacel, Romania.

Remarks: Originally described from the Pliocene of Italy. Juvenile forms of this taxon may resemble A. proxima.
Amphicoryna proxima (Silvestri)
Plate 76, figures 10 - 11

Nodosaria proxima SILVESTRI 1872, pl. 6, figs. 138 - 147 (fide Ellis & Messina 1940, et. seq.)
Nodosaria proxima Silvestri. --MACFADYEN 1930, pl. 2, fig. 35
Amphicoryna proxima (Silvestri). --POPECU 1975, pl. 19, fig. 5, textfig. 10

Description: Small delicate taxon. Two to three uniserial inflated chambers. Rounded periphery, acute short spine at initial end, last chamber extended to ovate shape. Initial chamber rounded and slightly larger than subsequent growth. Suture distinct. Characteristic longitudinal low costae cover test, parallel to one another, confined to individual chambers. Aperture a rounded opening with phialine lip.

Occurrence: Observed in the Chechis Marls, Romania.
Remarks: Originally described from the Pliocene of Italy. Known from the Miocene of the Gulf of Suez region (Souya 1965).

Genus ASTACOLUS de Montfort, 1808

Astacolus insolitus (Schwager)
Plate 76, figures 12a, 12b

Cristeilaria insolita SCHWAGER 1866, pl. 6, fig. 85 (fide Ellis & Messina 1940, et. seq.)
Astacolus insolitus (Schwager). --POPECU 1975, pl. 37, fig. 1

Description: Elongate slightly compressed test. Marginally coiled early chambers, becoming uncoiled with successive growth. Chambers increase in size considerably as added, elongate and sinuous. Sutures, slightly depressed and limbate. Wall smooth. Terminal radial aperture on the outer margin of the last formed chamber.

Occurrence: Observed in Sacel, Romania.
Remarks: Originally described form the Tertiary of Car Nicobar. Specimens of the M. S. Srinivasan collection (NHM) tend to be more elongate and show a greater acuteness to the margin.

Astacolus ovatus Galloway & Heminway

Astacolus ovatus GALLOWAY & HEMINWAY 1941, pl. 8, fig. 10
Marginulina ovata (Galloway & Heminway). --CUSHMAN & RENZ 1947, pl. 4, fig. 3
Astacolus sp. aff. ovatus Galloway & Heminway. --RENZ 1948, pl. 4, fig. 11
Astacolus ovatus Galloway & Heminway. --BOLLI, et. al. 1994, pl. 77, fig. 23

Description: Elongate compressed test, coiled early chambers, becoming uncoiled with successive growth. Chambers increase regularly in size, sutures distinct though not depressed. Wall smooth. Terminal radial aperture on the outer margin of the last formed chamber.

Occurrence: Offshore Cabinda single specimen found in CABGOC 115-1X at 9,180'. Single specimen identified in Lapugiu du Sus, Romania.
Remarks: Originally described from the Oligocene of Puerto Rico, also known from Trinidad. In the Caribbean this taxon is confined to the Upper Oligocene (Renz 1948).
**Astacolus sublituus** (Nuttall)

**Plate 23, figure 6**

*Cristellaria sublituus* NUTTALL 1932, pl. 1, figs. 13 - 14

*Lenticulina sublituus* (Nuttall). --PALMER 1940, p. 130

*Astacolus sublituus* (Nuttall). --GALLOWAY & HEMINWAY 1941, pl. 8, fig. 11. --RENZ 1948, p. 115

*Marginulina sublituus* (Nuttall). --CUSHMAN & STAINFORTH 1945, pl. 16, fig. 14

**Description:** Elongate test, slightly bilaterally compressed. Test walls smooth and unornamented. Sutures oblique and narrow. Aperture terminal and stellate.

**Occurrence:** Few specimens in the *V. herricki* and *G. fohsi* Zones in Venezuela. Single specimen present in the Chechis Marls, Romania.

**Remarks:** Renz (1948) remarked upon this species as common in the Lower Acostian. Also found in Trinidad, Cuba, Puerto Rico, and Mexico. Recognised along the Gulf Coast (Garret 1938). Known to be morphologically very variable (Cushman and Renz 1947).

**Astacolus sp. a Renz**

**Plate 58, figure 4**

*Astacolus* sp. a RENZ 1948, pl. 4, fig. 22

**Description:** Small taxon. Ovate test, semi-compressed. Subacute periphery. Chambers increase in size rapidly as added, sutures flush and limbate. Aperture terminal and radiate.

**Occurrence:** Offshore Cabinda single specimen found in CABGOC 128-3 at 10,100'.

**Remarks:** Poor preservation.

**Astacolus sp. 1**

**Plate 23, figure 7**

**Description:** Small bulbous test, ovate, inflated. Initially arcuate, small indistinct chambers. Subsequent large inflated chamber embraces majority of test. Wall smooth. Aperture a large radiate opening.

**Occurrence:** Confined to *V. herricki* Zone in Venezuela.

**Remarks:** First record of this taxon from the Agua Salada Formation.

Genus MARGINULINA d’Orbigny, 1826

**Marginulina cf. celata** Koch

**Plate 77, figure 2**

*Marginulina celata* KOCH 1926, textfig. 9 (fide Ellis & Messina 1940, et seq.)

*Marginulina celata* Koch. --POPESECU 1975, pl. 20, figs. 2 - 3

**Description:** Large test, robust and rounded in cross section. Rounded periphery. Five to six chambers of similar size, low and inflated, last chamber rounded. Initial end rounded and offset from subsequent growth. Aperture on a short neck offset slightly from the centre, radiate.

**Occurrence:** Single specimen identified in Sacel, Romania.

**Remarks:** Originally described from the Tertiary of Borneo.
Marginulina cf. glabra obesa Cushman

Plate 58, figure 5

Marginulina cf. glabra var. obesa CUSHMAN 1923, pl. 37, fig. 1
Marginulina cf. glabra var. obesa Cushman. --RENZ 1948, pl. 4, fig. 21. --BOLLI, et. al. 1994, pl. 77, fig. 24

Description: Distinctive robust taxon, rounded profile. Three inflated chambers visible, rapidly increase in size. Chambers square, separated by indistinct, slightly depressed, oblique sutures. Wall smooth. Aperture an off centre extension of the last formed chamber, radiate.

Occurrence: Offshore Cabinda found in CABGOC 128-3 at 5,000' and 10,040', and in CABGOC 115-1X at 7,560'.

Remarks: Originally described from Recent material from the north-east American coast. Differs from the typical taxon in more robust form and larger size.

Marginulina hirsuta (d'Orbigny)

Plate 76, figures 5 - 6

Marginulina hirsuta d'ORBIGNY 1826, p. 259 (fide Ellis & Messina 1940, et. seq.)
Marginulina hirsuta d'Orbigny. --d'ORBIGNY 1846, pl. 3, figs. 17 - 18. --POPESCU 1975, pl. 22, figs. 2 - 5.
--PAPP & SCHMID 1985, pl. 22, figs. 1 - 7. --CARBONI & DI BELLA 1997, pl. 2, fig. 9. --CICHA, et. al. 1998, pl. 25, figs. 13 - 14


Occurrence: Found in the Chechis Marls and Sacel, Romania.

Remarks: Specimens compare well with those in the Gubler collection (P33233), although juvenile chambers in this collection show a degree of compression not as evident in the specimens of this study. Compares well with the Burrow and Holland Marginulina hirsuta specimens (slide C, NHM).

Marginulina striatula Cushman

Plate 77, figure 3

Marginulina striatula CUSHMAN 1913, pl. 23, fig. 4

Description: Elongate test separated by distinct constrictions. Juvenile portion of test forms a partial coil. Chambers inflated, may show faint longitudinal striae. Aperture terminal and radiate on short neck.

Occurrence: Offshore Cabinda single specimen found in CABGOC 115-1X at 9,600'. Single specimen identified in the Chechis Marls, Romania.

Remarks: Originally described from Recent sediments from offshore Hawaii.

Marginulina cf. striatula Cushman

Plate 23, figures 8a, 8b; Plate 58, figure 6

Marginulina striatula CUSHMAN 1913, pl. 23, fig. 4
Marginulina cf. striatula Cushman. --RENZ 1948, pl. 4, figs. 15 - 16. --BLOUW 1959, p. 123 - 124. --BOLLI, et. al. 1994, pl. 77, figs. 25 - 26
Description: Elongate test, differs from typical in the inflation of the final of the chamber and loss of striae. Often abraded.

Occurrence: Ranges from the M. basispinosus to the S. transversa Zones in Venezuela. Infrequent. Rare offshore Cabinda, found in CABGOC 128-3 at 6,860', and in CABGOC 115-1X at 9'600'.

Remarks: Originally described from Recent sediments offshore the Hawaiian Islands. Renz (1948) found the taxon 'scarce, but present in most samples' throughout the Agua Salada Formation. Blow (1959) similarly found the species scarce. Preservation variable. Also known from Costa Rica and Trinidad.

Marginulina subbulla Hantken

Plate 77, figures 4 - 5

Marginulina subbulla HANTKEN 1875 (1876), pl. 4, figs. 9 - 10; pl. 5, fig. 9 (fide Ellis & Messina 1940, et seq.)

Marginulina subbulla Hantken. --CUSHMAN & LAIMING 1931, pl. 10, fig. 8. --LE ROY 1939, pl. 1, figs. 11 - 13. --PALMER 1940, p. 279. --CUSHMAN & RENZ 1947, pl. 4, fig. 1. --RENZ 1948, pl. 4, figs. 13 - 14. --BLOW 1959, p. 124. --FINGER 1992, pl. 6, figs. 32 - 33


Occurrence: Infrequent occurrence throughout the Venezuelan section. Offshore Cabinda found in CABGOC 128-3 between 4,110' and 9,980', and in CABGOC 115-1X at 7,380' and 8,700'. Found in the Chechis Marls, Romania.

Remarks: Originally described from the Oligocene of Hungary. Renz (1948) found the species throughout the Agua Salada Formation, but most common in the upper Acostian and lower Araguatian. Blow (1959) found the taxon 'generally ubiquitous'. Known commonly throughout the Tertiary of tropical America: Costa Rica, Barbados, Carriacou, Trinidad, Cuba, Jamaica, Mexico, and California. Recognised along the Gulf Coast (Garret 1938).

Marginulina sp. 1

Description: Small test, semi-compressed, keeled. Bulbous initial chambers followed by less inflated adult growth. Prominent longitudinal costae, three on each side. Aperture terminal with short neck.

Occurrence: Single specimen found offshore Cabinda in CABGOC 128-3 at 6,860'.

Remarks: Poor preservation.
Genus VAGINULINOPSIS Silvestri, 1904

*Vaginulinopsis spinulosa* (Stache)

Plate 58, figure 7

*Vaginulinopsis spinulosa* (Stache). --CAMERON 1978, pl. 1, fig. 4

Description: Small unilocular fragment. Spherical chambers, gradually increase in size as added. Sutures distinct and depressed. Test covered with numerous irregular short hisps and spines.

Occurrence: Single specimen found offshore Cabinda in CABGOC 128-3 at 10,040'.

Remarks: Poor preservation.

*Vaginulinopsis superbus* (Cushman & Renz)

Plate 58, figure 8

*Marginulina superba* CUSHMAN & RENZ 1941, pl. 2, figs. 19-20

*Marginulina superba* Cushman & Renz. --CUSHMAN & RENZ 1947, pl. 4, fig. 4

*Vaginulinopsis superbus* (Cushman & Renz). --RENZ 1948, pl. 4, figs. 17-18. --BOLLI, et al. 1994, pl. 77, fig. 18-19

Description: Elongate compressed test. Subacute periphery with slight keel. Initial chambers enrolled, later growth uncoiled. Chambers increase in size as added rapidly, uninflated. Sutures curved and raised, in earlier growth ornamented with discontinuous knobs. Longitudinal costae strong on early chambers, become weaker towards the aperture. Aperture on a slender extension of the last formed chamber, rounded.

Occurrence: Single specimen found offshore Cabinda in CABGOC 128-3 at 9,980'.

Remarks: Poor preservation. Known from the Miocene of Venezuela (Bermúdez and Fuenmayor 1966).

Subfamily VAGINULININAE Reuss, 1860

Genus CITHARINA d'Orbigny, 1839

*Citharina* sp.

Description: Flattened test, triangular profile. Numerous low, broad, uniserial chambers, increase in size slowly as added, curved. Sutures curved and depressed. Wall ornamented by numerous longitudinal costae, regularly spaced. Aperture a wide radiate opening with stout neck.

Occurrence: Two specimens observed in Sacel, Romania.

Genus PLANULARIA Defrance, 1826

*Planularia arbenzi* Cushman & Renz

Plate 24, figure 1

*Planularia arbenzi* CUSHMAN & RENZ 1941, pl. 2, fig. 13

*Planularia arbenzi* Cushman & Renz. --CUSHMAN & RENZ 1947, pl. 3, fig. 13. --RENZ 1948, pl. 4, fig. 6. --BOLLI, et al. 1994, pl. 80, fig. 14

*Lenticulina (Robulus) arbenzi* (Cushman & Renz). --WHITTAKER 1988, pl. 5, figs. 15-16 (not 17-18)

Description: Evolute test, compressed with thin keel. Prominent umbos. Chambers distinct and slightly inflated. Increase uniformly in size, eight to ten in a whorl. Sutures distinct and slightly
curved, may be raised, though often abraded. Become thicker towards the periphery. Wall smooth, aperture on the outer peripheral angle, radiate.

**Occurrence:** Infrequent species. Found in *M. basispinosus, V. herricki, S. transversa* and *L. wallacei* Zones in Venezuela.

**Remarks:** Cushman and Renz (1941) found the taxon throughout the Agua Salada Formation. Renz (1948), suggested a doubtful generic position for the species, he found it restricted to the Acoastian and Araguatian. Also noted in Barbados, Trinidad, and Mexico. Specimens compare well with Whittakers (1988) meglospheric forms (P51943).

**Planularia clara** Cushman & Jarvis

**Plate 24, figure 2**

*Planularia clara* CUSHMAN & JARVIS 1929, pl. 2, figs. 14 - 15

*Planularia clara* Cushman & Jarvis. --CUSHMAN & RENZ 1947, pl. 3, fig. 12. --RENZ 1948, pl. 4, fig. 4. --BLOW 1959, p. 128 - 129. --BOLLI, et. al. 1994, pl. 80, fig. 12

*Planularia cf. clara* Cushman & Jarvis. --SNYDER, et. al. 1988, pl. 2, figs. 16 - 18

**Description:** Compressed test, parallel sides and close coiled. Keeled periphery. Chambers distinct, increase in size as added. Sutures distinct, spiral suture slightly raised, though may be abraded. Sutures separating chambers limbate, broaden towards periphery. Wall smooth and finely perforate. Aperture radiate, at peripheral angle of apertural face. '.. a very beautiful species with very broad, clear, limbate sutures increasing in width toward the periphery', Cushman and Jarvis (1929).

**Occurrence:** Scarce, confined to the *V. herricki, G. fohsi* and *L. wallacei* Zones in Venezuela. Single specimen found offshore Cabinda in CABGOC 115-1X at 8,340'.

**Remarks:** Originally described from the Miocene of Trinidad. Renz (1948) found the species scarce in the Acoastian and upper Araguatian, but common in the lower Araguatian. Blow (1959) however, finds the species into much younger sediments of the Agua Salada Basin. Also known from Barbados and Trinidad.

**Planularia karreri** (Rzehak)

**Plate 76, figure 13**

*Cristellaria karreri* RZEHAK 1886, pl. 1, fig. 10 (*fide* Ellis & Messina 1940, *et. seq.)*

*Planularia karreri* (Rzehak). --POPESCU 1975, pl. 26, fig. 1

**Description:** Test of moderate size, acute periphery, wide keel, compressed. Six chambers visible, inflated, steadily increase in size as added, later three curve gently toward the periphery. Sutures distinct and incised. Wall smooth. Aperture at peripheral angle of apertural face.

**Occurrence:** Single specimen identified in the Chechis Marls, Romania.

**Remarks:** Originally described from the Neogene of Czechoslovakia.

170
Planularia partschi (Michelotti)

Cristellaria partschi MICHELOTTI 1847 (*fide* Ellis & Messina 1940, *et. seq.*)

Planularia partschi (Michelotti). —POPESCU 1975, pl. 27, fig. 3

Description: Large test for genus, biconvex, acute periphery extended into wide keel. Four to five chambers of equal size in the last whorl. Sutures flush and slightly limbate. Lobulate outline. Aperture un-observed, broken specimen.

Occurrence: Single specimen identified in the Chechis Marls, Romania.

Remarks: Originally described from the Miocene of Italy.

Planularia venezuelana Hedberg

Plate 24, figure 3; Plate 76, figure 14

Planularia venezuelana HEDBERG 1937, pl. 90, fig. 14

Planularia venezuelana Hedberg. —CUSHMAN & RENZ 1947, pl. 3, fig. 11. —RENZ 1948, pl. 4, fig. 5. —BLOW 1959, p. 129. —POPESCU 1975, pl. 23, fig. 6, pl. 24, figs. 4 - 5. —BOLLI, et al. 1994, pl. 80, fig. 13

Description: Compressed test, close coiled. Periphery with delicate keel. Chambers inflated, increase gradually in size as added. Sutures distinct, curved and increase in breadth towards the periphery. Aperture at peripheral angle of aperture face, radiate. Similar to *P. clara* but has single median keel, inflated chambers, sutures curve more strongly and evidence for apertural siphons.

Occurrence: Confined to the *V. herricki* and *G. fohsi* Zones in Venezuela. Also found in the Chechis Marls, Romania.

Remarks: Renz (1948) found the species common in the lower Acostian. Blow (1959) found the species scarce. Also known from Barbados and Trinidad. Considered a good marker for the Middle-Upper Oligocene in the Caribbean region.

Planularia sp. 1

Plate 77, figures 1a, 1b

Description: Poor preservation obliterates distinguishing features.

Occurrence: Found in Costei and the Chehcis Marls, Romania.

Genus VAGINULINA d'Orbigny, 1826

Vaginulina midwayana Fox & Ross

Plate 24, figure 4; Plate 58, figure 9

Vaginulina midwayana FOX & ROSS 1942, p. 669 (*fide* Skinner & Steinkraus 1972)

Vaginulina midwayana Fox & Ross. —SKINNER & STEINKRAUS 1972

Description: Elongate test, broad and compressed. Tapers bluntly, coiled initial chambers, adult chambers uniserial and of equal size. Sutures oblique and distinctly raised, may become discontinuous. Wall smooth. Aperture not recovered.

Occurrence: Confined to *V. herricki* and *S. transversa* Zones in Venezuela. Rare. Single specimen found offshore Cabinda in CABGOC 128-3 at 9,980'.

Remarks: Originally described from the Miocene of Texas. First record of this species from the Agua Salada Formation. Rarely complete.
**Vaginulina sp. a Renz**

**Plate 24, figure 5**

*Vaginulina* sp. a *RENZ 1948, pi. 4, fig. 23*

**Description:** Small taxon for genus, subacute margin, elongate and compressed. Strongly slanting sutures, limbate, slightly raised. Chambers uniflated, indistinct. Juvenile coiled portion indistinct.

**Occurrence:** Few specimens in the *V. herricki* and *G. fohsi* Zones in Venezuela. Single specimen found offshore Cabinda in CABGOC 115-1X at 6,540'.

**Remarks:** Renz (1948) found this form in the upper Acostian.

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**Family LAGENIDAE Reuss, 1862**

**Genus LAGENA Walker and Jacob, 1798**

**Lagena sp. 1**

**Description:** Distinctive small taxon with pustulose ornament.

**Occurrence:** Single specimen in the *V. herricki* Zone in Venezuela.

**Remarks:** First record of this taxon in the Agua Salada Formation.

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**Lagena sp.**

**Description:** Partial specimen, insufficient to describe.

**Occurrence:** Single specimen identified in Sacel, Romania.

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**Family POLYMORPHINIDAE d'Orbigny, 1839**

**Subfamily POLYMORPHININAE d'Orbigny, 1839**

**Genus GUTTULINA d'Orbigny, 1839**

**Guttulina communis** (d'Orbigny)

**Plate 58, figure 10; Plate 77, figure 6**

*Polymorphina communis* d'ORBIGNY 1826, pl. 12, fig. 1 - 4 (*fide* Ellis & Messina 1940, *et. seq.*)

*Globulina irregularis* d'ORBIGNY 1846, pl. 13, figs. 9 - 10

*Guttulina problema* d'ORBIGNY 1846, pl. 12, figs. 26 - 28

*Polymorphina communis* d'Orbigny. --MACFADYEN 1930, pl. 3, fig. 25

*Guttulina communis* (d'Orbigny). --d'ORBIGNY 1846, pl. 13, figs. 6 - 8. --POPESECU 1975, pl. 39, fig. 3. --PAPP & SCHMID 1985, pl. 70, figs. 2 - 12, pl. 71, figs. 1 - 4. --CICHA, *et. al.* 1998, pl. 28, figs. 2 - 3

**Description:** Broad test, inflated chambers. Aperture closed and radiate.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 between 4,650' and 10,160', and in CABGOC 115-1X at 9,180' and 9,840'. Observed in Costei, Romania.

**Remarks:** Originally described from the Tertiary of the Vienna Basin. Considered to be a shallow water taxon (Papp and Schmid 1985), who also synonymised the taxon with *G. irregularis* d'Orbigny and *G. problema* d'Orbigny, a combination followed herein.
Guttulina frankei Cushman & Ozawa

Plate 77, figures 7a, 7b

_Guttulina frankei_ CUSHMAN & OZAWA 1930, pl. 4, fig. 1
_Guttulina frankei_ Cushman & Ozawa. --CICHA, et. al. 1998, pl. 28, figs. 4 - 6

**Description:** Asymmetrical robust test. Initial and apertural ends acute. Bulbous chambers increase rapidly in size as added and becoming extended. Quinqueloculine arrangement, unembracing. Sutures distinct and depressed. Wall perforate and smooth. Aperture radiate.

**Occurrence:** Single specimen in Costei, Romania.

**Remarks:** Originally described from the Oligocene of Germany. This taxon differs from _G. irregularis_ in the acute nature of its initial end; this is more rounded in _G. irregularis_.

Guttulina jarvisi Cushman & Ozawa

Plate 58, figure 11

_Guttulina jarvisi_ CUSHMAN & OZAWA 1930, pl. 7, figs. 4 - 5
_Guttulina jarvisi_ Cushman & Ozawa. --RENZ 1948, pl. 6, fig. 2

**Description:** Large ovate test. Greatest breadth towards the centre. Rounded periphery. Base rounded, apertural end becoming tapered and acute. Chambers bulbous and embracing, of similar size and shape. Sutures depressed and distinct. Wall smooth. Aperture radiate.

**Occurrence:** Offshore Cabinda in CABGOC 128-3 at 10,040', and in CABGOC 115-1X between 9,660' and 9,780'.

**Remarks:** Originally described from the Oligocene of Trinidad. Invariably preserved as a pyrite internal mould.

Genus POLYMORPHINA d'Orbigny, 1826

*Polymorphina* sp.

Plate 24, figure 6

**Description:** Small ovoid test, rounded periphery. Smooth wall. Large radiate aperture.

**Occurrence:** Single specimen in _L. wallacei_ Zone in Venezuela.

Family ELLIPSOLAGENIDAE Silvestri, 1923

Subfamily OOLININAE Loeblich & Tappan, 1961

Genus OOLINA d'Orbigny, 1839

*Oolina hexagona* (Williamson)

Plate 24, figure 7

*Entosolenia squamosa* var. *hexagona* WILLIAMSON 1848, pl. 2, fig. 23 (fide Ellis & Messina 1940, et. seq.)

_Lagena hexagona_ (Williamson). --CUSHMAN 1930, pl. 5, fig. 11. --CUSHMAN & CAHILL 1933, pl. 5, fig. 8. --BERMÚDEZ & SEIGLIE 1963, pl. 17, fig. 10

*Entosolenia hexagona* (Williamson). --ASANO 1951, p. 35, fig. 151

_Oolina hexagona_ (Williamson). --AKERS & DORMAN 1964, pl. 6, fig. 8. --KOHL 1985, pl. 16, fig. 4. --Snyder, et. al. 1988, pl. 3, fig. 15. --FINGER, et. al. 1990, pl. 2, fig. 23. --FINGER 1992, pl. 8, figs. 23 - 25

_Favulina hexagona_ (Williamson). --FILIPESCU 1996, pl. 4, fig. 4. --CICHA, et. al. 1998, pl. 28, fig. 11
Description: Free, unilocular test, rounded in cross section with a short thick neck. Test ornamented with reticulate pattern of raised hexagonal cells. Aperture a small rounded opening.

Occurrence: Single specimen in G. fohsi Zone in Venezuela.

Remarks: First record of this species from the Agua Salada Formation. Known from Recent sediments of the Côte d'Ivoire (Calvez 1963), the Miocene of Egypt (Macfadyen 1930), the Gulf of Suez region (Souya 1965), and additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966). Specimens compare well with those of the Heron-Allen and Earland collection (NHM).

Entosolenia sp. 1
Plate 24, figure 8; Plate 59, figure 1
Entosolenia? sp. RENZ 1948, pl. 6, fig. 17

Description: Single chambered small biconvex species. Ovate in profile with distinct keel. Aperture simple slit like opening with protruding rounded lip.

Occurrence: Found sporadically throughout the Venezuelan section. Offshore Cabinda found in CABGOC 128-3 between 9,980' and 10,160', and in CABGOC 115-1X between 6,480' and 8,940'.

Remarks: This species resembles the taxon depicted by Renz (1948) reasonably. However, without a description, informed comparison is impossible. Renz found his species ranging from the 'Uvigerinella' sparsicostata Zone, through the Acostian, Araguanian, and Lucian. Also noted in Trinidad.

Entosolenia sp. 2

Description: Poorly preserved individual. Inflated with keel. Simple elongate aperture on the margin. Possibly a abraded F. marginata (Montagu).

Occurrence: Single specimen identified in Vâlcele, Romania.

Subfamily ELLIPSOLAGENINAE Silvestri, 1923
Genus FISSURINA Reuss, 1850
Fissurina kerguelensis Parr
Plate 24, figure 9
Fissurina kerguelensis PARR 1950, pl. 8, fig. 7
Fissurina kerguelensis Parr. –BORNMALM 1997, fig. 17C
Fissurina sp. 'D' AKERS & DOORMAN 1994, pl. 7, figs. 11 - 12

Description: Test free and unilocular. Slightly compressed and rounded in side view. Apertural end extended, aperture a simple slit in the plane of compression. Three to four distinctive spines extend from basal area of test. Wall smooth.

Occurrence: Confined to T. panamaensis zoole and V. herricki Zone in Venezuela.

Remarks: First record of this taxon in the Agua Salada Formation. Differs from F. neptuni (Buchner) in the fewer number of basal projections and a single keel.
**Fissurina marginata** (Walker & Boys)

**Plate 24, figure 10**

*Lagena marginata* WALKER & BOYS 1784, pl. 1, fig. 7

*Vermiculum marginatum* MONTAGU 1803, p. 524 (fide Bornmalm 1997)

*Lagena marginata* (Walker & Boys) — BAGG 1905, pl. 4, fig. 5. — NUTTALL 1927, pl. 4, fig. 4. — RENZ 1948, pl. 5, fig. 30

*Entosolenia marginata* (Walker & Boys). — BLOW 1959, p. 151 - 152

*Entosolenia cf. marginata* (Walker & Boys). — CUSHMAN & STAINFORTH 1945, pl. 6, figs. 8 - 10

*Fissurina marginata* (Montagu). — KOHL 1985, pi. 15, fig. 5. — LECKIE & WEBB 1986, pl. 18, figs. 9 - 10. — SPROVIERI & HASEGAWA 1990, pl. 1, fig. 16. — BORNMALM 1997, fig 17 D - E

**Description:** Unilocular species, small, test free, partially inflated. Subacute margin, phialine aperture. Usually broken.

**Occurrence:** Common in *V. herricki* and *G. fohsi* Zones, acme at sample 2612 of the *V. herricki* Zone in Venezuela. Offshore Cabinda found in CABGOC 115-1X between 7,440' and 9,600', rare.

**Remarks:** Renz (1948) found the species scarce in the *'Uvigerinella' sparsicostata* Zone, Acostian, Araguatian, and Lucian. Blow (1959) however, found the taxon ubiquitous in all zones below his *S. seminulina* Zone. Also noted in Trinidad, Puerto Rico, Cuba, and California. Hermelin (1989) regards this species as erroneously attributed to Walker and Boys (1784), preferring designation of Montagu (1803). Specimens in the Earland collection (NHM) are eroded and compare well with the African examples of this study. Specimens in the Heron-Allen and Earland collection (NHM) compare well. Known from the Miocene of the Gulf of Suez region (Souya 1965) and additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966).

**Fissurina miocenica** (Ferasin)

**Plate 77, figures 8a, 8b**

*Entosolenia orbignyana* (Seguenza) var. *miocenica* FERASIN 1954, pl. 5, fig. 1 (fide Ellis & Messina 1940, et. seq.)

**Description:** Small delicate species. Single chamber shows a single marginal flange extending radially and along entosolenian neck to aperture. Wall smooth and glassy.

**Occurrence:** Observed in Vâlceie in Romania.

**Remarks:** Originally described from the lower Miocene of Italy.

Superfamily CERATOBULIMINACEA Cushman, 1927

Family CERATOBULIMINIDAE Cushman, 1927

Subfamily CERATOBULIMININAE Cushman, 1927

Genus CERATOCANCRI Finlay, 1939

**Ceratocancris hauriae** (d'Orbigny)

**Plate 77, figures 9a, 9b**

*Rotalina haueri* d'ORBIGNY 1876, pl. 7, figs. 22 - 24 (fide Ellis & Messina 1940, et. seq.)

*Ceratocancris hauriae* (d'Orbigny) — POPESCU 1975, pl. 89, fig. 5. — PAPP & SCHMID 1985, pl. 48, figs. 1 - 6. — CICHA, et. al. 1998, pl. 29, figs. 14 - 16
Description: Broad, oval, trochoid test. Rounded profile, sutures slightly depressed. Aperture a small slit on the ventral side. Perforate.

Occurrence: Common to Costei and Lapugiu du Sus, Romania.

Remarks: Originally described from the Tertiary of the Vienna Basin.

Family EPISTOMINIDAE Wedekind, 1937
Subfamily EPISTOMININAE Wedekind, 1937
Genus HOEGLUNDINA Brotzen 1948

*Hoeglundina elegans* (d’Orbigny)

Rotalina elegans d’ORBIGNY 1826 p. 276 (*fide* Ellis & Messina 1940, *et. seq.*)

*Epistomina elegans* (d’Orbigny). --CUSHMAN 1948, pl. 26, figs. 3 - 4


Höglundina elegans (d’Orbigny). --HALLER 1980, pl. 12, fig. 1

**Description:** Thick shelled trochoid test with slight keel. Dorsal side convex, ventral side flat to slightly convex. Chambers narrow, sutures flush on the ventral side, slightly depressed on the dorsal side. Aperture a narrow slit below the keel on the periphery of the last formed chamber. Characteristic glassy appearance to ventral side.

**Occurrence:** Single specimens found in Lapugiu du Sus and the Chechis Marls, Romania.

**Remarks:** Originally described from the Tertiary of the Vienna Basin. Known from Recent sediments of the Côte d’Ivoire (Calvez 1963) and Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966).

Superfamily BOLIVINACEA Glaessner, 1937

Family BOLIVINIDAE Glaessner, 1937

Genus BOLIVINA d’Orbigny, 1839

*Bolivina advena* Cushman

**Plate 59, figure 2**

*Bolivina advena* CUSHMAN 1925, pl. 5, fig. 1

*Bolivina advena* Cushman. --CUSHMAN & PONTON 1932, pl. 12, fig. 3. --CUSHMAN 1837, pl. 10, fig. 16. --RENZ 1948, pl. 6, fig. 23. --BLOW 1959, p. 144. --SMITH 1960, pl. 57, figs. 3 - 4. --KLEINPELL, *et. al.* 1980, pl. 7, fig. 1. --BRUN, *et. al.* 1984, pl. 2, fig. 16. --SNYDER, *et. al.* 1988, pl. 4, fig. 7. --WHITTAKER 1988, pl. 10, figs. 31 - 33. --FINGER 1990, p. 24 - 25. --FINGER, *et. al.* 1990, pl. 4, fig. 1. --FINGER 1992, pl. 15, figs. 2 - 6. pl. 17, fig. 48. --BOHLM, *et. al.* 1994, pl. 78, fig. 13

**Description:** Robust test. Partially flattened in its early portion, inflated with successive growth. Chambers increase in size with growth, early chambers low, later ones high. Sutures limbate at initial end, becoming straight and depressed. Periphery rounded, though subacute in early portion. Varying striate ornamentation, becoming slightly crenulate in some African individuals. Wall punctate, alignment of pores in some cases.
Occurrence: Offshore Cabinda found in CABGOC 128-3 between 1,080' and 10,040', acme between 3,870' and 4,050' in CABGOC 115-1X between 3,830' and 8,640'. Two specimens observed in Lapugi, du Sus, Romania.

Remarks: Originally from the Miocene Monterey Shale of California. Renz (1948) found the taxon common in the Lucian of Venezuela, although it was not identified in the El Mene-Pozon section in this study. Blow (1959) identifies the taxon in the Pozon-El Mene Road section. Finger (1990) notes variability in striate ornamentation and crenulation in Californian specimens. Specimens in the Whittaker collection tend to be more perforate than those of this study (P51755). Known from Recent sediments of the Côte d'Ivoire (Calvez 1963).

**Bolivina cf. advena** Cushman

Plate 59, figure 3

*Bolivina advena* CUSHMAN 1925, pl. 5, fig. 1

Description: Differs from the typical in a greater inflation of the test and a slightly irregular chamber arrangement.

Occurrence: Offshore Cabinda found in CABGOC 128-3 between 4,890' and 7,820', rare.

**Bolivina byramensis** Cushman

Plate 25, figure 1; Plate 59, figure 4

*Bolivina caelata* CUSHMAN var. *byramensis* CUSHMAN 1923, pl. 1, fig. 9

*Bolivina byramensis* CUSHMAN 1937, pl. 8, figs. 18 - 20

*Brizalina* sp. 1. PETTERS 1979, pl. 2, fig. 15

*Bolivina byramensis* Cushman. --CORYELL & RIVERO 1940, pl. 44, fig. 17. --RENZ 1948, pl. 6, fig. 22. --BLOW 1959, p. 144 - 145. --TJALSMA 1983, pl. 1, fig. 1. --VAN MORKHOVEN, et. al. 1986, pl. 71, figs. 1 - 2. --BOLLI, et. al. 1994, pl. 78, fig. 20

*Brizalina byramensis* (Cushman). --WHITTAKER 1988, pl. 11, figs. 24 - 26

Description: Small species, always fragmented. Strongly compressed, sutures very distinct and raised, sloping. Periphery acute. Centre of test displays a noticeable ridge. Surface ornament in semi-irregular reticulate pattern. Aperture always missing or broken.

Occurrence: Rare species in the *M. basispinosus* and *V. herricki* Zones in Venezuela. Offshore Cabinda found in CABGOC 128-3 at 7,180' and 9,080'.

Remarks: Renz (1948) found the species common in the Acostian but rare in the Araguatian. On the whole, he noted his specimens tended to be smaller than the topotypes from the Oligocene of Mississippi. Dendritic pattern of surface ornament not as well developed in the specimens of the Whittaker collection (P51767), although figured Venezuelan specimen shows strong surface ornament obscuring sutures. Recognised in additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966).
**Bolivina caudriae** Cushman & Renz

*Plate 25, figure 2; Plate 59, figure 5*

*Bolivina caudriae* CUSHMAN & RENZ 1941, pl. 3, figs. 13 - 14

*Bolivina caudriae* Cushman & Renz. --RENZ 1948 pl. 7, fig. 1. --BLOW 1959, p. 145. --PETTERS 1982, pl. 11, figs. 1 - 2. --BRUN, et. al. 1984, pl. 2, fig. 17. --DIAZ de GAMERO 1985a, pl. 5, fig. 12. --BOLLI, et. al. 1994, pl. 78, figs. 9 - 10

**Description:** Elongate tapering test, gently compressed, rounded periphery. Chambers distinct and curved, increasing uniformly in size. Sutures distinct, oblique with a triangle of clear shell material towards the centre. Wall smooth and perforate. Aperture high arched slit at base of the last chamber in the median line.

**Occurrence:** Occurs sporadically throughout the Venezuelan section. Offshore Cabinda found in CAGOC 128-3 between 2,370' and 10,160', rare.

**Remarks:** Cushman and Renz (1941) found the species confined to the Lower Agua Salada Formation. Renz (1948) reported the taxon as scarce in the 'Uvigerinella' sparsicostata Zone and Upper Acostian, but common in the Lower Acostian. Blow (1959) recovered isolated specimens in his *C. stainforthi* and *G. insueta* Zones. Diaz de Gamero (1985a) found the species limited to her uppermost two samples. Whittaker (1988) placed this taxon in synonymy with *B. arta* Macfadyen, however, *B. caudriae* Cushman & Renz in this study is much larger, and particularly wider than Macfadyen's species. Both taxa are nondescript and may be ecophenotypes.

**Bolivina fastigia** Cushman

*Plate 77, figure 10*

*Bolivina fastigia* CUSHMAN 1936, pl. 7, fig. 17

*Bolivina fastigia* Cushman. --CUSHMAN 1937, pl. 9, figs. 12 - 14. --POPESCU 1975, pl. 43, fig. 7. BRUN, et. al. 1984, pl. 1, fig. 13. --CICHA, et. al. 1998, pl. 42, fig. 14

**Description:** Compressed test with marked longitudinal central ridge. Periphery sub-acute. Initial end rounded, tapering rapidly towards the aperture, much of the test with sub-parallel sides. Chambers distinct and sloping, uninflated, low with lobe connecting to the central ridge. Sutures distinct and limbate, flush with the surface. Wall finely perforate. Characteristic longitudinal costae develop from the initial end, fanning out up the test. Do not develop further than halfway along the test.

**Occurrence:** Identified in Vâlcele and the Chechis Marls, Romania.

**Remarks:** Originally described from the Oligocene of Germany.

**Bolivina fastigia droogeri** Cicha & Zapletalova

*Plate 77, figure 11*

*Bolivina fastigia* var. *droogeri* CICHA & ZAPLETALOWA 1963

*Bolivina fastigia* var. *droogeri*. --POPESCU 1975, pl. 43, figs. 6 - 9

**Description:** Differs from the typical in greater limbation of the sutures and a more perforate test.

**Occurrence:** Identified in Vâlcele, Lapugiu du Sus, and the Chechis Marls, Romania.
**Bolivina floridana regularis** Cushman & Renz

Plate 25, figures 3a, 3b

*Bolivina floridana var. regularis* CUSHMAN & RENZ 1941, pl. 3, fig. 7

*Bolivina floridana var. regularis* Cushman & Renz. --CUSHMAN & RENZ 1944, p. 78

*Bolivina imporcata* Cushman & Renz. --CUSHMAN & RENZ 1947, pl. 6, fig. 9. --RENZ 1948, pl. 7, fig. 3. --DIAZ de GAMERO 1985a, pl. 5, fig. 11. --KOHL 1985, pl. 17, fig. 1. --BOLLI, et. al. 1994, pl. 78, fig. 19

*Bolivina floridana* Cushman. --CUSHMAN & CAHILL 1933, pl. 8, fig. 11. --SKINNER & GLASER 1972, pl. 2, fig. 7. --WHITTAKER 1988, pl. 10, figs 8 - 9 (not 10 - 17)

**Description:** Elongate tapering test, smooth test wall. Chambers form distinctive longitudinal ridges through downward projections of the chamber wall. Sutures crenulate with marked retral processes arranged in overlapping rows. Aperture a terminal elongate slit on the median line.

**Occurrence:** Found in discrete floods throughout the Venezuelan section. Most common across the *M. basispinosus / V. herricki* Zonal boundary. Acme in sample 2601.

**Remarks:** Cushman and Renz (1941) recorded the species throughout the Agua Salada basin, Renz (1948) found it more common in the upper Acostian, Araguatian, and Lucian. Díaz de Gamero (1985a) found the species throughout her superior calcareous assemblage. Whittaker (1988) discussed the differing 'types' of *B. floridana*. These specimens compare with the 'imporcata' type in the Whittaker collection (P51745).

**Bolivina hebes** Macfadyen

Plate 77, figure 12

*Bolivina hebes* MACFADYEN 1930, pl. 2, fig. 5

*Bolivina hebes* Macfadyen. --SOUYA 1965, pl. 3, fig. 20. --CICHA, et. al. 1998, pl. 43, fig. 14

**Description:** Small robust test, rounded periphery. Test tapers slightly to initial end, though broadly rounded. Five to seven pairs of chambers, indistinct, sutures depressed and indistinct, slightly limbate. Coarsely perforate test, irregular surface and slight excavations on the underside of successive chambers.

**Occurrence:** Few specimens identified in the Chechis Marls, Romania.

**Remarks:** Originally described from the Miocene of Sinai. The excavations on the underside of successive chambers are reminiscent of *B. floridana* and its varieties but *B. hebes* differs in the profile of the test and elevation of the lobes.

**Bolivina isidroensis** Cushman & Renz

Plate 25, figure 4

*Bolivina isidroensis* CUSHMAN & RENZ 1941, pl. 3, figs. 10 - 11

*Bolivina isidroensis* Cushman & Renz. --RENZ 1948, pl. 7, fig. 5. --BLOW 1959, p. 145 - 146. --DIAZ de GAMERO, 1985a, pl. 5, fig. 13. --BOLLI, et. al. 1994, pl. 78, fig. 12

*Brizalina isidroensis* Cushman & Renz. --KOHL 1985, pl. 17, fig. 12

**Description:** Elongate test with near parallel sides. Rounded periphery, numerous low, broad chambers of uniform size and shape. Sutures oblique and limbate. Wall perforate, occasionally with longitudinal costae. Aperture high and narrow on the median line.
Occurrence: Found occasionally on the *M. basispinosus* and *V. herricki* Zones in Venezuela. Offshore Cabinda found in CABGOC 115-1X between 2,930' and 8,520', rare. Single specimen tentatively referred to as this taxon in Lapugiu du Sus, Romania.

Remarks: Cushman and Renz (1941) reported the species from the upper Agua Salada Formation. Renz (1948) found the taxon common in the Araguatian and Lucian. Diaz de Gamero (1985a) found the taxon in her uppermost calcareous assemblage. Also found in Trinidad and Columbia. Differs from *B. caudriae* in faint longitudinal short striae towards the apical end. Known from additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966).

*Bolivina rudderi* Cushman & Renz

Plate 25, figures 5a, 5b

*Bolivina rudderi* CUSHMAN & RENZ 1941, pl. 3, fig. 12
*Bolivina rudderi* Cushman & Renz. —RENZ 1948, pl. 7, fig. 13. —BOLLI, et. al. 1994, pl. 78, fig. 6

Description: Small robust test, strongly tapering, subrounded periphery. Chambers low and broad, sutures curved and limbate. Wall smooth, aperture narrow with slight lip on the median line.

Occurrence: Infrequent occurrence in upper portion of the Venezuelan section, specimens tentatively referred to this taxon. Offshore Cabinda found in CABGOC 115-1X between 1,970' and 7,260' acme at 3,970'.

Remarks: Originally described from the lower and upper Agua Salada Formation. Renz (1948) subsequently found it scarce in the Araguatian and Lucian.

*Bolivina suteri* Cushman & Renz

Plate 25, figure 6

*Bolivina suteri CUSHMAN & RENZ 1941, pl. 3, fig. 10
*Bolivina suteri Cushman & Renz. —RENZ 1948, pl. 7, fig. 15. —BLOW 1959, p. 148. —BOLLI, et. al. 1994, pl. 78, fig. 21

Description: Preserved as internal moulds. Small, lobate periphery, rounded inflated chambers. sutures distinct and depressed.

Occurrence: Rare in *T. panamaensis* zonule and *S. transversa* Zone in Venezuela. Offshore Cabinda found infrequently in CABGOC 128-3 between 3,810' and 10,160', and in CABGOC 115-1X between 3,650' and 6,540'.

Remarks: The poor preservation of this species suggests its preservation potential is low and dissolution of individuals may be prevalent. Renz (1948) suggested the species to be endemic and found it scarce in the lower Acostian, Araguatian, and Lucian. Blow (1959) found only a few specimens. Known from additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966).
**Bolivina tenuisstriata** Cushman & Ellisor

Plate 25, figure 7; Plate 59, figures 6 - 7

*Bolivina tenuisstriata* CUSHMAN & ELLISOR 1939, pl. 1, fig. 8

**Description:** Elongate, broad test, gradually tapering. Rounded periphery, chambers slightly inflated. Sutures indistinct and oblique. Wall ornamented by numerous longitudinal striae. Perforate.

**Occurrence:** Occurs sporadically throughout the Venezuelan section. Acme in sample 2710 of the *S. transversa* Zone. Offshore Cabinda found in CABGOC 128-3 between 3,690' and 9,980', common. In CABGOC 115-1X found at 3,890' and 8,280'.

**Remarks:** First record of this species from the Agua Salada Formation.

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**Bolivina thalmanni** Renz

Plate 25, figure 8

*Bolivina thalmanni* RENZ 1948, pl. 12, fig. 13

*Bolivina thalmanni* Renz. --BLOW 1959, p. 148 - 149. --BOLLI, et. al. 1994, pl. 78, fig. 18

*Bolivina cf. B. thalmanni* Renz. --WRIGHT 1978, pl. 2, figs. 17 - 18

**Description:** Short, broad test, tapering and somewhat compressed. Periphery rounded, greatest breadth at apertural end. Chambers and sutures obscured by pronounced reticulate ornamentation. Ridges anastomose to give reticulate appearance. Test wall finely perforate. Aperture a elongate slit at the inner margin of the last chamber.

**Occurrence:** Occurs rarely in the *T. panamaensis* zonule and the *V. herricki* Zone in Venezuela.

**Remarks:** Renz (1948) found the species restricted to the upper Araguatian. This species differs from *Bolivina bryamensis* in the nature of the ornamentation and lateral compression of the test. Blow (1959) recorded isolated specimens in his *G. mayeri* Zone.

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**Bolivina sp. 1**

Plate 25, figures 9a, 9b

**Description:** Small taxon, inflated and tapering, rounded periphery. Chambers increase rapidly in size as added, last two chambers significantly larger, low and broad. Sutures limbate, distinct and depressed. Wall distinctly punctate, these may appear to align vertically in some specimens. Aperture a high narrow arch at the base of the last formed chamber.

**Occurrence:** Occurs frequently throughout the Venezuelan section. Reaches acme in sample 2609A of the *V. herricki* Zone.

**Remarks:** First record of this taxon in the Agua Salada Formation.

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**Bolivina sp. 2**

**Description:** Poor preservation obliterates distinguishing characteristics.

**Occurrence:** Observed in the Chechis Marls, Romania.
Genus BRIZALINA Costa 1856

*Brizalina alata* (Seguenza)

**Plate 59, figure 8**

*Vulvulina alata* SEGUENZA 1862, pl. 2, fig. 5 (*fide* Ellis & Messina 1940, *et. seq.*)

*Brizalina* sp. 2 PETTERS 1979, pl. 2, fig. 16

*Bolivina beyrichi* Reuss var. *alata* (Seguenza). --BRADY 1884, pl. 53, figs. 2 - 4. --MACFADYEN 1930, pl. 2, fig. 3

*Bolivina alata* (Seguenza). --CUSHMAN 1936, pl. 5, fig. 9. --CUSHMAN 1937, pl. 13, figs. 3 - 11. --LE ROY 1939, pl. 7, figs. 1 - 2. --RENZ 1948, pl. 6, fig. 26, pl. 12, fig. 12. --AKERS & DOORMAN 1964, pl. 8, fig. 24. --POPESCU 1975, pl. 43, figs. 3 - 4. --HERMELIN 1991, pl. 1, figs. 4 - 5. --BOLLI, *et. al.* 1994, pl. 78, figs. 4 - 5. --CARBONI & PALAGI 1997, pl. 1, fig. 10

*Brizalina alata* (Seguenza). --KOHL 1985, pl. 17, fig. 6. --CIMERMAN & LANGER 1991, pl. 61, figs. 12 - 14. --AKIMOTO 1994, pl. 2, fig. 1

**Description:** Compressed test, tapering, broadest near apertural end. Periphery carinate with keel (often abraded). Distinct chambers, slightly inflated, increase in size as added, overlap slightly. Basal portion of each chamber projects downward to form a serrate margin. Sutures distinct and curved, flush to slightly depressed. Wall smooth, finely perforate. Aperture an elongate narrow slit with slight lip.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 between 4,050' and 9,080', and in CABGOC 115-1X between 3,780' and 9,960'. Single specimen observed in Lapugi du Sus, Romania.

**Remarks:** Originally described from the Pleistocene of various Italian localities. Differs from *B. pisciformis* and *B. alazanensis* in fewer higher chambers. Renz (1948) found the taxon scarce in the Araguatian. Also known from Trinidad, Jamaica, and Cuba. This taxon was not identified in the Venezuelan samples of this study, but is recognised in the Venezuelan Miocene (Bermúdez and Fuenmayor 1966). Known from Recent material from Philippines (Cushman 1921).

*Brizalina alazanensis* (Cushman)

**Plate 25, figure 10; Plate 59, figure 9**

*Bolivina alazanensis* CUSHMAN 1926, pl. 12, figs. 1a - b

*Bolivina alazanensis* Cushman. --NUTTALL 1932, p. 20. --PALMER & BERMÚDEZ 1936, p. 290. --CUSHMAN 1937, pl. 8, figs. 6, 7. --CUSHMAN 1948, pl. 25, fig 1. --RENZ 1948, pl. 12, fig. 7. --BLOW 1959, p. 144. --BOLLI, *et. al.* 1994, pl. 53, figs. 2 - 3, pl. 78, fig. 3

**Description:** Periphery with narrow keel, test in transverse section is rhomboid. Chambers distinct with lobe towards centre, slightly imbricate. Sutures distinct forming ridge towards centre. Wall smooth and punctate. Aperture elongate.

**Occurrence:** Common throughout the Venezuelan section. Acme occurrences at sample 2606 of the *V. herricki* Zone and sample 2618 of the *G. fohsi* Zone. Offshore Cabinda found in CABGOC 128-3 between 2,370' and 9,080', acme between 2,370' and 2,610'. Frequent in CABGOC 115-1X between 1,790' and 10,020', acme between 4,430' and 5,160'.

**Remarks:** Renz (1948) only noted the species within the 'Uvigerinella' sparsicostata Zone and the Lower Acostian. Blow (1959) reported isolated specimens in his *C. stainforthi* Zone.
Originally described from the Lower Oligocene of Mexico. Recognised along the Gulf Coast (Garret 1938).

**Brizalina cf. cochei** (Cushman & Adams)

**Plate 59, figure 10**

*Bolivina cochei* Cushman & Adams 1935, pl. 3, figs. 6 - 7

*Bolivina cf. cochei* Cushman & Adams. --RENZ 1948, pl. 6, figs 27 - 28. --BOLLI, et. al. 1994, pl. 78, figs. 7 - 8

**Description:** Compressed tapering test. Rounded periphery, initial end acute. Sutures distinct, limbate, wall perforate and smooth. Differs from *B. pisiciformis* in less serrate periphery and rotund test, chambers are lower.

**Occurrence:** Confined to the *M. basispinosus* and *V. herricki* Zones in Venezuela. Offshore Cabinda found in CABGOC 128-3 between 2,730' and 6,380', and in CABGOC 115-1X at 7,800' and 7,860'.

**Remarks:** Renz (1948) found the taxon common throughout the Araguatian and Lucian, but scarce in the Upper Acostian. Originally described from the Miocene of California. May represent the juvenile form of *B. pisiciformis* (Bolli et. al. 1994).

**Brizalina harangensis** (Cushman & Ellisor)

**Plate 25, figure 11**

*Bolivina harangensis* Cushman & Ellisor 1939, pl. 1, fig. 9

**Description:** Short broad test, compressed and tapering with acute margin. Greatest breadth at apertural end. Chambers inflated and increase in height as added, sutures oblique and may be depressed. Numerous longitudinal costae continuous over sutures. Aperture elongate slit on medial line.

**Occurrence:** Rare in *M. superbus* zonule and *M. basispinosus* Zone in Venezuela.

**Remarks:** First record of this species from the Agua Salada Formation.

**Brizalina inconspicua** (Cushman & Renz)

*Bolivina inconspicua* Cushman & Renz 1941, pl. 3, figs. 10 - 11

*Bolivina inconspicua* Cushman & Renz. --RENZ 1948, pl. 7, figs. 9 - 10. --BOLLI, et. al. 1994, pl. 78, figs. 22 - 23

**Description:** Small test, compressed, subacute periphery, may become serrate. Chambers low, increase in size gradually as added, uniform shape, inflated. Sutures depressed, straight, and oblique, may curve slightly. Wall smooth. Aperture an arched opening on the medial line.

**Occurrence:** Offshore Cabinda found infrequently in CABGOC 128-3 between 2,970' and 7,180', and in CABGOC 115-1X at 1,880'.

183
Brizalina multicostata (Cushman)

Plate 25, figure 12

Bolivina aenariensis (COSTA) var. multicostata CUSHMAN 1918, pl. 10, fig. 2
Bolivina marginata var. multicostata Cushman. —CUSHMAN 1930, pl. 8, figs. 13 - 14. —CUSHMAN & CAHILL 1933, pl. 8, fig. 10. —CUSHMAN 1937, pl. 10, figs. 7 - 10. —CUSHMAN & RENZ 1947, pl. 6, fig. 10. —RENZ 1948, pl. 7, figs. 6 - 8
Bolivina marginata multicostata Cushman. —BLOW 1959, p. 146. —DIAZ de GAMERO 1985a, pl. 5, fig. 14. —BOLLI, et. al. 1994, pl. 53, figs. 8 - 9, pl. 78, figs. 14 - 16
Bolivina multicostata Cushman. —WHITTAKER 1988, pl. 11, figs. 10 - 13. —FINGER 1992, pl. 17, fig. 56

Description: Test moderately compressed, periphery semi-carinate. Sutures curved and depressed. Similar to the typical species but with varying extremes of longitudinal costae of differing lengths, often anatomising. Wall finely perforate.

Occurrence: Confined to sample 2617 of the G. fohsi Zone in Venezuela. Offshore Cabinda found in CABGOC 115-1X at 6,900'

Remarks: Renz (1948) reported the species as scarce in the Acostian and lower Lucian, becoming more abundant in the upper Lucian. Blow (1959) found the species only in the upper part of his G. menardii menardii / G. nepenthes Zone and the lower part of his S. seminulina Zone. Diaz de Gamero (1985a) found the taxon limited to the base of her upper calcareous zone. Originally described from the Miocene of Florida as a variation of B. aenariensis, B. marginata var. multicostata differs from this species in its smooth form.

Brizalina pisciformis (Galloway & Morrey)

Plate 25, figure 13; Plate 59, figure 11

Bolivina pisciformis GALLOWAY & MORREY 1929, pl. 5, fig. 10
Bolivina pisciformis Galloway & Morrey. —CUSHMAN & RENZ 1947, pl. 6, fig. 6. —RENZ 1948, pl. 7, figs. 11 - 12. —BLOW 1959, pl. 6, fig. 21. —DIAZ de GAMERO 1985a, pl. 5, fig. 15. —WHITTAKER 1988, pl. 13, figs. 4 - 9. —BOLLI, et. al. 1994, pl. 53, fig. 1, pl. 78, figs. 1 - 2

Description: Distinctive species, elongate and severely compressed with serrated keel of clear calcite, occasionally forming short spines at the base of the chambers. Initial end acute. Chambers often depressed, oblique. Sutures raised, curved and sloping. Wall thin and often punctured. Medial line often with line of clear shell material. Smooth, perforate.

Occurrence: Present sporadically throughout the Venezuelan section. Acme occurrences in sample 2612 of the V. herricki Zone and sample 2725 of the L. wallacei Zone. Offshore Cabinda found infrequently in CABGOC 128-3 between 2,490' and 9,980', and in CABGOC 115-1X between 4,370' and 10,070'.

Remarks: Originally described from the Oligocene of Ecuador. Renz (1948) found the taxon common in the Acostian and lower Araguatian. Diaz de Gamero (1985a) found the species restricted to a single sample in her upper calcareous assemblage. Also found in Costa Rica, Trinidad, Barbados, Cuba, and Mexico. Noted in the Miocene of California (Smith 1960). Commonly used as a time stratigraphic marker for the Middle and Upper Oligocene in Central America. Bolivina alazanensis is considered to be ancestral (Renz 1948). B. pisciformis is slightly smaller than B. alazanensis, the former showing a slower increase in chamber height.
Known from additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966). Specimens in the Whittaker collection tend to be shorter than those of this study (P51784).

**Brizalina pozonensis** (Cushman & Renz)

**Plate 25, figure 14**

*Bolivina pozonensis* CUSHMAN & RENZ 1941, pl. 3, fig. 6

*Bolivina pozonensis* Cushman & Renz. --RENZ 1948, pl. 7, fig. 14. --BLOW 1959, p. 146 - 147. --BOLLI, *et. al.* 1994, pl. 78, fig. 11

*Brizalina pozonensis* (Cushman & Renz). --WHITTAKER 1988 pl. 13, figs. 10 - 12

**Description:** Small species. Elongate, compressed and tapering. Greatest breadth with last formed pair of chambers. Sutures straight and oblique. Wall roughened. Traces of longitudinal costae. Aperture elliptical with slight lip, becoming terminal.

**Occurrence:** Confined to *M. basispinosus* and G. *fohsi* Zones in Venezuela. Occurs offshore Cabinda found CABGOC 128-3 between 2,310' and 5,000', and in CABGOC 115-1X at 8,870'.

**Remarks:** These examples seem to be narrower than the typical species, but otherwise conform to the diagnosis of Cushman and Renz (1941). Originally described from the upper Agua Salada Formation, Renz (1948) found it common in the upper Araguatian and Lucian. Also known from Trinidad and additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966). Differs from *B. caudriae* and *B. isidroensis* in a broader test.

**Brizalina simplex** (Cushman & Renz)

**Plate 26, figure 1**

*Bolivina interjuncta* CUSHMAN var. *simplex* CUSHMAN & RENZ 1941, pl. 3, fig 15

*Bolivina simplex* Cushman & Renz. --RENZ 1948, pl. 7, fig. 4. --BLOW 1959, p. 147 - 148. --PETTERS 1982, pl. 10, figs. 6 - 7. --BOLLI, *et al.* 1994, pl. 78, fig. 17

**Description:** Strongly tapering test, compressed with acute periphery. Chambers increase regularly in size, slightly inflated. Sutures distinct, depressed, oblique and slightly limbate. Four to five regular longitudinal costae migrate from apical end over sutures to produce 'fan' shape. Aperture a elongate slit with lip on the median line.

**Occurrence:** Scarce throughout the Venezuelan section. Offshore Cabinda found in CABGOC 115-1X between 7,380'and 7,680'.

**Remarks:** Cushman and Renz (1941) found the taxon throughout the Agua Salada Formation, though more common towards the upper regions. Renz (1948), found the species scarce in the 'Uvigerinella' *spariscostata* Zone and lower Araguatian, but more common in the upper Araguatian and Lucian. Blow (1959) regards it as an ecologically controlled taxon. *B. simplex* has fewer costae than *B. marginata multicostata.* Also noted in Trinidad, Columbia and additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966).
Brizalina subaenariensis mexicana (Cushman)
Plate 26, figure 2

Bolivina subaenariensis var. mexicana CUSHMAN 1922, pl. 8, fig. 1
Bolivina subaenariensis var. mexicana Cushman. --DIAZ de GAMERO 1985a, pl. 5, fig. 16

Description: Compressed test, carinate periphery. Sutures curved, flush and limbate. Three to four longitudinal costae develop from the apical end fanning out toward the latter chambers. Wall finely perforate.

Occurrence: Occurs from the R. spinulosa zonule to the V. herricki Zone in Venezuela. Most common across the M. basispinosus / V. herricki Zonal boundary, acme occurrence at samples 2620 and 2619 of the M. basispinosus Zone. Offshore Cabinda found in CABGOC 115-1X between 6,900' and 8,400'.

Remarks: Diaz de Gamero (1985a) found the species in her G. acostaensis Zone.

Brizalina tongi (Cushman)
Plate 26, figure 3

Bolivina tongi CUSHMAN 1929, pl. 13, fig. 29
Bolivina tongi Cushman. --NUTTALL 1932, pl. 5, fig. 4. --RENZ 1948, pl. 6, figs. 24 - 25. --BOLLI, et al. 1994, pl. 78, figs. 24 - 25
Bolivina tongi (Cushman). --WHITTAKER 1988, pl. 11, figs. 21 - 23

Description: Preserved as internal mould. Small tapering test, truncated periphery, chambers numerous and slightly inflated. Sutures distinct and depressed. Prominent longitudinal costae not as obvious in internal mould.

Occurrence: Single specimen in the L. wallacei Zone in Venezuela. Offshore Cabinda found in CABGOC 128-3 between 4,770' and 6,140'.

Remarks: Renz (1948) noted the species as scarce in the 'Uvigerinella' sparsicostata Zone, but also present in Cuba and Mexico. Recognised along the Gulf Coast (Garret 1938) and additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966).

Family BOLIVINOIDIDAE Loeblich & Tappan, 1984
Genus BOLIVINOIDES Cushman, 1927

Bolivinoides sp.
Plate 59, figure 12

Description: Large taxon, partial internal mould. Subacute periphery, tapering. Limbate chambers increase in size slowly as added, sutures slightly depressed. Aperture and initial chambers not recovered.

Occurrence: Single specimen found offshore Cabinda in CABGOC 115-1X at 5,880'.

Remarks: Poor preservation.
Superfamily CASSIDULINACEA d'Orbigny, 1839
Family CASSIDULINIDAE d'Orbigny, 1839
Subfamily CASSIDULININAE d'Orbigny, 1839
Genus CASSIDULINA d'Orbigny

**Cassidulina cf. califomica** Cushman & Hughes

*Plate 26, figure 4; Plate 59, figures 13a, 13b*

*Cassidulina califomica* CUSHMAN & HUGHES 1925, pl. 2, fig. 1

*Cassidulina sp. aff. califomica* Cushman & Hughes. --RENZ 1948, pl. 9, fig. 7

**Description:** Oval test. Inflated chambers alternate. Sutures depressed and limbate. Preserved as pyrite internal mould so nature of test wall unknown. Aperture large comma slit on apertural face of the last formed chamber on the axis of coiling. Apertural tooth not observed.

**Occurrence:** Confined to *L. wallacei* Zone in Venezuela. Offshore Cabinda found in CABGOC 128-3 between 4,530' and 10,160', and in CABGOC 115-1X between 5,160' and 8,160'.

**Remarks:** Originally described from the Pliocene of California. Renz (1948) found his specimens to be about the half the size of the typical species and confined to the upper Acostian. This is in agreement with the individuals recovered in this study which appear to be dwarfed and display a reduced aperture in comparison to that of Finger (1990).

**Cassidulina carapitana** Hedberg

*Plate 26, figure 5*

*Cassidulina carapitana* HEDBERG 1937, pl. 92, fig. 6

*Cassidulina carapitana* Hedberg. --CUSHMAN & RENZ 1947, pl. 8, fig. 3. --RENZ 1948, pl. 9, fig. 8. --BLOW 1959, p. 165 - 166. --BOLLI, et. al. 1994, pl. 80, fig. 34

**Description:** Lenticular test, involute, almost circular in outline. Periphery sub-acute. Chambers elongate and narrow, curved towards umbo. Sutures depressed and curved about umbos. Preserved as pyrite internal moulds so nature of wall unknown. Aperture elongate opening in the plane of coiling on apertural face of the last formed chamber.

**Occurrence:** Occurs intermittently throughout the Venezuelan section. Acme in sample 2611 of the *V. herricki* Zone. Offshore Cabinda found in CABGOC 115-1X between 7,080' and 9,600', infrequent. Also recognised at Vâlcele and in the Chechis Marls, Romania.

**Remarks:** Originally described from the mid Tertiary of north-eastern Venezuela and considered similar to *Cassidulina laevigata*. Renz (1948) found the taxon in the 'Uvigerinella' sparsicostata Zone, Acostian, Araguatian, and Lucian. Blow (1959) similarly found the taxon common in all zones. Known to have a wide geographic distribution in the Tertiary of the Caribbean-Antillean area, known from additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966).

**Cassidulina crassa** d'Orbigny

*Plate 26, figure 6; Plate 60, figure 1; Plate 77, figures 13a, 13b*

*Cassidulina crassa* d'ORBIGNY 1839, pl. 7, figs. 18 - 20 (fide Ellis & Messina 1940, et. seq.)

*Cassidulina crassa* d'Orbigny. --d'ORBIGNY 1846, pl. 21, figs. 42 - 43. --CUSHMAN 1930, pl. 11, fig. 6. --CUSHMAN & CAHILL 1933, pl. 12, fig. 2. --CUSHMAN 1936, pl. 5, fig. 12. --RENZ 1948, pl. 12, fig. 23. --BLOW 1959, p. 166. --WRIGHT 1978, pl. 3, figs. 11 - 12. --MILLER & KATZ 1987, pl. 3, fig.1.
Description: Invariably preserved as internal moulds. Small oval convex test, involute. Chambers inflated, sutures oblique and depressed. Aperture a wide opening in the plain of coiling on the apertural face of the last formed chamber. Preservation generally better in Paratethys samples.

Occurrence: Intermittent occurrence throughout the Venezuelan section. Acme in sample 2609A of the V. herricki Zone. Offshore Cabinda found in CABGOC 128-3 between 5,480' and 10,100', and in CABGOC 115-1X between 5,700' and 7,440'. Identified at Vâlcete, Romania.

Remarks: Originally described from Recent sediments of an un-designated area offshore the Falkland Islands. Renz (1948) found the species scarce in the 'Uvigerinella sparsicostata Zone, and more common in the Acostian, Araguatian, and Lucian. Brady (1884) reported the species from much of the Atlantic, Pacific, and Mediterranean. Rare occurrence in the Miocene of Egypt (Macfadyen 1930). Known from Recent sediments of the Côte d'Ivoire (Calvez 1963) and additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966). In general a cosmopolitan species with wide geographic range. Also known from Costa Rica, Ecuador, Barbados, Trinidad, Cuba, Jamaica, Mexico, and California. Specimens compare well with those of the Heron-Allen and Earland collection (P32399-32450, P32472-32499).

Cassidulina delicata Cushman
Plate 26, figure 7
Cassidulina delicata CUSHMAN 1927, pl. 6, fig. 5
Cassidulina delicata Cushman. --RENZ 1948, pl. 9, fig. 10. --BLOW 1959, p. 166. --KLEINPELL 1980, pl. 18, fig. 5. --WHITTAKER 1988, pl. 14, figs. 4 - 5. --BOLLI, et. al. 1994, pl. 80, fig. 35
Description: Small, compressed species, ovate. Periphery sub-acute, chambers inflated, broad and low, four in the last whorl. Sutures depressed and almost straight. Specimens preserved as pyrite internal mould so nature of test wall unknown. Aperture an elongate narrow slit extending from the periphery to the umbilical region.

Occurrence: Found intermittently throughout the Venezuelan section. Acme at sample 2618 of the G. fohsi Zone. Single specimen found offshore Cabinda in CABGOC 115-1X at 6,540'.

Remarks: Renz (1948) found the species a good stratigraphic marker for the upper Acostian though scarce. Also known from Barbados, Mexico, and California. Originally described from Recent sediments offshore Panama.

Cassidulina laevigata d'Orbigny
Plate 26, figures 8a, 8b; Plate 78, figures 1a, 1b
Cassidulina laevigata d'ORBIGNY 1826, pl. 15, figs. 4 - 5 (fide Ellis & Messina 1940, et. seq.)
Cassidulina laevigata d'Orbigny. --MACFADYEN 1930, pl. 2, fig. 6. --RENZ 1948, pl. 9, fig. 9. --BLOW 1959, p. 166. --AKERS & DOORMAN 1964, pl. 11, fig. 4. --SOUYA 1965, pl. 3, fig. 33. --WRIGHT 1978, pl. 3, figs. 13 - 14. --PETTERS 1982, pl. 9, figs. 1 - 2. --BASOV & KRASHENINNIKOV 1983, pl. 17, fig. 8. --OSTERMAN & QVALE 1989, pl. 2, fig. 2. --HERMELIN 1990, pl. 2, figs. 3 - 5. --CIMERMAN & LANGER
Description: Lenticular test, involute, almost circular in outline. Periphery acute. Chambers elongate and narrow, slightly curved towards umbo. Sutures depressed and curved about umbos. Preserved as pyrite internal moulds so nature of wall unknown. Aperture elongate opening in the plane of coiling on apertural face of the last formed chamber.

Occurrence: Occurs intermittently throughout the Venezuelan section as discrete floods. Acme occurrence at sample 2609A of the *V. herricki* Zone. Offshore Cabinda found in CABGOC 115-1X between 7,800' and 8,040'.

Remarks: First description of unknown provenance. Renz (1948) found the species scarce in the Acostian and Lucian, but common in the Araguatian, and abundant in the Lucian. Blow (1959) found the species common to all zones. Known from Recent sediments of the Côte d'Ivoire (Calvez 1963), the Miocene of Trinidad (Nuttall 1927), and additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966). Specimens compare well with those of the Heron-Allen and Earland collection (P32472-32499) and other unnumbered slides, the Burrow and Holland collection (slide D, NHM), and the Helvetian Gubler collection (P33259). Noted throughout the Atlantic and Pacific and reported from Colombia, Barbados, Trinidad, Puerto Rico, Jamaica, Mexico, and California.

*Cassidulina plicocenica* (Natland)

*Cassidulinella plicocenica* NATLAND 1940, pl. 69, figs. 5 - 6 (fide Ellis & Messina 1940, et. seq.)

Description: Always preserved as pyrite internal moulds. Small test, compressed, rounded periphery. Numerous elongate chambers coil in a biserial arrangement, slightly inflated. Rapidly increase in size as added becoming longer and extending half the circumference of the test. Sutures distinct and depressed. Aperture an elongate slit extending the length of the last two chambers on the periphery.

Occurrence: Offshore Cabinda found in CABGOC 128-3 between 4,770' and 9,260', and in CABGOC 115-1X between 6,240' and 7,560'.

Remarks: Originally described form the Pliocene of California. Recognised as a constituent of a diverse bathyal benthonic association offshore West Africa (Haman, et. al. 1993). Poor preservation.

*Cassidulina sp.* a Diaz de Gamero

*Cassidulina sp.* a DIAZ de GAMERO 1985a, pl. 8, fig. 3

Description: Small delicate taxon. Distinguished by extreme perforate wall.

Occurrence: Single specimen identified in Vâlceie, Romania.

*Cassidulina sp.*

Description: Poor preservation obliterates distinguishing characteristics.

Occurrence: Offshore Cabinda found in CABGOC 128-3 between 4,890' and 9,260', and in CABGOC 115-1X at 6,600' and 7,440'.

Remarks: Poor preservation, internal mould.
Genus **CASSIDULINOIDES** Cushman 1927

**Cassidulinoides erecta** Cushman & Renz

Plate 26, figure 9; Plate 60, figure 2

*Cassidulinoides erecta* CUSHMAN & RENZ 1941, pl. 4, figs. 6 - 7

*Cassidulinoides erecta* Cushman & Renz. —RENZ 1948, pl. 9, fig. 15. —BLOW 1959, p. 167. —BOLLI, et al. 1994, pl. 80, fig. 33

*Rutherfordoides erecta* (Cushman & Renz). —KOHL 1985, pl. 18, fig. 2

**Description:** Invariably preserved as pyrite internal moulds. Elongate test, rarely complete. Closely coiled, becoming uncoiled in biseri al arrangement. Chambers distinct and inflated, increasing in size. Sutures depressed. Aperture high and narrow in the axis of the uncoiled portion in the apertural face.

**Occurrence:** Scarce species, found as single isolated specimens throughout the Venezuelan section. Offshore Cabinda found infrequently in CABGOC 128-3 between 4,110' and 10,160', and in CABGOC 115-1X between 5,940' and 10,020'.

**Remarks:** Cushman and Renz (1941) found this taxon towards the base of the Agua Salada Formation. Renz (1948) subsequently found the species scarce in the upper Acostian and Lucian, but occasionally locally common. Blow (1959) only recorded the species scarcely in his *G. fohsi* Zone.

*Cassidulinoides* sp. 1

Plate 78, figures 2a, 2b

**Description:** Elongate test, inflated. Closely coiled initial portion, becomes uncoiled. Chambers distinct and inflated, increasing in size. Sutures depressed. Aperture a simple opening high on the apertural face.

**Occurrence:** Single specimen in Costei, Romania.

Genus **GLOBOCASSIDULINA** Voloshinova, 1960

**Globocassidulina subglobosa** (Brady)

Plate 27, figure 1

*Cassidulina subglobosa* BRADY 1881, p. 60 (*fide* Ellis & Messina 1940, *et. seq.*)

*Cassidulina subglobosa* BRADY 1884, pl. 54, fig. 17

*Cassidulina subglobosa* Brady. —MACFADYEN 1930, pl. 2, fig. 8. —CUSHMAN 1933, pl. 33, fig. 4. —CUSHMAN & STAINFORTH 1945, pl. 12, fig. 1. —CUSHMAN & RENZ 1947, pl. 8, fig. 2. —RENZ 1948, pl. 9, figs. 11 - 12. —BLOW 1959, p. 166 - 167. —BERGGREN 1972, pl. 6, fig. 16. —DOUGLAS 1973, pl. 6, fig. 3. —CAMERON 1978, pl. 1, fig. 12. —WRIGHT 1978, pl. 3, fig. 17. —OSTERMAN & QVALE 1989, pl. 2, fig. 4

*Globocassidulina subglobosa* (Brady). —BOERSMA 1977, pl. 3, fig. 4. —PETTERS 1982, pl. 9, figs. 5 - 6, 8. —CLARK & WRIGHT 1984, pl. 6, fig. 6. —THOMAS 1985, pl. 7, fig. 4. —KOHL 1985, pl. 30, figs. 3 - 4. —BELANGER & BERGGREN 1986, pl. 4, fig. 6. —KURIHARA & KENNEDY 1986, pl. 5, figs. 4 - 6. —LECKIE & WEBB 1986, pl. 12, figs. 4 - 6. —HULSBOS 1987, pl. 5, fig. 1. —KATZ & MILLER 1987, pl. 3, fig. 5. —MILLER & KATZ 1987, pl. 3, fig. 4. —WHITTAKER 1988, pl. 14, figs. 10 - 11 (not 8 - 9). —HERMELIN 1990, pl. 2, fig. 11. —CIMERMAN & LANGER 1991, pl. 63, figs. 4 - 6. —NOMURA 1991, pl. 5, fig. 8. —
Description: Invariably preserved as internal pyrite moulds. Large, subglobular test, slightly compressed, ovate in transverse section. Rounded periphery, sutures depressed, chambers inflated. Chambers increase gradually in size as added, sutures slightly curved. Aperture a comma shaped opening on the ventral face of the last formed chamber.

Occurrence: Confined to V. herricki and L. wallacei Zones in Venezuela. Offshore Cabinda found in CABGOC 128-3 between 9,980' and 10,160', and in CABGOC 115-1X between 3,290' and 6,580', acme at 6,420'.

Remarks: Brady (1884) remarked that 'C. subglobosa occurs in all the great ocean basins, and is for the most part a deep water species'. Originally described from Recent sediments of an undesignated location, Renz (1948) found the species throughout the Agua Salada Basin, but most common in the Acostian. Blow (1959) said of the species it is 'ubiquitous although rather scarce'. Also known from Colombia, Ecuador, Trinidad, Cuba, Jamaica, Mexico, and California. See Bornmalm (1997) (p. 64 - 65) for an ecological review. Recognised in the Miocene of the Gulf of Suez region (Souya 1965). Found to be slightly truncate and flattened towards the apertural end in the Miocene of Egypt (Macfadyen 1930). Specimens compare well with those of the Heron-Allen and Earland collection (P32399-32450, P32472-32499), though some dwarfism of these specimens is evident.

Globocassidulina subglobosa horizontalis (Cushman & Renz)
Cassidulina subglobosa var. horizontalis CUSHMAN & RENZ 1941, pl. 1, fig. 8
Cassidulina subglobosa var. horizontalis Cushman & Renz. --RENZ 1948, pl. 9, fig. 14. --DIAZ de GAMERO 1985a, pl. 8, fig. 8
Globocassidulina subglobosa ('horizontalis-type'). --WHITTAKER 1988, pl. 14, figs. 8 - 9
Globocassidulina horizontalis Cushman. --NOMURA 1991, pl. 5, fig. 7

Description: Differs from the typical taxon in the last chamber which is added at an angle forcing the aperture to elongate at 90° to the normal.

Occurrence: Offshore Cabinda found infrequently in CABGOC 115-1X between 5,880' and 8,640'.

Remarks: Invariably preserved as pyrite internal moulds.

Subfamily EHRENBURGGININAE Cushman, 1927
Genus EHRENBURGINA Reuss, 1850

Ehrenbergina carribea Galloway & Heminway

Plate 27, figures 2a, 2b
Ehrenbergina bradyi CORYELL & RIVERO 1940, pl. 44, fig. 22
Ehrenbergina carribea GALLOWAY & HEMINWAY 1941, pl. 32, fig. 4
Ehrenbergina carribea Galloway & Heminway. --RENZ 1948, pl. 9, fig. 17. --BLOW 1959, p. 167. --THOMAS 1985, pl. 7. figs. 7 - 8. --SNYDER, et. al. 1988, pl. 8, figs. 13 - 14. --BOLLI, et. al. 1994, pl. 80, fig. 26
Description: Short subtriangular test. Biconvex, ventral side more strongly convex, with broad flat ridge at centre. Periphery acute, short spine at end of each chamber often broken. Chambers indistinct, sutures curved and overlapping, limbate and flush. Wall finely perforate and smooth. Aperture a small curved slit at terminal portion of periphery with lower lip.

Occurrence: Sporadic occurrence throughout the Venezuelan section. Acme at sample 2617 of the G. fohsi Zone.

Remarks: Originally described from the Tertiary of Puerto Rica. Renz (1948) found the taxon scarce through the Acostian and Araguatian. Blow (1959) only noted it in his G. mayeri and G. fohsi Zones. Also known from Haiti. Known from additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966).

Superfamily TURRILINACEA Cushman, 1927
Family TOSAIIIDAE Saidova, 1981
Genus TOSAIA Takayanagi, 1953
Tosaia hanzawaia Takayanagi
Plate 27, figure 3
Tosaia hanzawaia TAKAYANAGI 1953, pl. 4, fig. 7 (fide Bermúdez & Fuenmayor 1966)
Tosaia hanzawaia Takayanagi. —BERMÚDEZ & FUENMAYOR 1966, pl. 1, figs. 1 - 2. —KAIHO 1992a, pl. 1, fig. 1. —AKIMOTO 1994, pl. 2, fig. 28
Description: Moderate sized inflated test, rounded periphery, lobulate profile. Chambers inflated, increase rapidly as added, bulbous. Sutures distinct and depressed. Wall smooth. Aperture not recovered.
Occurrence: Restricted to V. herricki Zone in Venezuela.
Remarks: Originally described from the Miocene of Japan. First record of this taxon from the Agua Salada Formation.

Family STAIN FORTHIIIDAE Reiss, 1963
Genus HOPKINSINA Howe & Wallace, 1932
Hopkinsina szakacensis (Majzon)
Uvigerina szakákensis MAJZON 1936, textfig. 5 - 6 (fide Ellis & Messina 1940, et. seq.)
Hopkinsina szakacensis (Majzon). —POPEȘCU 1975, pl. 47, fig. 3
Description: Elongate test, lobulate periphery. Initial triserial chambers indistinct, become inflated and increase in size in biserial stage. Sutures depressed and limbate. Ornament of low costae covers test, 7 - 10 costae independent to a chamber. Aperture an ovate opening on short slender neck with slight lip.
Occurrence: Observed in Vâlcele, Romania.
Remarks: Originally described from the Tertiary of Hungary.
Superfamily BULIMINACEA Jones, 1875
Family SIPHOGENERINOIDEAE Saidova, 1981
Subfamily TUBULOGENERININAE Saidova, 1981
Genus SIPHOGENERINA Schlumberger, 1882

*Siphogenerina hubbardi* Galloway & Heminway

**Plate 27, figure 4**

*Siphogenerina hubbardi* GALLOWAY & MORREY 1941, pl. 34, fig. 2
*Siphogenerina hubbardi* Galloway & Morrey. —DIAZ de GAMERO 1985a, pl. 6, fig. 11. —BOLLI, et. al. 1994, pl. 81, fig. 11

*Rectuvigerina hubbardi* (Galloway & Morrey). —WHITTAKER 1988, pl. 9, figs. 14 - 16

**Description:** Elongate test, cylindrical. Initial triserial portion approximately 1/3 of the test, four chambers in uniserial portion. Chambers slightly inflated, sutures depressed. Ornamentation of approximately thirty longitudinal costae continuous over chambers and sutures. Aperture terminal, with small lip on a short neck.

**Occurrence:** Two specimens in the *V. herricki* and *G. fohsi* Zones in Venezuela.

**Remarks:** Originally described from the Oligocene of Puerto Rico. This form differs from *S. multicostata* Cushman & Jarvis in the continuous nature of the costae.

*Siphogenerina kugleri* Cushman & Renz

**Plate 27, figure 5**

*Siphogenerina kugleri* CUSHMAN & RENZ 1941, pl. 3, fig. 23
*Siphogenerina kugleri* Cushman & Renz. —RENZ pl. 7, fig. 28. —DIAZ de GAMERO 1985a, pl. 6, fig. 12. —BOLLI, et. al. 1994, pl. 78, fig. 46

**Description:** Elongate, slender test. Gradually tapers and slightly curved. Chambers distinct, increase gradually in size as added. Last few chambers display a crenulation at the base of the chamber. Sutures distinct and depressed. Wall ornamented with numerous fine longitudinal costae, these may anastomose. Costae independent of sutures. In last few chambers costae lost and wall smooth. Aperture rounded and terminal, slight lip and short neck.

**Occurrence:** Single specimen in sample 2725 of the *L. wallacei* Zone in Venezuela.

**Remarks:** Cushman and Renz (1941) found the species in the lower and upper Agua Salada Formation. Renz (1948) subsequently found the taxon scarce in the Acostian and Araguatian. Diaz de Gamero (1985a) found the taxon in her upper calcareous assemblage. Also known from Barbados, Carriacou, and Trinidad.

*Siphogenerina cf. kugleri* Cushman & Renz

**Plate 27, figure 6**

*Siphogenerina kugleri* CUSHMAN & RENZ 1941, pl. 3, fig. 23
*Siphogenerina kugleri* Cushman & Renz. —CUSHMAN & RENZ 1947, pl. 7, fig. 4. —RENZ 1948 pl. 7, fig. 28. —BLOW 1959, p. 152 - 153

**Description:** Differs from the typical taxa in the less distinct crenulation at the base of the last few chambers and greater inflation of the test.

**Occurrence:** Single occurrence in *V. herricki* Zone in Venezuela.
Remarks: All authors have found this species s.s. scarce.

*Siphogenerina lamellata* Cushman

*Siphogenerina lamellata* CUSHMAN 1918, pl. 12, fig. 3

*Siphogenerina lamellata* Cushman. --CUSHMAN 1930, pl. 9, fig. 11. --CUSHMAN & CAHILL 1933, pl. 9, fig. 4. --SKINNER & GLASER 1972, pl. 2, fig. 8. --DIAZ de GAMERO 1985a, pl. 6, figs. 13 - 14. --KOHL 1985, pl. 22, figs. 4 - 6. --BOLLI, et. al. 1994, pl. 78, fig. 49

*Transversigerina lamellata* (Cushman). --WHITTAKER 1988, pl. 9, fig. 6

Description: Elongate large test, tapers gradually from initial end, broadest towards apertural end. Eight to ten chambers visible, indistinct, increase in size slowly as added. Sutures indistinct, horizontal. Distinctive ornamentation of seven to eight high, equidistant, longitudinal, continuous, lamellae along the length of the test. Lamellae join at the apertural end. Aperture on a tubular neck with phialine lip.

Occurrence: Offshore Cabinda found in CABGOC 128-3 at 9,080’.

Remarks: Originally described from the Miocene of Florida. Differs from *S. transversa* in a smaller more delicate test and less costae. Well known from the Miocene of tropical Central America (Cushman and Renz 1947; Bermúdez and Fuenmayor 1966). Specimen compare well with those of the Whittaker collection (P51836).

*Siphogenerina senni* Cushman & Renz

Plate 27, figure 7

*Siphogenerina senni* CUSHMAN & RENZ 1941, pl. 3, figs. 21 - 22

*Siphogenerina senni* Cushman & Renz. --CUSHMAN & RENZ 1947, pl. 7, fig. 5. --RENZ 1948, pl. 7, figs. 29 - 30. --BLOW 1959, p. 153. --PETTERS 1979, pl. 3, fig. 10. --SCHNITKER 1980, pl. 3, fig. 5. --BOLLI, et. al. 1994, pl. 54, fig. 37, pl. 81, fig. 10

*Rectuvigerina senni* (Cushman & Renz). --VAN MORKHOVEN, et. al. 1986, pl. 58, figs. 1 - 2. --KATZ & MILLER 1993, pl. 1, fig. 6. --BOLLI, et. al. 1994, pl. 78, figs. 47 - 48

Description: Elongate test, tapering and rounded in transverse section. Chambers distinct, slightly inflated and of uniform size and shape. Sutures distinct, slightly depressed. Wall ornamented with 10 - 12 longitudinal costae, continuous over chambers and sutures from the apical end to the base of the last formed chamber. This chamber is smooth with downward projections linking to the tops of the costae. Aperture rounded, terminal, with a slight lip and neck.

Occurrence: Intermittent recovery throughout the Venezuelan section. Most common over the *V. herricki / G. foehsi* boundary.

Remarks: Cushman and Renz (1941) found the taxon in the lower and upper Agua Salada Formation. Renz (1948) subsequently found the species in the Acostian and Araguatian. Blow (1959) found the taxon scarce. He also suggested a conspecific relationship with *S. cummingsi* Galloway and Heminway and *S. yumuriana* Palmer.
**Siphogenerina smithi** Kleinpell

*Siphogenerina smithi* KLEINPELL 1938, pl. 6, figs. 1-2

*Siphogenerina smithi* Kleinpell. —RENZ 1948, pl. 12, figs. 18 - 19

**Description:** Large test. Chambers slightly inflated, triserial becoming uniserial. Sutures indistinct. Ornamented with numerous longitudinal discontinuous costae. Aperture missing.

**Occurrence:** Two specimens recovered from the *M. basispinosus* Zone and *S. transversa* Zone in Venezuela. Offshore Cabinda found in CABGOC 128-3 at 5,240'.

**Remarks:** Originally described from the Tertiary of California. Considered to be a siphogenerine development from *Uvigerinella sparsicostata* (Cushman and Laiming 1931). Regarded as a good biostratigraphic marker for the 'Uvigerinella' *sparsicostata* Zone and Acostian (Renz 1948). Found throughout the Caribbean region.

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**Siphogenerina transversa** Cushman

Plate 27, figure 8; Plate 60, figure 3

*Siphogenerina raphana* (Parker & Jones) var. *transversus* CUSHMAN 1918, pl. 22, fig. 8

*Siphogenerina raphanus* var. *transversus* Cushman. —CUSHMAN 1926, pl. 1, fig. 6. —NUTTALL 1927, pl. 6, fig. 14. —CUSHMAN 1929, p. 95

*Siphogenerina transversa* Cushman. —CUSHMAN & LAIMING 1931, pl. 12, fig. 13. —CUSHMAN & PARKER 1931 pl. 2, figs. 5, 6. —TOLMACHOFF 1934, pl. 40, figs. 30, 31. —HADLEY 1934, pl. 2, fig. 15. —HEDBERG 1937, pl. 91, fig. 18. —PALMER 1940, pl. 15, figs. 5, 6. —CUSHMAN & RENZ 1947, pl. 7, figs. 2 - 3. —RENZ 1948, pl. 7, figs. 27 - 28; pl. 12, fig. 9. —BLOW 1959, pl. 6, fig. 25. —KLEINPELL, et. al. 1980, pl. 13, fig. 14, pl. 14, fig. 5, pl. 15, fig. 9, 13 - 17. —CLARK & WRIGHT 1984, pl. 11, fig. 9. —DIAZ de GAMERO 1985a, pl. 6, fig. 15. —SNYDER, et. al. 1988, pl. 5, figs. 13 - 15. —BOLLI, et. al. 1994, pl. 54, figs. 39 - 40, pl. 78, figs. 50 - 52, pl. 81, fig. 9


*Siphogenerina* sp. —SNYDER, et. al. 1988, pl. 5, fig. 12

*Transversigerina transversa* (Cushman). —WHITTAKER 1988, pl. 9, figs. 8 - 10

**Description:** Large elongate species, widest breadth towards centre. Chambers and sutures distinct. Sutural arches. Ten to twelve prominent longitudinal equidistant costae that fade out at base of last chamber. Aperture in last formed chamber without neck.

**Occurrence:** Found commonly throughout the Venezuelan section apart from the *M. superbus* zonule. Reaches acme at sample 2612 of the *G. fohsi* Zone. Single specimen found offshore Cabinda in CABGOC 128-3 at 6,440'.

**Remarks:** Originally described from the Oligocene of Panama. Has been considered a good biostratigraphic marker for the Oligocene in the Caribbean. Renz (1948) found the species scarce in the 'Uvigerinella' *sparsicostata* Zone, and abundant in the Acostian, often dominating samples at this level. Diaz de Gamero (1985a) found the taxon confined to one sample in her upper calcareous assemblage. Known to show considerable ontogenetic, dimorphic, and ecophenotypic variation (Finger 1990). Specimens compare well with those of the Whittaker collection (P51837-51839). Also known from Barbados, Carriacou, Trinidad, Cuba, Mexico, and California.
**Siphogenerina** sp. 1  
Plate 27, figures 9 - 10  
Description: Elongate slender test. Tapers gently to the apertural end, much of the adult growth with parallel sides. Microspheric and megalospheric forms recovered differing only in the extent of the initial triserial chambers. Megalospheric shows a short rounded triserial stage, microspheric form has a acute extended triserial portion. Subsequent biserial and uniserial growth in both forms. Test wall thin and covered with numerous short, low, longitudinal striae, perforate. Aperture a terminal round opening on a short neck.  
Occurrence: Confined to sample 2725 of the *L. wallacei* Zone in Venezuela.  
Remarks: First report of this form from the Agua Salada Formation.

**Siphogenerina** sp. 2  
Plate 60, figure 4  
Occurrence: Offshore Cabinda found infrequently in CABGOC 115-1X between 3,350' and 7,020'.

Family BULIMINIDAE Jones, 1875  
Genus BULIMINA d'Orbigny, 1826  
*Bulimina aculeata* d'Orbigny  
*Bulimina aculeata* d'ORBIGNY 1826 *(fide Ellis & Messina 1940 et. seq.)*  
*Bulimina aculeata* d'Orbigny. --PARKER, et. al. 1871, pl. 11, fig. 128 *(fide Ellis & Messina 1940 et. seq.)*. --Fornasini 1902, textfig. 4 *(fide Ellis & Messina 1940 et. seq.)*. --AKERS & DOORMAN 1964, pl. 7, fig. 33. --PFLUM et. al. 1976, pl. 1, fig. 8. --HASEGAWA, et. al. 1990, pl. 3, figs. 14 - 15. --CIMERMAN & LANGER 1991, pl. 63, figs. 10 - 11. --HERMELIN 1991, pl. 1, figs. 11 - 12. --KAIHO 1992a, pl. 3, fig. 2. --AKimoto 1994, pl. 2, fig. 9. --OSTERMAN 1996, pl. 2, fig. 1  
Description: Medium sized tapering test, rounded periphery. Initial end subacute, chambers small and obscured by numerous small projections and spines extending downwards. Subsequent chambers un-ornamented, enlarge rapidly as added, inflated, overlapping earlier growth slightly. Sutures depressed. Aperture a comma shaped opening low on the last formed chamber.  
Occurrence: Single specimen found offshore Cabinda in CABGOC 115-1X at 6,440'.  
Remarks: Originally described from Recent material from the Adriatic. Well known offshore West Africa, multiple variatal taxa. Known from the Miocene of Venezuela (Bermúdez and Fuenmayor 1966).
**Bulimina alazanensis** Cushman

**Plate 60, figures 5a, 5b**

*Bulimina alazanensis* Cushman. --PARKER & BERMÚDEZ 1937 pl. 58, fig. 5. --CUSHMAN & STAINFORTH 1945, pl. 6, fig. 2. --BLOW 1959, p. 149. --SOYA 1965, pl. 2, fig. 9. --DOUGLAS 1973, pl. 7, figs. 1-2. --POPESE 1975, pl. 49, fig. 8. --RESIG 1976, pl. 1, fig. 5. --WRIGHT 1978, pl. 3, figs. 5-6. --TJALMA 1983, pl. 1, figs. 4-5. --CLARK & WRIGHT 1984, pl. 3, fig. 4. --DIAZ de GAMERO 1985a, pl. 5, fig. 18. --KOHL 1985, pl. 20, fig. 2. --THOMAS 1985, pl. 2, fig. 6. --BOERSMA 1986, pl. 5, fig. 7. --HULSBOS 1987, pl. 2, fig. 3. --KATZ & MILLER 1987, pl. 1, fig. 7. --MILLER & KATZ 1987, pl. 2, fig. 7. --MILLER & KATZ 1987, pl. 3, figs. 12-13. --BOERSMA 1990, pl. 1, fig. 3. --BOLLI, et. al. 1994, pl. 78, fig. 30, pl. 81, fig. 13. --DOWSETT & ISHMAN 1995, pl. 2, fig. 1. --SCHONFELD & SPIEGLER 1995, pl. 2, fig. 6. --BORNMALM 1997, fig. 18J-K

*Bulimina rostrata* Brady. --WHITTAKER 1988, pl. 7, figs. 8-9. --NOMURA 1991, pl. 1, fig. 24. --KAIHO 1992a, pl. 4, fig. 5

*Bulimina rostrata alazanensis* Cushman. --PFLUM et. al. 1976, pl. 1, fig. 9

*Bulimina cf. B. alazanensis* Cushman. --CIMERMAN & LANGER 1991, pl. 64, fig. 1 (not 2)

**Description:** Small, short, test, tapering, broadest toward the apertural end. Numerous chambers obscured by distinctive ornamentation of continuous equidistant longitudinal costae. Sutures indistinct. Aperture a comma shaped opening.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 between 2,310' and 10,160', acme at 2,310', and in CABGOC 115-1X between 7,370' and 9,900'.

**Remarks:** Originally described from Vera Cruz, Mexico. Also found in Cuba and Trinidad. Miller & Katz (1987) noted the variable nature of the costae, some specimens display sub-parallel ornamentation, others anastomose. Pfum et. al. (1976) reported the species from deeper bathyal waters of the Gulf of Mexico. Rathburn and Corliss (1994) considered the genus to be indicative of high organic carbon sediments in low oxygen conditions, while Bolli et. al. (1994) considered it to be facies tolerant. Whittaker (1988) commented on the close relationship of *B. alazanensis* Cushman, *B. dominicana* Bermúdez, *B. jugosa* Cushman & Parker, and *B. ecuadorana* Cushman & Stevenson. Recognised as a constituent of a diverse bathyal benthonic association offshore West Africa (Haman, et. al. 1993).

*Bulimina cf. alazanensis* Cushman

**Plate 27, figure 11**

*Bulimina alazanensis* CUSHMAN 1948, pl. 25, fig. 4

*Bulimina cf. alazanensis* Cushman. --RENZ 1948, pl. 6, fig. 14. --DIAZ de GAMERO 1985a, pl. 5, fig. 18

**Description:** Test small, occasionally preserved as internal moulds. Greatest breadth near apertural end, tapers to initial end. Rounded in cross section, length almost twice the width. Chambers slightly inflated, sutures slightly depressed. Prominent longitudinal costae ending in basal end in globose projection. Aperture elongate comma shape.

**Occurrence:** Occurs infrequently throughout the Venezuelan section.

**Remarks:** Originally described from Vera Cruz, Mexico. Also found in Cuba and Trinidad. In the Agua Salada Basin Renz (1948) found specimens from the Acostian, Araguatian, and Lucian
smaller than topotypes but identical in all other aspects. Diaz de Gamero (1985a) found the species intermittently throughout the basin.

**Bulimina faiconensis** Renz

**Plate 60, figures 6 - 7**

*Bulimina faiconensis* RENZ 1948, pl. 6, figs. 15a - b

*Bulimina buchiana* CUSHMAN & PONTON 1932, pl. 12, figs. 1a - b

*Bulimina sculptilis* RENZ 1942, p. 533

*Bulimina faiconensis* Renz. --BLOW 1959, p. 149 - 150. --BOLLI, et. al. 1994, pl. 78, fig. 32

*Bulimina uvigerinaformis* Cushman & Kleinpell. --WHITTAKER 1988, pl. 7, fig. 3 (not 1 - 2, 4)

**Description:** Similar to *B. alazanensis* but slimmer. Elongate test tapers bluntly. Greatest breadth towards aperture. Chambers numerous and slightly inflated, sutures indistinct and depressed. Numerous irregular longitudinal costae, depress as they cross sutures, slightly fluctuating. Aperture a comma slit at inner margin of last chamber. In some specimens possible to identify a slight lip.

**Occurrence:** Confined to sample 2817 of *L. wallacei* Zone in Venezuela. Offshore Cabinda found in CABGOC 128-3 between 4,770' and 10,160', and in CABGOC 115-1X between 7,200' and 9,060'.

**Remarks:** Renz (1948) found the species scarce in the Araguatian. Diaz de Gamero (1985a) identified a morphologically similar species, *Bulimina truncanella*, the degree to which this is a synonym is unknown. Differs from *B. sculptilis* in a more slender test. Recognised as a constituent of a diverse bathyal benthonic association offshore West Africa (Haman, et. al. 1993).

**Bulimina inflata** Seguenza

**Plate 27, figure 12; Plate 78, figure 3**

*Bulimina inflata* SEGUENZA 1862, pl. 1, fig. 10 (fide Ellis & Messina 1940 et. seq.)

*Bulimina inflata* Seguenza. --CUSHMAN 1921, pl. 31, fig. 6. --CUSHMAN 1930, pl. 8, fig. 6. --CUSHMAN & JARVIS 1930, pl. 33, fig. 5. --MACFADYEN 1930, pl. 1, fig. 20. --NUTTALL 1932, pl. 5, fig. 2. --CUSHMAN & CAHILL 1933, pl. 8, figs. 1a - b. --LE ROY 1939, pl. 5, figs. 1 - 3. --CORYELL & RIVERO 1940, p. 341. --RENZ 1948, p. 121. --BLOW 1959, p. 150. --POPESCU 1975, pl. 49, figs. 4 - 5. --WRIGHT 1978, pl. 3, figs. 8 - 9. --BOLTOVSKOY 1980, pl. 1, fig. 5. --PETTERS 1982, pl. 10, fig. 18. --BASOV & KRASHENINNIKOV 1983, pl. 15, fig. 6. --FINGER 1990, p. 62 - 63. --FINGER 1992, pl. 20, figs. 14 - 16

*Bulimina rinconensis* RENZ 1942, pp. 548, 556

**Description:** Often deformed and preserved as a pyrite internal mould. Small inflated ovate test. Prominent longitudinal costae obscure chambers and sutures. Broadest above the centre point. Chambers overhang the basal edge, apical end may have a short apical spine. Aperture a comma shaped slit with slight lip.

**Occurrence:** Occurs throughout the Venezuelan section. Most common in *G. fohsi*, acme at sample 2718 of the *L. wallacei* Zone. Offshore Cabinda found in CABGOC 128-3 between 4,170' and 10,160', and in CABGOC 115-1X between 3,350' and 9,780'. Also identified in the Chechis Marls and Sacel, Romania.
Remarks: Originally described from the Pleistocene of Italy. Renz (1948) found the species throughout the Agua Salada Formation. Diaz de Gamero (1985a) identified a morphologically similar species, *Bulimina striata mexicana*, the degree to which this is a synonym is unknown. The specimens of this study appear to grade between *B. inflata* Seguenza and *B. striata* d’Orbigny. Le Roy (1939) notes the small size of specimens in Sumatran samples. Specimens in the M. S. Srinivasan collection are larger than those of this study and posses an elongate slit shaped aperture rather than a comma (P48531). Specimens compare well with those of the Heron-Allen and Earland collection (P32472-32499) and the Gubler collection (P33282). Also known from Ecuador, Colombia, Costa Rica, Trinidad, Cuba, Haiti, Mexico, California, and additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966). Recognised along the Gulf Coast (Garret 1938), and as a constituent of a diverse bathyal benthonic association offshore West Africa (Haman, et. al. 1993).

*Bulimina cf. Inflata* Seguenza

Plate 28, figure 1

*Bulimina inflata* SEGUENZA 1862, pl. 1, fig. 10 (fide Ellis & Messina 1940 et. seq.)

*Bulimina inflata* Seguenza. —CUSHMAN & PARKER 1938, pl. 10, figs. 4 - 5

*Bulimina cf. inflata* Seguenza. —RENZ 1948, pl. 12, fig. 14. —BOLLI, et. al. 1994, pl. 78, fig. 29

Description: Differs from the typical species in shorter, squat test and more open aperture.

Occurrence: Occurs intermittently throughout the Venezuelan section, commonly with the typical species. Offshore Cabinda found in CABGOC 115-1X between 6,240' and 7,440'.

Remarks: Renz (1948) found the form throughout the Agua Salada Basin. Also found in Trinidad, Jamaica, and Mexico.

*Bulimina inflata alligata* Cushman & Laiming

Plate 28, figures 2a, 2b

*Bulimina inflata var. alligata* CUSHMAN & LAIMING 1931, pl. 11, fig. 17

*Bulimina inflata var. alligata* Cushman & Laiming. —KLEINPELL 1938, pl. 7, fig. 1. —RENZ 1948, pl. 6, fig. 13

*Bulimina alligata* (Cushman & Laiming). —BLOW 1959, pl. 6, fig. 23

*Bulimina inflata alligata* Cushman & Laiming. —BOLLI, et. al. 1994, pl. 78, fig. 31

*Bulimina alligata* Cushman & Laiming. —FINGER 1992, pl. 20, fig. 12

Description: Similar to *B. inflata*, but more slender and costae less prominent, arranged into longitudinal lines. Some forms transitional to the typical form.

Occurrence: Intermittent occurrence throughout the Venezuelan section. Acme at sample 2612 of the V. herricki Zone. Offshore Cabinda found infrequently in CABGOC 128-3 between 5,060' and 10,160', and in CABGOC 115-1X between 4,310' and 8,400'.

Remarks: Originally described from the Saucesian of California. Renz (1948) found the taxon scarce through much of the Agua Salada basin, becoming common in the Acostian and upper Araguatian. Blow (1959) elevated the taxon to specific rank, and found it restricted to the upper Toycuyo Formation and the Pozón Formation. Also found in Trinidad and additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966).
**Bulimina sp. 1**
Plate 60, figure 8

**Description:** Poor preservation obliterates defining characteristics.

**Occurrence:** Offshore Cabinda found infrequently in CABGOC 128-3 between 5,000’ and 10,160’, and in CABGOC 115-1X at 5,820’.

**Remarks:** Poor preservation.

**Bulimina sp. 2**

**Description:** Poor preservation obliterates defining characteristics.

**Occurrence:** Single specimen found offshore Cabinda in CABGOC 115-1X at 6,900’.

**Remarks:** Poor preservation.

Genus GLOBOBULIMINA Cushman, 1927

_Globobulimina affinis_ (d’Orbigny)

Plate 28, figure 3; Plate 60, figure 9

_Bulimina affinis_ d’ORBIGNY 1839, pl. 2, figs. 25 - 26 (fide Ellis & Messina 1940, _et. seq._)
_Bulimina affinis_ d’Orbigny. –MACFADYEN 1930, pl. 1, fig. 12. –CORYELL & RIVERO 1940, pl. 44, fig. 21. –DIAZ de GAMERO 1985a, pl. 5, fig. 17

**Description:** Elongate ovoid test. Chambers and sutures indistinct, chambers inflated, embracing. Broadest towards the middle of the test, ovate in cross section. Sutures distinct and depressed. Aperture a comma shaped opening, normally obscured by nature of internal mould, hence toothplate not observed.

**Occurrence:** Occurs intermittently throughout the Venezuelan section. Offshore Cabinda found in CABGOC 128-3 between 930’ and 10,100’, and in CABGOC 115-1X between 3,290’ and 9,720’.

**Remarks:** Originally described from Recent material from Cuba. Specimens preserved as pyrite internal moulds. Diaz de Gamero (1985a) found the species limited to her uppermost calcareous assemblage. Pfium _et al._ (1976) found the species to have a wide ranging bathymetry in the Gulf of Mexico from the lower neritic to the abyssal. Rathburn and Corliss (1994) considered the genus to favour the environmental parameters of _Bulimina_, high organic carbon and low oxygen. Known from additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966).

_Globobulimina gibba_ (d’Orbigny)

Plate 78, figures 4a, 4b

_Globobulimina gibba_ d’ORBIGNY 1826, p. 266 (fide Ellis & Messina 1940, _et. seq._)
_Globulina aequalis_ d’ORBIGNY 1846, pl. 13, figs. 11 - 12
_Globulina tubulosa_ d’ORBIGNY 1846, pl. 13, figs. 15 - 16
_Globobulimina gibba_ d’Orbigny. –d’ORBIGNY 1846, pl. 13, figs. 13 - 14. –POPESCU 1975, pl. 39, fig. 1. –PAPP & SCHMID 1985, pl. 71, figs. 5 - 12
_Globobulimin a gibba_ d’Orbigny. –SNYDER, _et. al._ 1988, pl. 3, fig. 6

200
**Globulina gibba** d'Orbigny. —Cushman 1930, pl. 5, fig. 21. —Cushman & Cahill 1933, pl. 6, fig. 6. —IVA 1970, pl. 1, figs. 6, 9. —Basilici, et al. 1997, pl. 4, fig. 2. —Cicha, et al. 1998, pl. 27, figs. 12-13

**Description:** Globose test, sub-oval to rounded in apertural view. Later chambers embrace earlier portion of test. Aperture closed and radiate.

**Occurrence:** Common to Vâlcele, Lapugiu du Sus, and Sacel in Romania.

**Remarks:** Originally described from the Tertiary of the Vienna Basin. Known from the Miocene of Trinidad (Nuttall 1927) and Egypt (Macfadyen 1930). Specimens compare well to *Polymorphina gibba* example of the Brady, and Heron-Alien and Earland collections (NHM). Papp and Schmid (1985) synonymised *G. aequalis* and *G. tubulosa*, a combination followed herein.

**Globobulimina ovata** (d'Orbigny)

**Plate 78, figures 5 - 6**

*Bulimina* ovata* d'ORBIGNY 1846, pl. 11, figs. 13-4

**Globobulimina ovata** (d'Orbigny). —Thompson 1980, pl. 6, fig. 9. —Diaz de Gamero 1985a, pl. 5, fig. 20. —Kohl 1985, pl. 21, fig. 3

**Description:** Always preserved as internal moulds in Venezuela and Cabinda. Test normally intact in Romania. Ellipsoid inflated test. Chambers elongate, overlapping one another and steadily increasing in size. Only the last three visible. Sutures distinct and depressed. Aperture invariably obscured due to nature of internal mould. Only adult forms recovered.

**Occurrence:** Intermittent occurrence from the *M. basispinosus* Zone to the *L. wallacei* Zone in Venezuela. Offshore Cabinda found in CABGOC 115-1X between 3,830' and 9,900'. Found in Vâlcele and Costei, Romania.

**Remarks:** Originally described from the Miocene of Japan. Diaz de Gamero (1985a) found the species in the upper section of her upper calcareous assemblage. Known from Recent sediments of the Côte d'Ivoire (Calvez 1963). Specimens compare well with those of the Heron-Allen and Earland Collection (P32399-32450), and the T. R. Jones Collection (P32973, P33245).

**Globobulimina perversa** (Cushman)

**Plate 28, figure 4; Plate 60, figure 10**

*Bulimina pyrula* var. *perversa* Cushman 1921, text fig. 2

*Bulimina* (Globobulimina) *perversa* (Cushman). —Renz 1948, pl. 6, fig. 16. — Blow 1959, p. 151. —Bolli, et al. 1994, pl. 78, fig. 28

**Globobulimina perversa** (Cushman). —Nomura 1992, pl. 3, fig. 3

**Description:** Always preserved as internal moulds. Broadest at base with flattened profile, chambers elongate, sutures depressed. Aperture obscured through nature of internal mould.

**Occurrence:** Confined to *V. herricki*, *G. fohsi* and *L. wallacei* Zones in Venezuela. Rare. Offshore Cabinda found in CABGOC 128-3 between 4,170' and 10,160', and in CABGOC 115-1X between 3,470' and 9,360'.

**Remarks:** Originally described from Recent sediments offshore Borneo. Renz (1948) found the species scarce in the 'Uvigerinella' sparsicostata Zone, Acostian, Araguatian, and Lucian. Blow
(1959) considered the patchy distribution of the species to be an ecological factor. Also known from Trinidad. Recognised in the Miocene of the Gulf of Suez region (Souya 1965).

Genus PROTOGLOBOBULIMINA Hofker, 1951

*Protoglobobulimina pupoides* (d'Orbigny)

**Plate 28, figure 5; Plate 78, figure 7**

*Bulimina pupoides* d'Orbigny. --Cushman 1921, pl. 31, fig. 8. --Macfadyen 1930, pl. 1, fig. 11. --Nuttall 1932, pl. 2, fig. 9. --Parker & Bermúdez 1937, pl. 59, figs. 3 - 5. --Cushman & Parker 1937, pl. 6, figs. 2 - 3. --Renz 1948, pl. 6, figs. 11 - 12. --Blow 1959, p. 150. --Souya 1965, pl. 2, fig. 29. --Schnitker 1980, pl. 2, figs. 19 - 20. --Boll, et al. 1994, pl. 53, fig. 21, pl. 78, figs. 26 - 27

*Bulimina pyrula* (d'Orbigny). --Papp & Schmid 1985, pl. 62, figs. 5 - 7


*Præglobobulimina pupoides* (d'Orbigny). --Cicha, et al. 1998, pl. 48, figs. 10, 14 - 17

*Protoglobobulimina pupoides* (d'Orbigny). --Cimerman & Langer 1991, pl. 65, figs. 1 - 3

**Description:** Always preserved as pyrite internal moulds. Rounded test, forming large spire. Triserial, chambers inflated and sutures depressed. Aperture always obscured through nature of internal mould.

**Occurrence:** Infrequent occurrence throughout the Venezuelan section. Most common in *G. fohsi* Zone. Offshore Cabinda found in CABGOC 128-3 between 2,610' and 9,980', and in CABGOC 115-1X between 2,990' and 9,720'. Common to Valcele, Costei, and Sacel, Romania.

**Remarks:** Type locality unknown. Renz (1948) noted the taxon as common in the 'Uvigerinella' sparsicostata Zone and scarce in the Acostian, Araguatian, and Lucian. Blow (1959) found the taxon in association with *G. perversa*. Also found in Trinidad, Cuba, Jamaica, and Mexico, known from the Badenian of the Vienna Basin. Recorded from Recent sediments of the Côte d'Ivoire (Calvez 1963) and recognised along the Gulf Coast (Garret 1938), the Miocene of California (Smith 1960) and additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966). Specimens compare well with those of the Heron-Allen and Earland collection (P32472-32499), the Burrow and Holland collection (slide F, NHM), the Brady collection (NHM), and that of the Helvetian Gubler collection (P3246). Recognised as a constituent of a diverse bathyal benthonic association offshore West Africa (Haman, et al. 1993).

Family BULIMINELLIDAE Hofker, 1951

Genus BULIMINELLA Cushman, 1911

*Buliminella cf. basistriata nuda* Howe & Wallace

**Plate 28, figure 6**

*Buliminella basistriata var. nuda* Howe & Wallace 1932, pl. 11, fig. 4 (fide Ellis & Messina 1940, et. seq.)

*Buliminella cf. basistriata var. nuda* Howe & Wallace. --Renz 1948, pl. 6, fig. 10

*Buliminella basistriata nuda* Howe & Wallace. --Blow 1959, p. 151

202
**Description:** Distinctive small species. Tapering test, greatest breadth towards apertural end. Chambers slightly inflated, sutures depressed. When present, wall smooth (although often only preserved as internal mould). Aperture large intermarginal comma.

**Occurrence:** Found intermittently throughout the Venezuelan section. Reaches acme abundance in sample 2603 of the *M. basispinosus* Zone. Common offshore Cabinda in CABGOC 128-3 between 2,430' and 10,160', found in CABGOC 115-1X at 7,380'.

**Remarks:** Renz (1948) found this taxon throughout the Agua Salada Formation. Blow (1959) considered it to be ecologically controlled. Also found in Costa Rica, Colombia, Trinidad, and Mexico. Originally described the Upper Eocene of Louisiana.

**Buliminella curta** Cushman

**Plate 60, figure 11**

*Buliminella curta* CUSHMAN 1925, pl. 5, fig. 33 (*fide* Skinner & Glaser 1972)

*Buliminella curta* Cushman. —CUSHMAN 1930, pl. 8, fig. 4. —CUSHMAN & LAIMING 1931, pl. 11, figs. 15 - 16. —CUSHMAN & CAHILL 1933, pl. 7, fig. 15. —CUSHMAN & LE ROY 1938, pl. 22, fig. 17. —SKINNER & GLASER 1972, pl. 2, fig. 5. —PETTERS 1982, pl. 6, figs. 7, 23. —WHITTAKER, 1988 pl. 7, figs. 16 - 17. —FINGER 1990, p. 68 - 69. —FINGER 1992, pl. 20, figs. 36 - 37 (not 38)

**Description:** Elongate, spiralling test, initial end rounded, increasing rapidly in diameter. Greatest width towards centre. Spiral suture depressed, five to six inflated chambers per whorl. Periphery lobulate. Wall smooth, though eroded. Aperture comma shaped in the concave face of the last formed chamber.

**Occurrence:** Single specimen in *V. herricki* Zone in Venezuela. Offshore Cabinda found in CABGOC 115-1X between 3,830' and 8,340'.

**Remarks:** First record of this species from the Agua Salada Formation. Originally described from the Miocene of California and subsequently noted there (Smith 1960). Cushman (1930) notes that during ontogeny specimens may begin to lose the degree of inflation of the chambers and hence diameter. Finger (1990) remarks upon an ecophenotypic gradation between the named taxon and *B. subfusiformis* Cushman, *B. californica* and *B. brevior* falling as intermediate forms. These were all described from the same locality. Here I follow the practise of Finger (1990), grouping the forms found as the end member *B. curta*; elongate *B. subfusiformis* forms were not encountered. Specimens compare well with those of the Whittaker collection (P51809).

**Family UVIGERINIDAE** Haeckel, 1894

**Subfamily UVIGERININAE** Haeckel, 1894

**Genus UVIGERINA** d'Orbigny, 1826

**Uvigerina altacostata** Cushman & Ellisor

**Plate 60, figure 12**

*Uvigerina altacostata* CUSHMAN & ELLISOR 1939, pl. 1, fig. 14

*Uvigerina altacostata* Cushman & Ellisor. —SKINNER & GLASER 1972, pl. 2, fig. 10

**Description:** Moderate sized test, broadest toward the centre, tapering to apical and apertural ends. Chambers distinct, inflated, often obscured by strong ornamentation. Sutures indistinct in
the early portion, depressed in adult growth. Strong ornamentation of chamber confined longitudinal costae. Aperture terminal with straight neck.

**Occurrence:** Offshore Cabinda found infrequently in CABGOC 128-3 between 4,410' and 6,500'.

**Remarks:** Originally described from the Miocene of Louisiana.

**Uvigerina attenuata** Cushman & Renz

**Plate 61, figure 1**

*Uvigerina auberiana* var. *attenuata* CUSHMAN & RENZ 1941, pl. 3, fig. 17

*Uvigerina auberiana* var. *attenuata* Cushman & Renz. —CUSHMAN & STAINFORTH 1945, pl. 7, fig. 18. —RENZ 1948, pl. 7, fig. 20. —BOLLI, *et al.* 1994, pl. 54, fig. 7, pl. 78, fig. 34, pl. 81, fig. 23

*Uvigerina auberiana* d'Orbigny. —WHITTAKER 1988, pl. 8, fig. 14

**Description:** Moderately sized test, rounded profile. Initial triserial growth, becomes biserial, and finally uniserial. Chambers increase in height rapidly as added, inflated. Sutures distinct and depressed. Wall covered with numerous short hisps. Last formed chamber slightly concave on inner side, extended into slender neck.

**Occurrence:** Offshore Cabinda found infrequently in CABGOC 128-3 between 4,770' and 10,160', and in CABGOC 115-1X between 4,709' and 8,340'.

**Remarks:** Differs from the *U. auberiana* in the greater inflation of the chambers in the triserial portion, and the possession of both biserial and uniserial growth. Differs from *U. proboscidea* Schwager through its smaller size, ‘tight’ coiling in the triserial portion, and the rapid development of biserial growth. Known from the Miocene of tropical Central America (Cushman and Renz 1947).

**Uvigerina cf. beccarii** Fornasini

**Plate 28, figure 7; Plate 78, figure 8**

*Uvigerina beccarii* FORNASINI 1898, pl. 1, fig. 5 (*fide* Ellis & Messina 1940, *et seq.*)

*Uvigerina beccarii* Fornasini. —GALLOWAY & MORREY 1929, pl. 6, fig. 2. —CUSHMAN 1929, pl. 13, fig. 37. —CUSHMAN & EDWARDS 1938, pl. 13, fig. 7. —CORYELL & RIVERO 1940, pl. 44, fig. 25. —POPESECU 1975, pl. 45, figs. 2 - 3. —BOERSMA 1984, pl. 1

*Uvigerina cf. beccarii* Fornasini. —RENZ 1948, pl. 7, fig. 22. —BOLLI, *et al.* 1994, pl. 78, fig. 41

*Uvigerina schwageri* Brady. —WHITTAKER 1988, pl. 8, fig. 11

**Description:** Medium sized ovoid test. Chambers and sutures indistinct, obscured by prominent irregular longitudinal striae. Aperture rounded at end of last chamber.

**Occurrence:** Confined to the *M. basispinosus, V. herricki,* and *G. fohsi* Zones in Venezuela. Rare. Offshore Cabinda found in CABGOC 128-3 between 4,720' and 10,160', and in CABGOC 115-1X between 6,420' and 9,720', acme at 7,440'. Recovered in Vâlcule, but at higher frequencies in the Chechis Marls and Sacel, Romania.

**Remarks:** Originally described from the Pliocene of Italy. Renz (1948), tentatively refers to this species as a good marker for the Oligocene of the Caribbean. Restricted to the Acostian in his study. Also known from Ecuador and Trinidad. Specimens compare favourably with those of the Whittaker collection (P51822). Cicha, *et al.* (1998) synonymise Paratethyan examples of this
taxa into *U. popescui* Rögl. This group of high costate taxa may represent differing end members of ecophenotypic variation.

**Uvigerina capayana** Hedberg  
Plate 61, figure 2; Plate 78, figure 9

*Uvigerina pygmae* d’ORBIGNY var. *capayana* HEDBERG 1937, pl. 91, fig. 19

*Uvigerina capayana* HEDBERG *et. al.* 1938, pl. 14, fig. 1

*Uvigerina* sp. 2 PETTERS 1979, pl. 2, fig. 11

*Uvigerina capayana* Hedberg. --CUSHMAN & STAINFORTH 1945, pl. 7, fig. 14. --RENZ 1948, pl. 12 fig. 15. --BOERSMA 1984, p. 25 - 27. --BOLLI, *et. al.* 1994, pl. 54, figs. 9 - 10, pl. 78, fig. 37

**Description:** Short stout test. Triserial coiling, chambers inflated, periphery lobulate. All chambers apart from the last distinctly ornamented with longitudinal costae normally restricted to individual chambers. The last chamber faintly ribbed. Elongate neck.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 between 2,310' and 10,160', frequent. In CABGOC 115-1X infrequent recovery between 7,560' and 8,640'. Single specimen recovered from Vâlcele, Romania.

**Remarks:** Originally described from the Tertiary of north-east Venezuela. Differs from *U. isidroensis* in less pronounced costae, and *U. pigmaea* d’Orbigny by fewer costae. In general tends to be more symmetrical than all similar taxa. Also known from Costa Rica, Ecuador, Barbados, Trinidad, Cuba, and Mexico.

**Uvigerina carapitana** Hedberg  
Plate 61, figure 3

*Uvigerina carapitana* HEDBERG 1937, pl. 91, fig. 20

*Uvigerina carapitana* Hedberg. --CUSHMAN & RENZ 1947, pl. 6, fig. 15. --RENZ 1948, pl. 7, fig. 21. --BOERSMA 1984, p. 28 - 30. --DÍAZ de GAMERO 1985a, pl. 6, fig. 2. --VAN MORKHOVEN, *et. al.* 1986, pl. 40B, fig. 1. --WHITTAKER 1988, pl. 8, fig. 15. --BOLLI, *et. al.* 1994, pl. 54, figs. 3 - 4, pl. 78, fig. 33

**Description:** Large, robust test, broad. Widest toward centre of test. Chambers show diversity in rapidity of increase in size. Chambers inflated and angular, sutures indistinct. Wall smooth, may show slight striae in some portions, not common. Neck set in slight terminal depression.

**Occurrence:** Offshore Cabinda infrequent recovery in CABGOC 128-3 between 5,240' and 8,240', single specimen in CABGOC 115-1X at 5,760'.

**Remarks:** Differs from *U. lirettensis* in shorter form and less pronounced faint striae, *U. laviculata* Coryell & Rivero shows greater pronounced striae. Specimens in the Whittaker collection (P51826) tend to be slightly slimmer than this study. Known from the Miocene of Venezuela (Bermúdez and Fuenmayor 1966).

**Uvigerina cubana** Palmer & Bermúdez  
Plate 78, figures 10 - 11

*Uvigerina cubana* PALMER & BERMÚDEZ 1936, pl.17, figs. 5 - 6

*Uvigerina cubana* Palmer & Bermúdez. --POPEȘCU 1975, pl. 45, figs. 4 - 5, text fig. 26

**Description:** Large robust test, ovoid shape, widest towards centre. Rounded periphery. Low chambers, slightly inflated, sutures indistinct. Prominent longitudinal plate-like costae cover test
obscurring chamber and suture arrangement. Three to five large costae extend from apical end mid way along the test, intermediate smaller costae cover one to two chambers each. Aperture a rounded opening with elongate neck and phialine lip, occasional remnants of tooth.

**Occurrence:** Single specimen recovered from Vâlcele, more common in the Chechis Marls and Sacel.

**Remarks:** Originally described from the lower Oligocene of Cuba. Popescu (1975) remarks upon this taxon's occurrence as deformed tests developing double apertures as 'siamois'. Differs from *U. gallowayi* in the prominent primary costae. Recognised along the Gulf Coast (Garret 1938). Cicha, *et al.* (1998) synonymise Paratethyan examples of this taxa into *U. popescui* Rögl. This group of high costate taxa may represent differing end members of ecophenotypic variation.

**Uvigerina gallowayi basicordata** Cushman & Renz

**Plate 28, figure 8**

*Uvigerina gallowayi var. basicordata* Cushman & Renz - CUSHMAN & RENZ 1941, pl. 3, fig. 18

*Uvigerina gallowayi var. basicordata* Cushman & Renz. –RENZ 1948, pl. 7, fig. 19. –DIAZ de GAMERO 1985a, pl. 6, fig. 3. –RESIG 1990, pl. 4, fig. 14. –BOLLI, *et al.* 1994, pl. 54, fig. 13, pl. 78, fig. 38

*Uvigerina gallowayi paucicostata* (Cushman & Renz). –BLOW 1959, p. 156

*Rectoglandulina gallowayi paucicostata* (Cushman & Renz). –BLOW 1959, pl. 6, fig. 14

*Uvigerina basicordata* (Cushman & Renz). –VAN MORKHOVEN, *et al.* 1986, pl. 65, figs. 1 - 2 (not 3)

**Description:** Medium sized ovoid test. Chambers slightly lobulate, coiling triserially and becoming biserial to uniserial in the last formed chamber. Longitudinal costae may become continuous from chamber to the next, some restricted to individual chambers. Terminal neck on uniserial chambers ends with reverted lip. Differs from the typical species in a shorter and broader form, ornamentation concentrated towards the base.

**Occurrence:** Single specimen in *L. wallacei* Zone in Venezuela.

**Remarks:** Cushman and Renz (1941) found this species in the lower Agua Salada Formation. Renz (1948) subsequently, identified the typical species in addition to this variety but was unable to critically separate the two and so regarded them both as the variant species. Boersma (1984) regarded the typical taxon to show more costae than this variety. Renz found the form to represent an 'excellent' Oligocene marker for the Oligocene in the Caribbean region, in the Agua Salada Basin restricted to the 'Uvigerinella' sparsicostata Zone and the Acostian. Blow (1959) found it generally scarce and only apparent in his G. *insueta* Zone. Diaz de Gamero (1985a) found the species in the oldest most samples she examined. *U. gallowayi basiquadrata* Petters & Sarmienta differs from this taxon in its initial quadrate test and more slender form. *U. porqueroensis* Petters & Sarmienta has the aperture set in a depression. Similar to *U. crassicostata*, specimens of which in the M. S. Srinivasan collection display a more central position of the neck and aperture on the last chamber, and a slightly greater elongation of the test (P48559). Known from the Miocene of tropical Central America (Cushman and Renz 1947).
**Uvigerina cf. hannai** Kleinpell

**Plate 61, figure 4**

*Uvigerina hannai* KLEINPELL 1938

*Uvigerina cf. hannai* Kleinpell. --RENZ 1948, pl. 12, figs. 16 - 17. --FINGER, et. al. 1990, pl. 5, fig. 17. --BOLLI, et. al. 1994, pl. 78, figs. 35 - 36

**Description:** Moderately sized test, broadest towards centre. Initial growth closely coiled, following growth becoming extended with larger, inflated chambers. Sutures depressed. Early portion of test ornamented with numerous fine striae, later growth smooth, though degree of ornamentation varies. Aperture on a short neck.

**Occurrence:** Offshore Cabinda found infrequently in CABGOC 128-3 between 4,650' and 10,100', in CABGOC 115-1X found at 6,960' and 7,440'.

**Remarks:** Originally described from the Upper Miocene (Monterey Shale) of California. Described as displaying greatest breadth toward apertural end, these specimens are broadest toward centre of test and tend towards lesser ornamentation.

**Uvigerina hantkeni** Cushman & Edwards

**Plate 78, figure 12**

*Uvigerina hantkeni* CUSHMAN & EDWARDS 1937, pl. 8, fig. 15 - 16

*Uvigerina hantkeni* Cushman & Edwards. --BOERSMA 1984, p. 67 - 69. --CICHA, et. al. 1998, pl. 52, fig. 6

**Description:** Large test, conical, and inflated. Appressed, elongate chambers, covered with thin, non-continuous striae and are distinctly lobate. Neck in slight terminal depression.

**Occurrence:** Single specimen recovered from Sacel.

**Remarks:** Originally described from Hungary.

**Uvigerina hispida** Schwager

**Plate 28, figure 9; Plate 61, figure 5**

*Uvigerina hispida* SCHWAGER 1866, pl. 7, fig. 95 (fide Ellis & Messina 1940, et. seq.)

*Uvigerina hispida* Schwager. --PFLUM et. al. 1976, pl. 8, figs. 8 - 10. --WRIGHT 1978, pl. 8, fig. 11. --HALLER 1980, pl. 8, fig. 1. --THOMPSON 1980, pl. 8, fig. 13. --BOERSMA 1984, p. 74 - 76. --DIAZ de GAMERO 1985a, pl. 6, fig. 4. --KOHL 1985, pl. 24, fig. 3. --BELANGER & BERGGREN 1986, pl. 2, figs. 8 - 9. --BOERSMA 1986, pl. 20, figs. 5 - 6. --KURIHARA & KENNERT 1986, pl. 3, figs. 7 - 8. --VAN MORKHOVEN, et. al. 1986, pl. 20, figs. 1 - 4. --KATZ & MILLER 1987, pl. 2, fig. 1. --MILLER & KATZ 1987, pl. 2, figs. 2, 4. --WHITTAKER 1988, pl. 8, figs. 16 - 17. --BOERSMA 1990, pl. 2, fig. 14. --KAIHO 1992a, pl. 4, fig. 9. --AKIMOTO 1994, pl. 2, fig. 17. --BORNMALM 1997, fig. 19H

**Description:** Medium sized test. Greatest breadth towards centre. Triserial to biserial coiling. Chambers inflated and lobate, increasing in size uniformly. Sutures depressed and indistinct. Dense ornament of short spines, less on last chamber. Aperture terminal with short neck with slight lip.

**Occurrence:** Intermittent occurrence throughout the Venezuelan section. Rare. Offshore Cabinda found infrequently in CABGOC 128-3 between 4,890' and 9,080'.

**Remarks:** Originally described from the Tertiary of India. Diaz de Gamero (1985a) found this species in the *G. fohsi fohsi* Zone. In the Gulf of Mexico, Pflum et. al. (1976) find the species indicative of the abyssal zone to the top of the lower middle bathyal zone. Boersma (1984)
describes the taxon as an open ocean intermediate to deep water species, rarely recovered from marginal basin sediments. Known to peak in abundance beneath upwelling regions with little detrital sediment input in the late Miocene. Considered to have an expanded depth range in the later Neogene, occurring in shallower sediments and migrating to greater depths in the early Pliocene. Specimens tend to be dwarfed and shortened in comparison to those of the M. S. Srinivasan collection (P48548). Much debate remains over the hispid to pustulose forms of *Uvigerina*. Here *U. hispida* Schwager, *U. mantaensis* Cushman & Edwards, and *U. prodiscidea* have been separated upon the basis of wall thickness, chamber arrangement, and Lastly ornamentation nature. Hispid ornamentation can readily become pustulose in abrasive conditions hence the less important status of this factor.

*Uvigerina isidroensis* Cushman & Renz  
Plate 28, figure 10; Plate 61, figure 6

*Uvigerina isidroensis* CUSHMAN & RENZ 1941, pl. 3, fig. 16  
*Uvigerina isidroensis* Cushman & Renz. --CUSHMAN & RENZ 1947, pl. 6, fig. 18. --RENZ 1948, pl. 7, fig. 18. --BOERSMA 1984, p. 85 - 87. --BOLLI, et. al. 1994, pl. 54, fig. 11, pl. 78, fig. 39

**Description:** Medium sized test, greatest breadth in the upper portion of the test. Triserial coiling becomes biserial, low transitional rate gives sutures the appearance of being horizontal and chambers stacked upon each other. Chambers increase gradually in size, inflated with lobate periphery. Longitudinal, low costae ornamentation may segregate to give the appearance of short spines. Costae restricted to individual chambers but may overhang previous chamber to give excavated appearance. Aperture in a terminal neck with reverted neck.

**Occurrence:** In Venezuela recovered between the *R. spinulosa* - *E. poeyanum* and *S. transversa* Zones, acme in 2609B and 2610. Offshore Cabinda found in CABGOC 128-3 between 3,990' and 7,820', and in CABGOC 115-1X between 3,410' and 8,280'.

**Remarks:** Originally described from Eastern Falcon, Venezuela, Cushman & Renz (1941) found the species throughout the Agua Salada Formation. Renz (1948) subsequently referred to the taxon as 'common to abundant' except for the *'Uvigerinellia' sparsicostata* Zone and the Lucian where it is scarce. Differs from *U. capayana* Hedberg and *U. pigmaea* d’Orbigny in greater size and elongation of the test. *U. peregrina* tends to be smaller with less well developed costae than *U. isidroensis*. Also known from Costa Rica, Colombia, and Trinidad.

*Uvigerina junecea* Cushman & Todd  
Plate 79, figures 1 - 2

*Uvigerina junecea* CUSHMAN & TODD 1941, pl. 20, figs. 4 - 11  
*Uvigerina junecea* Cushman & Todd. --POPESCU 1975, pl. 45, fig. 1, pl. 46, figs. 4 - 5

**Description:** Elongate slender test, round in cross section and tapering to the initial end. Lobate periphery. Triserial initial chambers, becoming biserial. Chambers large and inflated, sutures depressed and distinct, curving slightly. Numerous longitudinal costae ornament test, isolated to individual chambers, less apparent towards the apertural end. Aperture a round opening on a short neck with phialine lip.

**Occurrence:** Recovered from Vâlcele and the Chechis Marls, Romania.
Remarks: Originally described from the Pliocene of California.

_Uvigerina laviculata_ Coryell & Rivero

_Uvigerina laviculata_ CORYELL & RIVERO 1940,

_Uvigerina laviculata_ Coryell & Rivero. --BOERSMA 1984, p. 91 - 94. --BOLLI, et al. 1994, pl. 54, fig. 5

**Description:** Large test, greatest breadth toward the apertural end. Periphery lobulate. Chambers inflated, increase in size rapidly as added. Sutures distinct. Wall covered in numerous discontinuous striae, restricted to individual chambers in most cases. Slightly curved. Final chambers less ornamented. Neck in slight terminal depression, rarely preserved.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 between 4,830' and 10,040'.

_Uvigerina lirettensis_ Cushman & Ellisor

_Plate 61, figure 7_

_Uvigerina lirettensis_ CUSHMAN & ELLISOR 1939, pl. 1, fig. 13

_Uvigerina lirettensis_ Cushman & Ellisor. --SKINNER & GLASER 1972, pl. 2, fig. 12. --SKINNER & STEINKRAUS 1972. --BOERSMA 1984, pl. 3

**Description:** Mostly preserved as internal moulds. Test elongate but stout. Apertural end truncate, chambers distinct and inflated, triserial. Sutures distinct and depressed, limbate. Short terminal neck. Aperture small, a slight depression on the truncate terminal face, with short cylindrical neck.

**Occurrence:** Intermittent recovery throughout the Venezuelan section. Acme in sample 2615 of the _G. fohsi_ Zone. Offshore Cabinda found in CABGOC 128-3 between 5,480' and 9,980', and in CABGOC 115-1X between 2,750' and 6,180'.

**Remarks:** Originally described from the Miocene of Louisiana. First record of this species from the Agua Salada Formation. Resembles to a certain extent _U. carapitana_ Hedberg from the Oligocene of Venezuela, but is larger, has greater inflation to chambers and a less conspicuous neck.

_Uvigerina mantaensis_ Cushman & Edwards

_Plate 61, figures 8 - 9_

_Uvigerina mantaensis_ CUSHMAN & EDWARDS 1938, pl. 14, fig. 8

_Uvigerina mantaensis_ Cushman & Edwards. --CUSHMAN & STAINFORTH 1945, pl. 7, fig. 17. --BOERSMA 1984, p. 103 - 106. --DIAZ de GAMERO 1985a, pl. 6, fig. 6. --KOHL 1985, pl. 24, fig. 4. --RESIG 1990, pl. 4, fig 15 (not 2). --BOLLI, et. al. 1994, pl. 54, fig. 8, pl. 81, fig. 24. --SCHÖNFELD & SPIEGLER 1995, pl. 2, fig. 7. --BORMALM 1997, fig. 19K. --CICHA, et. al. 1998, pl. 49, figs. 15 - 16

**Description:** Robust, stout test, greatest breadth towards centre. Chambers large, inflated, increase rapidly in size as added, may become stretched. Sutures distinct and depressed. Wall covered with numerous large hisps, often worn to appear as knobs. Short wide neck.

**Occurrence:** Common offshore Cabinda. Found in CABGOC 128-3 between 2,610' and 10,160', acme at 10,160', and in CABGOC 115-1X between 1,790' and 10,020, acme at 7,440'.

**Remarks:** Boersma (1984) noted unique dwarfed individuals with reduced necks in the Miocene sediments of northern Angola. This was attributed to periodic dysoxia. Known from the Miocene...
of tropical Central America (Cushman and Renz 1947; Bermúdez and Fuenmayor 1966). Specimens compare well with 'mantaensis type' *U. hispida* of the Whittaker collection.

**Uvigerina modeloensis** Cushman & Keinpell

*Plate 61, figure 10*

*Uvigerina modeloensis* CUSHMAN & KLEINPELL 1934, pl. 2, fig. 8

*Uvigerina modeloensis* Cushman & Kleinpell. --KLEINPELL, et. al. 1980, pl. 12, fig. 1. --BOERSMA 1984, pl. 3

*Uvigerina hootsi* Rankin. --FINGER 1992, pl. 22, fig. 1 (not 2 - 6). --BOLLI, et. al. 1994, pl. 54, figs. 1 - 2

*Uvigerina hootsi?* Rankin. --HALLER 1980, pl. 7, fig. 12

**Description**: Large bulbous test, rounded periphery. Inflated chambers distinctively arranged in three vertical rows, some twisting along the vertical axis. Chambers increase in size rapidly as added initially, adult chambers of similar size and shape, overlapping slightly. Sides subparallel in the adult growth stage. Sutures depressed. Aperture high on the last formed chamber with a short neck and phialine lip.

**Occurrence**: Offshore Cabinda found in CABGOC 128-3 between 4,410' and 10,160', acme between 9,080' and 10,160', and in CABGOC 115-1X between 5,820' and 9,960'.

**Remarks**: Originally described from the Miocene of California. Differs from *U. hootsi* Rankin in a broader form and greater inflation of the chambers. It is possible these two taxa grade into one another and may be ecophenotypes, more samples need to be examined to ascertain their relative status.

**Uvigerina peregrina** Cushman

*Uvigerina peregrina* CUSHMAN 1923, pl. 42, figs. 7 - 10

*Uvigerina peregrina* Cushman. --CORYELL & RIVERO 1940, pl. 44, fig. 10. --AKERS & DOORMAN 1964, pl. 9, fig. 26. --DOUGLAS 1973, pl. 8, figs. 4 - 6, 9. --LUTZE 1979, pl. 1, fig. 3. --PETTERS 1982, pl. 10, fig. 16. --BOERSMA 1984, p. 124 - 127. --DIAZ de GAMERO 1985a, pl. 6, fig. 8. --KOHL 1985, pl. 24, fig. 7. --BELANGER & BERGGREN 1986, pl. 2, figs. 10 - 11. --KURIHARA & KENNET 1986, pl. 2, figs. 1 - 3. --WHITTAKER 1988, pl. 8, figs. 2 - 3, 6 (not 1, 4 - 5). --HERMELIN 1990, pl. 3, figs. 11, 14 - 15. --RESIG 1990, pl. 3, figs. 8 - 9. --NOMURA 1991, pl. 1, fig. 10. --SCHÖNFELD & SPIEGLER 1995, pl. 1, fig. 1. --BORNMALM 1997, figs. 20A - C

*Uvigerina subperegrina* Cushman & Kleinpell. --KLEINPELL 1980, pl. 12, figs. 10 - 11, pl. 13, fig. 4. --FINGER 1990, p. 248 - 249

*Uvigerina 'peregrina'* Cushman. --FINGER 1990, p. 242 - 243

**Description**: Elongate test, widest portion towards the centre, rounded. Numerous chambers, inflated and distinct. Sutures depressed, the line of the suture obscured by heavy ornamentation. Triserial coiling throughout. Longitudinal non-continuous costae cover test, become broken toward apical and apertural ends. Aperture a circular opening on a short neck, often spinose and with lip.

**Occurrence**: Extremely abundant throughout the Venezuelan section. Acme in sample 2606 of the *V. herricki* Zone. Common offshore Cabinda in CABGOC 115-1X between 3,410' and 9,420', acme at 5,160'.
Remarks: Originally described from Recent sediments offshore the north-eastern USA. Diaz de Gamero (1985a) found the species throughout her upper calcareous assemblage. This is a cosmopolitan taxon with a wide morphologic range. Boersma (1984) concluded costate ornamentation is more typical of the Atlantic populations. Lamb and Miller (1984) distinguished costae type as depth indicators, small costate forms (subperegrina type) are indicative of 100 – 200m depth, larger forms (peregrina type) are more suggestive of 200 – 1000m depth. Belanger and Berggren (1986) found the species to be common in outer neritic to upper bathyal environments, but also extended its range into abyssal depths. In general the genus and species appear to migrate readily both up and down the bathymetric column, see Bornmalm (1997) (p. 55) for a review. U. peregrina is common to the open ocean, most abundant at the base of the continental slope on the eastern seaboard of north America, and in the upper bathyal zone on the western seaboard (Boersma 1984). The taxon is morphologically profoundly affected by environmental factors, the costae becoming weakly developed and spinose variants predominating in reduced oxygen conditions, such as those that operate in the Californian borderland basins. South Atlantic morphologically variant populations correlate to low oxygen conditions. In the Gulf of Mexico the abundance peak of U. peregrina parallels the shelf slope break. Boersma (1984) regarded this as a Recent species, evolving in the Pliocene from an unknown ancestor. U. subperegrina is often regarded as the Miocene equivalent of U. peregrina. However, these two taxa are distinguished upon the less prominent costae of U. subperegrina in comparison to those of U. peregrina. These specimens have distinct platy costae, occasionally developing to form flanges, more typical of U. peregrina, though occasionally reduced through abrasion / dissolution. Specimens compare well with U. subperegrina examples of the Burrow and Holland collection (slide F, NHM) and some U. peregrina specimens of the Whittaker collection (P51814 and 51817).

_Uvigerina pigmaea_ d'Orbigny
Plate 28, figure 11; Plate 61, figures 11 - 12
_Uvigerina pigmaea_ d'ORBIGNY 1826, p. 269 (fide Ellis & Messina 1940, et. seq.)
_Uvigerina pigmaea_ d'Orbigny. —d'ORBIGNY 1846, pl. 11, figs. 25 - 26. —MACFADYEN 1930, pl. 3, fig. 27. —NUTTALL 1932, pl. 5, fig. 6. —CORYELL & RIVERO 1940, pl. 44, fig. 20. —BOERSMA 1984, p. 128 - 130. —DIAZ de GAMERO 1985a, pl. 6, fig. 9. —BOERSMA 1990, pl. 1, fig. 15. —KATZ & MILLER 1993, pl. 4, fig. 3
_Uvigerina pygmaea_ d'Orbigny. —THOMAS 1980, pl. 3, fig. 3. —OSTERMAN & QVALE 1989, pl. 3, figs. 15, 17 (not 16)
_Description:_ Small test, as long as broad, greatest breadth towards centre. Triserial coiling, occasionally biserial. Periphery lobate, chambers inflated, sutures distinct. Ornament of costae restricted to individual chambers, irregularly orientated, occasionally fragmented to short spines. Final chamber often shows reduced ornamentation. Neck terminal, reverted lip.
Occurrence: Occurs commonly throughout the Venezuelan section in floods. Acme in sample 2617 of G. fohsi Zone. Offshore Cabinda found in CABGOC 128-3 between 4,890' and 6,500', and in CABGOC 115-1X at 3,650'.
Remarks: Originally described from an unknown sediment in Italy. Diaz de Gamero (1985a) found the species sporadically throughout her study. A cosmopolitan species, common to the open ocean on topographic highs and in deeper basins. Subject to marked morphologic variation dependant upon environment. In shallower sites rich in clay it may become reduced in size and costae dominated. In carbonate environments it displays a tendency toward hispid final chambers. Open ocean individuals are smaller than their marginal counterparts, hispido-costate, and elongate (Boersma 1984). This suggests *U. multicostata* Le Roy (1939), may be synomous with *U. pigmaea*, however, type material needs to be consulted to ascertain this. Known from Cuba (Palmer 1940) and the Tertiary of Trinidad (Nuttall 1927). Specimens compare well with those of the Heron-Allen and Earland collection (P32546-32595), though some show a high degree of variety. Distinguished from *U. peregrina* through less plate-like costae and the smoother nature of the surface.

*Uvigerina pilulata* Cushman & Ellisor

Plate 29, figure 1; Plate 61, figure 13

*Uvigerina pilulata* Cushman & Ellisor. CUSHMAN & ELLISOR 1939, pl. 1, fig. 12

Description: Short and stout test, greatest breadth towards centre. Distinct chambers, inflated, sutures depressed. Well ornamented with longitudinal striae, independent to chambers, and frequently beaded. Aperture rounded terminal with neck and lip.

Occurrence: Extremely abundant throughout the Venezuelan section. Acme in sample 2607 of the *V. herricki* Zone. Offshore Cabinda found infrequently in CABGOC 128-3 between 3,690’ and 10,160’, but commonly in CABGOC 115-1X between 1,790’ and 8,160’, acme at 3,350’.

Remarks: Originally described from the Miocene of Louisiana. First record of this species in the Agua Salada Formation.

*Uvigerina proboscidea* Schwager

Plate 61, figure 14

*Uvigerina proboscidea* Schwager. SCHWAGER 1866, pl. 7, fig. 96 (fide Ellis & Messina 1940, et seq.)

*Uvigerina proboscidea* Schwager. BOLTOVSKOY 1980, pl. 3, fig. 8. THOMAS 1980, pl. 3, fig. 2. BOERSMA 1984, p. 131 - 133. BELANGER & BERGGREN 1986, pl. 2, fig. 7. VAN MORKHOVEN, et al. 1986, pl. 6, figs. 1 - 4. BOERSMA 1990, pl. 1, fig. 12. FINGER 1990, p. 244 - 245. AKIMOTO 1994, pl. 2, fig. 21

*Siphouvigerina auberiana* (d’Orbigny). KOHL 1985, pl. 22, figs. 7 - 8, pl. 23, fig. 1

Description: Small to medium test, elongate and tapering, with greatest breadth towards the centre. Extended triserial to biserial coiling, last formed chambers may become uniserial. Chambers inflated and lobate, sutures depressed and distinct. Ornamented with numerous short spines and hisps. Neck terminal and extended, with small reverted lip.

Occurrence: In Venezuela found in the *S. transversa* and *L. wallacei* Zones, rare. Offshore Cabinda found in CABGOC 128-3 between 4,530’ and 10,160’.

Remarks: First record of this taxon from the Agua Salada Formation. First described from the Tertiary of the Bay of Bengal. This is a cosmopolitan species common to planktonic foraminiferal
oozes. Boersma (1984) records the species as a lower to mid latitude taxon, she finds it common to most open ocean localities and suggests it is an index for low rates of organic accumulation in sediments. Fingers (1990) illustration shows the shortest end member of the individuals recovered from Venezuela, many of which may become extremely extended to adopt an almost uniserial arrangement of the last two to three chambers. Specimens of the M. S. Srinivasan collection (P48573) are similarly toward the shorter end of the cline recovered in Venezuela. Known from the Miocene of the Gulf of Suez region (Souya 1965).

_Uvigerina rugosa_ d'Orbigny

**Plate 61, figure 15; Plate 62, figure 1**

_Uvigerina rugosa_ d'ORBIGNY 1852, p. 194 (*fide* Boersma 1984)

_Uvigerina rugosa_ d'Orbigny. —BOERSMA 1984, pl. 141 - 144. —WHITTAKER 1988, pl. 8, figs 18 & 20 (not 19)

**Description:** Small test, greatest breath towards upper centre, periphery lobulate. Chambers inflated, sutures depressed. Coiling may become stretched. Wall ornamented with irregular knobs and nodes. Short wide neck.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 between 4,770' and 10,100'.

**Remarks:** Differs from _U. auberiana_ d'Orbigny in triserial coiling throughout, _U. hispida_ Schwager displays a finer ornament and is larger than _U. rugosa_. _U. mantaensis_ Cushman & Edwards is larger with a 'stockier' test and a less dense ornament. Known from the Miocene of the Gulf of Suez region (Souya 1965).

_Uvigerina rustica_ Cushman & Edwards

**Plate 62, figure 2**

_Uvigerina rustica_ CUSHMAN & EDWARDS 1938, pl. 14, fig. 6

_Uvigerina rustica_ Cushman & Edwards. —CUSHMAN & STAINFORTH 1945, pl. 7, fig. 13. —RENZ 1948, pl. 7, figs 23 - 24. —BOERSMA 1984, pl. 7. —RESIG 1990, pl. 4, fig. 16. —BOLLI, et al. 1994, pl. 54, fig. 6, pl. 78, figs. 43 - 44, pl. 81, fig. 15

**Description:** Small test, greatest breath towards apertural end, periphery lobulate. Chambers inflated, sutures depressed. Wall ornamented with dense irregular knobs and nodes. Very short wide neck.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 between 4,770' and 10,160', and in CABGOC 115-1X between 3,410' and 9,900'.

**Remarks:** Originally described from the Oligo-Miocene of northern Venezuela. Known from the Miocene of tropical Central America (Cushman and Renz 1947; Bermúdez and Fuenmayor 1966). Differs from _U. rugosa_ in the denser ornamentation and squat neck. Recognised as a constituent of a diverse bathyal benthonic association offshore West Africa (Haman, _et al._ 1993).
Uvigerina spinosa Boersma

Plate 62, figures 3 - 4

Uvigerina spinosa BOERSMA 1984, p. 160 - 162

Uvigerina rugosa d'Orbigny --WHITTAKER 1988, pl. 8, fig. 19

Description: Small test, broadest toward apertural end, periphery lobulate, triangular profile. Triserial, chambers inflated, increase rapidly in size. Sutures depressed. Dense ornamentation of short spines and hisps. Short, oval neck.

Occurrence: Offshore Cabinda found in CABGOC 128-3 between 4,530' and 10,100', and in CABGOC 115-1X between 6,420' and 7,140'.

Remarks: Differs from other spinose species in reduced size and triangular shape.

Uvigerina sp. 1

Plate 62, figure 5


Occurrence: Offshore Cabinda found in CABGOC 128-3 between 4,410' and 6,500', and in CABGOC 115-1X between 7,080' and 8,460'.

Genus UVIGERINELLA Cushman, 1926

Uvigerinella sparsicostata Cushman & Laiming

Plate 29, figure 2; Plate 62, figure 6

Uvigerinella sparsicostata CUSHMAN & LAIMING 1931, pl. 12, figs. 12a - b

Uvigerinella sparsicostata Cushman & Laiming. --KLEINPELL 1938, p. 292. --RENZ 1948, pl. 12, fig. 20

Uvigerina sparsicostata (Cushman & Laiming). --PETTERS 1982, pl. 5, figs. 2 - 3, pl. 10, fig. 17. --BOLLI, et al. 1994, pl. 78, fig. 42

Description: Medium sized species. Lobate periphery, distinct chambers, slightly inflated, triserial becoming biserial. Sutures distinct, slightly depressed. Ornament of numerous longitudinal course costae. Short neck with slight lip.

Occurrence: Single specimen in L. wallacei Zone in Venezuela. Offshore Cabinda found infrequently in CABGOC 128-3 between 4,530' and 10,160', and in CABGOC 115-1X between 3,290' and 8,460'.

Remarks: Originally described from the Miocene of California. Distinguished from S. smithi by the more uvigerine development, but in all other aspects identical in size, shape, and ornamentation. Renz (1948) describes the presence of a thin internal tube in specimens he sectioned, placing the species in to Siphogenerina. However, separation in his case, is rendered impractical through the large percentage of juvenile specimens, the presence of intermediate forms, and in some horizons poor preservation. Separation has been conducted to a certain extent, end member representatives falling into one or another category. Intermediate forms were placed in the more appropriate S. smithi species designation. Renz (1948) found the species limited to the 'Uvigerinella' sparsicostata Zone and lower Acostian.
Subfamily ANGULOGERININAE Galloway, 1933
Genus ANGULOGERINA Cushman, 1927

Angulogerina illingi Cushman & Renz

Plate 29, figure 3

Angulogerina illingi CUSHMAN & RENZ 1941, pl.3, figs. 19 - 20
Angulogerina illingi Cushman & Renz. --RENZ, pl. 7, figs. 31 - 32. --BLOW 1959, p. 143 - 144. --BOLLI, et. al. 1994, pl. 80, fig. 31
Trifarina illingi (Cushman & Renz). --PETTERS 1982, pl. 6, figs. 25, 29. --DIAZ de GAMERO 1985a, pl. 6, fig. 10. --SNYDER, et. al. 1988, pl. 5, fig. 16

Description: Test tapers to a sharp point, triangular in section and strongly keeled. Chambers distinct, inflated and triangular, sutures depressed. Wall smooth. Terminal rounded aperture, with short neck and lip.

Occurrence: Single specimen in V. herricki Zone in Venezuela. Offshore Cabinda found in CABGOC 115-1X between 3,350' and 8,340', acme at 5,160'.

Remarks: Originally described from throughout the Agua Salada Formation (Cushman & Renz 1941). Renz (1948) found the species rare in the Upper Araguatian and Lucian. Blow (1959) reported the taxon in isolated samples from his G. fohsi robuste and G. mayeri Zones. Whittaker (1988) synonymised T. carinata Cushman with this taxon, however, these specimens show a slight keel not apparent on Whittaker's example of T. carinata, and the chambers of these specimens are less inflated. Also found in Trinidad and Cuba.

Genus TRIFARINA Cushman, 1923

Trifarina bradyi Cushman

Plate 62, figure 7

Trifarina bradyi CUSHMAN 1923, pl. 22, figs. 3 - 9
Trifarina bradyi Cushman. --CUSHMAN & STAINFORTH 1945, pl. 8, fig. 4. --RENZ 1948, pl. 7, fig. 33. --WHITTAKER 1988, pl. 9, fig. 3. --CICHA, et. al. 1998, pl. 54, figs. 13 - 15

Description: Broken specimens recovered. Elongate test, tapering slightly to each end. Triangular in cross section, carinae at the three angles emphasising this shape. Chambers distinct, increasing gradually in size as added, may be slightly offset to give a twisted profile to the test. Sutures flush. Thin test wall, aperture terminal with a short neck.

Occurrence: Offshore Cabinda infrequently found in CABGOC 128-3 between 3,870' and 6,320'.

Remarks: Originally described from the Recent of the Caribbean. Known from the Miocene of the Gulf of Suez region (Souya 1965) and Venezuela (Bermúdez and Fuenmayor 1966). Specimens compare well with those of the Whittaker collection (P51834).
Family REUSSELLIDAE Cushman, 1933
Genus REUSSELLA Galloway, 1933

*Reussella spinulosa* (Reuss)

**Plate 29, figure 4; Plate 79, figure 3**

*Vermeulinina spinulosa* REUSS 1850, pl. 47, fig. 12 (*fide* Ellis & Messina 1940, *et. seq.)*


*Reussia spinulosa* (Reuss). —CUSHMAN 1930, pl. 8, fig. 17. —CUSHMAN & CAHILL 1933, pl. 9, fig. 1

**Description:** Poor preservation precludes comprehensive description. Test pyramidal, triangular in cross section, sides slightly concave, initial end rounded. Chambers uninflated, sutures raised and limbate. Wall perforate.

**Occurrence:** Single specimen in sample 2725 of the *L. wallacei* Zone in Venezuela. In Romania, single specimen recovered from the Chechis Marls.

**Remarks:** Originally described from the Tertiary of Austria. Renz (1948) found the species restricted to the Lucian and considers it a facies indicator. Blow (1959) found the taxon in stratigraphically lower sediments but also considers it to be governed by ecological conditions. Specimens compare well with those of the Heron-Allen and Earland collection (P32546-32595) and other unnumbered slides, and the Brady collection (NHM). Also known from Colombia, Trinidad, Cuba, and Jamaica.

Superfamily FURSENKOINACEA Loeblich & Tappan, 1961
Family FURSENKOINIDAE Loeblich & Tappan, 1961
Genus CORYPHOSTOMA Loeblich & Tappan, 1962

*Coryphostoma digitalis* (d'Orbigny)

**Plate 79, figure 4**

*Polymorphina digitalis* d'ORBIGNY 1846, pl. 14, figs. 1 - 4

*Bolivina digitalis* (d'Orbigny). —PAPP & SCHMID 1985, pl. 76, figs. 1 - 6

*Coryphostoma digitalis* (d'Orbigny). —CICHA, *et. al.* 1998, pl. 54, fig. 23

**Description:** Elongate test, oval in cross section. Biserial chambers separated by weakly depressed sutures. Wall ornamented by numerous distinct pores and striae. Terminal aperture an elongate oval with slight lip.

**Occurrence:** Identified in Costei and the Chechis Marls, Romania.

**Remarks:** Originally described from the Tertiary of the Vienna Basin.

Genus FURSENKOINA Loeblich & Tappan, 1961

*Fursenkoina* cf. *acuta* (d'Orbigny)

**Plate 79, figure 5**

*Polymorphina acuta* d'ORBIGNY 1846, pl. 13, figs. 4 - 5, pl. 14. figs. 5 - 7

**Description:** Slender test of alternating chambers, radiate aperture. This specimen appears to be more inflated than that of the type figure.

**Occurrence:** Single specimen in Vâlcele, Romania.

**Remarks:** Originally described from the Tertiary of the Vienna Basin.
**Fursenkoina exilis** (Cushman & Ellisor)  
Plate 62, figure 8  

Virgulina exilis CUSHMAN & ELLISOR 1939, pl. 1, fig. 11  

**Description:** Elongate, slender test. Parallel sides, rounded periphery, slightly flattened. Early triserial growth somewhat twisted, subsequent biserial portion comprises majority of test. Four to five pairs of uniform inflated chambers, sutures distinct, sloping and slightly curved. Wall smooth. Aperture a wide slit high on the apertural face.  

**Occurrence:** Offshore Cabinda found infrequently in CABGOC 128-3 between 4,770' and 6,680', and in CABGOC 115-1X between 3,050' and 9,720'.  

**Remarks:** Originally described from the Miocene of Louisiana.

**Fursekoina pontoni** (Cushman)  
Plate 79, figure 6  

Virgulina pontoni CUSHMAN 1932, pl. 3, fig. 7  

Virgulina pontoni Cushman. --CUSHMAN & PONTON 1932, pl. 12, figs. 10, 11. --RENZ 1948, pl. 6, fig. 18. --BLOW 1959, p. 157 - 158  

Virgulina bramlettei (RENZ 1942), p. 554  

Fursenkoina pontoni (Cushman). --AKERS & DOORMAN 1964, pl. 8, fig. 32. --PETTERS 1982, pl. 5, fig. 27. --KOHL 1985, pl. 29, fig. 2. --DIAZ de GAMERO 1985a, pl. 8, fig. 11  

**Description:** Elongate, tapering test, greatest breadth towards apertural end. Rounded periphery. Chambers distinct and inflated, only biserial portion preserved. Sutures distinct and depressed. Aperture elongate and narrow slit.  

**Occurrence:** Intermittent occurrence throughout the Venezuelan section. Offshore Cabinda found infrequently in CABGOC 128-3 between 5,060' and 10,040', and in CABGOC 115-1X between 6,960' and 7,440'. Low frequency in Vâlcele and Costei, Romania.  

**Remarks:** Originally described from the Miocene of Florida. Renz (1948) found the taxon scarce throughout the basin. Diaz de Gamero (1985a) found the species in her upper calcareous assemblage. Also known from Trinidad, Jamaica, and California. Known from additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966). Always preserved as partial internal moulds in Venezuela and Africa. Test frequently complete in Romanian sample. Specimens compare well with those of the Burrow and Holland collection (slide F, NHM).

Family VIRGULINELLIDAE Loeblich & Tappan, 1984  
Genus VIRGULINELLA Cushman, 1932  

**Virgulinella cf. ossamagnifica** Haman, et. al.  
Plate 62, figure 9  

Virgulinella ossamagnifica HAMAN, et. al. 1993. pl. 1, figs. 1 - 5  

**Description:** Moderate sized test, rounded periphery, tapering, greatest width towards the apertural end. Initial chambers triserial, indistinct. Subsequent growth biserial, inflated, chambers rapidly increasing in size as added. Lower margin of each chamber characterised by arrangement of ponticuli separated by deep fossettes. Ponticuli may coalesce with adjacent
chambers to obscure sutures. Aperture a comma shaped terminal opening on final chamber. Individuals always preserved as pyrite internal moulds hence wall and toothplate not observed.

**Occurrence:** Rare offshore Cabinda, found in CABGOC 128-3 between 4,290' and 10,040', and in CABGOC 115-1X between 5,940' and 8,280'.

**Remarks:** Originally described from lower middle Miocene of Cabinda. These specimen appear more bulbous than the type figures of Haman, *et al.* (1993). Recognised as a constituent of a diverse bathyal benthonic association offshore West Africa (Haman, *et al.* 1993).

Superfamily **DELOSINACEA** Parr, 1950  
Family **CAUCASINIDAE** Bykova, 1959  
Subfamily **CAUSCASINIAE** Bykova, 1959  
Genus **CAUCASINA** Khalilov, 1951

**Caucasina elongata** (d'Orbigny)

Plate 79, figure 7

*Bulimina elongata* d'ORBIGNY 1846, pl. 11, figs. 19 - 20  
*Baggotella elongata* (d'Orbigny). –POPESCU 1975, pl. 49, fig. 1, textfig. 21  
*Bulimina elongata* d'Orbigny. –MACFADYEN 1930, pl. 1, fig. 17. –CIMERMAN & LANGER 1991, pl. 64, figs. 3 - 8. –HOTTINGER, *et. al.* 1993, pl. 124, figs. 3 - 7. –BASILICI, *et al.* 1997, pl. 4, figs. 3 - 4  
*Bulimina elongata elongata* d'Orbigny. –SOUYA 1965, pl. 2, fig. 16. –CICHA, *et al.* 1998, pl. 47, fig. 5

**Description:** Slender elongate test, increases in width slightly towards the apertural end, test may curve slightly in wide arch. Extended triserial chamber arrangement. Rounded periphery. Chambers inflated, increase in size as added, last two to three chambers slightly larger. Sutures depressed. Wall smooth, finely perforate. Aperture a comma shaped opening in a depression at the interiomargin of the last chamber.

**Occurrence:** Observed in the Chechis Marls, Romania.

**Remarks:** Originally described from the Tertiary of the Vienna Basin.

**Caucasina subulata** (Cushman & Parker)

Plate 79, figure 8

*Bulimina elongata* d'Orbigny var. *subulata* CUSHMAN & PARKER 1937, pl. 7, figs. 6 - 7  
*Baggotella subulata* (Cushman & Parker). –POPESCU 1975, pl. 48, figs. 5 - 7  
*Bulimina subulata* Cushman & Parker. –CICHA, *et al.* 1998, pl. 46, figs. 15 - 19

**Description:** Elongate test, increases in width towards the apertural end. Extended triserial chamber arrangement. Periphery rounded. Chambers inflated, increase in size as added, last two to three chambers significantly larger. Sutures depressed. Wall smooth, finely perforate, basal spinose projections. Aperture a comma shaped opening in a depression at the interiomargin of the last chamber.

**Occurrence:** Found in Vâlcele, Costei, and Lapugiu du Sus, Romania.

**Remarks:** Originally described from the Miocene of the Vienna Basin. This form differs from *C. elongata* in its basal spinose projections and a greater inflation of the test. Basal projections are occasionally eroded and broken. Known from the Miocene of the Gulf of Suez region (Souya 1965).
Superfamily PLEUROSTOMELLACEA Reuss, 1860
Family PLEUROSTOMELLIDAE Reuss, 1860
Subfamily PLEUROSTOMELLINAE Reuss, 1860
Genus PLEUROSTOMELLA Reuss, 1860

Pleurostomella alterans Schwager

Plate 29, figure 5

Pleurostomella alterans SCHWAGER 1866, pl. 6, figs. 79 - 80 (fide Ellis & Messina 1940, et. seq.)
Pleurostomella alterans Schwager. --NUTTALL 1927, pl. 3, fig. 10. --CORYELL & RIVERO 1940, pl. 44, fig. 23. --RENZ 1948, pl. 8, fig. 2. --POPESCU 1975, pl. 52, figs. 1 - 3. --WRIGHT 1978, pl. 7, fig. 5. --CLARK & WRIGHT 1984, pl. 11, fig. 1. --BOERSMA 1986, pl. 5, fig. 6. --BOERSMA 1990, pl. 2, fig. 8. --THOMAS 1985, pl. 14, fig. 5. --AKIMOTO 1994, pl. 4, fig. 7. --BORNMALM 1997, fig. 22C. --CICHA, et. al. 1998, pl. 55, figs. 10 - 12

Pleurostomella cf. alterans Schwager. --CUSHMAN & STAINFORTH 1945, pl. 8, fig. 6 (not 7 - 8)

Description: Characteristic small species. Test free and biserial throughout, elongate. Chambers inflated and increase in size as added, last chamber very much enlarged and extended. Sutures distinct and depressed. Aperture a small comma shaped opening in terminal chamber.

Occurrence: Occurs intermittently throughout the Venezuelan section. Single specimen found offshore Cabinda in CABGOC 115-1X at 7,260'. Single specimen recovered from Vâlcele, Romania.

Remarks: Originally described from the Tertiary of India, Renz (1948) found the taxon scarce in the upper Acostian. Recognised in the Miocene of the Gulf of Suez region (Souya 1965), the Clysmic area of Egypt (Macfadyen 1930), the Recent of Philippines (Cushman 1921), and Cuba (Palmer 1940). Always preserved as pyrite internal moulds in Venezuela. Test more complete in Romanian samples. Specimens compare well to those of the M. S. Srinivasan collection (P48590), Heron-Allen and Earland collection (NHM), and the Gubler collection (P33284). Pliocene examples in the Earland collection (NHM) tend to be dwarfed. Also known from Ecuador, Barbados, Trinidad, Cuba, Haiti, Jamaica, and Mexico.

Pleurostomella biergeri Palmer & Bermúdez

Plate 29, figure 6

Pleurostomella biergeri PALMER & BERMúdeZ 1936, pl. 17, figs. 7 - 8
Pleurostomella biergeri Palmer & Bermúdez. --CUSHMAN & STAINFORTH 1945, pl. 8, fig. 15. --RENZ 1948, pl. 8, fig. 1. --SCHNITKER 1980, pl. 5, fig. 4. --CLARK & WRIGHT 1984, pl. 11, fig. 2

Description: Medium sized ovoid test. Apical extremity pointed, greatest breadth towards centre of test. Chambers embracing, the final chamber very much extended. Sutures depressed. Aperture a comma shaped slit in the depressed face of the final chamber.

Occurrence: Rare in the V. herricki, G. fohsi, S. transversa and L. wallacei Zones in Venezuela. Offshore Cabinda found infrequently in CABGOC 115-1X between 2,870' and 9,720'. Found in Lapugiu du Sus, Romania.

Remarks: Originally described from the Oligocene of Cuba. Renz (1948) found the species scarce in the 'Uvigerinella' sparsicostata and upper Acostian. Also known from Trinidad and...
Puerto Rico. Invariably preserved as pyrite internal moulds in Venezuela, test somewhat more complete in Romanian examples.

Superfamily STILOSTOMELLACEA Finlay, 1947
Family STILOSTOMELLIDAE Finlay, 1947
Genus ORTHOMORPHINA Stainforth, 1952

Orthomorphina ewaldi (Reuss)

*Nodosaria ewaldi* REUSS 1851, pl. 3, fig. 2 *(fide* Ellis & Messina 1940, *et. seq.)*
*Orthomorphina ewaldi* (Reuss). —POPESCU 1975, pl. 15, figs. 6 - 7

**Description:** Slender uniserial test. Elongate chambers separated by abrupt horizontal constrictions. Smooth wall.

**Occurrence:** Single specimen recovered in Lapugiu du Sus, Romania.

**Remarks:** Originally described from the Eocene of Germany. Differs from *N. longiscata* in the greater exaggeration of the sutural constrictions.

*Orthomorphina filipescul* Popescu

Plate 79, figure 10

*Orthomorphina filipescul* POPESCU 1975, pl. 15, fig. 8

**Description:** Uniserial test, elongate cylindrical chambers. Distinctive spiral ornament along entire test, spiralling costae show differing degrees of elevation, primary spiral alternating with less pronounced secondary spiral. Sutures and successive arrangement of chambers not observed.

**Occurrence:** Observed in Sacel, Romania.

**Remarks:** Originally described from the Miocene of the Carpathians.

*Orthomorphina* sp. 1

Plate 79, figure 11

**Description:** Elongate cylindrical test, slightly arcuate. Bulbous chambers of equal size, horizontal sutures of varying incision. Un-ornamented.

**Occurrence:** Observed in the Chechis Marls and Costei, Romania.

Genus STILOSTOMELLA Guppy, 1894

*Stilostomella adolphina* (d'Orbigny)

Plate 62, figure 10

*Dentalina adolphina* d'ORBIGNY 1846, pl. 2, figs. 18 - 20
*Stilostomella adolphina* (d'Orbigny). —PAPP & SCHMID 1985, pl. 14, figs. 8 - 11. —CICHA, *et. al.* 1998, pl. 56, fig. 6
*Nodogenerina adolphina* (d'Orbigny). —SCHÖFELD & SPIEGLER 1995, pl. 2, fig. 1
Description: Uniserial test, chambers increase in size slowly as added, inflated. Chambers exhibit spinose circular flange towards the upper mid portion of each chamber. Wall smooth and finely perforate. Constriction between one chamber and the next abrupt.

Occurrence: Offshore Cabinda found in CABGOC 128-3 at 6,780'.

Remarks: Specimens in the Gubler collection (P33236) show a tendency for the spinose flange to extend further up the chamber, especially in the earlier chambers. Specimens in the Burrow and Holland collection compare well (slide B, NHM); specimens in the Brady collection show variety in the degree of ornamentation.

**Stilostomella basicarinata** Hornibrook

Plate 29, figure 7

*Stilostomella basicarinata* HORNIBROOK 1961, figs. 104 - 105

*Stilostomella basicarinata* Hornibrook. --CAMERON 1978, pl. 1, fig. 7. --BOERSMA 1986, pl. 16, fig. 7

Description: Small species, uniserial. Distinct carina encircling the lower third of each chamber. Chambers distinct, inflated and round. Sutures apparent as severe sutural constrictions. Aperture a short stout neck, lip missing.

Occurrence: In Venezuela occurs from *M. basispinosus* to *G. fohsi* Zones. Most common in *V. herricki* Zone.

Remarks: First record of this species from the Agua Salada Formation. Fragmentary nature of recovery precludes faunal analysis.

**Stilostomella bradyi** (Cushman)

*Nodogenaria bradyi* CUSHMAN 1927, p. 79

*Stilostomella bradyi* (Cushman). --POPEȘCU 1975, pl. 44, figs. 3 & 6

Description: Uniserial test, chambers increase in size as added, inflated. Chambers exhibit spinose circular flange towards the base of each chamber. Wall smooth and finely perforate. Constriction between one chamber and the next abrupt. Aperture, when present, a rounded opening with short neck and phialine lip.

Occurrence: Observed in the Chechis Marls, Romania.

Remarks: Originally described from Recent material from offshore the Ki Islands, South Pacific. Superficially resembles *Stilostomella adolphina*, however this taxon's circular flange is higher on the chamber wall giving the chambers less of an overlapping appearance.

**Stilosotomella elegans** (d'Orbigny)

Plate 79, figure 12

*Dentalina elegans* d'ORBIGNY 1846, pl. 1, figs. 52 - 56

*Stilosotomella elegans* (d'Orbigny). --POPEȘCU 1975, pl. 17, fig. 8

*Dentalina elegans* d'Orbigny. --PAPP & SCHMID 1985, pl. 10, figs. 1 - 5

Description: Uniserial, short and slightly arcuate. Chambers slightly inflated, sutures at right angles to the test axis. Slight longitudinal striae. Radiate aperture.

Occurrence: Observed in Costei, Romania.
Remarks: Originally described from the Vienna Basin. These specimens compare well with those of the Burrow and Holland collection (slide B, NHM) and the Brady collection.

**Stilostomella stachel** Srinivasan  
Plate 62, figure 11

*Stilostomella stachel* SRINIVASAN 1966, pl. 2, fig. 4.

*Nodogenerina antipoda* (Stache). --FINLAY 1946, p. 243

*Stilostomella antipoda* (Stache). --HORNIBROOK 1961, pl. 6, fig. 98

*Stilostomella stachel* Srinivasan. --CAMERON 1978, pl. 1, fig. 9

**Description:** Small slender test, uniserial. Chambers gradually increase in size, constrictions between gentle. Specimens always with aperture missing, always fragments.

**Occurrence:** Sporadic occurrence throughout the Venezuelan section. Offshore Cabinda found infrequently in CABGOC 128-3 between 6,200' and 10,160', and in CABGOC 115-1X and 4,970'.

**Remarks:** First record of this species from the Agua Salada Formation. Fragmentary nature of recovery precludes faunal analysis.

**Stilostomella sp. 1**  
Plate 62, figure 12

**Description:** Short test, three to four spherical chambers of near equal size. Sutures distinct and incised. Wall smooth. Simple aperture on elongate neck, may possess slight lip.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 between 3,210' and 9,080', and in CABGOC 115-1X at 3,770'.

**Remarks:** Fragmentary nature of recovery precludes faunal analysis and full description.

**Stilostomella sp. 2**

**Description:** Elongate, tapering test, bulbous chambers increase in size as added. Sutures horizontal and depressed. Slight longitudinal costae apparent on some specimens.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 between 4,170' and 6,500', and in CABGOC 115-1X between 1,790' and 5,160'.

**Remarks:** Fragmentary nature of recovery precludes faunal analysis and full description.

**Stilostomella sp. 3**

**Description:** Short robust test. Three bulbous chambers separated by slight constriction of the test. Slight longitudinal costae on initial chamber.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 at 6,380'.

**Remarks:** Fragmentary nature of recovery precludes faunal analysis and full description.
**Stilostomella sp. 4**
Plate 62, figure 13

**Description:** Small delicate taxon. Round chambers of similar size separated by slight constriction of the test. Slight longitudinal costae. Aperture on elongate neck.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 between 3,870' and 6,380'.

**Remarks:** Fragmentary nature of recovery precludes faunal analysis and full description.

**Stilostomella sp. 5**
Plate 62, figure 14

**Description:** Ovoid chambers of gradually increasing size separated by distinct sutures. Wall smooth. Aperture ornamented with four vertical extensions, possibly remnants of radiate aperture.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 between 4,410' and 10,160'.

**Remarks:** Fragmentary nature of recovery precludes faunal analysis and full description.

**Stilostomella sp. 6**

**Description:** Elongate cylindrical test, slightly arcuate. Bulbous chambers of equal size, horizontal sutures, deeply incised. Un-ornamented.

**Occurrence:** Observed in Costei and Lapugiu, Romania.

**Remarks:** Fragmentary nature of recovery precludes faunal analysis and full description.

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**Superfamily DISCORBACEA Ehrenberg, 1838**

**Family BAGGINIDAE Cushman, 1927**

**Subfamily BAGGININAE Cushman, 1927**

**Genus CANCRIS de Montford, 1808**

**Cancris auricula** (Fitchel & Moll)

*Nautilus auricula* FITCHEL & MOLL 1803, pl. 20, figs. a - f (*fide* Ellis & Messina 1940, *et. seq.*)

*Cancris auricula* (Fitchel & Moll). --LE ROY 1939, pl. 3, figs. 1 - 3. --POPESCU 1975, pl. 80, figs. 3 - 4. --PAPP & SCHMID 1985, pl. 82, figs. 7 - 13


**Description:** Asymmetrical flat test with slight keel. Chambers increase in size as added causing oval asymmetric shape to develop. Last chamber envelopes earlier formed chambers on ventral side.

**Occurrence:** Single specimen identified in Vâlcele, Romania.

**Remarks:** Originally described from the Tertiary of the Vienna Basin.

**Cancris panamaensis** Natland

Plate 29, figure 8

*Cancris panamaensis* NATLAND 1938, pl. 6, fig. 1

*Cancris panamaensis* Natland. --RENZ 1948, pl. 12, fig. 22. --BLOW 1959, p. 158. --WHITTAKER 1988, pl. 15, figs. 10 - 12. --BOLLI, *et. al.* 1994, pl. 79, fig. 1

223
Description: Biconvex test, compressed with slight keel. Last formed whorl increases rapidly in size, chambers slightly inflated. Sutures limbate, may be raised in juvenile portion, but depressed in adult stage. Test finely perforate. Aperture narrow slit with cover of clear shell material on the ventral side extending from the last formed chamber.

Occurrence: Infrequent occurrence throughout the Venezuelan section. Single specimen found offshore Cabinda in CABGOC 115-1X at 7,200'.

Remarks: Renz (1948) found the species common to abundant in the Araguatian and Lucian. Blow (1959) found the species common in all zones. First described from Recent sediments offshore Panama. Known from additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966). Specimens compare well with those of the Whittaker collection (P51849).

*Cancris sagra* (d'Orbigny)

Plate 63, figure 1

*Rotalia sagra* d'ORBIGNY 1839, pl. 5, figs. 13 - 15 (*fide* Ellis & Messina 1940, et. seq.)

*Cancris sagra* (d'Orbigny). --CUSHMAN 1918, pl. 11, fig. 4. --CUSHMAN 1930, pl. 11, fig. 4. --CUSHMAN 1931, pl. 15, fig. 2. --CUSHMAN & LAIMING 1931, pl. 14, fig. 3. --NUTTALL 1932, pl. 6, figs. 6 - 7. --CUSHMAN & CAHILL 1933, pl. 11, figs. 4 - 5. --RENZ 1948, pl. 9, fig. 3. --BLOW 1959, p. 158. --AKERS & DOORMAN 1964, pl. 11, figs. 24 - 25. --SNYDER, *et. al.* 1988, pl. 6, figs. 8 - 10. --WHITTAKER 1988, pl. 15, figs. 13 - 15. --BOLLI, *et. al.* 1994, pl. 79, fig. 2

*Cancris sagra* (d'Orbigny). --BERMÚDEZ & FUENMAYOR 1966, pl. 1, figs. 30 - 32

Description: Large species, biconvex, longer than broad. Acute periphery, six to seven chambers increasing in size. Sutures indistinct, slightly depressed on the dorsal side, but raised on the ventral side, curved. Wall smooth, aperture with a slight lip and a overhang of clear shell material on the ventral side. Normally abraded.

Occurrence: Single specimen in *M. basispinosus* Zone in Venezuela. Offshore Cabinda found in CABGOC 128-3 between 4,890' and 10,160'.

Remarks: Renz (1948) found the species scarce in the lower Araguatian and Lucian. Blow (1959) found the species 'rarely and sporadically'. Also found in Colombia, Trinidad, Cuba, Jamaica, Mexico and California. Considered to be a shallow water species (Renz 1948; Whittaker 1988). Specimens compare well with that of the T. R. Jones collection (P32989), although this individual is somewhat deformed.

Genus *CIBICORBIS* Hadley, 1934

*Cibicorbis herricki* Hadley

*Cibicorbis herricki* HADLEY 1934, pl. 5, figs. 1 - 3

*Valvulineria collis* CORYELL & RIVERO 1940, pl. 43, fig. 24

*Cibicides kugleri* (Hadley). --CUSHMAN & RENZ 1941, pl. 4, fig. 11

*Valvulineria herricki* (Hadley). --RENZ 1948, pl. 8, fig. 10. --AKERS & DOORMAN 1964, pl. 10, figs. 16 - 17

*Cibicorbis herricki* Hadley. --KOH 1985, pl. 25, fig. 6. --VAN MORKHOVEN, *et. al.* 1986, pl. 33, figs. 1 - 2. --BOLLI, *et. al.* 1994, pl. 79, fig. 5
**Description:** Plano-convex species, distinctive. Dorsal side almost flat, ventral side strongly convex. Periphery subacute, slightly keeled. Chambers distinct, increasing in size. Sutures not very distinct, limbate and slightly depressed. Wall smooth.

**Occurrence:** Confined to *M. basispinosus* and *V. herricki* Zones in Venezuela. Offshore Cabinda found in CABGOC 128-3 between 9,980' and 10,100', acme at 10,040', and in CABGOC 115-1X between 4,980' and 10,020'.

**Remarks:** Originally described from the Upper Oligocene of Cuba. Cushman and Renz (1941) note this taxon's resemblance to the genus *Cibicides*. Previously only recorded in the upper Agua Salada Formation as *C. kugleri* Hadley. Whittaker (1988) reviews the synonymy of *C. kugleri* Hadley with numerous others. He places *Cibicorbis hitchcockae* (Galloway & Wissler) as the senior synonym, however, this taxon has a distinctively excavated umbilicus on the ventral side and a thickening of the periphery not apparent in these specimens. Known from additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966).

**Genus VALVULINERIA Cushman, 1926**

*Valvulineria complanata* (d’Orbigny)

**Plate 79, figures 16a, 16b**

*Rosalina complanata* d’ORBIGNY 1846, pl. 10, figs. 13 - 15

*Valvulineria complanata* (d’Orbigny). --POPESCU 1975, pl. 80, fig. 2. --PAPP & SCHMID 1985, pl. 59, figs. 7 - 11. --CICHA, et. al. 1998, 57, figs. 11 - 13

**Description:** Trochospiral test, smooth walled. Chambers steadily increase in height on the dorsal side causing convexity and the covering of the umbilicus. Aperture a slit-like opening on the dorsal side.

**Occurrence:** Common in Vâlcele, Romania.

**Remarks:** Originally described from the Tertiary of the Vienna Basin.

*Valvulineria Inequalis lobata* Cushman & Renz

**Plate 29, figures 9a, 9b; Plate 63, figure 2**

*Valvulineria inaequalis var. lobata* CUSHMAN & RENZ 1941, pl. 3, fig. 24

*Valvulineria inaequalis var. lobata* Cushman & Renz. --RENZ 1948, pl. 8, fig. 8

*Valvulineria inaequalis lobata* Cushman & Renz. --BLOW 1959, p. 165. --BOLLI, et. al. 1994, pl. 79, fig. 6

**Description:** Large species, test trochoïd, dorsal side flattened, ventral side convex. Periphery lobate. Chambers distinct and inflated and rounded, five in the last whorl. Sutures distinct, depressed and slightly curved. Wall smooth. Aperture umbilical. Often preserved as pyrite internal moulds.

**Occurrence:** Confined to the *V. herricki* Zone in Venezuela. Spurious specimen in the *M. basispinosus* zonule. Offshore Cabinda found in CABGOC 128-3 at 6,260'.

**Remarks:** Cushman and Renz (1941) found the species throughout the Agua Salada Formation. Renz (1948) and Blow (1959) subsequently found the form scarce in the Acostian and upper Araguatian. Also known from Barbados, Carriacou, Trinidad, and Cuba.
Valvulineria palmerae Cushman & Todd

Plate 63, figure 3

Valvulineria palmerae CUSHMAN & TODD 1945, pl. 8, fig. 18
Valvulineria araucana (d'Orbigny). --PALMER 1941, pl. 15, figs. 15-17. --PALMER 1945, p. 57
Valvulineria palmerae Cushman & Todd. --CUSHMAN & RENZ 1947, pl. 7, fig. 13. --AKERS & DOORMAN 1964, pl. 10, figs. 13, 28. --DIAZ de GAMERO 1985a, pl. 6, figs. 18 - 19. --BOLLI, et. al. 1994, pl. 55, figs. 14 - 15

Description: Large trochoid test, dorsal side flattened, ventral side convex. Rounded periphery. Distinct chambers, inflated, seven in the last whorl. Last two chambers develop umbilical lip over aperture. Sutures distinct, raised in overall depression, curved. Wall smooth. Often preserved as pyrite internal moulds.

Occurrence: Single specimen in the V. herricki Zone in Venezuela. Offshore Cabinda found in CABGOC 128-3 at 8,240' and 10,100'.

Remarks: Originally described from the Miocene of Massachusetts. Significantly smaller than V. venezuelana. Known from the Miocene of Venezuela (Bermúdez and Fuenmayor 1966).

Valvulineria venezuelana Hedberg

Valvulineria venezuelana HEDBERG 1937, pl. 91, fig. 21
Valvulineria venezuelana Hedberg. --CUSHMAN & RENZ 1947, pl. 7, fig. 16. --RENZ 1948, pl. 8, fig. 9. --Snyder, et. al. 1988, pl. 7, figs. 1 - 3. --WHITTAKER 1988, pl. 15, figs. 4 - 6. --BOLLI, et. al. 1994, pl. 55, figs. 10 - 11, pl. 79, fig. 7

Description: Large test, biconvex and umbilicate on the ventral side. Periphery subacute, becoming lobate in the last formed chambers. Chambers inflated, rapidly increase in size, the last formed consisting of approximately one quarter of the size. Sutures incised and curved, may become raised towards the umbilicus. Wall smooth. Aperture marked by slight lip (often broken) and extends towards the umbilicus

Occurrence: Offshore Cabinda found in CABGOC 128-3 at 4,530' and 6,440', and in CABGOC 115-1X between 6,360' and 10,020'. Two specimens identified in Vâlcele, Romania.

Remarks: Originally described from the mid Tertiary of north-eastern Venezuela. Specimens compare well with the Whittaker collection (P51847).

Family EPONIDIDAE Hofker, 1951
Subfamily EPONIDINAE Hofker, 1951
Genus EPONIDES de Montfort, 1808

Eponides cf. africana de Klasz & Rérat

Plate 63, figure 4

Eponides africana de KLASZ & RÉRAT 1961, pl. 3, figs. 1 - 2
Eponides africana de Klasz & Rérat. --KOGBE & MEHES 1986, textfig. 15

Description: Small test, rounded periphery, biconvex. Ventral side involute, dorsal side a low trochospire, evolute. Umbilicus on ventral face often filled with secondary deposit. Chambers inflated, increase in size as added. Sutures depressed in adult whorl, raised in early whorls, curved. Aperture obscured, small slit on inner margin of last formed chamber, extends to ventral face.

226
Occurrence: Offshore Cabinda found in CABGOC 128-3 between 5,360' and 9,080', and in CABGOC 115-1X between 1,790' and 3,410'.
Remarks: Originally described from the Eocene of West Africa. Always poorly preserved, re-silicified.

*Eponides repandum* (Fitchel & Moll)

Plate 79, figures 17a, 17b

*Nautilus repandum* FITCHEL & MOLL 1798, pl. 3, figs. a - d (fide Ellis & Messina 1940, et. seq.)

*Eponides repandum* (Fitchel & Moll). --HALLER 1980, pl. 11, fig. 5. --DIAZ de GAMERO 1985a, pl. 7, fig. 11. --HOTTINGER, et. al. 1993, pl. 137, figs. 1 - 10. --CICHA, et. al. 1998, pl. 57, figs. 1 - 3

Description: Medium sized biconvex test. Sub acute periphery, lobulated. Ovate in transverse section. Involute chamber arrangement, nine chambers in the last whorl, gradually increasing in size as added, slightly inflated. Sutures distinct, flush with surface and curved towards the periphery. Wall smooth. Aperture a comma shaped opening with slight thickening of the margin.

Occurrence: Single specimen identified in Lapugiu du Sus, Romania.

Remarks: Originally described from Recent material of the Mediterranean. Known from Miocene Venezuelan localities (Bermúdez and Fuenmayor 1986).

*Eponides umbonatus ecuadorensis* (Galloway & Morrey)

Plate 29, figure 10; Plate 63, figure 5

*Rotalia ecuadorensis* GALLOWAY & MORREY 1929, pl. 3, fig. 13 (fide Ellis & Messina 1940, et. seq.)

*Eponides umbonatus* (Reuss) var. *ecuadorensis* (Galloway & Morrey). --HEDBERG 1937, pl. 91, fig. 22

*Eponides umbonatus* (Reuss). --CORYELL & RIVERO 1940, pl. 43, fig. 21. --CUSHMAN & STAINFORTH 1945, pl. 11, fig. 4

*Eponides umbonatus* var. *ecuadorensis* (Galloway & Morrey). --RENZ 1948, pl. 12, fig. 25

*Eponides umbonatus ecuadorensis* (Galloway & Morrey). --BLOW 1959, p. 159 - 160. --AKERS & DOORMAN 1964, pl. 10, figs. 36 - 37. --BOLLI, et. al. 1994, pl. 79, fig. 18, pl. 88, fig. 16

*Oridorsalis ecuadorensis* (Galloway & Morrey). --DIAZ de GAMERO 1985a, pl. 8, fig. 14

*Oridorsalis umbonatus ecuadorensis* (Galloway & Morrey). --BOLLI, et. al. 1994, pl. 88, fig. 16


*Oridorsalis tener umbonatus* (Reuss). --PFLUM et. al. 1976, pl. 6, figs. 5 - 7

Description: Small biconvex test, the ventral side more convex. Umbonate on both sides. Periphery acute. Sutures flush with surface, curved and oblique on the dorsal side, radial on the ventral side, made of clear shell material. Aperture with lip.

Occurrence: Occurs intermittently throughout the Venezuelan section. Acme at sample 2605 of the *V. herricki* Zone. Offshore Cabinda found in CABGOC 128-3 between 6,140' and 6,500', and in CABGOC 115-1X between 6,300' and 8,640'.

Remarks: Originally described from the Oligocene of Ecuador. Renz found the taxon to range from the 'Uvigerinella' sparsicostata Zone through the Acostian, Araguatian and Lucian. Differs from the typical taxon in curved sutures on the umbilical side, variation within a population is recorded in the literature (see Whittaker [1988]), though not in this study. Also known from
Barbados, Trinidad, Cuba, Haiti, Mexico, California, and additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966). Recognised as a constituent of a diverse bathyal benthonic association offshore West Africa (Haman, et. al. 1993).

**Eponides sp. 1**

**Description:** Poor preservation obliterates defining characteristics.

**Occurrence:** Offshore Cabinda in CABGOC 128-3 at 6,500'.

**Remarks:** Poor preservation.

Family **DISCORBIDAE** Ehrenberg, 1838

Genus **DISCORBIS** Lamarck, 1804

**Discorbis subaraucana dissona** Cushman & Ellisor

*Discorbis subaraucana var. dissona* Cushman & Ellisor. --SKINNER & GLASER 1972, pl. 2, fig. 13

**Description:** Moderate size test, slightly plano-convex, rounded periphery, oval shape. Dorsal side slightly convex, ventral side flat to slightly concave. Chambers increase in size rapidly as added, last chamber greatly inflated. Sutures flush and limbate, may become wider towards the umbilical region and extend over the umbilical margin. Wall smooth. Aperture a low interiomarginal to extraumbilical arch.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 between 6,500' and 9,980', and in CABGOC 115-1X between 1,790' and 8,520', acme at 8,400'.

**Remarks:** Originally described from the Oligocene of Louisiana, known to have a wide stratigraphic range. Known from Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966).

Genus **NEOEPIGNIDES** Reiss, 1960

**Neoeponides campester** (Palmer & Bermúdez)

*Eponides cubensis* PALMER & BERMÚDEZ 1936, pl. 21, figs. 10 - 12

*Eponides bryamensis var. campester* PALMER & BERMÚDEZ 1941, p. 192

*Eponides bryamensis var. cubensis* (Palmer & Bermúdez). --RENZ 1942, pp. 546, 556

*Gyroidinoides bryamensis var. campester* (Palmer & Bermúdez). --RENZ 1948, pl. 8, fig. 15; pl. 9, fig. 1


**Neoeponides campester** (Palmer & Bermúdez). --BERMÚDEZ & FUENMAYOR 1968, pl. 2, figs. 19 - 21. -DIAZ de GAMERO 1985a, pl. 7, figs. 3 - 4. --VAN MORKHOVEN, et. al. 1986, pl. 50, fig. 1

**Description:** Small, biconvex, more so on the dorsal side than the ventral. Small open umbilicus, some specimens may show clear calcitic filling. Wall coarsely perforate, sutures broad and limbate. Periphery rounded. Umbilical aperture in last formed chamber, apertural lips not detected, aperture extends to become sub-parallel with periphery.

**Occurrence:** Two specimens recovered from the *V. herricki* and *G. fohsi* Zones in Venezuela. Offshore Cabinda found infrequently in CABGOC 128-3 between 930' and 10,160', and in CABGOC 115-1X between 3,410' and 9,780'.
Remarks: Originally described from the Oligocene of Cuba. Renz (1948) found the taxon to range from the Acostian through the Araguatian, to the Lucian. Blow (1959) found the species scarce. Also known from Barbados, Trinidad, Cuba, and questionably Mexico. Palmer (1940) refers to the ecophenotypic nature of this taxon throughout the Tertiary.

Neoeponides parantillarum (Galloway & Heminway)
Plate 29, figures 11a, 11b; Plate 63, figure 6
Eponides antillarum CUSHMAN & JARVIS 1930, pl. 33, fig. 14; pl. 34, fig. 2
Eponides parantillarum GALLOWS & HEMINWAY 1941, pl. 18, fig. 1
Eponides parantillarum Galloway & Heminway. --RENZ 1948, p 133. --BLOW 1959, p. 159. --BOLLI, et al. 1994, pl. 55, fig. 18
Neoeponides parantillarum (Galloway & Heminway). --AKERS & DOORMAN 1964, pl. 10, figs. 38 - 39. --KOH L 1985, pl. 25, figs. 7 - 8
Description: Small biconvex test, dorsal side more convex than ventral. Periphery acute with keel. Chambers enlarge gradually, suture flush with surface, radial on ventral side, oblique and narrowly limbate on dorsal. Deep umbilical depression on ventral side.
Occurrence: Intermittent occurrence throughout the Venezuelan section. Acme at sample 2609A of the V. herricki Zone. Offshore Cabinda common in CABGOC 128-3 between 2,310' and 9,440', present in CABGOC 115-1X between 7,500' and 9,960'.
Remarks: First described from the Oligocene of Ecuador, and closely related to E. antillarum (d'Orbigny) from Puerto Rico. Renz (1948) found this species confined to the Lucian. Blow (1959) subsequently found the species common, but restricted to his S. seminulina Zone. Californian specimens (Finger 1990) display a lower spire and less thickened umbilical sutures. Also noted in Trinidad, and Jamaica. Known from additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966).

Neoeponides schreiberscii (d'Orbigny)
Plate 79, figures 18a, 18b
Rotalina schreiberscii d'ORBIGNY 1846, pl. 8, figs. 4 - 6
Neoeponides schreiberscii (d'Orbigny). --POPESCU 1975, p. 96. --PAPP & SCHMID 1985, pl. 49, figs. 7 - 12. --FILIPESCU 1996, pl. 3, fig. 7. --CICHA, et al. 1998, pl. 59, figs. 4 - 6
Description: Trochoid test, highly convex on the dorsal side, flattened ventral side. Blunt keel. Successive whorls are slender, chambers on the ventral side separated by depressed and rounded sutures, slender 'reinforcements' may be found within these depressions. Aperture a slit-like opening.
Occurrence: Common to Costei in Romania.
Remarks: Originally described from the Tertiary of the Vienna Basin.

Neoeponides sp.
Description: Poor preservation obliterates defining characteristics.
Occurrence: Offshore Cabinda found in CABGOC 115-1X between 3,350' and 7,380'.
Remarks: Poor preservation.
Family ROSALINIDAE Reiss, 1963
Genus NEOCONORBINA Hofker, 1951
Neoconorbina cf. patella (Egger)
Plate 80, figures 1a, 1b
Rosalina patella EGGER 1857, pl. 10, figs. 12 - 14 (fide Ellis & Messina 1940, et. seq.)
Description: Low trochospire. Rounded periphery. Inflated, comma shaped chambers, marginally increase in size as added, last two to three chambers noticeably larger. Sutures limbate and depressed. On spiral side spiral suture slightly depressed. On ventral side chambers overlap to largely obscure earlier growth. Wall perforate.
Occurrence: Found in Vâlcele and Lapugiu du Sus, Romania.
Remarks: Originally described from the Miocene of Germany. Specimens slightly more inflated than the typical.

Family SPHAEROIDINIDAE Cushman, 1927
Genus SPHAEROIDINA d'Orbigny, 1826
Sphaeroidina bulloides d'Orbigny
Sphaeroidina bulloides d'ORBIGNY 1826, p. 267 (fide Ellis & Messina 1940, et. seq.)
Sphaeroidina bulloides d'Orbigny. --AKERS & DOORMAN 1964, pl. 11, figs. 9 - 10. --POPESCU 1975, pl. 49, fig. 10. --BOLTOVSKOY 1980, pl. 3, fig. 7. --HALLER 1980, pl. 14, fig. 7. --DIAZ de GAMERO 1985a, pl. 6, fig. 1. --KOHL 1985, pl. 14, fig. 6. --PAPP & SCHMID 1985, pl. 90, figs. 7 - 12. --BELANGER & BERGGREN 1986, pl. 1, fig. 18. --VAN MORKHOVEN, et. al. 1986, pl. 24, figs. 1 - 2. --SNYDER 1988, pl. 3, figs. 16 - 17. --WHITTAKER 1988, pl. 14, figs. 12 - 13. --HASEGAWA, et. al. 1990, pl. 4, figs. 10 - 11. --HOTTINGER, et. al. 1993, pl. 147, figs. 4 - 11. --CICHA, et. al. 1998, pl. 60, fig. 4
Description: Large, globular test. Multilocular with depressed sutures, chambers inflated. Test glassy with small pores. Aperture a small, narrow slit. Specimens invariably worn and broken.
Occurrence: Recovered from Vâlcele, Costei, and Lapugiu du Sus, Romania.
Remarks: Ubiquitous Cenozoic species.

Superfamily GLABRATELLACEA Loeblich & Tappan, 1964
Family GLABRETELLIDAE Loeblich & Tappan, 1964
Genus CONORBELLA Hofker, 1951
Conorbella cf. patelliformis (Brady)
Discorbina patelliformis BRADY 1884, pl. 88, fig. 3, pl. 89, fig. 1 (fide Cimerman & Langer 1991)
Conorbella patelliformis (Brady). --CIMERMAN & LANGER 1991, pl. 73, figs. 1 - 3
Description: Planoconvex, trochospiral test, rounded periphery, triangular in side view. Spiral side convex, umbilical side slightly concave with depressed umbilicus. Chambers difficult to discern, sutures flush and indistinct. Spiral side punctate, umbilical side ornamented with numerous pustules fused to form radial striae. Aperture an interiomarginal arched slit on umbilical side.
Occurrence: Single specimen found in Lapugiu du Sus, Romania.
Genus GLABRATELLA Doreen, 1948

Glabratella sp.1
Plate 80, figures 2a, 2b

description: Distinctive taxon. Rounded periphery. Trochospiral chambers initially taper, then develop into parallel sided growth. Chambers and sutures indistinct, recognised through distribution of punctate ornamentation over the chamber lumina and smooth bands over the sutures. Aperture not observed.

decurrence: Single specimen recovered from Lapugiu du Sus, Romania.

superfamily SIPHONINACEA Cushman, 1927
family SIPHONINIDAE Cushman, 1927
subfamily SIPHONININAE Cushman, 1927
Genus SIPHONINA Reuss, 1850

Siphonina bradyana Cushman
Plate 30, figures 1a, 1b

Siphonina bradyana CUSHMAN 1927, pl. 1, fig. 4.
Siphonina bradyana Cushman. --Diaz de GAMERO 1985a, pl. 7, fig. 1

description: Biconvex test, acute periphery with broad thin frimbrate carina, some siphon evident. Five chambers in last formed whorl, not inflated. Sutures distinct, limbate. Wall coarsely perforate. Aperture elliptical, with broad flaring lip and short neck, rarely preserved.

decurrence: Occurs infrequently throughout the Venezuelan section.

Remarks: Originally described from Recent sediments offshore the West Indies. Diaz de Gamero (1985a) found the species towards to the top of her upper calcareous assemblage.

Siphonina davisi Cushman & Ellisor

Siphonina davisi CUSHMAN & ELLISOR 1939, pl. 2, fig. 3
Siphonina davisi Cushman & Ellisor. --SKINNER & STEINKRAUS 1972

description: Compressed test, unequally biconvex. Dorsal side has raised umbo. Periphery subacute, without definite keel. Chambers distinct, slightly inflated and few in the final whorl. Increase rapidly in size. Sutures distinct, limbate and slightly depressed. Wall coarsely perforate. Aperture an elongate opening on the periphery of the last formed chamber without a definite lip.

decurrence: Sporadic occurrence throughout the Venezuelan section. Rare.

Remarks: Originally described from the Miocene of Louisiana. Also known from the Gulf Coast. First record of this taxon in the Agua Salada Formation.

Siphonina pozonensis Cushman & Renz
Plate 30, figures 2a, 2b

Siphonina pozonensis CUSHMAN & RENZ 1941, pl. 4, fig. 3
Siphonina pozonensis Cushman & Renz. --RENZ 1948, pl. 8, fig. 16. --BLOW 1959, p. 164. --KOHL 1985, pl. 26, fig. 2. --DIAZ de GAMERO 1985a, pl.7, fig. 2. --VAN MORKHOVEN, et. al. 1986, pl. 47, figs. 1 -4. --BOLLI, et. al. 1994, pl. 80, fig. 8
Description: Biconvex test, slightly unequal, dorsal side slightly flatter than the ventral. Margin keeled, though often broken, and slightly lobulate. Approximately five chambers in the last whorl, slightly inflated. Sutures not depressed, strongly oblique on the dorsal side, curved on the ventral side. Wall perforate. Aperture offset to the ventral side of the periphery, slight neck and lip, though often abraded.


Remarks: Cushman and Renz (1941) found the species throughout the Agua Salada Fauna. Renz (1948) subsequently supported this with similar results. Blow (1959) noted the species occurred with varying frequency. Regarded by Belli et al. (1994) to be synonymous with *S. pulchra*. Also known from Carriacou, Trinidad, Mexico, and additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966).

**Siphonina reticulata** (Czjzek)

Plate 80, figures 3 - 4

*Rotalina reticulata* czjzek 1848, pl. 13, figs. 7 - 8 (*fide* Ellis & Messina 1940, *et. seq.)*


Description: Small test, slightly inflated and biconvex, low trochoid. Five to six chambers in the final whorl. Spiral side smooth, glassy appearance, chambers indistinct. Ventral side sutures depressed and chambers inflated, last chamber much larger than earlier growth. Perforate surface, occasional remnants of short hisps. Periphery extended into frimbrate keel, often abraded. Aperture an ovate opening on short neck lying in the plane of the keel.

Occurrence: Single specimen found in Vâlcele, more common in Sacel, Romania.

Remarks: Originally described from the Tertiary of Austria. Known from the Miocene of Trinidad (Nuttall 1932), and Venezuela (Bermúdez and Fuenmayor 1966). Specimens compare well with those of the Heron-Allen and Earland collection (P32399-32450, P32500-32545), the Brady collection (NHM), and with examples in the Burrow and Holland collection (slide E, NHM).

Superfamily **DISCORBINELLACEA** Sigal, 1952

Family **PARRELLOIDIDAE** Hofker, 1956

Genus **CIBICIDOIDES** Thalmann, 1939

**Cibicidoides crebbsi** (Hedberg)

Plate 30, figures 3a, 3b; Plate 63, figures 7 - 8

*Eponides crebbsi* Hedberg 1937, pl. 92, fig. 1

*Cibicides sinistralis* Coryell and Rivero 1940, pl. 44, fig. 12

*Eponides crebbsi* (Hedberg). –CUSHMAN & RENZ 1947, pl. 7, fig. 19. –RENZ 1948, pl. 12, fig. 26. –SKINNER & GLASER 1972, pl. 3, fig. 1. –BOLLI, *et. al*. 1994, pl. 55, figs. 16 - 17, pl. 79, fig. 8

*Cibicides crebbsi* (Hedberg). –DIAZ de GAMERO 1985a, pl. 7, fig. 12

Description: Distinctive species, ventral side convex, dorsal side slightly convex. Three whorls visible, 10 - 14 chambers in the last, chambers gradually increase in size. Subacute periphery with narrow border. Sutures distinctive, sinuous on the ventral side, raised on the dorsal side. Aperture and last chamber always broken.

Occurrence: Sporadic occurrence throughout the Venezuelan section. Acme at sample 2718 of the L. wallacei Zone. Common offshore Cabinda in CABGOC 128-3 between 4,770' and 10,160', and in CABGOC 115-1X between 3,290' and 9,900'. Also identified in Lapugi du Sus, Romania. 

Remarks: First described from the Tertiary of north-eastern Venezuela. Renz (1948) found the species common in the Acoistan and Araguatian. Diaz de Gamero (1985a) found the taxon infrequently in her upper calcareous assemblage. Specimens compare well with the Whittaker collection (P51862 and 51863). Also known from Trinidad, Haiti, and the Gulf Coast (Garret 1938). Recognised as a constituent of a diverse bathyal benthonic association offshore West Africa (Haman, et. al. 1993) and known from additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966).

**Cibicidoides faiconensis** (Renz)

Plate 30, figures 4a, 4b; Plate 63, figure 9

*Cibicides faiconensis* RENZ 1948, pl. 11, figs. 6 - 7

*Cibicidoides faiconensis* (Renz). --BOLLI, et. al. 1994, pl. 79, figs. 10 - 11

Description: Small species, dorsal side slightly convex, ventral side more so. Acute periphery, becomes lobate and bordered by small fringe of shell material (often broken). Wall thin and perforate. Sutures on dorsal side curved and raised between earlier chambers, becoming flush with later chambers, secondary growth common on spiral suture. Aperture crescentic on inner periphery of last chamber. Chambers curved, gradually increasing in size.

Occurrence: Found intermittently throughout the Venezuelan section. Acme in sample 2725 of the L. wallacei Zone. Offshore Cabinda found in CABGOC 128-3 between 4,770' and 6,500', and in CABGOC 115-1X between 6,240' and 9,900', acme between 8,520' and 8,700'.

Remarks: Renz (1948) described the taxon as common in the lower Acoistan and scarce in the upper Acoistan and Araguatian. He also noted its appearance in Trinidad and Mexico. Differs from *H. matanzasensis* in the smaller test size and greater convexity.

**Cibicidoides floridanus** (Cushman)

Plate 30, figures 5a, 5b

*Truncatulinatina floridana* CUSHMAN 1918, pl. 19, fig. 2

*Truncatulinatina floridana* Cushman. --NUTTALL 1927, pl. 7, figs. 14 & 16

*Cibicides floridanus* (Cushman). --CUSHMAN 1930, pl. 12, fig. 3. --CUSHMAN & LAIMING 1931, pl. 14, fig. 8. --CUSHMAN & CAHILL 1933, pl. 13, fig. 1. --CORYELL & RIVERO 1940, pl. 44, fig. 10. --KLEINPELL 1980, pl. 21, fig. 5. --SNYDER, et. al. 1988, pl. 7, figs. 6 - 8

*Cibicidoides floridanus* (Cushman). --LE ROY & LEVINSON 1974, pl. 8, figs. 7 - 9. --KOHL 1985, pl. 35, fig. 2

Description: Trochospiral, biconvex test. Subacute margin. Early chambers obscured by secondary calcite on spiral side. Sutures raised, limbate and curved. Wall smooth but coarsely
perforate. Aperture a low interiomarginal arch with a slight lip extending across the periphery to the spiral side and continuing along the spiral suture. Distinguished from *C. perforatus* Coryell and Rivero through subacute margin.

**Occurrence:** Very rare in Venezuela. Only found in the *M. basispinosus* and *G. fohsi* Zones. Offshore Cabinda found in CABGOC 128-3 between 5,480' and 9,080', infrequent. Low abundance in Sacel, Romania.

**Remarks:** First record of this species from the Agua Salada Formation. Known from the Carapitana Formation of Venezuela (Hedberg 1937). Coryell and Rivero (1940) noted a considerable degree of variation in their Haitian specimens, this is not seen in the samples of this study. Cushman (1930) suspected the relation of this species to *Planulina floridana* may be that of megalospheric and microspheric forms. Specimens compare well with the Whittaker collection (P51859).

*Cibicidoides matanzasensis* (Hadley)

**Plate 31, figures 1a, 1b**

*Planulina matanzasensis* HADLEY 1934, pl. 4, figs. 1 - 3
*Cibicides matanzasensis* (Hadley). --PALMER 1941, pl. 28, fig. 6. --RENZ 1948, pl. 11, fig. 12
*Cibicidoides matanzasensis* (Hadley). --VAN MORKHOVEN, et. al. 1986, pl. 52, figs. 1 - 5. --BOLLI, et. al. 1994, pl. 79, fig. 9

**Description:** Slightly trochoid, often broken. Biconvex, ventral side more convex. Periphery has rounded keel. 10 - 12 chambers in last whorl. Umbilicus filled, secondary growth on dorsal sutures towards centre fill completely. Sutures raised, curving. Aperture often missing with last formed chamber, when present at base of last formed chamber.

**Occurrence:** In Venezuela confined to *V. herricki* and *G. fohsi* Zones. Acme in sample 2609A of the *V. herricki* Zone. Offshore Cabinda found in CABGOC 128-3 between 1,440' and 10,160', and in CABGOC 115-1X between 7,380' and 8,800', acme between 8,820' and 8,520'. Single specimen recognised in Vâlcele, Romania.

**Remarks:** Differs from *C. falconensis* in its larger size, greater degree of biconvexity, more numerous chambers, and stronger sutures. Originally described from the Upper Oligocene of Cuba. Renz (1948) found the taxon common in the *Uvigerinella* sparsicostata Zone and lower Acostian, become scarce in the upper Acostian and upper Araguatian. Also known from Trinidad and Cuba. Specimens in the Whittaker collection compare well (P51881). Recognised as a constituent of a diverse bathyal benthonic association offshore West Africa (Haman, et. al. 1993) and known from additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966).

*Cibicidoides mexicanus* (Nuttall)

*Cibicides mexicanus* NUTTALL 1932, pl. 9, figs. 7 - 9
*Cibicides mexicanus* Nuttall. --CUSHMAN & STAINFORTH 1945, pl. 15, fig. 5. --DIAZ de GAMERO 1985a, pl. 7, figs. 15 - 16
*Cibicidoides mexicanus* (Nuttall). --TJALSMA 1983, pl. 3, fig. 5, pl. 9, figs. 2 - 2. --THOMAS 1985, pl. 9, figs. 1 - 4. --VAN MORKHOVEN, et. al. 1986, pl. 76A, figs. 1 - 3, pl. 76B, figs. 1 - 3, pl. 76C, figs. 1 - 2. --MILLER & KATZ 1987, pl. 8, fig. 2
*Heterolepa mexicana* (Nuttall). --BOLLI, et. al. 1994, pl. 60, figs. 1 - 5, pl. 89, fig. 6

234
**Description:** Plano-convex test, flattened dorsal side, ventral side acutely convex. Sub-acute periphery. Chambers indistinct on the dorsal side apart from last whorl. Earlier whorls obscured by secondary shell material ornamentation. Chambers distinct on the ventral side, sutures limbate and raised. Wall perforate. Aperture an elongate slit extending from the periphery towards the umbilicus along the ventral face of the last chamber.

**Occurrence:** Confined to *M. basispinosus, V. herricki* and *G. fohsi* Zones in Venezuela. Scarce. Offshore Cabinda found in CABGOC 115-1X between 3,290' and 10,020'. Two individuals identified in Sacel, Romania.

**Remarks:** Originally described from the Oligocene of Mexico. Diaz de Gamero (1985a) found the species in the lowermost portion of her lower calcareous Zone. Recognised along the Gulf Coast (Garret 1938).

*Cibicidoides perlicidus* (Nuttall)

**Plate 31, figures 2a, 2b; Plate 63, figure 10**

*Cibicides perlicida* NUTTALL 1932, pl. 8, figs. 10 - 12

*Cibicides perlicida* Nuttall. --NUTTALL 1932, pl. 8, figs. 10 - 12. --PALMER & BERMÚDEZ 1936, p. 314. - -RENZ 1948, pl. 11, fig. 9

*Cibicidoides perlicidus* (Nuttall). --DOUGLAS 1973, pl. 15, figs. 7 - 9; pl. 24, figs. 13 - 14, 17 - 18. -- SCHNITKER 1980, pl. 11, figs. 10 - 12. --BASOV & KRASHENINNIKOV 1983, pl. 14, figs. 4 - 5. -- TJALMSA 1983, pl. 9, fig. 3. --THOMAS 1985, pl. 9, figs. 5 - 6. --BOLLI, et. al. 1994, pl. 79, fig. 21, pl. 88, fig. 3

*Cibicides perlicida* Nuttall. --DIAZ de GAMERO 1985a, pl. 8, figs. 1 - 2

**Description:** Biconvex, ventral side more so than dorsal. Two whorls visible dorsally, suture slightly raised. Distinctive coarse perforate walls. Ventral umbo filled, sutures depressed and curved. Aperture a narrow slit at the base of the last chamber. Great range in size.

**Occurrence:** Intermittent recovery throughout the Venezuelan section. Acme at sample 2608 of the *V. herricki* Zone. Offshore Cabinda found in CABGOC 128-3 between 1,200' and 10,160', and in CABGOC 115-1X between 3,350' and 8,040'. Recognised in Vâlcele, Romania.

**Remarks:** Originally described from the Lower Oligocene of Mexico. Renz (1948) found the species scarce in the lower Acastian. Also noted in Barbados, Puerto Rico, Cuba, California, and the south-west Atlantic. Diaz de Gamero (1985a) found the taxon in the lowermost portion of her lower calcareous assemblage. Recognised along the Gulf Coast (Garret 1938) and known from additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966). Specimens compare well with those of the Brady collection (NHM), but tend to be slightly more compressed than those of the Whittaker collection (P51874).

*Cibicidoides pseudoungerianus* (Cushman)

**Plate 80, figures 5a, 5b**

*Truncatulina pseudoungeriana* CUSHMAN 1922, pl. 20, fig. 9

*Cibicidoides pseudoungerianus* (Cushman). --POPE 1975, pl. 85, figs. 2 - 3. --PFLUM et. al. 1976, pl. 2, fig. 9. --OSTERMAN & QVALE 1989, pl. 4, figs. 11 - 13. --CIMERMAN & LANGER 1991, pl. 74, figs. 2 - 3. --BOLLI, et. al. 1994, pl. 57, fig. 1, pl. 88, fig. 8

*Cibicidoides pseudoungerianus* (Cushman). --BUCEFALO PALLIANI, et. al. 1997, pl. 4, figs. M1 - M3
Description: Biconvex, periphery subacute and 'lobulated'. Semi-involute, sutures raised in the last whorl, depressed in earlier whorls. Chambers raised on the dorsal side, particularly the last few. Punctate. Umbilicus filled on the ventral side, more finely punctate.

Occurrence: Common to Vâlcele and Lapugiu du Sus, Romania.

Remarks: Originally described from the Oligocene of Mississippi, USA. Known from the Miocene of Trinidad (Cushman and Renz 1947) and Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966).

*Cibicidoides ungerianus* (d'Orbigny)

*Rotalina ungeriana* d'ORBIGNY 1846, pl. 8, figs. 16 - 18
*Cibicides ungerianus* (d'Orbigny). --NUTTALL 1932, pl. 9, figs. 4 - 6. --PAPP & SCHMID 1985, pl. 51, figs. 7 - 11
*Cibicidoides ungerianus* (d'Orbigny). --POPEȘCU 1975, pl. 85, fig. 1. --SPROVIERI & HASEGAWA 1990, pl. 4, figs. 3 - 5. --BOLLI, et. al. 1994, pl. 56, figs. 9 - 11
*Cibicidoides ungerianus ungerianus* (d'Orbigny). --CICHA, et. al. 1998, pl. 61, figs. 15 - 17

Description: Asymmetric test with distinctive keel. Dorsal side flattened, ventral side convex. Test wall smooth and thin, perforate. Sutures sinuous.

Occurrence: Observed in Sacel, Romania.

Remarks: Originally described from the Tertiary of the Vienna Basin. Specimens compare well with those of the Heron-Allen and Earland collection (P32399-32450, P32500-32545). Recognised along the Gulf Coast (Garret 1938).

Family PSEUDOPARRELLIDAE Voloshinova, 1952
Subfamily PSEUDOPARRELLINAE Voloshinova, 1952
Genus *EPISTOMINELLA* Husezima & Maruhashi, 1944

*Epistominella* cf. *pacificia* (Cushman)

*Pulvinulinella pacifica* CUSHMAN 1927, pl. 5, figs. 14 - 15

Description: Small trochoid test, plano-convex, periphery acute, with slight keel. Dorsal side flattened, ventral side convex. Chambers distinct, seven to eight in the last coil. Sutures wide and flush, curve slightly. Wall smooth. Aperture rarely intact, sub-parallel slit near periphery on the ventral side.

Occurrence: Offshore Cabinda found in CABGOC 115-1X between 2,150' and 10,020', acme between 2,990' and 4,430'.

Remarks: Originally described from Recent material from the Pacific. Differs from the typical form in the less pronounced convexity of the ventral side. Distinctive flood characteristic offshore Cabinda. Known to be confused with *E. smithi* (Stewart & Stewart) (Finger 1990).
Superfamily PLANORBULINACEA Schwager, 1877
Family PLANULINIDEA Bermúdez, 1952
Genus PLANULINA d'Orbigny, 1826
*Planulina dohertyi* Galloway & Morrey

**Plate 31, figure 3**

*Planulina dohertyi* GALLOWAY & MORREY 1929, pl. 4, fig. 7

*Planulina dohertyi* Galloway & Morrey. --RENZ 1948, pl. 10, fig. 6. --VAN MORKHOVEN, et. al. 1986, pl. 39, fig. 1. --KATZ & MILLER 1993, pl. 2, fig. 6. --BOLLI, et. al. 1994, pl. 79, fig. 12

**Description:** Biconvex test, dorsal side almost flat, ventral side slightly convex. Depression under periphery, periphery keeled and lobate. Umbilicus filled with clear shell material, but not raised. Chambers inflated and sutures depressed and limbate. Wall coarsely perforate with secondary thickening. Aperture a narrow opening with lip at the base of the septal face on the inner periphery and extending to the dorsal side.

**Occurrence:** Confined to *T. panamaensis* zonule and *L. wallacei* Zone in Venezuela. Single specimen found offshore Cabinda in CABGOC 115-1X at 9,420'.

**Remarks:** Originally described from the Eocene (?) of Manta, Ecuador. Renz (1948) found the taxon scarce in the upper Acostian. Whittaker (1988) placed this taxon as a junior synonym to *C. subtenuissimus* (Nuttall), however, this study finds the taxon distinctly different and not the juvenile growth stage attributed by Whittaker. Known from the Miocene of tropical Central America (Cushman and Renz 1947), also additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966).

*Planulina harangensis* Cushman & Ellisor

**Plate 31, figures 4a, 4b**

*Planulina harangensis* CUSHMAN & ELLISOR 1939, pl. 2, fig. 9

*Planulina harangensis* Cushman & Ellisor. --SKINNER & GLASER 1972, pl. 3, fig. 5

**Description:** Compressed test, slightly umbonate and semi-evolute. Periphery rounded, chambers distinct, low and broad, curved. Sutures curved and raised in early portion, depressed in later portion, slightly limbate. Wall coarsely perforate, aperture a small opening on the periphery, extending to the dorsal side with a slight lip.

**Occurrence:** Single specimens in *V. herricki* and *L. wallacei* Zones in Venezuela.

**Remarks:** First record of this species in the Agua Salada Formation. Originally described from the Miocene of Louisiana. Known from additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966).

*Planulina mexicana* Cushman

**Plate 31, figures 5a, 5b**

*Planulina mexicana* CUSHMAN 1927, pl. 23, fig. 5

*Planulina mexicana* Cushman. --GALLOWAY & HEMINWAY 1941, pl. 26, fig. 3. --VAN MORKHOVEN, et. al. 1986, pl. 53, figs. 1 - 4. --BOLLI, et. al. 1994, pl. 79, fig. 14

*Planulina cf. mexicana* Cushman. --RENZ 1948, pl. 11, fig. 5
Description: Compressed test, periphery rounded but not keeled. Chambers narrow and curved. Sutures limbate. Wall coarsely perforate, aperture peripheral, at the base of the peripheral face of the chamber.


Remarks: Originally described from the Eocene of Mexico. Renz (1948) tentatively referred to the species in the upper Acostian, upper Araguatian, and Lucian. Also known from Trinidad, Puerto Rico, and Cuba. Recognised along the Gulf Coast (Garret 1938).

Planulina subtenuissima (Nuttall)

Anomalina subtenuissima NUTTALL 1928, pl. 7, figs. 13, 15. textfig. 6

Planulina subtenuissima (Nuttall). --RENZ 1948, pl. 11, figs. 4. --DIAZ de GAMERO 1985a, pl. 7, figs. 7 - 8. --VAN MORKHOVEN, et. al. 1986, pl. 67A, figs. 1 - 2. --BOLLI, et. al. 1994, pl. 57, fig. 9, pl. 79, fig. 13

Cibicidonoides subtenuissimus (Nuttall). --WHITTAKER 1988, pl. 21, figs. 13 - 15

Description: Compressed test, finely perforate. Rounded periphery and small boss on ventral and dorsal sides. Chambers curved and distinct. Sutures distinct and depressed, strongly curved. Aperture broad opening extending to the dorsal surface.

Occurrence: Confined to sample 2725 of the L. wallacei Zone in Venezuela. Offshore Cabinda found in CABGOC 115-1X between 9,060' and 9,600'.

Remarks: Originally described from the Oligocene of Trinidad. Renz (1948) found the taxon common in the lower Acostian and scarce in the upper Acostian. Diaz de Gamero (1985a) found the species intermittently in the upper reaches of her upper calcareous assemblage. Known from the Miocene of tropical Central America (Cushman and Renz 1947) and known from additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966).

Family CIBICIDIDAE Cushman, 1927
Subfamily CIBICIDINAE Cushman, 1927
Genus CIBICIDES de Montford, 1808
Cibicides americanus (Cushman)

Plate 32, figure 1

Truncatulina americana CUSHMAN 1918, pl. 23, fig. 2

Cibicides americana (Cushman). --CUSHMAN 1930, pl. 12, fig. 5. --NUTTALL 1932, pl. 7, figs. 10 - 11

Cibicides americanus (Cushman). --CUSHMAN & LAIMING 1931, pl. 14, fig. 6. --CUSHMAN & CAHILL 1933, pl. 13, fig. 2. --RENZ 1948, pl. 11, fig. 10. --SNYDER, et. al. 1988, pl. 7, figs. 4 - 5

Cibicides americanus americanus (Cushman). --KLEINPELL 1980, pl. 21, fig. 4

Hanzawala americana (Cushman). --BOLLI, et. al. 1994, pl. 80, fig. 3

Description: Plano-convex test, ventral side convex, dorsal side almost flat. Periphery keeled, chambers numerous and slightly inflated, sutures limbate and distinct. Aperture almost peripheral. Wall smooth.

Occurrence: Occurs intermittently throughout the Venezuelan section, acme in sample 2609A of the V. herricki Zone. Offshore Cabinda found in CABGOC 115-1X between 3,290' and 8,100'. Also identified in Vâlcele, Romania.
**Remarks:** Originally described from the Oligocene of the Panama Canal. Renz (1948) found the species scarce to common in the Acostian, Araguatian, and Lucian. Known from the Carapitana Formation, Venezuela (Hedberg 1937). Also known from Colombia, Trinidad, Puerto Rico, Mexico, and California. Recognised along the Gulf Coast (Garret 1938).

*Cibicides cartensi* Cushman & Ellisor

**Plate 32, figure 2; Plate 64, figure 1**

*Cibicides cartensi* CUSHMAN & ELLISOR 1939, pl. 2, figs. 8a - c
*Cibicides cartensi* Cushman & Ellisor. --PALMER 1941, pl. 29, fig. 5. --CUSHMAN & RENZ 1947, pl. 8, figs 10 - 11. --RENZ 1948, pl. 11, fig. 11. --SKINNER & GLASER 1972, pl. 3, fig. 7

*Hanzawaia cartensi* (Cushman & Ellisor). --BOLLI, et al. 1994, pl. 61, figs. 9 - 11, pl. 80, fig. 6

**Description:** Test equally biconvex. Periphery subacute, chambers distinct and slightly inflated, increasing gradually in size, uniform shape. Sutures distinct and slightly raised and limbate, forming thickened ring towards centre. Wall distinctly perforate, aperture with lip, apertural face flat.

**Occurrence:** Rare, only recovered from the *M. basispinosus* and *L. wallacei* Zones in Venezuela. Offshore Cabinda found in CABGOC 128-3 between 5,480'.

**Remarks:** Originally described from the Miocene of Louisiana. Renz (1948) found the species rare in the 'Uvigerinella' sparsicostata Zone, Araguatian and Lucian. He considered specimens called *C. americana* by Nuttall (1932) from Mexico to be synonymous with *C. cartensi* Cushman and Ellisor, an approach followed here. Also known from Colombia, Trinidad, Cuba, and Mexico.

*Cibicides cartensi opima* Cushman & Ellisor

*Cibicides cartensi var. opima* CUSHMAN & ELLISOR 1939, pl. 2, fig. 7
*Cibicides cartensi opima* Cushman & Ellisor. --SKINNER & GLASER 1972, pl. 3, fig. 8

*Hanzawaia cartensi opima* (Cushman & Ellisor). --SKINNER & STEINKRAUS 1972

**Description:** Test almost equally biconvex, umbilicus depressed on both sides. Differs from the typical in thicker and more rounded test, more inflated chambers and raised, limbate sutures, thickening toward the umbilicus region. Periphery rounded, without keel. Wall smooth and finely perforate. Aperture extends from the periphery to the dorsal side, occasional evidence for a slight lip.

**Occurrence:** Found offshore Cabinda found in CABGOC 128-3 between 6,380' and 6,860', and in CABGOC 115-1X between 6,540' and 8,340'. Identified in Costei, and Sacel, Romania.

**Remarks:** Originally described from the Miocene of core material from Louisiana.

*Cibicides compressus* Cushman & Renz

**Plate 32, figures 3a, 3b; Plate 64, figures 2 - 3**

*Cibicides floridanus var. compressus* CUSHMAN & RENZ 1941, pl. 4, fig. 9
*Cibicides compressus* Cushman & Renz. --RENZ 1948, pl. 10, fig. 9. --DIAZ de GAMERO 1985a, pl. 7, figs. 13 - 14. --VAN MORKHOVEN, et al. 1986, pl. 44, figs. 1 - 2. --KATZ & MILLER 1993, pl. 2, fig. 2

*Heterolepa compressa* (Cushman & Renz). --BOLLI, et al. 1994, pl. 79, fig. 24

239
Description: Large, slightly biconvex species. Umbilicate ventral side. Chambers narrow and curved. Sutures depressed, indistinct. Periphery subacute, perforate wall.

Occurrence: Found throughout the Venezuelan section. Becomes more abundant from the G. foehsi to L. wallacei Zones. Offshore Cabinda found in CABGOC 128-3 between 4,770' and 10,160, acme at 9,260'; and in CABGOC 115-1X between 3,290' and 10,020'.

Remarks: Cushman and Renz (1941) originally found the sub-species throughout the Agua Salada Basin. Renz (1948) subsequently elevated this form to specific rank and confirmed its distribution. He also noted its presence in Costa Rica, Colombia, Barbados, Trinidad, and Puerto Rico. Diaz de Gamero (1985a) found the taxon throughout her upper calcareous assemblage. Known from additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966).

Family PLANORBULINIDAE Schwager, 1877
Subfamily PLANORBULININAE Schwager, 1877
Genus PLANORBULINA d'Orbigny, 1826
Planorbulina mediterranensis d'Orbigny
Plate 80, figures 6a, 6b
Planorbulina mediterranensis d'ORBIGNY 1825, pl. 114, fig. 2 (fide Ellis & Messina 1940 et seq.)
Planorbulina cf. mediterranensis d'Orbigny. --POPESCU 1975, pl. 94, figs. 1 - 3
Planorbulina mediterranensis d'Orbigny. --d'ORBIGNY 1846, pl. 9, figs. 15 - 17. --PAPP & SCHMID 1985, pl. 55, figs. 5 - 7. --CIMERMAN & LANGER 1991, pl. 78, figs. 1 - 3, 7 - 8 (not 4 - 6). --CICHA, et. al. 1998, pl. 64, fig. 4
Description: Compressed test, planispirally coiled. Globular chambers dependant on the nature of the substrate for curvature, in general convex dorsally and flattened ventrally. Smooth test wall, perforate dorsally. Apertures visible as small elliptical openings with slight lips on the ventral side, two per chamber.

Occurrence: Single specimen recovered from Costei, Romania.

Remarks: Originally described from the Miocene of the Vienna Basin. Specimen compares well with those of the Heron-Allen and Earland collection (P32546-32595). Known from Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966).

Superfamily ASTERIGERINACEA d'Orbigny, 1839
Family ASTERIGERINIDAE d'Orbigny, 1839
Genus ASTERIGERINA d'Orbigny, 1839
Asterigerina planorbis d'Orbigny
Plate 81, figures 1a, 1b
Asterigerina planorbis d'ORBIGNY 1846, pl. 11, figs. 1 - 3
Asterigerina planorbis d'Orbigny. --PAPP & SCHMID 1985, pl. 66, figs. 9 - 14. --CICHA, et. al. 1998, pl. 64, figs. 8 - 10
Description: Trochoid test, steeply convex dorsal side with four to five spiral coils, flat to concave ventral side. Aperture radiate.

Occurrence: Recovered in Vâlcele, Costei, and Lapugiu du Sus, Romania.
Remarks: Originally described from the Tertiary of the Vienna Basin. Considered to be a shallow water taxon (Papp & Schmid 1985).

Family AMPHISTEGINIDAE Cushman, 1927
Genus AMPHISTEGINA d'Orbigny, 1826

Amphistegina lessonii d'Orbigny

Plate 81, figures 2a, 2b

Amphistegina lessonii d'Orbigny. —CUSHMAN 1930, pl. 11, fig. 5. —NUTTALL 1932, pl. 6, fig. 12. —CUSHMAN & CAHILL 1933, pl. 11, fig. 6. —AKERS & DOORMAN 1964, pl. 11, figs. 32, 33. —POPEsCU 1975, p. 96. —KOUYOUmONTzAKIS 1984, pl. 2, figs. 1 - 8, textfig. 1(2), 2(4 - 5 [labelled 25]). —HOTTINGER, et. al. 1993, pl. 184, figs. 1 - 11, pl. 185, figs. 1 - 7. —BOLLI, et. al. 1994, pl. 80, fig. 23

Description: Large robust test. Biumbilicate, dorsal side slightly more convex than the ventral. Periphery sub-acute, wall smooth. Ten to fourteen chambers in the last whorl, strongly arcuate, sweeping back towards earlier chambers toward the periphery. Sutures flush with the surface, sinuous. Pustulose ornamentation often apparent about the apertural region on the ventral side.

Occurrence: Offshore Cabinda found CABGOC 115-1X between 7,920' and 8,100'. Observed in Costei, Romania.

Remarks: Originally described from Recent sediments of Mauritius. A cosmopolitan tropical shallow water species. Renz (1948) recorded this taxon in the Agua Salada Formation. Specimens compare well to those of the Brady collection (NHM) and W. K. Parker collection (P47858-47859).

Superfamily NONIONACEA Schultze, 1854
Family NONIONIDAE Schultze, 1854
Subfamily NONIONINAE Schultze, 1854
Genus NONION de Montford, 1808

Nonion costiferum (Cushman)

Plate 32, figure 4; Plate 64, figures 4a, 4b

Nonionina costifera CUSHMAN 1926, pl. 13, fig. 2
Nonion medioconstatum RENZ 1942, p. 553

Nonion costifera (Cushman). —CUSHMAN & LAIMING 1931, pl. 11, fig. 9

Nonion costiferum (Cushman). —RENZ 1948, pl. 6, fig. 5; pl. 12, fig. 6. —HALLER 1980, pl. 5, fig. 3. —KLEINPELL, et. al. 1980, pl. 2, figs. 7, 9, 12. —PETTERS 1982, pl. 12, figs. 9, 13

Nonion costifera (Cushman). —BLOW 1959, p. 141

Nonion aff. N. costiferum (Cushman). —SMITH 1960, pl. 58, figs. 5 - 6


Description: Test longer than broad, with acute periphery. Asymmetric low trochospire. Numerous chambers, sutures distinct and imitate, increase in thickness towards the umbilicus. Wall smooth. Apertural face triangulate, aperture a small semi-circular opening at base.

Occurrence: Intermittent occurrence throughout the Venezuelan section. Acme in sample 2613 of the V. herricki Zone. Offshore Cabinda found in CABGOC 128-3 at 10,100', appears as
discrete floods in CABGOC 115-1X between 1,790' and 10,020'. Identified in Lapugiu du Sus, Romania.

**Remarks:** Originally described from the Miocene of California. Renz (1948) found the species most common in the Araguatian and Lucian, but also present in the Lucian. Blow (1959) found the taxon ubiquitous to all zones. Fingers (1990) specimens show a greater degree of asymmetry than those of this study. Specimens compare well with examples in the Burrow and Holland collection (slide D, NHM). Known from the Miocene of California (Smith 1960), also noted in Trinidad.

**Nonion incisum** (Cushman)

*Nonionina incisa* CUSHMAN 1926, pl. 13, fig. 3

*Nonion incisa* (Cushman). --CUSHMAN & LAIMING 1931, pl. 11, fig. 10. --CUSHMAN & PARKER 1931, pl. 1, fig. 26. --CUSHMAN & LE ROY 1938, pl. 22, fig. 8. --KLEINPELL 1980, pl. 2, figs. 10 - 11

*Nonion incisum* (Cushman). --CUSHMAN & CAHILL 1933, pl. 7, figs. 4

**Description:** Often preserved as pyrite internal moulds. Compressed, rounded apertural face, narrow apertural chamber.

**Occurrence:** Common offshore Cabinda in CABGOC 128-3 between 4,770' and 10,100', and in CABGOC 115-1X between 1,790' and 9,900', more common towards the top of the well. Identified in Costei, Romania.

**Remarks:** Originally described from the Miocene of California. Previously found throughout the Agua Salada Formation, Blow (1959) found the taxon in association with *N. costiferum*. Renz (1948) noted the presence of *N. pizarrense* Berry in the Agua Salada Fauna amongst *N. incisum* individuals. This study was unable to separate these two species. Also known from Colombia, Trinidad, and California. Specimens compare well with that of the Helvetian Gubler collection (P33243).

**Nonion kerensis** Kleinpell

*Plate 32, figures 5a, 5b, 5c*

*Nonion incisum* (Cushman). --CUSHMAN & PARKER 1931, pl. 1, fig. 26

*Nonion incisum* (Cushman) var. --CUSHMAN & LE ROY 1938, pl. 22, fig. 9

*Nonion incisa* (Cushman). --CUSHMAN & LAIMING 1931, pl. 11, fig. 10

*Nonion incisum var. kemensis* KLEINPELL 1938, p. 232

*Nonion cf. mesonense* RENZ 1942, pp. 553, 556

*Nonion incisum var. kemensis* Kleinpell. --RENZ 1948, pl. 6, fig. 4

*Nonion incisum kerensis* Kleinpell. --BLOW 1959, p. 141 - 142

*Nonion kerensis* Kleinpell. --KLEINPELL 1980, pl. 5, fig. 9

**Description:** Often preserved as pyrite internal moulds. Compressed, rounded apertural face, narrow apertural chamber. Differs from *N. incisum* (Cushman) in more compressed test, more rounded apertural face, narrow apertural chamber, and shorter ultimate chambers. Pustular ornament common about umbilicus.

**Occurrence:** Common throughout the Venezuelan section. Acme at samples 2612 and 1613 of the *V. herricki* Zone. Offshore Cabinda found in CABGOC 128-3 at 10,100'.
Remarks: Renz (1948) noted the presence of *N. pizarrense* Berry in the Agua Salada Fauna amongst this species association. This study was unable to identify *N. pizarrense* Berry. Previously found throughout the basin. Blow (1959) found the taxon in association with *N. costiferum*. Originally described from the Miocene of California. Also known from Colombia, Trinidad, and California.

*Nonion* spp.

Plate 81, figures 3 - 4

Description: Small test, rounded periphery, lobulate profile. Bulbous chambers steadily increase in size as added. Sutures straight and depressed. Wall smooth.

Occurrence: Two indeterminate specimens observed in Lapugiu du Sus, single specimen in Costei, Romania.

Genus NONIONELLA Cushman, 1926

*Nonionella miocenica* Cushman

Plate 64, figure 5

*Nonionella miocenica* Cushman. —HALLER 1980, pl. 5, fig. 4. —FINGER, et. al. 1990, pl. 7, figs. 4 - 6. —RESIG 1990, pl. 1, figs. 6 - 8. —FINGER 1992, pl. 32, figs. 8 - 16

Description: Small test, rounded periphery. Eight to ten chambers in the last whorl, gradually increase in size as added. Dorsal side not completely involute, last chamber forms distinctive lobe over the umbilical region. Sutures depressed and curved. Wall smooth. Aperture a low arch.

Occurrence: Offshore Cabinda found infrequently in CABGOC 115-1X between 5,300' and 8,400'.

Remarks: Originally described from the Miocene of California, subsequently cited there (Smith 1960). This study uses *N. miocenica* Cushman rather than *N. auris* Cushman, as this is established in previous works and aids comparison.

Subfamily PULLENIINAE Schwager, 1877

Genus MELONIS de Montford, 1808

*Melonis affine* (Reuss)

Plate 32, figures 6a, 6b

Noionuna affinis REUSS 1851, pl. 5, fig. 32 (fide Ellis & Messina 1940, et. seq.)

*Noion affine* (Reuss). —RENZ 1948, pl. 6, fig. 3

*Melonis affinis* (Reuss). —DIAZ de GAMERO 1985a, pl. 9, fig. 13. —BORNMALM 1997, fig. 27D - F

Description: Small, biumbilicate, involute test. Compressed, umbilici excavated. Ten to twelve chambers in the last whorl, separated by radial to slightly curving sutures, flush to the surface. Umbilicus open. Wall smooth and perforate. Aperture an interior-marginal to umbilical undivided slit.
**Melonis pompilioides** (Fitchel & Moll)

**Plate 33, figures 1a, 1b; Plate 64, figure 6**

*Nautilus pompilioides* FITCHEL & MOLL 1798, pl. 31, fig. 2 (*fide* Ellis & Messina 1940, *et seq.*)

*Nonion pompilioides* (Fitchel & Moll). --CUSHMAN 1929, pl. 13, fig. 25. --CUSHMAN & CAHILL 1933, pl. 7, fig. 5. --CORYELL & RIVERO 1940, p. 333. --PALMER 1940, p. 289. --CUSHMAN & STAINFORTH 1945, pl. 5, fig. 9. --RENZ 1948, pl. 5, figs. 31 - 32. --BLOW 1959, p. 142. --SKINNER & GLASER 1972, pl. 3, fig. 6


**Description:** Distinctive planispiral involute test. Periphery rounded, sutures distinct and radial, depressed. Wall coarsely perforate. Aperture interior-marginal and umbilical, undivided slit. Umbilici deep.

**Occurrence:** Intermittent occurrence throughout the Venezuelan section. Acme in sample 2612 of the *V. herricki* Zone. Common offshore Cabinda in CABGOC 128-3 between 4,890' and 10,160', and in CABGOC 115-1X between 6,120' and 8,760'. Identified in Vâlcele, Costei, Lapugiu du Sus, and Sacel, Romania.

**Remarks:** Originally described from the Eocene of Germany. Specimens compare well with those labelled *Pullenia* sp. in the T. R. Jones Collection (P10890). Known from Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966).
collection (slide D, NHM), and Pullenia sp. of the Parker and Jones collection (P10892). Recognised as a constituent of a diverse bathyal benthonic association offshore West Africa (Haman, et. al. 1993).

Genus PULLENIA Parker and Jones, 1862

Pullenia bulloides (d'Orbigny)

Plate 33, figures 2a, 2b; Plate 64, figures 7a, 7b

Nomenclature: Pullenia bulloides d'ORBIGNY 1848, pl. 5, figs. 9 - 10

Pullenia bulloides (d'Orbigny). --KLEINPELL 1938, pl. 5, figs. 10, 13. --CUSHMAN & TODD 1943, pl. 2, figs. 15 - 18. --CUSHMAN & STAINFORTH 1945, pl. 12, fig. 10. --RENZ 1948, pl. 10, fig. 2. --BLOW 1959, p. 168. --AKERS & DOORMAN 1964, pl. 11, figs. 11 - 12. --DOUGLAS 1973, pl. 8, figs. 1 - 2. --POPESCU 1975, pl. 83, fig. 1. --BOERSMA 1977, pl. 3, fig. 3. --CAMERON 1978, pl. 1, fig. 13 - 14. --WRIGHT 1978, pl. 7, fig. 7. --BOLTOVSKOY 1980, pl. 3, fig. 2, pl. 4, fig. 10. --SCHNITKER 1980, pl. 7, figs. 9 - 10. --THOMPSON 1980, pl. 7, fig. 9. --PETTERS 1982, pl. 8, fig. 5. --BASOV & KRASHENINNIKOVA 1983, pl. 14, figs. 8 - 9. --KOHL 1985, pl. 32, fig. 5. --PAPP & SCHMID 1985, pl. 34, figs. 6 - 9. --BELANGER & BERGGREN 1868, pl. 5, fig. 1. --KURIHARA & KENNETH 1986, pl. 6, figs. 5 - 6. --KATZ & MILLER 1987, pl. 3, fig. 4. --MILLER & KATZ 1987, pl. 4, fig. 4. --WHITTAKER 1988, pl. 24, figs. 30 - 32. --OSTERMAN & QAUE 1989, pl. 3, figs. 9, 13. --CLARK 1990, pl. 3, fig. 1. --HERMINEL 1990, pl. 3, figs. 8 - 9. --RESIG 1990, pl. 3, fig. 5. --HERMINEL 1991, pl. 3, figs. 8 - 9. --NOMURA 1991, pl. 3, fig. 9. --KAIHO 1992, pl. 8, figs. 1 - 2. --NOMURA 1992, pl. 4, fig. 8. --AKIMOTO 1994, pl. 1, fig. 5. --DOWSETT & ISHMAN 1995, pl. 1, fig. 1. --BORNMALM 1997, figs. 23H - J BUCEFALO PALLIANI, et. al. 1997, pl. 5, fig. B. --CICHA, et. al. 1998, pl. 66, figs. 12 - 13

Description: Small distinctive species. Test free, planispiral, and involute. Rounded periphery, smooth wall. Test divided to 4 - 5 equally sized chambers, inflated. Sutures slightly limbate, early sutures flush, later becoming slightly raised. Wall smooth and finely perforate. Aperture a slender slit extending from one umbilicus to the other at the base of the apertural face.

Occurrence: Confined to the V. herricki and G. fohsi Zones in Venezuela. Offshore Cabinda found in CABGOC 128-3 between 9,980' and 10,160', and in CABGOC 115-1X between 8,400' and 9,840'. Identified in Vâlcele, Romania.

Remarks: Originally described from the Tertiary of the Vienna Basin. Renz (1948) found the taxon throughout the Agua Salada Basin. Blow (1959) found the species scarce, but in all zones below his S. seminulina Zone. Widely distributed throughout the Tertiary of Tropical America and the Atlantic showing a diverse bathymetric range. See Bornmalm (1997) (p. 68 - 69) for an ecologic review. Recognised in the Miocene of the Gulf of Suez region (Souya 1965) and additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966). Specimens compare well with Pullenia sp. of the Parker and Jones collection (P10887, P10891) and with examples in the Burrow and Holland collection (slide D, NHM).

Pullenia salisburyi R. E. & K. C. Stewart

Plate 33, figure 3; Plate 64, figures 8a, 8b

Pullenia salisburyi R. E. & K. C. STEWART 1930, pl. 8, fig. 2

Pullenia salisburyi R. E. & K. C. Stewart. --CUSHMAN & MOYER 1930, pl. 8, fig. 13. --CUSHMAN & LAIMING 1931, pl. 14, fig. 2. --CUSHMAN & PARKER 1931, pl. 2, fig. 15. --CUSHMAN & LAIMING 1931, pl. 14, fig. 2. --CUSHMAN & TODD 1943, pl. 3, figs. 10 - 11. --RENZ 1948, pl. 12, fig. 24. --BLOW
Pullenia aff. salisburyi R. E. & K. C. Stewart. --LE ROY 1939, pl. 4, figs. 23 - 24


Occurrence: Intermittent occurrence throughout the Venezuelan section. Offshore Cabinda found in CABGOC 128-3 at 4,890', and infrequently in CABGOC 115-1X between 3,530' and 9,900'.

Remarks: Originally described from the Pliocene of California. Renz (1948) found the species scarce throughout the Agua Salada Basin. Blow (1959) only recovered specimens from his G. insueta, G. fohsi, and G. mayeri Zones. Le Roy (1939) notes Sumatran specimens 'smaller on the average than the Californian forms'. Also known from Barbados and Trinidad.

Pullenia sp.

Description: Poor preservation obliterates defining characteristics

Occurrence: Offshore Cabinda found in CABGOC 115-1X at 6,840' and 7,020'.

Remarks: Poor preservation.

Superfamily CHILOSTOMELLACEA Brady, 1881
Family CHILOSTOMELLIDAE Brady, 1881
Subfamily CHILOSTOMELLINAE Brady, 1881
Genus CHILOSTOMELLA Reuss, 1849

Chilostomella oolina Schwager

Plate 81, figure 5

Chilostomella oolina SCHWAGER 1850, pl. 1, fig. 16 (fide Ellis & Messina 1940, et seq.)
Chilostomella oolina Schwager. --HEDBERG 1937, pl. 92, fig. 3. --LE ROY 1939, pl. 5, figs. 29 - 30. --POPESCU 1975, pl. 55, fig. 3. --HASEGAWA, et al. 1990, pl. 2, fig. 15. --KAIHO 1992a, pl. 7, figs. 7 - 8. --AKIMOTO 1994, pl. 4, fig. 8. --BORNMALM 1997, fig. 23C

Description: Delicate ovoid test. Inflated, last chamber enveloping previous. Aperture a curved slender slit in septal face.

Occurrence: Observed in Chechis, Romania.

Remarks: Specimens compare well with that of the Helvetian Gubler collection (P33262). Recognised along the Gulf Coast (Garret 1938), the Miocene of Florida (Cushman 1930; Cushman and Cahill 1933), and Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966).
**Chilostomella ovoidea** Reuss

**Plate 65, figure 1**; **Plate 81, figure 6**

Chilostomella ovoidea REUSS 1850, pl. 48, fig. 12 (fide Ellis & Messina 1940, et. seq.)


**Description:** Always preserved as internal moulds in Venezuela and Africa. Found with complete test in Romania. Ovoid test, inflated. Last chamber enveloping previous. Aperture a curved slender slit in septal face. Often found as partial fragments of last chamber.

**Occurrence:** Occurs intermittently throughout the Venezuelan section. Offshore Cabinda found in CABGOC 128-3 between 4,110' and 10,040', and in CABGOC 115-1X between 3,290' and 9,420'. Found at Costei and Lapugiu du Sus, and Sacel, Romania.

**Remarks:** Renz (1948) found the species scarce in the 'Uvigerinella' sparsicostata Zone, Acostian, Araguatian, and Lucian. Blow (1959) remarks on the species poor preservation and only finds scarce specimens in his G. insueta and G. fohsi Zones. The wideness of the aperture appears to vary considerably, this has been treated as intra-specific variation in this study. Known from the Miocene of tropical Central America (Cushman and Renz 1947). Originally described from the Tertiary of Austria. Recognised as a constituent of a diverse bathyal benthonic association offshore West Africa (Haman, et. al. 1993) and known from additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966).

Family **OSANGULARIIDAE** Loeblich & Tappan, 1964

Genus **OSANGULARIA** Brotzen, 1940

**Osangularia culter** (Parker & Jones)

**Plate 33, figures 4a, 4b**

Planorbulina fareta (Fitchel & Moll) var. ungeriana (d'Orbigny) subvar. culter PARKER & JONES 1865, pl. 19, fig. 1 (fide Ellis & Messina 1940, et. seq.)

Truncatulina culter (Parker & Jones). --NUTTALL 1927, pl. 7, fig. 7

Pulvinulinella culter (Parker & Jones). --CUSHMAN 1929, pl. 14, fig. 13. --CUSHMAN 1948, pl. 26, figs. 8 - 9. --RENZ 1948, pl. 9, fig. 6. --BLOW 1959, p. 163

Osangularia aff. O. culter (Parker & Jones). --VINCENT, et. al. 1974, pl. 3, fig. 11

Osangularia culter (Parker & Jones). --WRIGHT 1978, pl. 7, figs. 2 - 3. --BOLTOVSKOY 1980, pl. 3, fig. 16, pl. 4, fig. 9. --PETTERS 1982, pl. 8, fig. 1. --KOHL 1985, pl. 34, fig. 6. --DIAZ de GAMERO 1985a, pl. 9, figs. 3 - 4. --BOERSMA 1986, pl. 12, figs. 4 - 6. --KURIHARA & KENNET 1988, pl. 7, figs. 4 - 6. --BOLLI, et. al. 1994, pl. 79, fig. 16

Osangularia bengalensis (Schwager). --WHITTAKER 1988, pl. 18, figs. 1 - 6

**Description:** Small distinct species. Biconvex test, serrate periphery of clear shell material. Semi-evolute chambers, slightly inflated. Sutures distinct, flush with the surface, wall smooth. Aperture not recovered.
Occurrence: In Venezuela, found in *M. basispinosus* and *V. herricki* Zones. Spurious specimens in *L. wallacei* Zone. Single specimen found offshore Cabinda in CABGOC 115-1X at 3,110'.

Remarks: Originally described from Recent sediments of the tropical Atlantic. Whittaker (1988) correctly argues the validity of this name, regarding it as a *nomen dubium*. This is a well recognised combination and hence for ease of communication it is maintained here. Renz (1948) found the taxon most common in the upper Acostian and *'Uvigerinella' sparsicostata* Zone. Known from the Miocene of Egypt (Macfadyen 1930). Also known from Ecuador, Barbados, Trinidad, Mexico, and California.

*Osangularia jarvisi* (Cushman & Renz)

**Plate 33, figures 5a, 5b**

*Pulvinulinella jarvisi* CUSHMAN & RENZ 1941, pl. 4, fig. 4

*Pulvinulinella jarvisi* Cushman & Renz. —RENZ 1948, pl. 9, fig. 5. —BLOW 1959, p. 163

*Osangularia jarvisi* (Cushman & Renz). —BOLLI, et. al. 1994, pl. 79, fig. 17

Description: Biconvex test, keeled periphery, with spines at margin of each chamber. Chambers increase uniformly in size, slightly inflated. Sutures distinct, limbate, slightly raised and curved on the dorsal side. Slightly depressed on the ventral side. Wall smooth, aperture elongate, on ventral side, almost parallel to the periphery.

Occurrence: Occurs intermittently throughout the Venezuelan section. Acme in sample 2725 of the *L. wallacei* Zone. Single specimen identified in Sacel, Romania.

Remarks: Cushman and Renz (1941) found the species in the lower Agua Salada Formation. Renz (1948) found the taxon restricted to the upper Acostian. Not known from other Caribbean localities.

Family ORIDORSALIDAE Loeblich & Tappan, 1984

Genus ORIDORSALIS Andersen, 1961

*Oridorsalis* sp. 1

Description: Poor preservation obliterates defining characteristics.

Occurrence: Single specimen found offshore Cabinda in CABGOC 128-3 at 6,500'.

Remarks: Poor preservation.

Family HETEROLEPIDAE Gonzáles-Donoso, 1969

Genus ANOMALINOIDES Brotzen, 1942

*Anomalinoides alazanensis* (Nuttall)

*Anomalina alazanensis* NUTTALL 1932, pl. 8, figs. 4, 8 - 9

*Anomalina alazanensis* Nuttall. —CUSHMAN & RENZ 1947, pl. 8, fig. 5. —RENZ 1948, pl. 10, fig. 7

*Anomalinoides alazanensis* (Nuttall). —OSTERMAN & QVALE 1989, pl. 4, fig. 16. —BOLLI, et. al. 1994, pl. 59, figs. 5 - 9, pl. 79, fig. 20

Description: Moderate sized test, semicompressed, rounded periphery. Dorsal side slightly raised and semi-involute, ventral side slightly depressed and semi-evolute, small boss. Chambers increase gradually in size as added, broad and narrow. Sutures flush to slightly
raised, limbate. Wall perforate. Aperture a low arch at the base of the last formed chamber extending to the periphery.

**Occurrence:** Offshore Cabinda found in CABGOC 115-1X between 7,020’ and 8,880’, acme at 7,140’.

**Remarks:** Originally described from the Miocene of Mexico.

**Anomalinoidea bilateralis** (Cushman)

**Plate 65, figure 2**

*Aanomalina bilateralis* CUSHMAN 1922, p. 97

*Aanomalina bilateralis* Cushman. —SKINNER & STEINKRAUS 1972

**Description:** Moderate sized test, rounded periphery, almost bilateral. Numerous chambers of similar shape and size. Sutures broad, curved and limbate, maybe slightly raised. Umbilical region filled with knob of clear shell material on both sides. Wall smooth and punctate. Aperture a narrow arch at the base of the final chamber.

**Occurrence:** Offshore Cabinda found infrequently in CABGOC 128-3 between 5,360’ and 6,500’, and in CABGOC 115-1X at 7,400’ and 7,500’.

**Remarks:** Originally described from the Miocene of Mississippi.

**Anomalinoidea trinitatensis** (Nuttall)

**Plate 65, figure 3**

*Truncatulina trinitatensis* NUTTALL 1928, pl. 7, figs. 3, 5 - 6

*Anomalinoidea trinitatensis* (Nuttall). —RENZ 1948, pl. 10, fig. 11. —BOLLI, et. al. 1994, pl. 59, figs. 22-27, pl. 79, fig. 19

*Cibicidoides trinitatensis* (Nuttall). —RESIG 1990, pl. 4, figs. 17 - 18

**Description:** Large test, plano-convex. Periphery sub-rounded. Dorsal side almost flat, ventral side convex. Chambers of uniform shape, increase in size gradually as added. Sutures flush, limbate, may become slightly raised towards the umbo on the dorsal side. Supplementary growth over the umbilicus on the dorsal side forming large boss. Wall smooth. Aperture an arched slit on the apertural face of the last formed chamber extending to the dorsal margin.

**Occurrence:** Offshore Cabinda found infrequently in CABGOC 128-3 between 5,840’ and 10,100’, and in CABGOC 115-1X between 7,260’ and 8,220’.

**Remarks:** Originally described from Upper Oligocene of Trinidad. Known from the Miocene of Venezuela (Bermúdez and Fuenmayor 1966).

Genus HETEROLEPA Fraznenau, 1884

**Heterolepa dutemplei** (d’Orbigny)

**Plate 81, figures 7a, 7b**

*Rotalina dutemplei* d’ORBIGNY 1846, pl. 8, figs. 19 - 21

*Heterolepa dutemplei* (d’Orbigny). —POPESECU 1975, pl. 86, figs. 1 - 2. —PAPP & SCHMID, pl. 48, figs. 5 - 9, pl. 50, figs. 1 - 3, pl. 52, figs. 1 - 6. —CICHA, et. al. 1998, pl. 71, figs. 1 - 3

**Description:** Trochoid, thick walled test, flat or weakly convex dorsally, convex ventral side. Dorsal side shows characteristic glassy appearance in most specimens. Aperture a slit-like
opening extending from the spiral side to the dorsal side at the base of the last chamber. Large pores apparent in the last whorl.

Occurrence: Common to Vâlcele, Costei, Lapugiu du Sus, the Chechis Marls, and Sacel in Romania.

Remarks: Originally described from the Tertiary of the Vienna Basin.

_**Heterolepa praecinta** (Karrer)_

**Plate 81, figures 8a, 8b**

_Rotalina praecinta_ KARRER 1868, pl. 5, fig. 7 (fide Ellis & Messina 1940, et. seq.)

_Heterolepa praecinta_ (Karrer). --POPEȘCU 1975, pl. 85, fig. 3


Occurrence: Single specimen found in Lapugiu du Sus, Romania.

Family GRAVELINELLIDAE Hofker, 1956

Subfamily GYROIDINOIDINAE Saidova, 1981

Genus GYROIDINOIDES Brotzen, 1942

_Gyroidinoides planulata_ (Cushman & Renz)

**Plate 34, figures 1a, 1b**

_Gyroidina planulata_ CUSHMAN & RENZ 1941, pl. 4, fig. 1

_Gyroidina laevis_ COR YE LL & RIVERO 1940, pl. 43, figs. 20, 28

_Gyroidinoides planulata_ (Cushman & Renz). --RENZ 1948, pl. 8, fig. 11. --BLOW 1959, p. 161. --SCHNITK ER 1980, pl. 9, figs. 10 - 12

_Gyroidina planulata_ Cushman & Renz. --CUSHMAN & RENZ 1947, pl. 7, fig. 17. --BASOV & KRASHENINNIKOV 1983, pl. 13, fig. 2. --DIAZ de GAMERO 1985a, pl. 8, fig. 15

_Gyroidinoides planulatus_ (Cushman & Renz). --WHITTAKER 1988, pl. 18, figs. 7 - 9. --BOERSMA 1990, pl. 2, fig. 22. --NOMURA 1992, pl. 4, fig. 2. --BOLLI, et. al. 1994, pl. 60, figs. 7 - 8, pl. 80, fig. 2, pl. 89, fig. 10

Description: Strongly compressed biconvex test. Umbilicate on ventral side. Rounded periphery. Chambers gradually increase in size, early sutures flush becoming raised, curved. Wall smooth. Low aperture, opening on ventral side from near the periphery to the open umbilicus.

Occurrence: Single specimen in the _T. panamensis_ zonule in Venezuela. Offshore Cabinda found infrequently in CABGOC 128-3 between 4,770' and 10,160', and in CABGOC 115-1X at 2,630' and 2,690'.

Remarks: Cushman and Renz (1941) originally found the taxon throughout the Agua Salada Formation. Renz (1948) and Blow (1959), subsequently found the species scarce in the Acastian and lower Araguatian. Diaz de Gamero (1985a) noted the species in her study. Renz (1948) notes the taxonomic dilemma faced amongst the Venezuelan _Gyroidina_ and _Gyroidinoides_ genera. Preservation is potentially a strong enough agent so as to marginilise genus characteristics such as apertural lips and the state of the umbilicus. Also known from Barbados, Ecuador, the south-west Atlantic, and questionably Haiti. Specimens compare well with those of the Whittaker collection (P51887).
Gyroidinoides venezuelana Renz
Plate 34, figures 2a, 2b
Gyroidinoides venezuelana RENZ 1948, pl. 8, fig. 21
Gyroidinoides venezuelana Renz. --BLOW 1959, p. 161 - 162. --BOLLI, et. al. 1994, pl. 80, fig. 1
Gyroidina venezuelana Renz. --DIAZ de GAMERO, pl. 8, figs. 16 - 17
Description: Small trochoid test. Slight convexity dorsally, strongly convex ventrally. Slightly perforate smooth wall. Periphery acute, but without keel. All chambers visible dorsally, only last whorl laterally. Chambers uninflated, suture flush with surface and distinct. Limbate on dorsal side and thick, width reducing towards periphery. Umbilicus open. Aperture an elongate slit extending from the periphery towards the umbilicus.
Occurrence: Intermittent occurrence throughout the Venezuelan section. Acme at sample 2719 of the L. wallacei Zone.
Remarks: Renz (1948) found the species scarce in the Araguatian and common in the Araguatian and Lucian, he also noted its presence in Trinidad and Mexico. Diaz de Gamero (1985a) noted the species as scarce towards the centre of her upper calcareous assemblage.

Subfamily GAVELINELLINAE Hofker, 1956
Genus GYROIDINA d'Orbigny, 1826
Gyroidina altiformis (R. E. & K. C. Stewart)
Plate 34, figures 3a, 3b; Plate 65, figures 4a, 4b, 4c
Gyroidina soldani var. altiformis R. E. & K. C. STEWART 1930, pl. 9, fig. 2
Gyroidina soldani altiformis R. E. & K. C. Stewart.--CORYELL & RIVERO 1940, pl. 43, fig. 19
Gyroidinoides soldanii var. altiformis (R. E. & K. C. Stewart). --RENZ 1948, pl. 8, fig. 13. --AKERS & DOORMAN 1964, pl. 10, figs. 33 - 35
Gyroidinoides altiformis (R. E. & K. C. Stewart). --BLOW 1959, pl. 7, fig. 27. --KOHL 1985, pl. 34, fig. 3. --CLARK 1990, pl. 2, fig. 1. --BOLLI, et. al. 1994, pl. 79, fig. 24, pl. 89, fig. 11. --CICHA, et. al. 1998, pl. 72, figs. 4 - 5
Gyroidina soldani var. altiformis R. E. & K. C. Stewart. --HALLER 1980, pl. 11, fig. 2. --DIAZ de GAMERO 1985a, pl. 8, figs. 9 - 10
Description: Trochoid test, strongly plano-convex. Dorsal side flattened, may show slight convexity, ventral side strongly convex, periphery rounded. Umbilicus open. Early chambers may become covered with secondary calcite growth. Sutures distinct, depressed about the umbilicus, on the dorsal side slightly raised. Tilting of chamber faces and extension of the chamber walls to form a slightly concave margin to the dorsal face to differ from the typical. Wall smooth and thick. Aperture an elongate slit on the inner margin of the ventral side.
Occurrence: Infrequent low abundance throughout the Venezuelan section. Acme at sample 2725 of the L. wallacei Zone. Offshore Cabinda found in CABGOC 128-3 between 6,680' and 10,160', and in CABGOC 115-1X between 7,380' and 9,900'. Identified in Vâlcele and Costei, Romania.
Remarks: Originally described from the Pliocene of California. Renz (1948) found the species common in the Acastian and scarce in the Araguatian and Lucian. Blow (1959) found the taxon common in all zones below his S. seminulina Zone. Diaz de Gamero noted the species in her study. Also known Trinidad, Cuba, Jamaica, and Mexico. The specimens of this study appear to show greater exaggeration to the concave surface of the ventral side than those of Finger (1990). Bathymetrically ranges from the lower bathyal (Smith 1964) to the upper mid bathyal (Ingle, et. al. 1980), also reported from the neritic (Whittaker 1988). Known from additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966). Believed by Coryell and Rivero (1940) to have originated in the Haitian area and migrated to California by Pliocene time. These specimens compare well with examples in the Burrow and Holland collection (slide E, NHM) and the Brady collection (NHM). They show more in common with the Whittaker collection 'cushman' type (P51891).

**Gyroidina parva** Cushman & Renz  
Plate 65, figures 5a, 5b

*Gyroidina parva* CUSHMAN & RENZ 1941, pl. 4, fig. 2  
*Gyroidina parva* Cushman & Renz. --RENZ 1941, pl. 8, fig. 12. --BLOW 1959, p. 160. --WHITTAKER 1988, pl. 18, figs. 10 - 12  
*Gyroidinoides parvus* (Cushman & Renz). --BOLLI, et. al. 1994, pl. 79, fig. 23

**Description:** Small species, trochoid, normally fragmented. Ventral side convex, periphery rounded, chambers inflated, gradually increasing in size. Sutures depressed and curved oblique dorsally, radial ventrally. Wall smooth, aperture elongate, lip not apparent.

**Occurrence:** Intermittent occurrence in the *L. senni* s.l., *M. basispinosus* and *V. herricki* Zones in Venezuela. Offshore Cabinda found in CABGOC 128-3 between 1,080' and 10,160', and in CABGOC 115-1X between 7,440' and 9,660'.

**Remarks:** Cushman and Renz (1941) found the species throughout the Agua Salada Formation. Renz (1948) subsequently found it to be most common in the upper Araguatian and Lucian, although present throughout the sequence. Specimens compare well with those of the Whittaker collection (P51888).

**Gyroidina scalata** Garret  
Plate 34, figures 4a, 4b; Plate 65, figure 6

*Gyroidina scalata* GARRET 1938, pl. 40, figs. 12 - 13  
*Gyroidina scalata* Garret. --CUSHMAN & ELLISOR 1939, pl. 2, fig. 1. --SKINNER & GLASER 1972, pl. 2, fig. 15

**Description:** Small trochoid test. Flattened dorsal side, convex ventral. Periphery rounded, umbilicus depressed. Twelve to fourteen chambers in the last whorl. Sutures flush with surface, radial to slightly curved. Wall smooth. Aperture low on base of apertural face on ventral side. Specimens often damaged.

**Occurrence:** Specimens in *M. basispinosus*, *G. fohsi*, and *L. wallacei* Zones in Venezuela. Offshore Cabinda found in CABGOC 128-3 between 4,890' and 10,160', and in CABGOC 115-1X between 7,020' and 10,020'.
Remarks: Originally recorded from the Oligocene of Louisiana. First record of this species from the Agua Salada Formation. Previously noted from the Gulf Coast.

**Gyroidina soldanii** d'Orbigny

Plate 65, figures 7a, 7b

Gyroidina soldanii d'ORBIGNY 1826, p. 278 (*fide* Ellis & Messina 1940, *et. seq.*)

Gyroidina soldanii d'Orbigny. –CUSHMAN 1929, pl. 14, fig. 7. –CUSHMAN & LAIMING 1931, pl. 13, fig. 2. –BERGGREN 1972, pl. 6, figs. 17 - 19. –SKINNER & GLASER 1972, pl. 2, fig. 16. –WRIGHT 1978, pl. 5, figs. 7 - 9. –BOLTOVSKOY 1980, pl. 3, fig. 9, pl. 4, fig. 5. –THOMPSON 1980, pl. 6, fig. 8. –PETTERS 1982, pl. 8, figs. 14, 20. –PAPP & SCHMID 1985, pl. 50, figs. 4 - 9. –NOMURA 1991, pl. 4, fig. 6. –AKIMOTO 1994, pl. 3, fig. 3

Gyroidinoides soldanii (d'Orbigny). –POPESTU 1975, pl. 84, fig. 2. –THOMAS 1985, pl. 6, figs. 7 - 8. –BELANGER & BERGGREN 1986, pl. 6, fig. 3. –BOERSMA 1990, pl. 2, fig. 23. –CIMERMAN & LANGER 1991, pl. 85, figs. 5 - 6

Gyroidina cf. soldanii d'Orbigny. –GALLOWAY & HEMINWAY 1941, pl. 15, fig. 7

**Description:** Distinctive thick test. Trochoid, highly convex ventral side, dorsal side slightly convex. Dorsal side shows two and a half coils with 10 - 11 chambers in the last whorl. Periphery rounded, umbilicus slightly depressed and open. Sutures flush with surface, radial on ventral side, slightly curved on dorsal. Wall smooth. Aperture a narrow slit, low on apertural face, apertural lips not distinguished on all specimens.

**Occurrence:** Intermittent occurrence throughout the Venezuelan section. Offshore Cabinda found in CABGOC 115-1X between 6,060’ and 9,900’. Found in Costei and Sacel in Romania.

**Remarks:** Originally described from Recent sediments offshore Italy. Renz (1948) tentatively referred to specimens from the Acostian as *G. cf. soldanii*. Also known from Ecuador, Barbados, Trinidad, Jamaica, Puerto Rico, Mexico, California, and the Gulf Coast. Common in the Badenian of the Vienna Basin. Recognised along the Gulf Coast (Garret 1938). Specimens compare well with those of the Heron-Allen and Earland collection (P32500-32545) and the Helvetic Gubler collection (P33252). Cicha, *et. al.* (1998), place the taxa into Hansenisca, following Loeblich and Tappan (1987), the status of these genera remains controversial.

**Gyroidina cf. soldanii** d'Orbigny

Gyroidina soldanii d'ORBIGNY 1826, p. 278 (*fide* Ellis & Messina 1940, *et. seq.*)

**Description:** Differs from the typical in smaller size and higher trochospire.

**Occurrence:** Offshore Cabinda found in CABGOC 128-3 between 3,930’ and 10,160’.

**Gyroidina zelandica** Finlay

Gyroidina zelandica FINLAY 1939, pl. 28, figs. 138 - 140

Gyroidinoides cf. zelandica (Finlay). –BLOW 1959, pl. 8, fig. 28

Gyroidina zelandica Finlay. –CAMERON 1978, pl. 1, figs. 18 - 20. –LECKIE & WEBB 1988, pl. 23, figs. 8 - 10

**Description:** Small, smooth walled species. Flat dorsal side, convex ventral. Small umbilicus with rim. Never complete.
**Occurrence:** Found rarely in *M. basispinosus*, *V. herricki*, and *G. fohsi* Zones in Venezuela. Offshore Cabinda found infrequently in CABGOC 128-3 between 6,380' and 10,100', and in CABGOC 115-1X at 10,020'.

**Remarks:** Originally described from the Miocene of New Zealand. Differs from *G. soldanii* and *G. soldanii* var. *altiformis* R. E. & K. C. Stewart in closed umbilicus, smaller size, and fewer chambers. Blow (1959) first identified the species in the Agua Salada Basin and found it scarce and only in isolated samples of his *G. insueta* and *G. fohsi fohsi* Zones.

Genus **HANZAWAIA** Asano, 1944

**Hanzawaia boueana** (d'Orbigny)

Plate 81, figures 9a, 9b

*Truncatulina boueana* d'ORBIGNY 1846, pl. 9, figs. 24 - 26

**Hanzawaia boueana** (d'ORBIGNY) --POPESCU 1975, pl. 87, fig. 3, pl. 88, fig. 1. --CICHA, et. al. 1998, pl. 72, figs. 9 - 11

*Cibicides boueanaus* (d'Orbigny). --PAPP & SCHMID 1985, pl. 56, figs. 6 - 9

**Description:** Low trochospire. Ventral side flat to concave, dorsal side convex. Sutures distinctly curved, wall smooth. Equatorial aperture with small lip extending to umbilicus

**Occurrence:** Single specimens found in Costei, Lapugiu du Sus, and Sacel, Romania.

**Remarks:** Originally described from the Tertiary of the Vienna Basin.

**Hanzawaia cf. boueana** (d'Orbigny)

*Truncatulina boueana* d'ORBIGNY 1846, pl. 9, figs. 24 - 26

**Description:** Differs from the typical in a greater inflation of the test.

**Occurrence:** Common to Vâlcele, Costei, Lapugiu du Sus, and Sacel in Romania.

**Hanzawaia concentricus** (Cushman)

*Truncatulina concentrica* CUSHMAN 1918, pl. 21, fig. 3

*Cibicides concentrica* (Cushman). --CUSHMAN 1930, pl. 12, fig. 4

*Cibicides concentricus* (Cushman). --CUSHMAN & CAHILL 1933, pl. 13, fig. 3. --CORYELL & RIVERO 1940, pl. 44, fig. 9. --RENZ 1948, pl. 10, fig. 8


*Cibcorbis concentricus* (Cushman). --BOLLI, et. al. 1994, pl. 79, fig. 3

**Description:** Plano-convex, dorsal side slightly convex, ventral side broadly convex. Periphery subcarinate, ventral side umbilicate. Sutures distinct and depressed, limbate. Seven to nine chambers in the adult whorl, inner portion on the proximal side fuses with adjacent chambers to form a concentric band separated by sutures. Final chambers rapidly increase in size. Wall smooth, aperture peripheral.

**Occurrence:** Found throughout the Venezuelan section. Acme in sample 2626 of the *M. superbus* zonule. Offshore Cabinda found in CABGOC 128-3 between 1,140' and 10,160', acme between 10,100' and 10,160', and in CABGOC 115-1X between 7,260' and 9,720'.
Remarks: Originally described from the Miocene of Florida. Great degree in variation of the spiral side. Renz (1948) found the taxon scarce in the upper Acostian, becoming more common in the Araguatian and Lucian. Cushman (1930) notes the similarity between this taxon as a juvenile form and C. americana. Differs from C. herricki in a smaller test size. Also known from Barbados, Cuba, Jamaica, and Haiti. Specimens compare well with those of topotype material in the Gubler collection and the Henson collection (P44628).

_Hanzawaia isidroensis_ (Cushman & Renz)

**Plate 34, figure 5**

*Cibicides isidroensis* Cushman & Renz 1941, pl. 4, fig. 10

*Cibicides isidroensis* Cushman & Renz. --RENZ 1948, pl. 10, fig. 10

*Hanzawaia isidroensis* (Cushman & Renz). --KOHL 1985, pl. 36, fig. 2

*Cibcorbis isidroensis* (Cushman & Renz). --BOLLI, et al. 1994, pl. 79, fig. 4

**Description:** Biconvex test, depressed umbo, sub-acute periphery with slight keel. Chambers distinct and inflated, increase rapidly in size. Sutures distinct and curved, thicken towards the umbo and slightly raised. Wall smooth, aperture on the periphery of the dorsal side.

**Occurrence:** Occurs throughout the Venezuelan section. Acme at sample 2626 of the _M. superb tus_ zonule. Offshore Cabinda found in CABGOC 115-1X between 6,300' and 8,700', infrequent. Also recognised in Vâlcele, Romania.

**Remarks:** Cushman and Renz (1941) noted the species differs from _C. concentricus_ in the more acute periphery and strongly curved sutures. In addition, they noted a differing range in the Agua Salada Basin, this taxon occurring throughout the basin. Renz (1948) noted the resemblance of this species to _C. cartensi_, and found it scarce in the upper Araguatian and Lucian. He also noted its distribution in Trinidad. Strongly keeled and limbate _C. concentrica_ Cushman may resemble this taxon. Known from additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966).

_Hanzawaia mantaensis_ (Galloway & Morrey)

**Plate 34, figures 6a, 6b**

*Anomalina mantaensis* Galloway & Morrey 1929, pl. 4, fig. 5

*Cibicides mantaensis* (Galloway & Morrey). --HEDBERG 1937, pl. 92, fig. 12. --CUSHMAN & RENZ 1947, pl. 8, fig. 7. --RENZ 1948, pl. 11, fig. 8

*Hanzawaia mantaensis* (Galloway & Morrey). --PETTERS 1982, pl. 13, figs. 9 - 10. --DIAZ de GAMERO 1985a, pl. 9, fig. 9. --VAN MORKHOVEN, et. al. 1986, pl. 32, figs. 1 - 2. --WHITTAKER 1988, pl. 23, figs. 7 -9. --KATZ & MILLER 1993, pl. 5, fig. 5. --BOLLI, et. al. 1994, pl. 61, figs. 1 - 3, pl. 80, fig. 7

**Description:** Distinctive small species. Slightly plano-convex, involute, 10 - 12 chambers in last whorl. Sutures distinct and sharply limbate, dark in colour. Wall finely perforate, apertural face usually missing, when present truncate, extending over to the ventral side. Aperture peripheral narrow slit along the inner margin of the last few chambers.

**Occurrence:** Occurs throughout the Venezuelan section. Acmes at samples 2608 of the _V. herricki_ Zone and 2725 of the _L. wallacei_ Zone. Offshore Cabinda found in CABGOC 128-3 between 1,200' and 9,440', and in CABGOC 115-1X between 4,730' and 8,700'.
Remarks: Originally described from the Oligocene of Ecuador. Hedberg (1937) noted a variable morphology to this taxon, this was not observed in this study. Renz (1948) reported the species as scarce in the 'Uvigerinella' sparsicostata Zone, and common through the Acostian to lower Araguatan. He also noted its distribution in Trinidad and Mexico and suggested an acute stratigraphic restriction to the Middle and Upper Oligocene throughout tropical America. Known from additional Miocene Venezuelan localities (Bermúdez and Fuenmayor 1966).

Hanzawaia sp. 1
Plate 66, figure 1
Description: Small planispire, subacute periphery, semi-evolute, compressed. Twelve to fifteen inflated chambers in the last whorl, steadily increase in size as added. Sutures depressed and limbate. Umbilicus depressed, wall smooth, aperture unobserved.
Occurrence: Offshore Cabinda found infrequently in CABGOC 128-3 between 3,690' and 10,160'.
Remarks: Poor preservation in many specimens.

Hanzawaia sp. 2
Plate 66, figure 2
Description: Small planispire, subacute periphery, compressed. Ten to twelve chambers in the last whorl, steadily increase in size as added. Sutures limbate and raised. Umbilicus raised and filled with clear shell material. Wall smooth, aperture unobserved.
Occurrence: Offshore Cabinda found infrequently in CABGOC 128-3 between 6,500' and 10,040'.
Remarks: Poor preservation.

Family COLETIDAE Loeblich & Tappan, 1984
Genus BUCELLA Andersen, 1952
Buccella mansfieldi (Cushman)
Eponides mansfieldi CUSHMAN 1930, pl. 11, fig. 1
Buccella mansfieldi (Cushman). --SKINNER & GLASER 1972, pl. 3, fig. 2
Occurrence: Offshore Cabinda found in CABGOC 115-1X at 3,140' and 3,200'.
Superfamily ROTALIACEA Ehrenberg, 1839  
Family ROTALIIDAE Ehrenberg, 1839  
Genus PARAROTALIA Le Calvez, 1949  

Pararotalia aculeata (d'Orbigny)  
Plate 82, figures 1a, 1b  

*Rotalina aculeata* d'ORBIGNY 1846, pl. 8, figs. 25 - 27  
*Rotalina aculeata* d'Orbigny. —PAPP & SCHMID 1985, pl. 53, figs. 1 - 6  
*Pararotalia aculeata* (d'Orbigny). —CICHA, et. al. 1998, pl. 73, figs. 4 - 6, 10  

**Description:** Trochoid test, convex dorsal side, slightly concave ventral side. Chambers of last whorl envelope earlier formed chambers and extend to form elongate spines along the periphery. Nodular ornamentation obscures sutures. Central pillar evident on the ventral side.  
**Occurrence:** Found in Vâlcele, Costei, and Lapugiu du Sus, Romania.  
**Remarks:** Originally described from the Tertiary of the Vienna Basin.  

Family ELPHIDIIDAE Galloway, 1933  
Subfamily ELPHINIINAE Galloway, 1933  

*Elphidium aculeatum* (d'Orbigny)  
Plate 82, figures 2 - 3  

*Polystomella josephina* d'ORBIGNY 1846, pl. 6, figs. 25 - 26  
*Polystomella josephina* d'ORBIGNY 1846, pl. 6, figs. 27 - 28  

**Description:** Medium sized test, compressed with slight keel. Septa terminate in short spines, often abraded.  
**Occurrence:** Identified in Vâlcele, Romania.  
**Remarks:** Originally described from the Tertiary of the Vienna Basin.  

*Elphidium crispum* (Linné)  
Plate 82, figures 4a, 4b  

*Nautilus crispus* LINNÉ 1758, p. 709 (fide Ellis & Messina 1940, et. seq.)  
*Polystomella crispa* Lamarck. —d'ORBIGNY 1846, pl. 6, figs. 9 - 14  
*Elphidium gr. crispum* (Linné). —ROSSET-MOULINIER 1971, pl. 1, figs. 1 - 6, pl. 2, figs. 1 - 4  

**Description:** Large test, somewhat rhombic in apertural view. Periphery acute. Large central boss. Chambers arcuate, septa form distinct curves.  
**Occurrence:** Observed in Vâlcele, Romania.  
**Remarks:** Originally described from the Tertiary of the Vienna Basin.
**Elphidium roishauseni** Cushman & Ellisor

*Plate 82, figures 5a, 5b*

*Elphidium roishauseni* CUSHMAN & ELLISOR 1939, pl. 1, fig. 7

**Description:** Compressed test, strongly biumbonate, with slightly thickened keel. Rounded periphery, numerous chambers, increasing gradually in size. Elongate retral processes, frequently extending beyond previous chamber and subparallel. Sutures indistinct. Wall perforate, papillae not recognised.

**Occurrence:** Observed in Vâlcele, Romania.

**Remarks:** Originally described from Miocene core material of Louisiana.

**Elphidium subtypicum** (Papp)

*Plate 82, figures 6a, 6b*

*Elphidium flexuosum* (d'Orbigny) subsp. *subtypicum* PAPP 1963, pl. 11, fig. 3, pl. 12, figs. 1 - 3 *(fide* Ellis & Messina 1940, *et seq.)*


**Description:** Robust test, biumblicate, large. Rounded periphery, subacute in some individuals. Low oval profile in transverse section, thick test wall. Inflated, wide boss of opaque shell material. Numerous strongly curving chambers. Sutures raised and swept back toward the periphery. Short retral processes.

**Occurrence:** Identified in Vâlcele and Lapugiu du Sus, Romania.

**Remarks:** Originally described from the Miocene of Austria.

Order ROTALIIDA Lankester, 1885
Suborder ROTALINA Delage & Hérouard, 1896
Superfamily NUMMULITACEA de Blainville, 1827
Family NUMMULITDAE de Blainville, 1827
Subfamily NUMMULITINAE de Blainville, 1827
Genus **PLANOSTEGINA** Banner & Hodgkinson, 1991

**Planostegina costata** (d'Orbigny)

*Plate 82, figures 7a, 7b*

*Heterostegina costata* d'ORBIGNY 1846, pl. 12, fig. 15, 17

*Heterostegina simplex* d'ORBIGNY 1846, pl. 12, fig. 12 - 14

*Heterostegina costata* d'Orbigny. –POPESCU 1975, pl. 92, fig. 10, 93, fig. 13, textfig. 29. –PAPP & SCHMID 1985, pl. 68, figs. 1 - 2, textfig. 12


**Description:** Large compressed test. Broad spiral, evolute. Septa curved, with long secondary septa occasionally present.

**Occurrence:** Common in Costei, Romania.

**Remarks:** Originally described from the Tertiary of the Vienna Basin. Specimens compare well to those of the Brady collection (P52284). Papp and Schmid (1985) synonymised *H. simplex*
d’Orbigny as a juvenile form, a practise followed herein. Known from the Miocene of Egypt (Macfadyen 1930).

**INDETERMINATE TAXA**

**Genus indet. 1**

**Plate 66, figure 3**

**Description:** Small round flattened test, periphery sub-acute. Dorsal side slightly convex, ventral side flat. Wall smooth, un-ornamented, orange to white in colour. Worn specimens show faint concentric rings on ventral side, closely and equally spaced. Centre of ventral surface possess small round ‘aperture’ without rim or neck, not apparent in all specimens.

**Occurrence:** Offshore Cabinda found in CABGOC 115-1X between 2,930’ and 7,560’. In Romania found in Sacel, the Chechis Marls, Costei, and Vâcelle.

**Genus indet. 2**

**Plate 66, figures 4 - 5**

**Description:** Distinctive flaring agglutinating species. Rounded periphery, inflated. Initial end closely coiled, rapidly flares outward in ‘trumpet-like’ form towards ‘apertural’ end, concave ‘apertural face’. Wall coarse grained obscuring chamber arrangement and sutures.

**Occurrence:** Two specimens found in CABGOC 115-1X at 6,300’ and 6,420’.
5. PHYSIOLOGICAL RESPONSE

*Paleoenvironments are interpretations of data, thus they don't have to make sense.*

*Dignes (pers. comm. 1998)*

The mass of foraminiferal data may be utilised to infer the palaeoenvironmental influence acting upon the benthos. This may take either or both of two forms. Firstly, the phylogenetic response through time of a lineage may give indications of a sustained environmental trend. Secondly, changes in assemblage character provide information on shorter term environmental fluctuations in addition to longer term trends. Table 5 lists ecoligic characters associated with selected benthic foraminifera found in this study.

5.1. PHYLOGENETIC RESPONSE

*Had I been present at the Creation, I would have given some useful hints for the better ordering of the Universe.*

*Alfonso the Wise*

The physiological response of the Cyclamminidae to oceanographic conditions has largely been neglected in the scientific literature. Alveolar forms have long been considered to have evolved in response to low oxygen conditions. The ability to evolve alveoles and apertural pores is considered to be a primitive character in multiple ancestral *Haplophragmoides* species that are essentially 'switched on' given the necessary environmental conditions, for example the development of an OMZ. There are numerous descriptive summaries of cyclamminid morphology in the literature depicting the varying approaches to taxonomic hierarchy, these are concisely summarised in Krymsalova (1980), and Banner (1970). Haynes (1990) gave a historical perspective of classification and outlines the shortfalls inherent in placing a human artefact upon a natural order.

The most comprehensive review of Lituolid evolution is Banner (1970). This places *Cyclammina* in the subfamily Cyclammininae (Marie 1941) and includes planispiral involute individuals with primary basal apertures, with or without areal openings and a septum differentiating from the alveolar epidermis and non-alveolar epidermis. *Cyclammina* s.s. is characterised by the presence of a basal slit-like aperture and additional supplementary openings (Fig. 4); alveolar structure becomes important at the species level. Berggren and Kaminski (1990) examine the phylogeny of the *C. cancellata* lineage through the Cenozoic (Fig. 3), and find a gradual loss against time of defining features. In essence, they propose a polyphyletic phylogeny initiating at an ancestral *Haplophragmoides* species and progressing through *Reticulophragmium* to *Cyclammina* s.s. In essence, *Cyclammina* may be perceived in this light as an ecophenotypic plexus resulting from convergent evolution.

Seiglie, *et. al.* (1986) highlighted the ambiguity of the Cyclamminidae, suggesting the degree of diversification is dependant upon the number of species recognised by the individual worker. They further indicate that Early Miocene to Recent diversification episodes occurred in deep-
water environments (the early episodes [Jurassic to Middle Eocene] were shallow water phenomena).

Charnock and Jones (1990; 1997) discussed the evolutionary relationship of North Sea Lituolids following Jenkins (1990), in promoting the case for subgenera and defining phylogeny. They speculated that a series of tectono-eustatically mediated low-stands, forcing rapid sedimentation, excess runoff, stratification, and reduced oxygenation, favour the agglutinated foraminifers, in particular the complex lituolids. Theyer (1971), using an ecophenotypic approach concluded that temperature had a major control over the size of *C. cancellata* Brady, relatively narrow individuals correlate with low oxygen levels in the Peru - Chile Trench. Haynes (1992) advocates this approach to counteract 'indiscriminate lumping'. McNeil (1988) observed increasing complexity in the wall structure of *C. cyclops* (McNeil) prevalent with greater depth. These data remain sparse for *Cyclammina* s.s. However, other members of the family Cyclamminidae display trends of note.

*Alveolophragmium crassum* (Reuss) is described here from an indeterminate interval between late and early mid Miocene in CABGOC 115-1X, a slight increase in the density and complexity of the wall structure removes the taxon to *Reticulophragmium* with time. Conversely, 'R' *rotundidorsatum* (Hantken) in CABGOC 128-3 is recovered between the late and early Miocene, more advanced complex forms in CABGOC 115-1X occur in the early mid Miocene, essentially describing a simplification of form.

Perhaps one of the best examples of a physiological response to dysoxia is observed in this study in the evolution of the internal structure of *P. johnrolandi* n.sp. from Venezuela. This taxon displays a clear propensity towards increasing complexity of the wall structure with time. Between N10 and N14 the taxon develops hemisepta, chamberlets, canals and pillars (Fig 23; Plates 2 - 5). This trend is mimicked in some individuals in their ontogeny, early chambers are comparatively simple, later development more complex. Of particular note is the increasing frequency of this taxon within the productivity zone of the El Mene - Pozon Road section, individual peaks coinciding with additional 'r' selected taxa typical of low oxygen conditions.

Within CABGOC 115-1X *R. venezuelanum* (Maync) displays a subtle trend toward increased size (Cope's Rule) and denser 'alveolation' of the test. Between the late and early Miocene a simple, small form termed *R. cf. venezuelanum* (Maync), is found in association with *R. venezuelanum* (Maync) s.s. This 'ancestral' form is eventually lost from the well, leaving just *R. venezuelanum* (Maync) s.s. in an indeterminate section in the late Miocene.

Following the approach of Maync (1952), Berggren and Kaminski (1990) and Gradstein and Berggren (1981) suggest *C. placenta* (Reuss) evolves to *C. cancellata* Brady at some point in the mid Cenozoic. The data of this study show *C. placenta* (Reuss) encompassed within the range of *C. cancellata* Brady in Venezuela. In CABGOC 115-1X *C. placenta* (Reuss) disappears.
from the well just prior to the last specimen of *C. cancellata* Brady in the late Miocene rendering absolute phylogenetic interpretation problematic.

5.2. ASSEMBLAGE RESPONSE

"The advice I give to students in science is to move laterally and up and down and peer all around."

*Edward O. Wilson, 1994 - Naturalist*

Akers questioned the implication of *Cyclaminidae* distribution, in particular *C. cancellata* Brady, as early as 1954. His extensive review found the taxon typical of depths ‘greater than the continental shelf’, but additionally noted low oxygen and turbidity as contributory factors. The data of this study remain sparse for *Cyclammina* s.s. Of the sites examined in this study, CABGOC 115-1X has by far the most diverse *Cyclamminidae* assemblage; further to the north, and further from the influence of the Zaire river outfall, *Cyclamminidae* are relatively impoverished. Within the Venezuelan material, *Cyclamminidae* data remain ambiguous, much of the material recovered is fragmentary.

Amongst the *Pavonitinidae* (Loeblich and Tappan 1961) transatlantic trends become apparent.

*Spiropsammina primula* Seiglie and Baker is common in particular sections offshore West Africa and found within Paratethys. However, recovery in the Venezuelan section is sporadic at best, the ‘niche’ of this small, compressed, complex taxon being largely filled morphologically similar *P. johnrolandi* n. sp. Similarly, *P. andulana* (Malecki) and *P. flabellum* Seiglie and Baker are common in the West African material but unobserved in the western tropical Atlantic. Seiglie and Baker (1983), and Seiglie, et. al. (1986) noted this provincialisation.

The *jebusellinae* display this trend to a large extent in the opposite sense. *J. karamatensis* Brönnimann, *A. pozonensis* (Cushman and Renz), and *A. pozonensis crassa* (Cushman and Renz) all occur relatively frequently in Venezuela but are unobserved offshore West Africa. It is of note that Seiglie, et. al. (1986) considered these taxa indicative of specific environmental conditions removed from upwelling zones, *Jarvisella* typical of ‘environments under stress’, and *Liebusella* (Alveovalvulinella) ‘relatively stable conditions’. Cabinda tends to contain taxa of similar dimensions but lacking diagnostic inner structures, i.e.: *Karrerulina, Eggerella, Karreriella*, etc. Seiglie, et. al. (1986) used this provincialisation to promote the establishment of two deep-water agglutinated foraminifera provinces: a Caribbean alveovalvulinidae province and a West African *Pavonitinidae / Spiropsammina* province.

This study appears to suggest a slight adjustment to this picture. Re-silicified *A. suteri* Brönnimann were found offshore West Africa, other members of the Alveovalvulinidae appear to be confined to the Caribbean province. In addition, extremely coarse grained specimens of *Spiropsammina*, tentatively placed in *S. cf. primula* Seiglie and Baker are recovered from Venezuela. In addition, the fauna recovered from the Cabinda area bears little resemblance to
the Gulf of Guinea taxa of Petters (1982), Kogbe and Mehes (1986), amongst others. It is
difficult to promote one of these African assemblages as a subset of the other. The Gulf of
Guinea taxa appear to show a high percentage of calcareous forms unknown further to the
south. Material from Cabinda tends to be dominated by agglutinating genera unrecorded further
to the north. These two areas are subject to two differing oceanographic regimes controlling to a
certain extent the benthic fauna. Only a detailed comparative study of these two regions will
reconcile this impasse.

*Textularia earlandi* Parker appears as a discrete component of the agglutinated fauna off West
Africa. However, in CABGOC 11501-X it acmes with *Brizalina alazanensis* Cushman,
dominating the assemblage. These two taxa are of similar size and dimension, both small and
extremely compressed. Douglas (1979) observed a trend within the *Bolivina* offshore California,
where taxon shape was interpreted as related to oxygen uptake. Neritic taxa are small and
inflated, while bathyal species are larger and compressed; this essentially demonstrates an
increase in surface area to volume ratio and may facilitate more efficient gaseous exchange in
oxygen stressed conditions. In as much, this co-domination of a sample by two taxa of similar
proportions yet differing wall construction suggests a low oxygen condition promoting a ‘form in
function’, but insufficiently severe to favour the dominance of one over the other.

A predominant *Bolivina / Brizalina* fauna becomes noticeable towards the top of both Cabinda
wells. Dominance of *Bolivina* spp. over other taxa is interpreted as low oxygen conditions at the
sea floor (Phleger and Soutar 1973). In CABGOC 128-3 *B. alazanensis* Cushman and *B.
advena* Cushman become prevalent as other taxa are lost, similarly, in CABGOC 115-1X these
two taxa are coupled with *Uvigerina* taxa indicative of high productivity (Boersma 1984).

Amongst further calcareous taxa several trends become apparent readily. Bandy and Arnal
(1960) were amongst the first to discuss ‘form and function’, followed by Pflium, *et. al.* (1976),
Haq and Boersma (1977), amongst numerous others. Douglas (1979) outlined the main
bathymetry criteria amongst the *Bulimina* and *Uvigerina*. To a large extent outer shelf species
are smooth to finely hispid / striate. Bathyal depths are dominated by costate forms (i.e.: *U.
peregrina*), these forms become costate-spinose with increasing depth, ultimately becoming
spinose in the lower bathyal / abyssal realm. The obvious drawback of this approach in deep
water low oxygen environments is preservation, which can render spinose forms pustulose,
strongly striate forms weakly striate, and finely ornamented taxa smooth to the inexperienced
taxonomist. While the data from the Venezuelan study would appear to largely support the
ornamentation trend of Douglas, inconsistencies arise in the Cabinda wells.

The co-occurence of *U. mantaensis* Cushman and Edwards, and *U. modoensis* Cushman and
Kleinpell offshore West Africa, and various pustulose and striate forms with *U.* sp. 1 is
problematic. Similarly, the co-occurrence of striate forms with *U. mantaensis* Cushman and
Edwards in the same region raises similar questions. Even bearing in mind the caution of Austin
(1994) concerning the disturbed nature of foraminiferal stratigraphy, it is difficult to reconcile
these conflicting signals.
Gooday (1993), identified small calcareous, trochospiral, transparent individuals in modern abyssal environments as characteristic opportunists. These taxa were interpreted as opportunistically adapted to seasonal food pulses by Smart et. al. (1994). Although this seasonal resolution is unlikely to be detected in the material of this study, the apparent 'flood' of *Epistominella cf. pacifica* (Cushman) in CABGOC 115-1X is reasonably interpreted as indicative of increased food input.
Table 5. Selected references for ecological characters associated with benthic foraminifera:

<table>
<thead>
<tr>
<th>Species</th>
<th>Interpretation</th>
<th>Age</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Recent</td>
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<td>Tertiary</td>
<td>Kaminski, et. al.</td>
<td>1988</td>
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<td>Eocene</td>
<td>McNeil 1984</td>
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<td>Stable conditions, eastern seaboard</td>
<td>Miocene</td>
<td>Seiglie, et. al. 1986</td>
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<td>Bathymetric migration to shallower depths</td>
<td>Recent</td>
<td>Pflum, et. al. 1976</td>
</tr>
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<td>Ammobaculites</td>
<td>Brickish; brickish - marine</td>
<td>Recent</td>
<td>Murray &amp; Armi 1960; Murray 1991</td>
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<td>A. agulitanus</td>
<td>Upper - lower bathyal</td>
<td>Miocene</td>
<td>Culver 1988</td>
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<td>Miocene / Recent</td>
<td>Culver 1988; Pflum, et. al. 1976</td>
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<td>Cenomanian -</td>
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<td>Recent</td>
<td>Albers, et. al. 1972; Murray 1991</td>
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<td>Murray 1991</td>
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<td>Recent</td>
<td>Murray 1991</td>
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<td>Recent</td>
<td>Albers, et. al. 1972; Murray 1991</td>
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<td>Bandy, et. al. 1984; Bernhard 1986; Kaho 1994; Perez-Cruz &amp; Machain-Castillo 1990; Phleger &amp; Soutar 1973; Sen Gupta &amp; Machain-Castillo 1993; Thomas 1986</td>
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<td>B. alata</td>
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<td>B. byramensis</td>
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<td>Cenozoic</td>
<td>Van Morkhoven, et. al. 1986</td>
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<td>Bulimina</td>
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<td>Douglas &amp; Woodruff 1981; Seiglie 1968</td>
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<td>B. aculeata</td>
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<td>Kaho 1994; Sen Gupta &amp; Machain-Castillo 1993</td>
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<td>B. oovidea</td>
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<td>Kaho 1994; Sen Gupta &amp; Machain-Castillo 1993</td>
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<td>Recent</td>
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267
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6. PALAEENVIRONMENTAL INTERPRETATION

6.1. VENEZUELAN BIOSTRATIGRAPHIC FRAMEWORK

Renz (1948) said of the Agua Salada Group of Eastern Falcón, Venezuela "...... (it) is very rich throughout in foraminifera ......". On the basis of this he outlined a biostratigraphic succession of units, subdivided into various subunits based upon the ranges of foraminifera. These units were determined from the examination of numerous specimens collected throughout Eastern Falcon from exploration well, pit, auger, and outcrop samples. Taxonomic nomenclatural advance subsequent to 1948 has rendered Renz's zonation ambiguous, hence the need to address the zonation scheme and refine where necessary is paramount.

Renz (1948) defined three stages, containing seven zones, and nine zonules. The biostratigraphic units are fundamental for inter-regional correlation and therefore not necessarily coincident with rock stratigraphic units. 'Zones' are the sub-divisions of a stage and are characterised by an assemblage of organisms, normally one is chosen as an index taxa. 'Zonules' were defined locally and can have time stratigraphic significance within local boundaries. They were defined primarily upon the basis of 'faunules' (distinctive assemblages of microfossils).

Table 6. Definition of 'Stages' as recognised by Renz (1948):

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<td>Lucian</td>
<td>Type area = Pozon (Loma Luca). Identified upon first occurrence of charophytes (Chara). Strongly facies influenced, ambiguous recognition. Varied fauna.</td>
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<td>Araguatian</td>
<td>Type area = Pozon (Loma Luca). Rich in forams. Recognised through presence of <em>Lenticulina subaculeatus</em> var. <em>glabratu</em>s and absence of <em>Siphogenerina transversa</em>. Uniform fauna.</td>
</tr>
<tr>
<td>Acostian</td>
<td>Type area = El Mene de Acosta. Rich in forams. Recognised as interval between last occurrence of <em>Siphogenerina transversa</em> and appearance of species not present in older sediments. Uniform fauna.</td>
</tr>
</tbody>
</table>

Renz recognised a total of 239 foraminiferal taxa from the Agua Salada Group. The type sections examined were the El Mene de Acosta (auger line) and Pozón Loma Luca (auger and pit line), which between them contained 199 benthic species. This study has identified 272 benthic foraminiferal species from the juxtaposed El Mene-Pozón road section, the "*Uvigerinella* sparticostata" Zone is not present at this locality.
Table 7. Zonal definitions of Renz (1948) (excluding the “Uvigerinella” sparicostata Zone):

<table>
<thead>
<tr>
<th>Zone</th>
<th>$N^\circ$ of Foram species (Renz 1948)</th>
<th>Characteristics (Renz 1948)</th>
<th>$N^\circ$ of Foram species (this study)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lenticulina senni (zonules below)</td>
<td>See zonules below</td>
<td>Facies influenced. First occurrence of Textularia panamaensis, last occurrence of Bolivina rudderi, Globobulimina perversa, Siphonia pozonensis, Textularia abbreviata.</td>
<td>See zonules below</td>
</tr>
<tr>
<td>Margulinopsis basispinosus</td>
<td>117 (inclusive of planktonic species)</td>
<td>Presence of Marginulina aculeata and Margulinopsis basispinosus. First occurrence of Bolivina advena, Lenticulina senni, Trochammina cf. pacifica, and Marginulina superbus.</td>
<td>117 (exclusive of planktonic species)</td>
</tr>
<tr>
<td>Valvulineria herricki</td>
<td>135 (inclusive of planktonic species)</td>
<td>Rich in forams. Presence of Lenticulina subaculeatus var. glabratatus and Valvulineria herricki, absence of Globorotalia fohsi and Bolivina pisciformis.</td>
<td>182 (exclusive of planktonic species)</td>
</tr>
<tr>
<td>Globorotalia fohsi</td>
<td>136 (inclusive of planktonic species)</td>
<td>Rich in forams. Presence of Globorotalia fohsi and Bolivina pisciformis, absence of Siphogenerina transversa.</td>
<td>148 (exclusive of planktonic species)</td>
</tr>
<tr>
<td>Siphogenerina transversa</td>
<td>177 (inclusive of planktonic species)</td>
<td>Rich in forams. Presence of Siphogenerina transversa, absence of Lenticulina wallacei, Saracenaria senni, Pseudogaudryina jacksonensis var. abnormis.</td>
<td>97 (exclusive of planktonic species)</td>
</tr>
<tr>
<td>Lenticulina wallacei</td>
<td>145 (inclusive of planktonic species)</td>
<td>Rich in forams. Significant species: Astoculus sublituus, Bolivina alazanensis; B. pisciformis, Cibicides mantaensis; Nodosaria nuttallii; Planulina venezuelana; Planulina subtenuissima; Pseudogaudryina comatula; Lenticulina wallacei; Saracenaria senni; Siphogenerina transversa; Valvulineria venezuelana.</td>
<td>111 (exclusive of planktonic species)</td>
</tr>
</tbody>
</table>
Table 8. Zonule definitions of Renz (1948):

<table>
<thead>
<tr>
<th>Lenticulina senni Zonules</th>
<th>N° of Foram species (Renz 1948)</th>
<th>Characteristics (Renz 1948)</th>
<th>N° of Foram species (this study)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elphidium poeyanum - Reussella spinulosa</td>
<td>16 (inclusive of planktonic species)</td>
<td>Facies influenced. Frequent Ammonia beccarii, Elphidium poeyanum and Reussella spinulosa. Presence of Bolivina simplex, Textularia pozonensis and Uvigerina isidroensis.</td>
<td>68 (exclusive of planktonic species)</td>
</tr>
</tbody>
</table>

A qualitative comparison of Renz's 1948 zonation, Blow's 1959 scheme and the data collected in this study reveal only a weak similarity. Blow (1959) had noted severe facies influence throughout the section. In this study a greater number of taxa per a zone were found than previously recognised. This is a product in part of taxonomic nomenclatural advancement subsequent to previous studies and also the greater recognition of agglutinating taxa. To what extent this is a reflection of processing techniques is not quantifiable.

The semi-quantitative nature of the data sets involved should be recognised at this point. Both Renz (1948) and Blow (1959) provided tables indicating the relative abundance of a taxa per zone. However, the number of samples considered per zone is not indicated in either publication, representing a substantial data loss and generalisation. Data displayed in this fashion will not denote fluctuations within a zone per taxon or relatively amongst taxa. This ambiguity is compounded in both papers as abundances are expressed in the subjective. Both Renz (1948) and Blow (1959) used: 'S' = scarce, 'C' = common, and 'A' = abundant to describe their data sets, the actual quantitative data for these value indicators is not given in either case.
The 58 samples collected and examined for this study were assigned to zones using the zonation of Renz (1948). In all cases, zonal assignments were based upon extrapolation of the Renz (1948) scheme made by Blow (1959) onto the Pozon El Mene Road section.

Table 9. Sample location in Zones of Renz (1948):

<table>
<thead>
<tr>
<th>Stage</th>
<th>Zone</th>
<th>Zonule</th>
<th>Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lucian</td>
<td>Lenticulina senni s. I. (of El Mene area - Renz 1948)</td>
<td>Reusella spinulosa - Elphidium poeyanum</td>
<td>2635; 2634</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Textularia panamaensis</td>
<td>2633; 2632; 2631.3; 2631.2; 2631.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Marginulina superbus &amp; Lenticulina senni</td>
<td>2630; 2629; 2628; 2627; 2626; 2625</td>
</tr>
<tr>
<td></td>
<td>Marginulina basispinosus</td>
<td></td>
<td>2624; 2623; 2622; 2621; 2620; 2619; 2610; 2602; 2603; 2604</td>
</tr>
<tr>
<td>Araguanian</td>
<td>Valvulineria herricki</td>
<td></td>
<td>2605; 2606; 2607; 2608; 2609A; 2609B; 2610; 2611; 2612; 2613</td>
</tr>
<tr>
<td></td>
<td>Globorotalia fohsi</td>
<td></td>
<td>2614; 2615; 2616; 2617; 2618; 2701</td>
</tr>
<tr>
<td>Acostian</td>
<td>Siphogenerina transversa</td>
<td></td>
<td>2702; 2708; 2709; 2710; 2711; 2713; 2714</td>
</tr>
<tr>
<td></td>
<td>Lenticulina wallacei</td>
<td></td>
<td>2715; 2716; 2717; 2718; 2719; 2720; 2721; 2722; 2723; 2724; 2725</td>
</tr>
<tr>
<td>No Stage defined</td>
<td>“Uvigerinella” sparcostata</td>
<td>Ammobaculites cf. strathearnensis</td>
<td>No representative samples</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bolivina alazanensis</td>
<td></td>
</tr>
</tbody>
</table>

These values apply per a zone, and not per a sample, so as to aid zone comparison. However, it must be born in mind that as a result, taxa abundance fluctuations per a zone are lost and reference to the original range chart must be made.

**Lenticulina wallacei Zone**

The lowermost zone of the Acostian Stage, this is the oldest zone considered in this study. Although broadly similar, the data of this study and that of Renz (1948) show notable disparity. Renz (1948) defined this zone upon the significance of Astocolus sublituus, Bolivina alazanensis, B. pisciformis, Cibicides mantaensis, Lenticulina wallacei, Planularia venezuelana, Planulina subtenuissima, Pseudoglandulina conatula, Saracenaria senni, Siphogenerina transversa, and Valvulineria venezuelana. However, of these A. sublituus, L. wallacei (the named taxon), P. venezuelana, S. senni, and V. venezuelana do not occur in this data set. Renz expanded this definition to confine Astocolus sublituus, Lingulina grimsdalei, Marginulina cf. glabra var. obesa, Pseudogaudryina alazanensis, and P. jacksonensis var. abnormis to the zone. However, none of these taxa were found in this study.
In contrast, several taxa not recognised by Renz were recovered in this study. *Alveovalvulina suteri* occur in low abundances, but were unrecognised by Renz. *Cancris panamaensis* is evident in this study but Renz reported it only within the younger Acostian and Lucian sediments. *Clavulina*, *Clavulinoides*, and *Cyclammina* taxa occur frequently within this zone in this study, but Renz did not recover these taxa. Similarly, *Glomospira charoides*, evident in this study was unrecorded by Renz, who only encountered *G. gordialis* occasionally in younger Zones. This study found two additional *Haplophragmoides* species unknown to Renz. *Karreriella* taxa are identified from this section for the first time. *Recurvoides* genera unknown to the earlier study and *Reticulophragmium* taxa, are present. *Planulina* taxa appear to occur out of zone in this study, as do *Pleurostomella*, *Plectofrondicularia* and *Pulvinulinella*. Additional *Siphogenerina* genera to those of Renz are also common. *Popovia* taxa occur in this Zone as in subsequent younger sediments, and are previously unknown to this area.

In comparison, Renz encountered several genera not found in these samples. An obvious discrepancy exists amongst the *Uvigerina* and *Textularia* genera. This study only encountered *T. crassisepta*, Renz found several species in addition to this one. *Uvigerina*, while frequent in both studies, are quite disparate at the species level. This may be a result of differing taxonomic concepts. However, both Renz (1948) and this study reveal comparative frequencies of *"Uvigerinella" sparicostata*. Renz recorded additional species of *Siphogenerina*, *Saracenaria*, *Pullenia*, *Pseudoglandulina*, *Pseudogaudryina*, *Martiontiella*, *Lenticulina*, *Gyrinoides*, *Frondicularia*, *Ehrenbergina*, *Bolivina*, and *Astoculus* taxa to those of this study. However, both studies hold almost 60 taxa in common implying a reasonable correlation can be made.

*Valvulina flexillis* was found in this zone by Renz (1948) and in this study.

**Siphogenerina transversa Zone**

The upper zone of the Acostian, the *Siphogenerina transversa* Zone in this data set digresses from the classic sense of Renz (1948). While the named taxon is present, and *Lenticulina wallacei*, *Saracenaria senni*, and *Pseudogaudryina jacksonensis abnormis* absent, other species regarded as restricted to this zone are not present, for example: *Anogerina illingi*, *Anomalina alazanensis*, *Bolivina inconspicua*, *Cassidulina cf. californica*, *Cassidulina delicata*, *Gaudryina thalmanni*, *Guttulina jarvisi*, *Lenticulina protruberans*, *Planulina dohertyi*, *P. marialana*, *Pulvinulinella jarvisi*, *Textularia concava*, *T. falconensis*, *T. kugleri*, *T. latickeri*, and *Vulvulina spinosa miocenica*. Renz considered his *Haplophragmoides* sp. to be restricted to this zone also, however, this study identifies additional *Haplophragmoides* species which extend beyond this zone into both younger and older sediments. Similarly, *Pleurostomella alterans*, considered by Renz to be restricted to the *Siphogenerina transversa* Zone extends into both younger and older zones of this data set.

By contrast, this study has identified considerable numbers of *Alveovalvulinella pozonensis* and *Alveovalvulina suteri* not recognised by Renz. In addition, the presence of various *Ammodiscoides* and *Ammodiscus* species were not noted previously, a case in point for the
Cyclammina as well. Eggerella, Gravellina, Jarvisella, Karreriella, Popovia, Recurvoides, Reophax, Reticulophragmium, Saccammina, Spiropsammina and Trochammina species are reported here for the first time. These additional taxa are all agglutinated genera adding credence to the proposal that much discrepancy exists as a product of greater agglutinating recognition at present in comparison to the past.

Taxa common to Renz (1948) and this study are sufficient to warrant correlation. These include: Bolivina, Brizalina, Bulimina, Buliminella, Cassidulina, Chilostomella, Cibicides, Ehrenbergina, Eponides, Lenticulina, Marginulina, Melonis and Plectofrondicularia genera amongst others, and number approximately 40. Renz identifies a greater number of Lenticulina taxa than apparent in this study, this is also true of the Cassidulina, Gyrinoides and Textularia. In the case of Textularia, this may be attributed to taxonomic discordance between Textularia and other elongate agglutinating genera such as Eggerella, Gravellina, Jarvisella, Reophax, etc. A taxonomic discrepancy is most likely attributable to the Glomospira discrepancy and Uvigerina inconsistency. Both studies identify the occurrence of agglutinating genera Alveovalvulinella pozonensis, its variation crassa, and Valvulina flexilis.

**Globorotalia fohsi Zone**

The presence of Siphogenerina transversa within this Zone extends its limit beyond its restriction in its taxon Zone and hence disputing the validity of both zones. While Brizalina pisciformis is present in substantial abundance, this is regarded as insufficient to unquestionably attribute the zone.

A marked increase in the recorded number of agglutinating taxa is seen in this data set compared with Renz (1948). Alveovalvulinella suteri, unrecognised by Renz, is abundant in these samples. Ammodiscus and Ammodiscoides taxa are present, where previously they remained unrecorded. In addition, several taxa of Cyclammina and Eggerella are found over the identifications of Renz. Although Haplophragmoides carinatus is identified in both studies, this investigation reveals five additional species of Haplophragmoides. Various elongate forms including Jarvisella, Karreriella, and Karreulina are found in the samples of this study and not recorded by Renz. This is also true of two species of Pseudogaudryina, Recurvoides, several species of Reophax, four species of Reticulophragmium, and the genera Spiroplectammina and Spiropsammina. Textularia species show a definite discrepancy, while both data sets contain a comparative number of Textularia species, only two of these species are in common. A certain degree of discordance exists between the species assignments of Bolivina, Bulimina, Cassidulina, Cibicides, Gyrinoides, Gryroidinoides, and Uvigerina. However, this study contains almost 50 species in common with Renz (1948) indicating a relatively good taxonomic consistency.

Alveovalvulinella pozonensis and A. pozonensis crassa, two very distinctive species, are both common to each data set. As are Valvulina chapmani and V. flexilis.
Valvulineria herricki Zone

The uppermost Zone of the Araguatian Stage, the Valvulineria herricki Zone, is largely a agglutinated assemblage unrecognised to a large extent by Renz. In general, the calcareous taxa correspond to both studies, taxonomic contrariety responsible for the discrepancies amongst the Uvigerina, Plectofrondicularia, Lenticulina, Cibicides, and Astocolus genera. However, the presence of Brizalina pisciformis and absence of the named taxon, not to mention the abundance of Siphogenerina transversa beyond its zonal limit, raise some questions over the validity of the Zone.

It is amongst the agglutinating taxa that the major discrepancy is seen. Renz recognised few agglutinating genera, and identified to a taxon level only rarely. Alveovalvulinella pozonensis and A. pozonensis crassa represent two of the agglutinating species common between the data sets, these are accompanied by Textularia crassisepta, T. abbreviata, Vulvulina jacuraensis, Pseudogaudryina bullbrooki, Haplophragmoides coronatum, Clavulina carinata, Ammodiscus incertus and Ammobaculites strathermensis. Alveovalvulinella suteri, unrecognised by Renz, is abundant in this data set. The zone contains three species of Ammodiscus in this data compared to Renz's single identification, and a further three species of Ammodiscoides not apparent to the earlier study. Similarly, the presence of Budashevella multicameratus went unnoted by Renz, as did various Cyclammina species, Discaminoides toberi, two Eggerella taxa, Gravellina narivaensis, multiple Haplophragmoides species, Jarvisella karamatensis, various Karreriella and Karreulina, and two Recurvoides taxa. For Renz's single informal Reophax identification, these samples revealed four Reophax species and a further two Subreophax taxa. Renz did not recognise any representatives of Reticulophragmium, Spiropsammina, Popovia, and Saccammina. Spiroplectammina barrowi, present in the samples observed in this study was likewise overlooked by earlier work. Here Trochammina cf. pacifica and three associated members of the genus are found out of zonal constraints. Interestingly, although Renz notes a diverse Textularia fauna, at the species level this bears little resemblance to the fauna revealed within these road section samples. Valvulina flexilis, absent from Renz's data in this zone, is abundant in this data set making this the youngest extent of the A. S. F. s. s. as according to Renz's definition.

Notwithstanding these obvious discrepancies, the two studies identified almost 70 common taxa suggesting substantial equivalence.

Margulinopsis basispinosus Zone

This is the lowermost Zone of the Lucian Stage as defined by Renz (1948). The data set of this study would appear to represent a certain degree of reworking between this zone and the overlying L. senni zonules. For instance, the only occurrence of L. senni within the section occurs within this zone of this data set. In addition, taxa more representative of the L. senni zonules according to Renz (1948), are found within this zone of this study, i.e.: Marginulina subbulata, Martiontiella pallida, and Textularia abbreviata.
However, the scheme of Renz applied to this study do share some common taxa: *Brizalina cochei*, *Bolivina isidroensis*, *B. pozonensis*, *Bulimina alazanensis*, *B. inflata*, *B. cf. inflata*, *B. inflata alligata*, *B. pupoides*, *Buliminella basistriata nuda*, *Cancris panamaensis*, *Cassidulina crassa*, *Cibicides americans*, *C. cartensi*, *C. compressus*, *C. concentricus*, *Eponides umbonatus ecuardorenensis*, *Gyrinoides parva*, *Gyroidinoides venezuelana*, *Haplophragmoides carinatus*, *H. coronatum*, *Lenticulina americanus*, *L. spinosus*, *L. clerici*, *L. formosus*, *L. lotus*, *L. melvilli*, *Nonion costiferum*, *Nonion incisum*, *Plectofrondicularia floridana*, *P. cf. longistriata*, *Pseudogaudryina bullbrooki*, *Pullenia salisburyi*, *Saracenaria latifrons*, *S. schnecki*, *Siphogenerina lamellata*, *Siphonia pozonensis*, and *Virgulina pontoni*. Taxonomic discrepancy may account for the erroneous occurrence of *Brizalina subaenariensis mexicana*, and various *Cibicides* and *Uvigerina* taxa in this data set not apparent to Renz. In total, the two works share over 40 taxa in common implying some correlation.

**Lenticulina senni Zone**

Following the lexicon of Blow (1959), the three zonules of the *Lenticulina senni* Zone of Renz (1948) have been incorporated wholly within the *L. senni* Zone. Renz (1948) erected the zonules as older sub-components of the younger defined zone. Blow (1959), recognised the extreme facies influence within the zone and zonules made clear distinction problematic, particularly at the Pozón-El Mene road section, and hence fully combined the system.

The three zonules all show elements in common with the *L. senni* Zone and are discussed individually below. In general, *Bulimina inflata*, *Buliminella basistriata nuda*, *Cibicides americanus*, *C. concentricus*, *Eponides umbonatus ecuardorenensis*, *Gyrinoides parva*, *G. venezuelana*, *Haplophragmoides carinatus*, *Lenticulina americanus*, *L. spinosus*, *Nonion costiferum*, *Nonion kemensis*, *Planulina mexicana*, *Saracenaria schnecki*, *Siphonia pozonensis* and *Textularia panamaensis* are all common to Renz's *L. senni* s. s. Zone and the zonules therein as defined by Blow (1959) and adopted in this study. Elements of the genera *Cancris*, *Cassidulina*, and *Plectofrondicularia* are common between the two studies. Taxonomic confusion may reflect the variation in *Bolivina*, *Brizalina*, and *Uvigerina* species identifications, but however goes no way to rationalise the only occurrence of the named taxon to the zone above its namesake.

**Marginulina superbus - Trochammina cf. pacifica zonule**

The first zonule of the *Lenticulina senni* Zone, the *Marginulina superbus - Trochammina cf. pacifica* zonule bears little resemblance between the two data sets. Renz (1948) notes the concurrent occurrence of *Amphistegina lessonii*, *Trochammina cf. pacifica*, *Textularia panamaensis*, and occasionally *Ammonia beccarii*. Of these indicator species, only *T. panamaensis* is present in the samples of this study. Taxa the two data sets share are limited to *Bulimina inflata*, *Buliminella basistriata nuda*, *Cibicides americanus*, *Gyrinoides parva*, *Haplophragmoides coronatum*, *Lenticulina americanus*, and *Nonion kemensis*. Taxonomic ambiguities may explain the respective occurrences of *Bolivina advena* and *B. floridana regularis*, *Brizalina simplex*, *Brizalina multicostata* and *Brizalina subaenariensis mexicana*; and
various Cassidulina and Uvigerina taxa between the data of Renz and this study. However, after rigorous consultation with holotype descriptions, this is considered unlikely.

The low frequency of many taxa found in this study and not that of Renz, and vice versa, may be disregarded zonally as inconsequential. However, relatively abundant Cibicides concentricus and Cibicides isidroensis in this study, and Eponides parantillanum in Renz's study, respectively not mirrored, remains equivocal. The studies share less than ten taxa in common, making absolute correlation dubious at best. The shallow palaeoenvironment assigned by Renz to this zonule may go some way to explain the variegated nature of the fauna.

Textularia panamaensis zonule

The Textularia panamaensis zonule continues this trend of little in common between the two studies. The named taxon is not apparent in the samples used for this study, other morphologically disparate Textularia taxa are present in preference. A high frequency of Uvigerina peregrina is noted in this study instead of Uvigerina isidroensis noted by Renz, Siphogenerina genera also record a high frequency not observed by Renz. The Lenticulina / Gyroidina / Eponides / Cibicides fauna recorded in this study was not apparent to Renz, who similarly recovered no Haplophragmoides species. The high frequency of Cibicides americanus, C. mataensis and Cassidulina delicata also remains ambiguous. Renz records low frequency Bolivina taxa, however, in this study substantial recordings of Bolivina floridana regularis, Brizalina pisciformis and B. subaenariensis mexicana are made, taxonomic adulteration is unlikely. The significant presence of Alveovalvulinella pozonensis in this study was also not evident in Renz's data.

Many taxa recorded in this zonule of this study are of low frequency, negating their zonal significance and supporting the conclusion of Renz (1948) and Blow (1959) of a varied, shallow environment, subject to the waxing and waning of genera. In common, the study of Renz (1948) this data record comparable abundances of Nonion kernensis, Lenticulina calcar, Cancris sagra, Buliminella basistriata nuda, and Bulimina inflata. However, the few elements in common remain insufficient to assuredly correlate the zonation.

Elphidium poeyanum - Reussella spinulosa zonule

The uppermost zonule of Renz's Lenticulina senni Zone, the Elphidium poeyanum - Reussella spinulosa zonule displays a clear discrepancy. This zonule was noted by Renz (1948) to be severely facies influenced and ephemeral, to such an extent that it is completely absent from the El-Mene section. However, this study does not reveal the Elphidium poeyanum - Reussella spinulosa s. s. from the Pozon section.

Renz defined this zonule upon the basis of the frequency of Ammonia beccarii, Elphidium poeyanum, and Reussella spinulosa, these taxa are not recovered in this study. However, other elements of Renz's fauna are identified, for example Bulimina inflata, Buliminella basistriata nuda, Cibicides americanus, and Nonion kernensis are evident in both studies. Many of the taxa
found in this study occur at low frequencies, adding credence to a marginal habitat environment subject to varied micro-habitats and facies influence. The Lenticulina fauna noted in this study is completely absent from Renz's scheme. Similarly, the samples of this study reveal high frequencies of agglutinating taxa Valvulina flexilis and Alveovalvulinella pozonensis not apparent in Renz's data until the older early Araguatian and Acostian Zones. The high frequency of Brizalina subaenariensis mexicana may be taxonomic misdemeanour with Renz's B. simplex frequency, however, this is unlikely. In addition, Bolivina floridana regularis occurs at a high frequency in this study, but is absent in the study of Renz. Other Uvigerina and Textularia taxa are not taxonomically comparative to elements of Renz's faunule. Of comparable perplexity is the high frequency of Uvigerina peregrina and Siphogenerina transversa, not present in Renz's definition of the zonule. S. transversa is regarded by Renz as a zonally definitive taxa within the Acostian, not present in younger sediments, while U. peregrina is not recorded within the fauna.

Clearly some discrepancy exists within the definition of this zonule. This is most likely a product of shallow, lagoonal conditions in equatorial conditions subjecting the benthos to pronounced intra-habitat variability, and rendering any attempt at zonal refinement impracticable.

The subsequent planktonic zonation of Blow (1959), based upon the Pozón-El Mene Road section examined in this study consists of 7 Zones and 8 sub-zones. Blow examined over 700 auger and pit samples from the road section, Renz's (1948) Loma Luca samples and elements of three wells in the Pozón-El Mene area.
Table 10. Sample location in Zones of Blow (1959):

<table>
<thead>
<tr>
<th>Zone</th>
<th>Sub-zone</th>
<th>Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Globigerina bulloides</em></td>
<td></td>
<td>2635; 2634; 2633; 2632</td>
</tr>
<tr>
<td><em>Sphaeroidinella seminulina</em></td>
<td></td>
<td>2631; 2631.2; 2631.3; 2630; 2629; 2628; 2627; 2626; 2625; 2624</td>
</tr>
<tr>
<td><em>Globorotalia menardii</em> / <em>Globigerina nepenthes</em></td>
<td></td>
<td>2623; 2622; 2621; 2620</td>
</tr>
<tr>
<td><em>Globorotalia mayeri</em> s.l.</td>
<td><em>Globorotalia mayeri</em> / <em>Globorotalia nepenthes</em></td>
<td>2619; 2601; 2602; 2603; 2604; 2605; 2606</td>
</tr>
<tr>
<td></td>
<td><em>Globorotalia mayeri</em> / <em>Globorotalia lenguensis</em></td>
<td>2607; 2608; 2609A; 2609B; 2610</td>
</tr>
<tr>
<td><em>Globorotalia fohsi</em> s. l.</td>
<td><em>Globorotalia fohsi robusta</em></td>
<td>2611; 2612; 2613</td>
</tr>
<tr>
<td></td>
<td><em>Globorotalia fohsi lobata</em></td>
<td>2614; 2515; 2616</td>
</tr>
<tr>
<td></td>
<td><em>Globorotalia fohsi fohsi</em></td>
<td>2617; 2618; 2701; 2702</td>
</tr>
<tr>
<td></td>
<td><em>Globorotalia fohsi barisanensis</em></td>
<td>2708</td>
</tr>
<tr>
<td><em>Globigerinatella insueta</em> s.l.</td>
<td><em>Globigerinatella insueta</em> / <em>Globigerinoides bispherica</em></td>
<td>2709; 2710; 2711</td>
</tr>
<tr>
<td></td>
<td><em>Globigerinatella insueta</em> / <em>Globigerinoides trilobata</em></td>
<td>2713; 2714; 2715; 2716; 2717; 2718; 2719</td>
</tr>
<tr>
<td><em>Catapsydrax stainforthi</em></td>
<td></td>
<td>2720; 2721; 2722; 2723; 2724; 2725</td>
</tr>
</tbody>
</table>

This study has revisited the Pózon-El Mene Road Section studied by Blow (1959), and in as much, correlation between the two studies should be somewhat more accurate.

**Catapsydrax stainforthi Zone**

The oldest Zone of Blow (1959), the *Catapsydrax stainforthi* Zone is a partial range within the *Lenticulina wallacei* Zone of Renz (1948). It was defined by Blow through the limited occurrence of *Catapsydrax dissimilis* and *Globigerinatella insueta*, *C. stainforthi* constituting a ‘conspicuous member of the zones fauna’. The very base of this zone is not seen at the Pózon-El Mene Road Section (Blow 1959).

The benthic fauna of both studies do show some equivalence. Approximately 30 taxa are in common, surprisingly low considering sampling location and corresponding taxonomic approach. Blow recognises *Ammodiscus* and *Ammobaculites* not found in this study. In addition, Blow identifies *Anomalinaeoides trinitatensis* and *Astocolus ovatus* consistently throughout the Acostian, Araguatian, and early Lucian not apparent in this study. Taxonomic discordance may account for various *Bolivina, Brizalina, Haplophragmoides, Lenticulina, Siphogenerina,* and *Uvigerina* discrepancies. However, *Lingulina* and *Laticarinina* were not encountered in this study and represent some demarcation for the lower component of the section according to Blow. Blow also distinguishes *Martinottiella pallida* as a significant component throughout much of the section, this is unacknowledged in this study, however, *M. communis* is present, and may represent a taxonomic disagreement. Similarly, the agglutinating genus *Pseudogaudryina* was not evident in this zone, but apparent to Blow.
Conversely, this study revealed several taxa unknown to Blow throughout the section. Many of these occur in low abundances and are not discussed herein. However, the abundance of *Pulvinulinella jarvisi* in this study, as that of *Plectofrondicularia* taxa, *Globobulimina ovata*, *Clavulinoides* taxa, and *Chilostomella ovoidea* remains un-reconciled.

To eliminate as best as possible taxonomic ambiguities amongst *Nodosaria* fragments, the taxa were grouped in this study to a generic level, this data displays reasonable correlation to that of Blow throughout the section. *Valvulina flexilis* is found in both studies in this Zone.

**Globigerinatella insueta s. l. Zone**
This Zone as defined by Blow is divided into two subzones and extends across the *L. wallacei* / *S. transversa* zonal boundary of Renz (1948).

**Globigerinatella insueta / Globigerinoides trilobata subzone**
The absence of *Globigerinoides bispherica* distinguishes this subzone from the overlying subzone. *Globigerinoides triloba triloba* is common. This subzone spans the boundary between the *L. wallacei* and *S. transversa* Zones of Renz (1948).

Correlation here between the two studies remains less precise than would have been expected, less than two dozen benthic taxa are in common. Much of the disparity occurs amongst the taxa found awry in the underlying *Catapsydrax stainforthi* Zone. However, in this case, two distinctive species of *Bolivina* and *Brizalina*, *B. alazanensis* and *B. floridana regularis* occur in this study, but not that of Blow, taxonomic confusion is unlikely. This also applies to the occurrence of *Bulimina inflata alligata* in this study and not that of Blow. The two studies recognise differing species of *Textularia*, and Blow also encounters a considerable occurrence of *Textulariella miocenica*, unknown throughout the section in this study. Both studies recover similar magnitudes of *Valvulina flexilis*.

**Globigerinatella insueta / Globigerinoides bispherica subzone**
The co-occurrence of the two named taxa defines this subzone according to Blow. Blow recognised phylogenetic trends amongst the *Orbulina*, *Biorbulina*, and *Globigerinoides bispherica* within this subzone. This subzone is contained wholly within the *S. transversa* Zone of Renz (1948).

Correlation here remains disappointing amongst the benthic fauna, less than two dozen taxa are common to both studies. Most of these are taxa relatively frequent throughout the section in both studies. Much of the disparity occurs amongst the same taxa as the previous two zones. In addition, *Bolivina tenuistriata* has become abundant in the samples of this study, but remains absent from Blows data. *Eggerelia karamatensis* is also now notable in this study, but unknown to Blow. It may be argued that taxonomic confusion may go some way to explain the single occurrence of *Frondicularia* in this data set, although not matching the species designation of Blow. This approach can tentatively be applied to the *Glomospira* impasse, Blow consistently
identifies *G. gordialis*, this study only encountered *G. charoides*. However, it becomes difficult to stretch the argument to *Haplophragmoides* taxa, where substantial continued altercation exists. While some coherence is apparent amongst the *Lenticulina* of the two studies, Blow has considerably more species than evident in this study.

This subzone represents the initial appearance of several agglutinating taxa with inner structures and alveoles unnoted by Blow. These include *Alveovalvulinella suteri*, *Popovia* taxa, and *Jarvisella karamatensis*. In addition, typical r selected taxa, such as *Reophax* appear for the first time in this data set. *Valvulina flexilis* is common to both studies.

**Globorotalia fohsi s. 1. Zone**

This zone as defined by Blow is divided into four subzones upon the basis of *G. fohsi* subspecies. It extends from the upper limit of the *S. transversa* Zone, through the *G. fohsi* Zone, and into the lower extent of the *V. herricki* Zone of Renz (1948).

**Globorotalia fohsi barisanensis subzone**

Encompassed within the *S. transversa* Zone of Renz (1948), this subzone is recognised through the co-occurrence of the named taxon, *Orbulina suturalis*, *O. universa*, and *Biorbulina bilobata*, and the absence of *Globigerinatella insueta*.

Faunal similarity between the two works is disappointingly poor, amongst the benthic fauna approximately 20 taxa are shared by both works. In general most taxa record 'scarce' occurrences, rendering 'significant' taxa difficult to identify.

This study displays a sudden reduction in the *Bolivina*, *Brizalina*, and *Gyrinoides* component of the fauna, while agglutinating elements with inner structures initially observed in the underlying subzone become more prevalent. These are joined with the initial appearance of sundry *Reticulophragmium* species. Interestingly, this studies data set also records a loss of the previously scant *Textularia* elements, an event not evident in Blow (1959). In addition, this study records a low abundance of *Valvulina flexilis*, absent from Blows data set.

**Globorotalia fohsi fohsi subzone**

This subzone spans the *S. transversa / G. fohsi* zonal boundary of Renz (1948). Blow characterised it through the presence of the named taxon and *Globorotalia menardii praemenardii*. He also considered *S. transversa* to become extinct towards the middle of the interval, this data set supplies evidence to the contrary.

Approximately 30 benthic taxa are shared between the two studies in this subzone, delineating a significant improvement in correlation. However, the data set of this study displays a notable increase in agglutinating genera. *Ammodiscoides* and *Ammodiscus* both occur in greater
abundance in this study than that of Blow, there is also a striking return of the *Bolivina / Brizalina* element to the fauna in the data set of this study. *Budashevella multicameratus* occurs in significant numbers in this study, as do various *Cyclammina* taxa. *Gravellina nairvaensis* becomes relatively common, out of zone in comparison to Blow's work, and *Haplophragmoides* taxa become abundant relative to Blow's species count. Perversely, Blow recorded several *Gyrinoides* and *Gyroidinoides* species not apparent within the samples of this study. *M. communis* has become abundant in the samples of this study as well as *Popovia, Reophax* and *Reticulophragmium* species. *Saccammina* species become abundant and *Textularia* taxa return to the data set of this study, though differ at the species level with that of Blow. This zone also records the first occurrence of *Trochammina* species and the distinctive *Veleronoides veleronis* in extremely high abundance. Taxonomic confusion may be responsible for disparity amongst the *Plectofrondicularia*.

This data set records the presence of *Valvulina flexilis*, not present in that of Blow.

**Globorotalia fohsi lobata subzone**

This subzone, wholly within the G. *fohsi* Zone of Renz (1948), is characterised by Blow by the presence of the named taxon, *Globorotalia menardii praemenardii* and *Globorotalia scitula gigantea*. *Globigerina bulbosa* and *Sphaeroidinella seminulina kochi* appear for the first time.

Approximately 40 benthic taxa are held in common in this subzone, continuing the trend of improved correlation. The agglutinating taxa continue to dominate the additional taxa found within this study, particularly those with inner structures as noted in the older subzones. *Clavulinoides* species become abundant and *Pavontina styrica* makes its only appearance. *Spiroplectammina barrowi* becomes common and this data set records a relative influx of *Textularia* species.

This data set records additional *Cibicides* taxa over that of Blow. However, Blow continued to record extra *Gyrinoides* and *Gyroidinoides* over this study. *S. transversa* is found in this data set in abundance out of zone.

*Valvulina flexilis* continues to occur in abundance in this data set.

**Globorotalia fohsi robusta subzone**

The last of the G. *fohsi* s. l. subzones, this is wholly contained within the *Valvulinera herricki* Zone of Renz (1948). Defined by Blow by the presence of the named taxon and the phylogenetic trend from *Globorotalia menardii praemenardii* to *G. menardii menardii*.

Over 30 benthic species are held in common within this subzone. The dominance of the agglutinating component of the fauna continues into this subzone, as above, particularly those with inner structures. The *Bolivina / Brizalina* element of the fauna from this data set expands slightly, the *Cibicides* maintain a comparative frequency. *Melonis pompieloides* is found in
abundance out of zone as according to Blow, as does S. transversa. Vulvulina jacurensis occurs in abundance, this is unrecorded by Blow, and V. flexilis continues its presence.

**Globorotalia mayeri s.l. Zone**
Blow divided this Zone into two subzones. It spans the boundary between the Valvulineria herricki Zone and Marginulina basispinosus Zone of Renz (1948).

**Globorotalia mayeri / Globorotalia lenguaensis subzone**
This subzone is wholly within the extent of the V. herricki Zone of Renz (1948). Defined by Blow, it is constrained by the co-occurrence of the two named taxa combined with the absence of Globorotalia fohsi robusta and Globigerina nepentes.

Benthic correlation remains less than perfect in this subzone as previously, less than 40 taxa common to both studies. The agglutinating component continues to account for most of the discrepancy, this study identifying genera unrecorded by Blow. This study identifies several additional species of Ammodiscus over that of Blow and some characteristic Ammodiscoides taxa. Budashevellla multicameratus increases its dominance, as does Eggerella forestensis and Gravellina narivaensis. Several Haplophragmoides taxa are identified in addition to those of Blow, and Carreriella and Karreulina species become prevalent. Jarvisella karamatensis with its distinguishing invaginations is found in abundance, and species with inner structures and alveoles continue their ubiquity in the section, these are now joined by the presence of Spiropsammina taxa. This study again finds plentiful Textularia species where Blow found none, Trochammina cf. pacifica is present in abundance, as is Veleronoides veleronis. The Bolivina component of the calcareous component of the fauna has expanded once again and Melonis pompielloides continues its predominance. S. transversa is still present in abundance out of Zone. Valvulina flexilis is present in abundance.

**Globorotalia mayeri / Globorotalia nepentes subzone**
Traversing the border of the Valvulineria herricki Zone and Marginulina basispinosus Zone of Renz (1948), Blow characterised this subzone through the co-occurrence of the two named taxa.

Correlation is slightly improved in this subzone amongst the benthic fauna, approximately 40 taxa are held in common. A noticeable loss of the agglutinating taxa is experienced in this data set, particularly those with inner structures. The Bolivina and Cibicides continue to show a high species frequencies and Pulvinulinaella jarvisi is found in abundance out of Zone as according to Blow. The trend of extraneous Textularia species continues, S. transversa is likewise present in abundance out of Zone. Valvulina flexilis, although less frequent, is present.

**Globorotalia menardii / Globigerina nepentes Zone**
Wholly confined within the Marginulina basispinosus Zone of Renz (1948), Blow defined this Zone upon the presence of Globigerina nepentes after the disappearance of Globorotalia
menardii. Globorotalia menardii menardii is typical and the phylogenetic trend from Globigerina praebulloides to G. bulloides is observed in this interval.

Benthic correlation dramatically decreases in this Zone to approximately two dozen taxa. The loss of agglutinating taxa is almost complete bar a few exceptions. Budashevella multicameratus, some Cyclammina and Haplophragmoides taxa are present at low frequency. Some Reophax species persist at reduced frequency. Textularia taxa are almost annihilated, although Valvulina flexilis continues at a scarce level. This study continues to find Bolivina and Cibicides taxa not recorded by Blow. S. transversa remains present out of Zone.

**Sphaeroidinella seminulina Zone**

Spanning the Marginulina basispinosus Zone, Marginulina superbus / Lenticulina senni, and Textularia panamaensis zonules of Renz (1948), Blow defined the interval through the continued presence of the two sub-species of the named taxon (S. seminulina seminulina and S. seminulina kochi).

The benthic fauna show a poor correlation, approximately a dozen taxa shared between the studies. The agglutinating component of the fauna is reduced to a minimal level, the calcareous element continuing to show discrepancy. This is particularly true of the Cancris, Cibicides, Bolivina, and Gyrinoides. This study has identified some Cyclammina over that of Blow. Valvulina flexilis is present in low numbers in both studies.

**Globigerina bulloides Zone**

Blows Globigerina bulloides Zone encompasses Renz's Elphidium poeyanum - Reussella spinulosa zonule and extends partially into the earlier Textularia panamaensis zonule. Blow found the planktonic fauna to become impoverished, and hence the zonal definition only applicable inter-regionally. The Zone is erected upon the disappearance of S. seminulina and the presence of the named taxon.

Benthic correlation is extremely poor, less than a dozen taxa shared between the studies. In general, this study has recovered a greater number of foraminiferal species over that of Blow, including a tangible resurgence amongst the agglutinating genera. Greatest dissimilarity exists amongst the Bolivina, Bulimina, Cassidulina, Cibicides, Eponides, Gyrinoides, Lenticulina, Plectofrondicularia, Siphonia, and Uvigerina taxa, where this study has identified species in addition to those of Blow. S. transversa occurs once again out of Zone. Amongst the agglutinating genera Textularia taxa are once again in greater abundance in this study and Valvulina flexilis is located out of Zone.
6.2. VENEZUELAN PALAEONENVIRONMENTAL INTERPRETATION

"When I am working on a problem I never think about beauty. I only think about how to solve the problem. But when I have finished, if the solution is not beautiful, I know it is wrong."

Buckminster Fuller (1895-1983)

The 57 samples of the Pozon - El Mene Road section span the Late Oligocene to Late Miocene (Messinian). Planktonic foraminifera recovery is poor and dating is extrapolated from Bolli, et. al. (1994, Table 71). The diverse benthic fauna (272 taxa) is readily divided into eight biofacies, ten sub-biofacies are apparent. The fauna indicates a slight shallowing palaeobathymetry, and evidence of some sea-level change. The biofacies are outlined below and summarised in Fig. 24, biofacies interpretations refer to Table 5 references, the reader is referred to Enclosure 1 for raw data. Biofacies are arranged in stratigraphic order.

Biofacies I - sample 2725
This biofacies is confined to the C. stainforthi Zone. The fauna is somewhat out of character with the overlying biofacies, sharing more affinity with Biofacies V (Langhian) and represents a significant environmental change. A high productivity, low oxygen, mid bathyal environment.

Although diversity is relatively low, particular taxa show extreme high abundances. Many of these taxa are considered excellent palaeoenvironmental indicators. Amongst the calcareous genera, the high abundance of Brizalina pisciformis and Osangularia jarvisi suggest low oxygen conditions and high organic flux respectively. Lenticulina, Dentalina and Haplophragmoides taxa are present in significant numbers so as to support a 'suboxic' interpretation, Uvigerina gallowayi basicordata similarly supports a high surface productivity episode. The co-occurrence of U. isidroensis and U. peregrina becomes a feature of much of this section and may be used in support of an interpretation of a fine grained organic rich sediment in an intermittent dysoxic environment at mid bathyal depths.

The relatively high numbers of Cassidulina laevigata suggest a lower bathyal depth, however Cibicidoides crebssi, Eponides umbonatus ecuadorensis, Hanzawaia mantaensis and Siphogenerina transversa are considered more upper bathyal indicators. Gyroidina altiformis is recorded throughout the bathyal realm, Martinottiella and Plectofrondicularia vaughani are known from bathyal to neritic depths. P. callifornica has a lower mid bathyal upper depth limit constraining this range slightly. Melonis pomplioides is known to bathymetrically migrate and is hence somewhat ambiguous.

The anomalous high occurrence of Clavulinoides sp. is of dubious implication.

Biofacies II - samples 2724 to 2718

This biofacies is largely dominated by calcareous genera suggesting that oxygen is not so extremely depleted so as to force 'r' selection amongst the agglutinating benthos.
Biofacies II comprises three sub-biofacies a, b, and c. Sub-biofacies a and c are broadly similar, b is depleted with regard to the fauna in a and c, and severely pyritised. Bathymetrically, the biofacies is comparable to underlying biofacies I, however, significant variation amongst the Bolivina / Brizalina taxa suggest oscillating relative oxygenation levels.

**Biofacies IIa - samples 2724 to 2723**
This biofacies is extremely similar to Biofacies I. Although the co-occurrence of *U. isidroensis* and *U. peregrina* continues into this section in support of a fine grained high organic sediment with intermittent dysoxia at mid bathyal depths, the loss of high abundance values for *B. pisciformis, E. umbonatus ecuadorensis*, some *Lenticulina* taxa, *O. jarvisi*, and *U. gallowayi basicordata* suggests a relaxation in the high productivity, low oxygen system. The low influx of *Planulina* taxa may represent a slight shallowing.

**Biofacies IIb - samples 2722 to 2700**
This section is distinguished from the rest of Biofacies II by the sudden and severe loss of the majority of the fauna. The few remaining individuals are almost exclusively genera that preserve as internal pyrite moulds. This implies severe pore water acidity forcing post-mortem dissolution of the assemblage subsequent to reducing conditions sufficient enough to precipitate pyrite.

Surviving with some test intact, *U. peregrina* is recovered at a depressed frequency. The remaining assemblage contains as internal moulds *Chilostomella ovoidea*, a oxygen minimum zone (OMZ) indicator, *Globobulimina ovata*, common in dysoxic environments, and additional taxa common as pyrite moulds. These two taxa are not recovered elsewhere in the biofacies at significant frequencies, implying a sudden expansion of the OMZ and concomitant acidic pore water formation removing susceptible foraminiferal tests in an upper bathyal setting.

This assemblage, while clearly unrepresentative of the life assemblage, gives some indication of the sudden severe environmental fluctuation experienced at this interval. This is coincident with a sudden (though slight) sea-level fall in the Late Burdigalian (Haq, et al. 1987). A lowering of sea-level introduces increased nutrient flux and chemical yield to the water column encouraging the intensification of oxygen minimum conditions and the formation of erosive bottom waters.

**Biofacies IIc - samples 2719 to 2718**
This interval returns for the most part to the fauna of IIa, however, some significant differences are apparent.

While the presence of *Brizalina alazanensis* is indicative of low oxygenation values to the now absent *B. pisciformis, Bolivina floridana regularis*, under the same scheme, is more suggestive of slightly increased oxygen. *Gyroidina* taxa are more commonly associated with suboxic conditions. The typical taxon of *Buliminella basistriata nuda* is considered a proxy for high organic carbon. *Uvigerina capayana* is more common in clay rich, dysoxic conditions.
The influx of *Bulimina inflata*, *Cibicides compressus* and *C. crebbsi* implies a mid to upper mid bathyal depth. The predominance of striate - costate *Uvigerina* taxa supports this interpretation. *Clavulinoides* sp., *Lenticulina*, *Plectofrondicularia*, and *Siphogenerina* all return to the assemblage implying a return to the conditions of biofacies IIa.

**Biofacies III - samples 2717 to 2711**

Biofacies III is a low diversity, low frequency unit characterised by poor preservation and pyritisation. A complete loss of the *Uvigerina* fauna is immediately apparent. Mid to upper bathyal.

Typical OMZ indicators such as pyrite moulds of *C. ovoidea* and *Pleurostomella alterans* are intermittent in this section. A slight influx of *Haplophragmoides* taxa towards the top of the interval with sporadic recovery of *Jarvisella karamatensis* indicates reduced oxygen and 'stressed' conditions. Similarly, low frequency *Valvulina flexilis* is observed throughout the section, indicative of moderate oxygen depletion and 'stressed' conditions, this implies a mid to upper bathyal palaeoenvironment.

This interval coincides with a major sea-level fall on the Haq, et al. (1987) curve at the Burdigalian / Langhian boundary.

**Biofacies IV - samples 2710 to 2701**

Biofacies IV represents a transitional phase. The fauna recovered in this section is varied, both agglutinating and calcareous genera are well represented. The fauna alters in character from the base of the interval to the top, in keeping with a migration towards sustained low oxygen conditions, possibly becoming slightly more severe with time. Bathymetry shallows from mid to upper mid bathyal.

The first appearance of *Alveovalvulinella pozonensis* and its variety *crassa* are considered to be proxies for 'stable' conditions. *Ammodiscus* species are more commonly associated with moderate oxygenation depletion. Interpretations of these two genera do not have to be contrary to one another. It may be suggested that the development of the 'alveolar' test in *Alveovalvulinella* is to facilitate more efficient gaseous exchange in sustained moderate oxygen depletion, as is often considered amongst the Cyclamminidae. The return to the section of *B. floridana regularis*, and appearance of *B. tenuisstriata* and *Eggerelia karamatensis* supports a moderately reduced ventilation hypothesis, although the presence of *B. alazanensis* at the base of the interval and a varied *Haplophragmoides* fauna is more indicative of slightly more severe oxygen deficiency. *J. karamatensis* occurs towards the centre of the interval, this is normally considered to indicate 'stress'. This is somewhat conflicting with the *Alveovalvulinella* data and difficult to reconcile. A distinctive 'Trochammina' interval is apparent towards the top of the biofacies, comprising of *T. sp. aff. altiformis*, *T. cf. pacific*, and *T. cf. squamata*, this is a clear organic input signal. High frequency *V. flexilis* data endorse a sustained moderate dysaerobic environment, becoming slightly more severe towards the top of the interval.
Of particular interest is the initial appearance of *Popovia johnrolandi* n.sp. toward the centre of this interval. As described elsewhere (see taxonomy), this taxon becomes more complex with time, possibly a response to prolonged and sustained depleted ventilation in the Agua Salada Basin. This taxon co-occurs to a certain extent with *Veleronoides veleronis*, possibly also a reduced oxygen indicator.

*Buliminella basistiata nuda* at the base of the interval is a proxy for high organic carbon input, possibly a hang over from the previous conditions in Biofacies III. Similarly, the flood of *Martinottiella, Bulimina, Bolivina, Cibicides* and *Uvigerina* taxa at the base of the interval may be viewed as a preservational lag. However, the co-occurrence of *U. isidroensis* and *U. peregrina* is more likely a continued signal for intermittent dysoxia.

*Ammodisoides turbinatus* towards the top of the section is recognised as an upper bathyal indicator. At the base, *B. inflata* is more implicative of a mid bathyal depth. *Cassidulina* taxa and *Cyclammina cancellata* are ambiguous palaeobathymetrically, however, the flux of *C. compressus, C. crebbsi* and *E. umbonatus ecuadorensis* support an upper middle to upper bathyal placement. Amongst the agglutinating genera, *Recurvoides* and *Reticulophragmium venezuelanum* are also seen as upper bathyal taxa. *Saccammina* is more commonly associated with an inner shelf setting.

**Biofacies V - samples 2618 to 2620**
This is complex high productivity zone subdivided into five sub-biofacies: a; b; c; d; e. It is observed fundamentally to change in character from an agglutinating characterised zone at sample 2618 to a calcareous dominated zone at sample 2620. Mid to upper bathyal.

**Biofacies Va - samples 2618 to 2611**
The first sub-biofacies of Biofacies V, this is a diverse, high frequency fauna. Agglutinating genera, while not dominating the unit, characterise it.

*Alveovalvulinella pozonensis* and its variation *crassa* are present in low numbers indicative of 'stable' conditions. The well represented *Cibicides / Cibicidoides* component of the fauna supports a relatively stable environment interpretation. However, the high frequency of *V. flexilis* suggests a more 'stressed' environment. *Bolivina rudderi* and *B. floridana regularis* suggest moderate oxygenation towards the top of the section, however intermittent recovery of *B. alazanensis*, and *B. pisciformis* implies less well ventilated conditions. High recovery of *Cassidulina* taxa support a less well ventilated scenario. *Cyclammina* taxa are more indicative of dysaerobic conditions. Elongate tapering taxa, such as *Eggerella, Gravellina* and *Textularia* while consistent with a dysaerobic interpretation, may also be an indication of 'r' selection in low oxygen conditions. *Fissurina* taxa in addition are a suboxic genus. *Hanzawaia* are often considered OMZ indicators, the flux of *Haplophragmoides, Lenticulina Nonion* and *Pullenia* taxa supporting a low oxygen explanation. Fluctuating occurrence of *U. capayana*, along with
associated *Uvigerina* taxa suggest intermittent high organic carbon input and affiliated dysoxia. Through this interval, it becomes apparent that the bond between *U. isidroensis* and *U. peregrina* is no longer as strong, *U. lirettensis* becoming a more dominant partner.

*Bulimina* taxa and *P. californica* suggest a mid bathyal setting, *Cassidulina laevigata* more typical of a lower bathyal position. *C. compressus*, *C. crebssi*, *C. mantanzaensis*, *E. umbonatus ecardorensis*, *H. mantaensis*, *S. transversa*, and *Siphonina pozonensis* indicate an upper mid to upper bathyal depth.

*Martinottiella communis* and *Melonis pomplioides* appear to co-occur towards the base of the unit (as in Biofacies I and Ila), *M. pomplioides* occurs alone toward the top of the section in a trend towards the loss of the agglutinating taxa and predominance of calcareous forms.

*P. johnrolandi* n.sp. continues its lineage through this interval. It continues to become more complex with time. *V. veleronis*, continues to co-occur with *P. johnrolandi*.

**Biofacies Vb - samples 2610 and 2609b**

This is an interval of poor preservation, but of a different faunal character to the pyrite intervals of sub-biofacies Iib and biofacies III. This interval coincides with a major sea-level fall at NN8 at the Serravallian / Tortonian boundary recorded by Haq, *et al.* (1987).

While this interval contains many of the characteristic pyrite internal mould taxa of previous poor preservation intervals, additional taxa suggest a differing environmental regime in this case.

Of particular interest is the apparent flux of agglutinating taxa *A. pozonensis*, its variation *crassa*, multiple *Ammodiscus* and *Ammodiscoides* taxa, *Budashevella multicameratus*, *G. narivaensis*, *J. karamatensis*, *P. johnrolandi* n.sp., *Spiropsammina uhligi* and *V. veleronis*. These taxa are generally accepted to imply conflicting oxygenation levels, however an upper bathyal position fits most genera. *Eggerelia* taxa, in tandem with other elongate tapering morphotypes including *Reophax*, *Subreophax* and *V. flexilis* suggests a degree of ‘r’ selection, *Haplophragmoides* species support a low oxygenation level. In addition, the high frequency recovery of complex *P. johnrolandi* n.sp. and co-occurring *V. veleronis*, and the introduction of *S. uhligi*, may be interpreted as a response to abrupt oxygen reduction.

The appearance of various calcareous taxa on either side of this two sample interval, the interval merely interrupting their range, suggests a brief period that either dissuaded their colonisation, or more likely, removed their tests from the sediment. As introduced earlier, a lowering of sea-level increases the chemical yield to the water column, in turn encouraging the dissolution of susceptible taxa through erosive bottom waters. The absolute increase of certain agglutinating taxa implies a chemical condition encouraging their brief proliferation in an opportunistic manner, for example, the flux of *T. pacifica* is indicative of high nutrient levels.
Biofacies Vc - samples 2609a to 2605
This interval sees a return to conditions similar to those of Biofacies Va, but with a loss of many agglutinating taxa in a general trend towards a calcareous assemblage.

Many taxa return to the section at similar frequencies as prior to the sub-biofacies Vb interruption, i.e.: Brizalina, Bulimina, Buliminella, Cassidulina, Cibicides, Cibicidoides, Hanzawaia, Lenticulina, Melonis, Nonion, Siphogenerina, Siphonina, and Uvigerina. Other agglutinating taxa are largely lost from the section, i.e.: V. veleronis, G. narivaensis, and Reophax taxa, suggesting a loss of the conditions favouring their selection.

Additional calcareous taxa appear in the section. Bolivina isidroensis, Cibicides americanus, and Plectofrondicularia floridana are apparent in significant numbers for the first time. Brizalina subaenariensis mexicana and Osangularia jarvisi suggest a low oxygen environment and high organic flux respectively. These conditions are clearly not so severe so as to exclude the calcareous genera in favour of the agglutinating 'r' selected morphotypes, but represent a mild dysoxia sufficient enough to modify a mid to upper bathyal assemblage noticeably.

Biofacies Vd - samples 2604 to 2603
This is a further poor preservation interval. This interval does not coincide with any sea-level low according to Haq, et. al. (1987).

Many genera traverse this interval unaffected, i.e.: B. floridana regularis, B. subaenariensis mexicana, Lenticulina americanus, L. spinosus, P. floridana, U. peregrina, and U. pilulata. However, many other species interrupt their ranges at this interval as with sub-biofacies Vb, i.e.: C. compressus, C. crebbsi, E. umbonatus ecuadorensis, G. venezuelana, H. isidroensis, and S. transversa. In addition, B. basistriata nuda appears to peak at this interval, implying selection for these individual conditions, typically high productivity.

In general the taxa data for this interval suggest a brief period of high organic flux and associated reduced oxygenation with no obvious sea-level causal mechanism. Palaeobathymetry is unconstrained, but likely to be consistent with the biofacies on either side of this interval.

Biofacies Ve - samples 2602 to 2620
The last of the sub-biofacies of Biofacies V, the interval is largely characterised by a return to the taxa of sub-biofacies Vc.

Bolivina floridana regularis and B. subaenariensis mexicana both peak in this interval at slightly differing samples indicating a slight progression of moderate oxygenation to depletion with time. This is coincident with a steady expansion of the Uvigerina component of the fauna typical of slight oxygen reduction at the mid to upper bathyal depth range.
Biofacies VI - samples 2621 to 2629
This interval is a low diversity, fluctuating abundance calcareous zone. The fauna is noticeably reduced, the taxa present appearing in an 'on / off' manner of 'noisy' data. Mid to upper bathyal.

Samples 2623, 2626, and to a certain extent 2629, represent 'on' phases of increased faunal counts. The faunal elements that turn 'on' at all or some of these points are *B. floridana regularis*, *B. subaenariensis mexicana*, *C. laevigata*, *C. americanus*, *H. concentricus*, *H. isidroensis*, *L. americanus*, *N. incisum*, *T. panamensis*, *U. isidroensis*, *U. litterensis*, *U. peregrina*, and *U. pilulata*. In combination this association suggests a periodic influx of organic carbon, forcing dysoxia at a mid to upper bathyal position. The flux of *C. laevigata* is clearly erroneous as a lower bathyal indicator. The 'off periods are likely to represent a post-mortem dissolution of the fauna in intensified 'on' conditions.

Biofacies VII - samples 2630 to 2631
A low abundance low diversity interval. This almost barren interval coincides with a slight sea-level fall on the Haq, et. al. (1987) eustatic curve in the early Tortonian.

Biofacies VIII - samples 2632 to 2635
The youngest biofacies of the Pozon - El Mene Road section. Again, this interval shows a manifest 'on / off' character in a largely calcareous fauna. Samples 2632 and 2634 are 'on' periods, 2633 and 2635 are 'off' intervals.

*Bolivina floridana regularis* and *B. subaenariensis mexicana* both 'turn on' with associated *Bolivina* and *Brizalina* taxa. Various *Bulimina* taxa emulate this trend to a lesser extent. Other taxa following this same pattern include members of the *Cibicidoides*, *Cibicides*, *Eponides*, *Gyroidina*, *Hanzawaia*, *Lenticulina*, *Melonis*, *Nonion*, *Siphogenerina*, *Siphonina*, and *Uvigerina* genera. Amongst the agglutinating taxa *V. flexilis*, *M. communis*, and *Eggerella* taxa exhibit the same system. Clearly, this is a return to the circumstance of Biofacies VI, here the slightly higher agglutinating frequency may indicate a marginal increase of oxygen depletion. As in Biofacies VI, 'off' periods are likely to be post-mortem dissolution of the fauna in intensified 'on' conditions.

Miocene palaeoceanographic events and the development of the Isthmus of Panama have had a profound effect upon this succession. The Isthmus of Panama elevated gradually disrupting circulation patterns as early as the Late Miocene (Duque-Caro 1990). Prior to the Mid Miocene, most coastal basins record a well aerated deep water environment. Early in the Mid Miocene the initial tectonic uplift of the Panama Sill occurred, forcing a deep water circulation barrier between the Atlantic and Pacific. In the latest Miocene this barrier is understood to have lessened to allow a brief period of communication between the two oceans, Early in the Pliocene the Isthmus emerged permanently. Benthic foraminiferal data is well documented in the Late Miocene / Pliocene (McDougall 1996), but less well recorded for the earlier Miocene. Other aspects of the meiofauna are popular for Pliocene study (Jackson, et. al. 1993).
These data record a period of high productivity and low oxygen conditions in the mid to early late Miocene, bordered on either side by periods of fluctuating ‘noisy’ data. Palaeoceanographically, this renders much of the data set ambiguous, however, some interpretations can be made. The literature review of Chapter 3, and accompanying summary diagram are the basis for the following interpretations.

Biofacies I as already mentioned, is of a different character to the overlying fauna and may reflect the transition of the faunal turnover of the mid Burdigalian in association with increased CaCO₃ dissolution. Naturally, ‘end member’ samples are inherently less constrained than a succession of samples, and to this end this interpretation of this biofacies must be treated with a certain degree of scepticism. Further sampling into the lower Burdigalian and Aquitanian should resolve this problem.

This benthic turnover is reflected in Biofacies II, III, and IV. During this period, the warming of the deep water masses and the increase in temperature gradients from the pole to the equator, in association with the Monterey Excursion. Possible correlation to sea-level change is mentioned above.

Biofacies V represents the onset of the initial raising of the Isthmus of the Panama and bottom water restriction. The abrupt change to a complex agglutinating fauna coincides with the initial uplift of the Panama Sill (McDougall 1985) obstructing intermediate water flow. It is reasonable to postulate that any water mass encountering this obstruction would be topographically forced to rise within the Gulf of Mexico and hence through the introduction of nutrients to the surface water, facilitate phytoplankton blooms and subsequent dysoxia. This combination of factors selects favourably for an agglutinating fauna, such as that of Biofacies V in the late Serravallian.

A degree of provincilisation occurs in Biofacies Va, with the recovery of A. pozonensis at the initial raising of the Isthmus. During the formation of Biofacies Vb, a fall in sea level accentuated the barrier to circulation forcing an expansion of the OMZ in association with increased nutrient input. Again, this is reflected by particular provincial conditions encouraging the proliferation of A. pozonensis in association with Ammodiscus and Ammodiscoioides taxa. Biofacies Vc suggests a slight sea-level rise permitting increased ventilation and a characteristic low oxygen calcareous fauna. Biofacies Vd remains anomalous, however, Biofacies Ve is clearly a reduced oxygen assemblage associated with reduced circulation and a raised Isthmus of Panama, though conditions were not as extreme as earlier within the biofacies.

The introduction of calcareous forms during the Tortonian implies improving aeration of the bottom water over time compared to that of the wholly agglutinating interval. While the interval remains a high productivity period, with associated low oxygen conditions, clearly a calcareous fauna is viable. Effected by sea level fluctuations, this data suggests that a short lived, or series of short lived, connections across the Isthmus of Panama facilitated an increase of ventilation and raised oxygen levels.
Biofacies VII and VIII represent continued intermittent Pacific-Atlantic shallow water connections. Biofacies VII coincides with a sea-level fall accounting for poor preservation. Biofacies VIII displays an exaggerated response to the disrupted shallow water connections in a clear on/off signal. Periodic influxes of cool aerated shallow water permit the sudden expansion of a largely calcareous reduced oxygen fauna. Intervening periods are too short lived for colonisation.

It is of note, that work conducted on Miocene samples from Colombia shows an abrupt loss of a 'Caribbean fauna' in the late Serravallian (Duque Caro 1990). The fauna is replaced by a 'Californian fauna'. This is consistent with a lost Caribbean connection at this point. Duque Caro (1990) described an interval in the lower Tortonian where an ephemeral shallow water exchange of the well aerated cool Californian Current took place to Colombia. It is reasonable to postulate that this initial raising of the Isthmus of Panama and subsequent 'ventilation episode' may be reflected in the Falcon Basin.
6.3. CABGOC 128-3 PALAEONENVIRONMENTAL INTERPRETATION

Ex Africa semper aliquid novi

Pliny, The Elder

The 77 composite 30' ditch cutting samples of CABGOC 128-3 span the Latest Oligocene (?) to Late Miocene (?). Planktonic foraminifera recovery is poor and dating is based upon Nannofossil work conducted by B. L. Shaffer. The diverse benthic fauna (248 taxa) is readily divided into five biofacies, seven sub-biofacies are apparent. The fauna indicates a slightly shallowing palaeobathymetry with time, and productivity intensification in association with an upwelling system and oxygen minima conditions. Some evidence of caving and down slope contamination is evident. Dissolution events are observed. The biofacies are outlined below and summarised in Fig. 25, biofacies interpretations refer to Table 5 references, the reader is referred to Enclosure 2 for raw data. Biofacies are arranged in down well appearance order as the nature of the samples render stratigraphic bottoms ambiguous.

Biofacies I - 630' to 2,310'

The first biofacies encountered down well and the youngest, this is a low diversity, low abundance interval. Preservation is extremely poor, foraminiferal recovery is sporadic. Upper bathyal.

*Textularia miozea* records an intermittent recovery throughout the interval suggestive of a dysaerobic environment, the presence of internal pyrite moulds of *Globobulimina affinis* intermittent *L. americanus* supports this suggestion. Rare *Cibicides* and *Cibicidoides* taxa are environmentally inconclusive.

*Sigmoilopsis schlumbergeri* and *Bulimina alazanensis* are ambiguous taxa, known to bathymetrically migrate and attributed to differing depths by differing workers. *S. schlumbergeri* is recovered as pyrite internal moulds indicating post-mortem dissolution. The occurrence of *Neoeponides campester* indicates an upper bathyal position.

This assemblage, while clearly unrepresentative of the life assemblage, gives some indication of the rapid severe environmental fluctuation experienced at this interval. Biostratigraphically, this interval is unconstrained, but known to be subsequent to post Tortonian. According to Haq, et. al. (1987), this was period of rapid sea-level fluctuation, poor preservation under these conditions is probable.

Biofacies II - 2,370' to 3,570'

This interval displays a marginal increase in diversity and abundance over Biofacies I. Preservation remains poor. Upper bathyal.

This interval is distinguished by the relative influx of *Bolivina* and *Brizalina* taxa typical of high productivity and dysaerobic conditions. *Bolivina advena* and *B. caudriae* indicate a dysoxic
environment at an upper bathyal depth. The presence of *Brizalina alazanensis* and additional 'compressed' forms implies a greater severity to the dysoxia. The typical taxon of *Buliminella basistriata nuda* is indicative of high productivity, the presence of *Uvigerina capayana* indicative of clay rich sediments commonly found in association beneath high productivity areas. The continued recovery of *L. americanus* supports this interpretation.

*S. schlumbergeri* is recovered as pyrite internal moulds typical of post-mortem pore water dysoxia and reducing conditions capable of removing most tests. Again, this biofacies is not age diagnostic, but known to be late to post Tortonian based on nannofossil stratigraphy.

**Biofacies III - 3,630' to 4,350'**

This biofacies is broadly similar to Biofacies II in the *Bolivina / Brizalina* element and continues a trend toward a steadily increasing diversity and abundance. Mid to upper bathyal.

Again, the *Bolivina / Brizalina* fauna continues to indicate a dysoxic environment, *B. basistriata nuda* continues to act as a proxy for high productivity, *U. capayana* is present as an indicator of an organic rich sediment. In addition to these taxa and their counterparts in Biofacies I and II, *Textularia kugleri* and *Textularia pozonensis* characterise this section. This genus is typical of dysaerobic facies, though gives an ambiguous bathymetric signal.

Towards the base of Biofacies III a marginal influx of agglutinating taxa becomes apparent. These, amongst others become the characteristic species of Biofacies IV. Nannofossil data suggests the interval to be Tortonian, no significant sea-level fall is coincident.

**Biofacies IV - 4,410' to 5,960'**

This is a complex high productivity zone subdivided into three biofacies; a, b, and c, largely upon preservational criteria. The zone comprises both calcareous and agglutinating genera in high abundance and diversity. Agglutinating genera distinguish the succession from this point down. Mid bathyal.

**Biofacies IVa - 4,410' - 4,650'**

The first of the sub-biofacies encountered down well, this is considered to be a poorly preserved extreme of the subsequent sub-biofacies IVb. Mid bathyal.

In this section, to a large extent, the loss of the dominant *Bolivina / Brizalina* taxa becomes common. Replacing these calcareous components, *Hanzawaia mantaensis* implies a deepening to upper mid bathyal depths, *Uvigerina spinosa* is more typical of a lower mid bathyal position. The presence of *U. lavicuiata* may be a product of caving, though its continued presence down well in greater numbers is problematic to interpret. Agglutinating components also contribute to this setting; *Recurvoides* is an upper bathyal taxa, *Reticulophragmium venezuelanum* a wide ranging bathyal taxon.
Cibicidoides taxa suggest a certain 'stability' to the environment, however the presence of Protoglobobulimina pupoides as pyrite internal moulds continues to indicate post-mortem pore water dysoxia and reducing conditions capable of removing susceptible tests. Uvigerina taxa attest to continued low oxygen conditions, U. capayana and U. isidroensis in particular. U. modeioensis is common adjacent to upwelling centres.

The sudden appearance of agglutinating taxa characterise this interval and palaoenvironmentmently are indicative of 'flysch' fauna in low oxygen conditions. The agglutinating fauna, while varied, contains few elements of known ecologic significance beyond the broad band low oxygen banner. Cyclammina taxa are known low oxygen species, as are Eggerella and Haplophragmoides. Eggerella and Karrerulina elements, as elongate, tapering, semi-infaunal taxa, re-establish a degree of 'r' selection in competitive conditions.

This interval is dated indeterminate, but known to occur between the mid to late Tortonian. Sea-level at this point fluctuated greatly (Haq, et. al. 1987) and may be indirectly responsible for poor preservation.

Biofacies IVb - 4,770' to 5,240'

This interval is a more representative fauna of Biofacies IV. Preservation at this interval is improved, diversity and abundance increased. The greatest increase in diversity is observed within the calcareous taxa. This is likely a product of improved pore water conditions facilitating better preservation in this susceptible group even though internal moulds of C. ovoidea and various Globobulimina and Protoglobobulimina taxa persist. In addition to the elements of Biofacies IVa the following taxa are observed. Mid bathyal.

Amongst the agglutinating genera, the first appearance of Alveolophragmium is consistent with a 'deep water' setting. Expansion of the Lenticulina group implies a mid bathyal depth. The Uvigerina component of the fauna undergo a relative expansion at this point going some way to improved palaeobathymetric interpretation. U. attenuata, U. rugosa, U. rustica, and U. spinosa in combination are indicative of a mid bathyal setting.

Ammodiscus taxa suggest a continued oxygen depletion, internal moulds of C. ovoidea attesting to some post-mortem dissolution. Members of the Trochammina indicate high organic input, Textularia taxa support a low oxygen setting. Many of the Brizalina and Bolivina taxa of Biofacies III return to the succession suggesting a perpetuation of the conditions typical of that interval. This is supported by the appearance of the low oxygen indicator Cassidulina. Cibicides and Cibicidoides taxa tend to suggest a 'stability' to the environment, though whether this may be interpreted as stable reduced oxygen conditions is open to question. Uvigerina capayana and Uvigerina isidroensis attest to high productivity in low oxygen conditions respectively. The recovery of Uvigerina mantaensis supports this interpretation. U. modeioensis places an upwelling centre in close proximity, possibly facilitating the high productivity and low oxygen conditions.
proxies observed. Sporadic recovery of 'Reticulophragmium rotundidorsatum' suggests periodic ecophenotypic forcing.

The appearance of consistent Karreriella microgranulosa, Melonis pompelloides, Pyramidulina laevigata and Uvigerina taxa begin to characterise this interval. This interval is largely coincident with a sea-level rise in the early to mid Tortonian (Haq, et. al. 1987), this may facilitate improved preservation.

Biofacies IVc - 5,360' to 5,960'
The lowermost of the sub-biofacies of Biofacies IV. This interval, similar to sub-biofacies IVa, marks a period of poor preservation in Biofacies IV. As expected in an interval of pore water dissolution, the calcareous taxa show the greatest loss. Mid bathyal.

Interestingly, the normally resilient Uvigerina taxa are largely lost in this interval, while the normally less persistent Cibicides and Cibicidoides endure at only slightly reduced frequencies. Pyrite internal moulds are apparent, attesting to post-mortem dissolution, and Cassidulina taxa suggest a suboxic environment. Reduced frequency Bolivina and Brizalina taxa affirm reduced oxygen conditions.

The majority of the agglutinating taxa evident in sub-biofacies IVb are apparent in this section, although at reduced and intermittent recovery. This is typical of a poor preservation interval where bottom conditions fluctuate sufficiently so as to remove tests sporadically. Of particular interest, Spiropsammina primula is indicative of bathyal to abyssal depths and may be coupled with reduced oxygen levels.

This interval comprises the latest Burdigalian through to the late Serravallian. According to Haq, et. al. (1987) this was a period of general sea-level fall, terminating at a major sea-level fall at the late Serravallian. This fall, coincident in time with the poor preservation evident at this interval, suggests a mechanism for dissolution.

Biofacies V - 6,080' to 10,160'
This is a long ranging biofacies comprising of four sub-biofacies: a, b, c, and d. The biofacies encompasses a gradual faunal change as outlined by the four sub-biofacies. Both agglutinating and calcareous taxa are prevalent in high abundances and diversities, the first appearance downhole of the Pavonitininae, particularly Pavonitina andulana and Pavopsammina flabellum.

The interval ranges from the late Serravallian to the late Chattian of the Late Oligocene. Poor preservation intervals are evident. Mid bathyal.

Biofacies Va - 6,080' to 6,920'
The first of the sub-biofacies encountered downhole. A sudden increase of both diversity and abundance is evident, similar to the proportions of sub-biofacies IVb. Mid bathyal.
In addition to the taxa of sub-biofacies IVb a high diversity, low abundance Ammodiscus fauna indicates a continuation of dysaerobic conditions. Elongate tapering agglutinating taxa i.e.: Eggerella, Gravellina, Karreriella, and Karrerulina suggest competitive conditions in 'stressed' conditions. A varied, though low frequency Textularia component to the fauna and the continued presence of V. flexilis supports a dysaerobic interpretation. A low frequency Bolivina / Brizalina fauna and the first appearance of a limited Bulimina fauna attests to continued dysaerobia in a high productivity regime. Hanzawaia species are indicative of oxygen minimum conditions, while a varied Cibicides / Cibicidoides component suggests the longevity of these conditions in a 'stable' environment. Fursenkoina taxa are associated with high productivity and dysoxia, Nonion taxa indicative of suboxic conditions. The Uvigerina fauna is identical to that of sub-facies IVb, re-affirming the proximity to an upwelling centre and a high productivity, low oxygen system.

Sporadic recovery of 'R.' rotundidorsatum variant a, suggests periodic ecophenotypic forcing. Internal moulds of C. ovoidea, Globobulimina perversa and Protaglobobulimina pupoides are present testifying to acidic pore waters.

As mentioned above, the interval is characterised by the bathyal to abyssal taxa P. andulana and P. flabellum, in addition, low frequencies of Pavonitina styriaca are recorded. Almost continuous recovery of Saccammina placenta and a sporadic Cancris element suggests the accepted shelf position for these taxa needs to be re-evaluated for West Africa. Recovery of Textulariella barretti is more in keeping with a upper bathyal depth. Hanzawaia mantansis and Cibicidoides species suggest a upper mid bathyal depth, F. pontoni is more common at mid bathyal depths, as is the return of the Uvigerina component. This interval falls into a single CN zone and extends over the latest Burdigalian, just subsequent to a major sea-level fall.

Biofacies Vb - 6,980' to 7,040'
Represented by just two samples, this is a brief period of dissolution and low abundance / diversity data. A few taxa traverse this interval largely unaffected, i.e.: Haplophragmoides obliquicameratus and V. flexilis; others are preserved as pyrite internal moulds, i.e.: G. perversa. But most taxa undergo a significant recovery reduction to gradually re-appear in sub-biofacies Vc. This interval is coincident with a major sea-level fall in the late Burdigalian.

Biofacies Vc - 7,180' to 8,240'
This interval is characterised a gradual downhole increase in abundance of the fauna. Calcareous elements remain rare, agglutinating components dominate. Mid bathyal.

Moving down the succession, faunal elements common to IVa gradually return successively to the data set. Recovery remains sporadic, but most agglutinating genera are restored to the sequence. In addition, the recovery of indeterminate Reophax taxa suggests an opportunistic fauna in 'stressed' conditions.
Calcareous genera lag in their downhole re-appearance, the more resilient taxa encountered first. *Bulimina* taxa continue to indicate a bathyal depth in a high productivity region, *Cibicidoides* taxa suggesting the continued stability of this equilibrium. Of note is the absence of significant *Uvigerina* genera normally resilient to trending conditions. *Rhizammina* fragments suggest a mid bathyal depth. This interval is interpreted as a gradual trend toward the severe conditions of Vb.

**Biofacies Vd - 9,080' to 10,160'**

The lowermost of the sub-biofacies of Biofacies V, this interval ranges to the base of the investigated section. The interval is interrupted by a mild dissolution horizon at 9,440'. The fauna is broadly similar to that of Biofacies IVb and Va, with the addition of a few subtle components and loss of other taxa. Mid bathyal.

Amongst the agglutinating component of the fauna *Alveovalvulina suteri*, *Budashveella multicameratus*, *Eggerella* taxa, *Haplophragmoides suborbicularis*, *Karreriella* taxa, and the *Pavonitina* and *Phyllopsammina* association are largely absent from the succession in this interval. However, towards the base of the interval, *Lepidoparatrochammina* sp. 1 and a *Reophax / Subreophax* association are introduced.

Trends become obvious in the calcareous data also. The *Bolivina / Brizalina* association is largely absent. *Cassidulina* cf. *californica* initiates a clear presence re-affirming a low oxygen environment, but palaeobathymetrically ambiguous. An influx of *Hanzawaia concentricus* implies a shelfal position, but is feasibly the product of down slope transport during sea-level fluctuations, this assumption may be applied to the anomalous recovery of *Globocassidulina subglobosa* and *Cibicorbis herricki*, both upper bathyal taxa. *Pullenia bulloides* is indicative of a mid bathyal position.

A slight increase in the proportion of *Gyroidina* and *Gyroidinoides* suggests suboxic bottom conditions. The return of the characteristic *Uvigerina* association of *U. mantaensis*, *U. modeloensis*, *U. rugosa*, *U. rustica*, and *U. spinosa*, with the addition of *U. proboscidea* re-affirms a low oxygen, high productivity mechanism adjacent to an upwelling system.

Clearly, while the bathymetric and palaeoenvironmental parameters are unchanged, a faunal turnover is apparent during this interval. The interval is largely biostratigraphically unconstrained, but known to range from the early Burdigalian to the latest Chattian. It is feasible that the dissolution event at 9,440' is the product of the marginal sea-level fall of the Haq, *et. al.* (1987) eustatic curve in the late Aquitanian.
6.4. CABGOC 115-1X PALAEOENVIRONMENTAL INTERPRETATION

"... he thought it was downright annoying that he didn't know more about life and the world ..."

Jostein Gaarder, 1990 - The Solitaire Mystery

The 137 composite 60' ditch cutting samples of CABGOC 115-1X span the latest Oligocene (?) to Late Miocene. Planktonic foraminifera recovery is poor and dating is based upon Nannofossil work conducted by B. L. Shaffer. The diverse benthic fauna (325 taxa) are readily divided into five biofacies, twelve sub-biofacies are apparent. The fauna indicates a slight shallowing of the palaeobathymetry, and productivity intensification in association with an upwelling system and oxygen minima conditions. There is some evidence of caving and down slope contamination. Dissolution events are observed. The biofacies are outlined below and summarised in Fig. 26, biofacies interpretations refer to Table 5 references, the reader is referred to Enclosure 3 for raw data. Biofacies are arranged in down well appearance order.

Biofacies I - 1,790' to 2,480'

The first of the biofacies encountered downhole, this is a low diversity, low abundance calcareous interval divided into two sub-biofacies upon the basis of preservation. Low upper to upper mid bathyal, mid Tortonian.

Biofacies Ia - 1,790' to 2,330'

*Nonion incisum* is the only taxon that appears relatively uninterrupted in this interval. Together with *N. costiferum*, a low diversity *Bolivina* / *Brizalina* assemblage, occasional *Epistominella cf. pacifica* specimens, and a short pulse of *Textularia* this suggests a dysaerobic, high productivity environment. Down slope contamination is likely. Rapid post-mortem dissolution is prevalent and may be linked to a slight sea-level fall in the mid Tortonian (Haq, et. al. 1987).

Biofacies Ib - 2,390' to 2,480'

This barren section is almost definitely a product of post-mortem dissolution of the benthos and similarly may be associated with the eustatic fall in the mid Tortonian (Haq, et. al. 1987).

Biofacies II - 2,560' to 4,860'

Abundance and diversity steadily increase down through this interval. Taxa are steadily added to the assemblage, the addition of particular taxa delimiting the boundaries of five sub-biofacies. Dissolution horizons are observed. The zone migrates from a wholly calcareous assemblage to a mixed assemblage with depth. Mid to upper bathyal, mid to late mid Tortonian.

Biofacies Ila - 2,560' to 2,930'

This interval consists of the first 'consistent' calcareous assemblage downhole, offering a more 'robust' platform from which to interpret. It is mid Tortonian in age.

*Lenticulina americanus*, *N. incisum*, and *E. cf. pacifica* are all recovered as continuous ranges. *Brizalina alazanensis* enters the fauna slightly further down the section. This association is
indicative of reduced oxygen conditions in a sustained high productivity system. The presence of *Melonis affinis* suggest a transitional fauna.

Clearly preservation is substantially improved over the conditions of Biofacies I suggesting a reduced level of pore water acidity responsible for dissolution.

**Biofacies IIb - 2,990' to 3,290'**

This interval is mid Tortonian. It is characterised by the first downhole appearance of a *Uvigerina* fauna. This appears in tandem with internal moulds of *Protoglobobulimina pupoides* suggestive of post-mortem dissolution subsequent to dysoxic pore water conditions sufficient for pyrite precipitation. The fauna remains calcareous.

The appearance of sustained *U. pilulata* in this interval is prior to a subsequent more mature *Uvigerina* fauna. *L. americanus, N. incisum, E. cf. pacifica* and *B. alazanensis* continue their unbroken ranges. This association is indicative of continued low oxygen conditions in a sustained high productivity system. The recovery of *Globobulimina affinis* at the base of this interval, and *Stillostomella* fragments throughout the interval supports this interpretation.

**Biofacies IIc - 3,350' to 4,430’**

Again, this zone sees the addition of taxa to the fauna suggestive of its maturity. The addition of agglutinating taxa is observed. The interval is mid Tortonian in age.

*Lenticulina americanus, N. incisum, E. cf. pacifica* and *B. alazanensis* continue their ranges suggestive of continued low oxygen, high productivity conditions. Amongst the calcareous taxa they are joined by *Bolivina advena, Bolivina sutera, Lenticulina culrata,* and *Lenticulina melvill.* A unknown *Neoeponides* species and *N. costiferum* are largely restricted to the interval. A low abundance, but high diversity *Cibicides / Cibicidoides* element supports the development of stable reduced oxygen conditions. Low diversity *Cyclammina* recovery and the gradual introduction of and a flux of *Haplophragmoides quinquelocularis* at the base of the interval supports a dysaerobic environment.

The introduction of *U. mantaensis* and *Uvigerina peregrina* add credence to a high productivity regime. A influx of *Buliminella curta* and a low abundance *Hanzawaia* component supports the proposition on oxygen minimum zone (OMZ) conditions.

The *Cibicides / Cibicidoides* element and *Bathysiphon* fragments are indicative of a mid to upper bathyal position, the presence of *Neoeponides campester* (an upper bathyal proxy) is probably the product of down slope caving contamination. In addition, various *Quinqueloculina* taxa are similarly anomalous as these are more usually associated with hypersaline oxic conditions at shallower depths and are likely a product of contamination.
Internal moulds of *Globobulimina perversa* and *P. pupoides* continue to suggest post-mortem dissolution subsequent to dysoxic pore water conditions sufficient for pyrite precipitation.

Biofacies IId - 4,490' to 4,550'

This two sample interval represents a subtle departure from overlying Biofacies IIc. The taxonomic character of the assemblage is largely maintained, however, the high frequency pulse of individual taxa, and temporary loss of others merits this sub-division. The interval is late mid Tortonian in age.

Most noticeable is the complete loss of *E. cf. pacifica* during this interval. In addition, *Cyclammina cancellata, H. inaequilateralis, Lenticulina iotus,* and *Saccammina placenta* exhibit frequency pulses. Clearly a short term reduction in productivity rates has a profound effect upon some aspects of the benthos, yet appears to show little or no reflection in other aspects of the fauna. Whether this is merely because the event was so short lived, or not of great enough magnitude is unknown. It is possible the event is a period of selective preservation, however, it is difficult to reconcile this particular faunal loss. The interval does not appear to coincide with a significant eustatic fluctuation.

Biofacies IIe - 4,610' - 4,860'

The last of the sub-biofacies of Biofacies II, this interval sees a return to a similar taxonomic composition to IIc, with the addition of further taxa. The productivity interruption of IId probably obscures a more realistic boundary between IIc and IIe.

In addition to the species present in IIc, *Cibicidoides pertucidus, Haplophragmoides carinatus, H. cf. narivaensis,* and *H. obliquicameratus* are recovered. The *Quinqueloculina* component is recovered at a greater frequency implying a serious contamination event, or requiring a re-evaluation of this taxon’s palaeoecological significance. Broken *Rhabdammina* fragments imply strong bottom currents.

In general, the fauna reflects conditions similar to those of IIc, the slightly greater diversity a reflection of greater maturity of the fauna and adaptation to ‘stable’ reduced oxygen conditions.

Biofacies III - 4,970' - 6,180'

Biostratigraphically this interval is unconstrained but known to range between the mid Burdigalian and late Serravaillian.

A substantial faunal change marks the upper limit of Biofacies III. The increased recovery of agglutinating taxa, in particular *Textularia* and *Spiropsammina primula* is the most obvious transition. The biofacies is divided into two sub-biofacies on the basis of faunal alteration. The mixed fauna reflects an established low oxygen mid bathyal environment.
The influx of *Textularia earlandi*, *Textularia pozonensis* and *S. primula* signal the onset of this interval. The co-occurrence of *T. earlandi* with *B. alazanensis* becomes a feature of this well implying dysoxia and a physiological foraminiferal response (see palaeoecological section). *Textularia kugleri*, also a small tapering taxon is abundant towards the top of the interval.

Tapering, elongate agglutinating taxa, i.e.: *Eggerella forestensis*, *Eggerella karamatensis* and *Gravellina narvaensis* also begin to become more frequent during this interval, suggestive of dysoxia and 'y' selection. *S. placenta* is once again recovered at a significant frequency adding credence to the suggestion that an inner shelf bathymetry is an incorrect depth limit in the Miocene.

Small, agglutinating forms with inner structures also become prevalent at this point in the well. *S. primula* and *Alveolophragmium planum* both have a high surface area to volume ratio, possibly in response to low oxygen conditions. Sporadic *Cyclammina* and *Discamminoides* recovery add additional 'alveolar' taxa appearing in significant numbers during this interval. It may be argued that the improved recovery of the compressed *Haplophragmoides carinatus* is also a response to reduced oxygen, its compressed test shape increasing surface area to volume ratio.

*Haplophragmoides obliquicameratus* begins to become a regular feature of the fauna during this interval, *H. quinquelocularis* becoming common towards the base of the sub-biofacies, both low oxygen indicators. *E. cf. pacifica*, while still present, begins to wane through the interval suggesting the progressive loss of organic flux. However, an influx of *U. peregrina* indicates continued high organic carbon at this time.

This interval maintains much of the character of the overlying sub-biofacies but with the addition of *Budashevelia multicameratus*, a varied *Cyclammina* component, *Recurvoides*, *Reticulophragmium*, and *Valvulina flexilis*. Additional *Uvigerina* taxa are recorded. This 'development' of the fauna indicates a continued low oxygen condition, but one capable of supporting a diverse fauna at a mid bathyal depth.

Low frequency *Ammodiscus* taxa are indicative of moderate dysaerobic conditions. Of note is the loss to a large extent of *Bolivina* taxa; *B. alazanensis* present at a reduced frequency. In tandem with the *B. multicameratus* flux, *Cibicidoides perticida* suggests the establishment of stable conditions. An increase in *Cyclammina* recovery is typical of maintained dysaerobic conditions, this is likely also the case for 'alveolar' *D. tobleri* and *Reticulophragmium* species which undergo a similar expansion. The *Haplophragmoides* fauna continues to strengthen with the uninterrupted addition of *H. quinquelocularis*, a small compressed taxon possibly emulating the increased surface area to volume ratio strategy of *H. carinatus*. *H. quinquelocularis* is largely confined to this interval and hence may be a reflection of oxygenation conditions at this point.
Flux proxy, *E. cf. pacifica*, continues to wane through this interval until its eventual loss from the well. However, this begins to be replaced by *Uvigerina mantaensis*, possibly reflecting a transition in the type or flux rate of organic carbon to the sediment. Internal *Globobulimina* pyrite moulds attest to post-mortem reducing conditions and the removal of susceptible tests. *Rhabdammina* fragments suggest strong bottom currents. Increased frequency of *Saccammina* taxa continue to suggest an expansion of their bathymetric range over previous ideas.

Biofacies IV - 6,240' to 9,180'
This is a complex mixed assemblage divided into four sub-biofacies based upon faunal composition. This is a high productivity, low oxygen interval, showing some evidence of upwelling and OMZ intensification. Mid Bathyal. The interval is largely indeterminate in age but known to range from the mid Burdigalian to the Aquitanian.

Biofacies IVa - 6,240' to 7,560
This interval is identified by the first appearance downhole and range of the Pavonitininae, particularly *Pavonitina andulana* and *Pavopsammina flabellum*. The associated fauna is varied and diverse, the addition of several taxa is apparent. The upper portion of the interval is indeterminate but known to be mid Burdigalian to late Serravallian, the lower portion is mid Burdigalian.

*Hanzawaia* taxa are observed for the first time at significant levels implying OMZ conditions. *Brizalina subaebrensis mexicana* and *Brizalina pisciformis* support this interpretation. Internal moulds of *Chliostomella ovoidea* become common suggesting a continued low oxygen pore water environment. A varied *Bulimina* and *Cassidulina* fauna supports a continued low oxygen theory, the addition of *Gyroidina* and *Gyroidinoides* implying an upper bathyal upper depth limit and a suboxic environment. The *Cibicides / Cibicidoides* fauna becomes a lot more prevalent suggesting adaptation to a sustained oxygen poor habitat. *Karrenella* elements become marked, in particular *K. microgranulosa*. Pulses of *Melonis pompeloides* remain bathymetrically ambiguous, however, a diverse *Reophax* fauna towards the top of the interval suggests re-colonisation and 'r' selection in competitive stress. Intermittent *Trochammina* recovery suggests sporadic organic flux and dysaerobia. *Uvigerina modeioensis* suggests the presence of a sustained upwelling system influencing the fauna.

In addition to the above taxa, continued pulses of *G. affinis* and *B. curta* support a low oxygen, high organic carbon setting. The continued diverse *Haplophragmoides* and *Reticulophragmium* fauna is indicative of reduced oxygen; *Saccammina* taxa are clearly well adapted to these OMZ conditions. *U. mantaensis* indicates a continued high productivity, low oxygen system. *V. flexilis* suggests maintained 'stress'. *T. earlandi* suffers a slight reduction in frequency during this interval, possibly as a result of the expansion of the *Karreriella* component.

*Cibicidoides matanzaensis*, *Cibicidoides crebbsi* and *Gyroidina soldanii* are normally considered upper bathyal indicators, *Cibicidoides mexicanus* is more commonly associated with mid to
lower bathyal depths. *Eponides umbonatus* has a upper mid bathyal upper depth limit. *Uvigerina spinosa* is indicative of mid to low bathyal depths, however, the recovery of smooth *Uvigerina* sp. 1 is more readily associated with a mid bathyal position. *Karrerulina apicularis* and *Karreriella bradyi* are upper bathyal taxa, however, *K. bradyi* is known to occur below the CCD, in addition, *Eggerella bradyi* is a lower bathyal taxon. Both *Spiropsammina primula* and *Spiropsammina uhligi* are known from bathyal to abyssal depths offshore West Africa. *Rhizammina* fragments suggest a mid bathyal depth, *Rhabdammina* fragments are indicative of strong bottom currents.

The assemblage appears to be sending conflicting signals regarding its depth, however, a mid bathyal position is reasonable with the overlying intervals. The environment, while clearly under OMZ conditions, has undergone a subtle transition probably influenced by the proximity of an upwelling system.

**Biofacies IVb - 7,620 to 8,160’**

The top of the interval is mid Burdigalian, the base is indeterminate but known to range to Aquitanian. The interval sees a general loss of abundance and patchy recovery amongst most taxa, although some of the agglutinated forms undergo a slight expansion. This is likely the effect of a brief period of dissolution, possibly at the time of deposition, permitting the expansion of particular resistant agglutinating forms.

The pulse of *Amphistegina lessonii*, typical of mid neritic depths, towards the centre of this interval remains anomalous and probably represents an episode of down slope slumping or down-well contamination. *Rhizammina* fragments in addition to *T. earlandi*, suggest a mid bathyal depth.

The majority of 'lost' taxa are calcareous forms, particularly amongst the *Bulimina*, *Cassidulina*, *Lenticulina* and *Uvigerina*. The Cibicides / Cibicoides group record a fluctuating presence, possibly a reflection of oscillating conditions interrupting the 'stable' conditions necessary for their colonisation. Many agglutinating forms also show a reduction in frequency, the *Cyclammina*, *Eggerella*, *Karreriella*, *Textularia* fauna largely disappears temporarily from the section. The Pavonitininae wane and are not observed again. However, *T. earlandi*, *Haplophragmoides walteri*, and *H. obliquicameratus* undergo a relative expansion. *Rhabdammina* fragments are indicative of continued strong bottom currents.

The assemblage continues to send ambiguous signals. While clearly under OMZ conditions, the environment appears to be subject to a poor preservational regime, fluctuating in its intensity. Following Haq, et. al. (1987), Burdigalian time was a period of exceptional, rapid sea-level fluctuation. It is possible that poor faunal recovery at this point is a reflection of this phenomenon.

**Biofacies IVc - 8,220’ to 8,400’**

The interval is indeterminate but known to range between the mid Burdigalian to Aquitanian. Abundance recovers substantially within these samples with the re-introduction of taxa absent
from IVb. The section is a subtle transitional phase at a mid bathyal position. The flood of shallower *Discorbis* taxa likely a product of down-slope slumping or down-well contamination.

The re-introduction of *Cibicides*, *Cibicidoides*, and *Hanzawaia* taxa suggest a return to established high productivity conditions. In addition, a partial recovery of the *Cyclammina*, *Eggerella*, *Karreriella*, and *Reticulophragmium* fauna is evident. *B. multicameratus* shows a strong presence at either extreme of this section. *Lenticulina* and *Uvigerina* taxa are observed again. This combination of taxa indicates continued oxygen depletion, the intermittent recovery of *U. modeloensis* suggestive of a continuing upwelling system. A reduction in *Rhabdammina* recovery may reflect a lessening of vigorous bottom current action.

**Biofacies IVd - 8,460' to 9,180'**

The interval is indeterminate but known to range between the mid Burdigalian to Aquitanian. It is characterised through a subtle faunal turnover recording the loss of *Bulimina* and *Cassidulina*, the gradual addition of *Ammodiscus* species, and expansion of particular *Cibicides* and *Cibicidoides* taxa amongst others.

The flood of *Cibicidoides matazanensis* and *Cibicidoides crebbsii* at this point confirms a bathyal position. The introduction of *Haplophragmoides sphaeriloculus* is a clear indication that an upper bathyal position for this taxa needs to be reconsidered. *Spiropsammina primula* confirms a bathyal to abyssal position. The occurrence of *Cibicidoides mexicanus* is indicative of deepening to the mid to lower bathyal.

*Ammodiscus* taxa are typically attributed to dysaerobic conditions, re-affirming continued OMZ existence. A subtle replacement within the *Cyclammina* sees the introduction of *C. cushmani*, *Pseudogaudryina* taxa also become common within this interval. A gradual re-introduction of *Haplophragmoides* taxa with the addition of *Veleronoides veleronis* supports a low oxygen palaeoenvironment. Relative high recovery of pyrite moulds denotes post-mortem dissolution. *Reophax* taxa suggest ‘stressed’ conditions, the flux of co-occurring *Saccammina* suggestive that this genus responds positively to colonisation in poor oxygen conditions. The continued presence of *V. flexilis* adds credence to a dysaerobic, ‘stressed’ environment. *Textularia crassisepta* becomes common towards the base of the interval, and *T. earlandi* is lost from the succession, indicative of a loss of those conditions which promoted its proliferation further up the well. *Trochammina* taxa suggest continued high productivity in tandem with *U. mantaensis*. Pulses of *Rhabdammina* fragments indicate a fluctuating bottom water velocity.

**Biofacies V - 9,240' to 10,020'**

The uppermost limit of the interval is indeterminate but known to range between the mid Burdigalian to Aquitanian, the base is uppermost Oligocene(?). The introduction of *Lepidoparatrochammina* sp. 2, *Martionotiella communis*, frequent *Karreriella horrida* and *Haplophragmoides discus*, and an expansion of the *Cyclammina* and *Ammodiscus* element
characterise this interval. The occurrence of Cibicidoides mexicanus is indicative of mid to lower bathyal depth.

An increased frequency of B. alazanensis and T. earlandi at the base of the interval suggests a possible return to the conditions of IVa at this point, but remains ambiguous with a lack of subsequent samples. Elsewhere in the sample, the expansion of the Cyclammina genus confirms oxygen depletion, Haplophragmoides taxa supporting this interpretation. A relative flux of D. tobleri promotes this taxa as a low oxygen tolerant form. Pyrite moulds of Globobulimina taxa are denotive of post-mortem dissolution, Glomospira charoides tends to be an ambiguous taxon to interpret palaeoenvironmental, but may reflect high organic input. Tapering, elongate Karreriella taxa may reflect ‘stress’ and colonisation is reduced competition, this premise may be extended to M. communis. Reophax and Saccammina taxa maintain a noticeable frequency during this interval, again, a possible reflection of reduced competition. S. primula records high values, its high surface area to volume ratio possibly facilitating its flux in typically ‘stressed’ conditions. Trochammina taxa continue to suggest high organic productivity, U. mantaensis supporting this premise and V. flexilis continuing to attest to dysaerobic conditions. A diverse Rhabdammina fauna suggests established strong bottom currents.
In stratigraphic order (up-well), there is a clear faunal trend in the Cabinda wells from an agglutinating fauna to a mixed fauna, and finally the development of a *Brizalina / Bolivina* association. On the basis of nannofossil biostratigraphy, this progression appears to be largely time independent. This possibly reflects an influential post-mortem alteration of the fauna. This particularly applies towards the top of the well and the development of the *Brizalina / Bolivina* association.

In general, both wells follow a trend from a mid to lower bathyal agglutinating assemblage into a mid bathyal mixed assemblage, and finally to a mid to upper bathyal calcareous association. Because of the stratigraphic ambiguity of much of these sections, relating this progression to established Miocene palaeoceanography is problematic.

CABGOC 128-3 offers the better nannofossil zonation from which to extrapolate Miocene palaeoceanographic events. This site is also further from the Zaire River outflow and less likely to be affected by its fresh water plume.

The Monterey Excursion and associated reduction of CaCO$_3$ may be tentatively identified from mid biofacies Vd to upper biofacies IVa. Assuming this correlation, the slight faunal turnover at the base of biofacies Vd may relate to that in association with the warming of deep water in the early to mid Burdigalian. Following this premise, biofacies III and the loss of the agglutinating fauna marks the onset of the Messinian Salinity Crisis and establishment of modern thermohaline circulation.

On a more local scale, the fluctuating upwelling signal in biofacies Vd, Va, and IVb may be treated as indicative of an oscillating extreme northward extension of the Benguela system to the Angola Dome. The first two of these upwelling signatures, in the Burdigalian, are significant as the earliest recording of a northward extension of the system. The progressive loss of agglutinating forms and flux of the *Brizalina / Bolivina* association in biofacies II and I, marks a less efficient upwelling system in transporting nutrients into the photic layer from the thermocline, although an OMZ is maintained it is not severe enough for an agglutinated fauna to dominate.

CABGOC 115-1X, while providing a more thorough benthic foraminiferal platform, shows a less complete Nannofossil progression. This site is also nearer the Zaire River outflow, and hence may be subject to the effects of its fresh water plume.

Biofacies IVb coincides to a large extent with the onset of the Monterey Excursion, the dominance of agglutinating taxa throughout biofacies IV is suggestive this crisis, though accurate dating is absent. Further up the well, biofacies II and I are coincident with the onset of
NADW increased intensity and the initiation of modern thermohaline circulation. Cause and effect is not established in this case. The remainder of the well is unconstrained.

Locally, the upwelling signal at CABGOC 115-1X appears to be more sustained and may reflect the well's more proximal position to the Benguela system influence. Again, this signal in the mid Miocene represents an earlier onset for this system than earlier reports.

In combination, the two wells provide evidence for a gently shallowing environment from a mid to lower bathyal to mid to upper bathyal setting through the latest Oligocene to late Miocene. The agglutinating fauna common to the mid to lower bathyal position until the mid Miocene is typical of OMZ conditions. Various taxa indicative of OMZ intensification are recorded in both wells at the early / mid Miocene transition, i.e.: Pavonitininae, providing a reasonable correlation. OMZ conditions are sustained and record the intermittent oscillation of an upwelling regime, possibly the Benguela / Angola Dome interaction, in the mid Miocene. This is the earliest evidence for the waxing and waning of this system. During the mid to late Miocene a less efficient upwelling system sees the development of a faunally restricted calcareous assemblage, this is eventually subject to severe post mortem bottom water erosive action.

TOC data in combination with foraminiferal data complicates the picture in CABGOC 128-3. The fauna at this site appears to migrate along a oxygen / food transition, reaching a 'switch' that alters the system from a food controlled environment to one regulated by oxygen levels (Fig 21) (see Appendix 1). TOC data is unavailable for CABGOC 115-1X.

Without examining data from additional wells in the region the extent of the influence of the Zaire River outflow on the fauna is unknown. CABGOC 115-1X shows little to suggest a more intense OMZ other than the characteristic *T. earlandi / B. alazanensis* association. Both of these taxa are present in CABGOC 128-3, though at much reduced frequencies, and not in association.
When attempting to correlate the West African biofacies, it has to be born in mind that the nature of the samples (composite ditch cuttings) render ambiguities inherent, and exact correlation is unlikely. This obstacle to stratigraphy is compounded by the problems inherent with benthic data. Planktonic forms usually record a more robust platform and are more commonly utilised, but are not preserved in this area.

The following is a discussion of the broad correlation possibilities as they occur down-well between wells CABGOC 128-3 and CABGOC 115-1X. Figure 27 summarises this section. The time-transgressive nature of the data is apparent in this diagram.

A general trend observed down-well from a low diversity Bolivina / Brizalina fauna that gradually increases in both diversity and abundance to include additional calcareous elements and a diverse agglutinating assemblage is observed in both wells examined and records a transition from an upper to mid bathyal position down-well. However, in many respects, the individual elements of this trend are extremely diverse, reflecting differing oceanographic influences. It is readily apparent that CABGOC 115-1X is an expanded section of part of CABGOC 128-3, the gradual introduction (working down-well) of taxa in CABGOC 115-1X occurring as rapid turnovers in CABGOC 128-3. However, in certain instances CABGOC 128-3 appears to show an expanded succession over CABGOC 115-1X, for instance the top and subsequent development of the Uvigerina fauna. Most biofacies are time-transgressive, this is illustrated particularly well by the Pavonitiniinae association.

The uppermost interval encountered down-well in both localities is a low abundance, low diversity fauna displaying poor preservation features such as pyrite internal moulds and etching. Recovery is intermittent, the faunal elements having little in common between the two wells. In general, a calcareous benthic assemblage is common to both wells at this point. Sporadic Textularia taxa may be present. The interval is palaeoenvironmentally ambiguous, post-mortem dissolution the only predominant factor. Post-mortem dissolution is likely to occur sometime after deposition.

Moving deeper down the succession, both wells display a prevalent Bolivina / Brizalina fauna, Biofacies II in CABGOC 128-3, and Biofacies IIa in CABGOC 115-1X. In both wells this biofacies is dominated by B. alazanensis, additional members of the genus are observed down-well. In CABGOC 115-1X the addition of the Bolivina / Brizalina taxa occurs with the top of a Uvigerina fauna in sub-biofacies IIa to IIb. In CABGOC 128-3, the additional Bolivina / Brizalina appear down-well rapidly, the Uvigerina fauna somewhat reduced in comparison. In CABGOC 115-1X there is a rapid expansion down-well of the Uvigerina fauna in IIb, the same down-well expansion in CABGOC 128-3 is somewhat delayed to biofacies IVa.
The intervening deeper biofacies III of CABGOC 128-3 is not observed in CABGOC 115-1X. Largely characterised by a small *Textularia* component, a similar faunal assemblage isn’t recognised in CABGOC 115-1X working down-well until the uppermost portion of Biofacies IIIa. This represents the first down-well correlation quandary. Biostratigraphically, this uncertainty is compounded as the biofacies appear to be slightly differing ages, CABGOC 115-1X the younger.

The succession becomes gradually more complex with depth. The down-well top of *Uvigerina* taxa is observed in Biofacies II in CABGOC 128-3, and in Biofacies IIb in CABGOC 115-1X. The subsequent down-well expansion of this genus is seen in Biofacies IVa in CABGOC 128-3, but in Biofacies IIc in CABGOC 115-1X. This again is a product of the intervening Biofacies III in CABGOC 128-3, not observed in CABGOC 115-1X.

The down-well development of a diverse agglutinating fauna is common to both wells. In CABGOC 128-3 this top occurs at IVa and expands down-well into IVb. In CABGOC 115-1X the same progression shows a top in IIa, developing down-well into IIIa to IIIb.

In general, biofacies IV and V correlate to each other in each well. However, faunal differences persist. The *Pavonitininae* form a discrete horizon in each well; in CABGOC 128-3 this is observed in Biofacies Va, in CABGOC 115-1X the same association occurs in Biofacies IVa, representing a significant depression in CABGOC 128-3. In both wells, the occurrence of the *Pavonitininae* is concomitant with upwelling proxies that remain present to the base of each well. Both wells see the top of the distinctive form *Reticulophragmium venezuelanum* towards the top of Biofacies IVa. The top of the *Cibicides / Cibicidoides / Hanzawaia* fauna at the same point in CABGOC 115-1X is depressed to IVb in CABGOC 128-3.

Obvious discrepancies exist amongst particular taxa. The characteristic *Brizalina alazanensis / Textularia earlandi* association of CABGOC 115-1X is not apparent in CABGOC 128-3. In addition, *Epistominella cf. pacifica* exhibits an extended un-interrupted down-well range in CABGOC 115-1X, un-observed in CABGOC 128-3. Clearly this is a reflection of the differing oceanographic influences operating at each site.

In general, CABGOC 128-3 is a condensed reflection of CABGOC 115-1X environmentally. Biofacies associations show little coherence with the established nannofossil zonation of these wells, elements of the benthic fauna clearly being time-transgressive. The gradual down-well introduction of taxa observed in CABGOC 115-1X occurs as rapid taxonomic turnovers in CABGOC 128-3. In addition, it appears that CABGOC 115-1X shallows earlier in time (CN7) than CABGOC 128-3 (CN9 or later).

To fully appreciate the relative position of one well to the next a graphic correlation approach should reconcile these discrepancies and further provide a framework for the entire region (Mann and Lane 1995 [and references therein]). An initial attempt, based upon 55 of the more
readily recognised taxa is shown in Figure 28. FAD refers to First Appearance Datum downhole, LAD refers to Last Appearance Datum downhole. While this plot is noisy, certain inferences may be made.

To a certain extent, correlation can be established between the two wells. The Line of Correlation (LOC) may be interpreted to display differing rates of accumulation, a slow rate of accumulation towards the base of the wells becomes faster towards the top of the wells. The development of a 'kink' in the LOC is typically known as a 'dogleg' configuration and indicative of down thrown blocks in expansion faulting provinces. The 'dogleg' in this instance (towards the centre of the cloud of data points) corresponds to a biostratigraphically indeterminate interval, possibly a product of contamination and mechanical reworking during movement.

Clearly a condensed section or sequence boundary is evident in CABGOC 128-3 between 4,200' and 4,600' extending over the biofacies III / IVa boundary, and to a certain extent between 9,100' and 10,100', in biofacies Vd. A similar occurrence is apparent at approximately 2,200' in the same well, corresponding loosely with the biofacies I to II transition. In CABGOC 115-1X a condensed section is tentatively identified at approximately 7,000', almost coincident with biofacies IVa and IVb boundary. These events are not comparable age wise; CABGOC 115-1X does not extend into young enough sediments to record the upper CABGOC 128-3 boundary, and a comparable event to the CABGOC 115-1X boundary is not apparent in CABGOC 128-3.

The creation of a Composite Standard should go some way to elucidate towards a rational Cabinda correlation. This demands much more data beyond the scope of this project.
6.7. ROMANIAN SAMPLES
6.7.1. INCLUSION OF SAMPLES

Shallow water Paratethyan samples are included within the remit of study to address the stratigraphic nature of this study. Most Neogene stratigraphical work has concentrated on this and the Mediterranean regions. The inclusion of biostratigraphically comparable samples from this region is intended to provide a more complete taxonomic database, the shallower facies notwithstanding. In addition, preservation of the Paratethyan material is excellent aiding taxonomic illustration.

A historical review of Neogene nomenclature is provided in Berggren (1971), Harland (1989), and Harland, et. al. (1989).

6.7.2. ROMANIAN PALAEOENVIRONMENTAL INTERPRETATION

All five Paratethyan samples are exceptionally well preserved in comparison to the Venezuelan and African material of this study. The lack of significant abrasion and dissolution in all of these samples implies sustained oxygenation in a lower to mid shelfal position. Raw data is provided in Enclosure 4.

Sacel - Chechis Formation - Eggenburgian

The stratigraphically oldest sample from Sacel, in the Chechis Formation is characterised by an association of Cylindroclavulina rudis and Reticulophragmium crassum un-apparent elsewhere. While these two taxa dominate the agglutinating portion of the assemblage, Ammodiscus planus, Bigenerina nodosarida directa, Cyclammina rotundidorsata, Reophax subfusiformis, Reticulophragmium venezuelana, Sigmoidopsis schlumbergeri, Textularia deltaidea, and Vulvulina pennulata are found in association. This assemblage of taxa suggests moderate dysaerobia on the outer shelf.

Amongst the calcareous taxa, Amplicoryna armata, Bulimina inflata, Gyroidina soldani, Heterolepa dutemplei, Siphonina reticulata, Uvigerina cf. beccarii, and Uvigerina cubana dominate. These taxa appear to contradict the agglutinating taxa through implying a marginally deeper bathymetry to a upper bathyal position. However, a moderate dysaerobic interpretation is supported and may account for upward bathymetric migration in a restricted basin.

Eggenburgian times experienced a significant transgression in the Paratethyan region in keeping with a slightly deeper palaeobathymetry.

Chechis Marls - Badenian

This sample similarly has a considerable agglutinating component, though with the significant loss of C. rudis and R. crassum. This possibly reflects the differing provenance of warm tropical waters in the Badenian. This highly diverse agglutinating fauna is ambiguous, all the taxa
present considered typical of a range of depths from bathyal to shelfal positions. However, in general they imply a continued moderate dysaerobia.

The calcareous taxa maintain a steady diversity over the older sample, although the assemblage composition has altered considerably. The significant loss of Cibicoides and Cibicides taxa, and introduction of Bolivina taxa suggest a less stable environment, possibly fluctuating O₂ saturation. The palaeoecological significance of the replacement of U. cubana by Uvigerina junecea is unknown.

Lapugi du Sus - Badenian - ‘Lower Lagenid Zone’
This sample sees the significant loss of agglutinating taxa and a maintained calcareous diversity. The Bolivina component is largely sustained implying continued mild dysaerobia, although the re-introduction of Cibicoides and Cibicides taxa suggests some instability to the environment. The introduction of more typically shallower taxa such as Elphidium, Neoconorbina, Triloculina, and additional milionid taxa implies a shallowing position to the mid shelf.

Costei - Badenian - ‘Upper Lagenid Zone’
Again, agglutinating taxa are significantly absent from this sample apart from a flux of Spiroplectammina carinata, Textularia agglutinans and additional Textularia taxa. Calcareous taxa undergo a slight diversity increase. The loss of most Lenticulina taxa in this sample suggests a sustained significant shallowing. Further expansion of Triloculina, and additional milionid taxa, including several Pyrgo taxa continues to support a mid shelf interpretation. Planorbulina mediterranensis and Planostegina costata are shelf taxa. A small influx of Nonion additionally supports this suggestion. However, the presence of deeper water taxa such as Cassidulina laevigata, Gyroidina altiformis, and Pullenia bulloides provide a quandary. Bolivina taxa continue to suggest moderate dysaerobia in combination with Hanzawaia taxa and the agglutinating taxa, the agglutinating taxa may suggest a mild intensification of this condition.

Vâlcele - Upper Badenian
The youngest sample from Transylvanian Basin in this study, the agglutinating component of the fauna is again largely lost. The calcareous component maintains a steady diversity. Valvulineria complanata dominates the sample along with Melonis affine, typical of dysaerobia. The remainder of the assemblage is largely unchanged from the ‘Upper Lagenid Zone’ of Costei suggesting little significant environmental change.
7. TOTAL ORGANIC CARBON

7.1. INTRODUCTION

Total Organic Carbon (TOC) data was obtained for CABGOC 128-3. High TOC values are interpreted as indicative of increased surface productivity. The introduction of nutrient rich upwelled waters to the continental margin expedites phytoplankton production. This is essentially a function of upwelling rate and nutrient concentration. Particulate organic matter (POM) descends through the water column, utilising oxygen as it is oxidised thereby expanding the OMZ (Demaison and Moore 1980; Southam et. al. 1982). Hence, TOC values reflect the intensity of the OMZ and the periodic intensification of the local upwelling system in the Cabinda Basin.

Morphogroup analysis of the Miocene benthonic foraminiferal assemblage coupled with TOC data is presented in Preece, et. al. (in press). At CABGOC 128-3 a gradually developing OMZ is identified through morphogroup analysis. This reveals a distinctive cyclicity in CABGOC 128-3, and undergoes a sudden expansion and intensification towards the top of the well in the late Miocene.

TOC data display a saw tooth pattern of gradual and constant increasing TOC values upwell.

Small, perforate, calcareous taxa with a high surface area to volume ratio are regarded as indicative of dysoxia. This group exhibits a sudden expansion towards the top of CABGOC 128-3, and is regarded as evidence for expanded OMZ conditions.

Epifaunal, planispiral, agglutinated taxa display a gradual increase in abundance up well in CABGOC 128-3. This group reflects the TOC profile within in its own curve, and hence is inferred to be more opportunistic than previously assumed. The sudden decline of this group towards the top of the well is coincident with the expansion of the small, perforate, calcareous taxa, and associated with the sudden expansion of the OMZ in CABGOC 128-3.

An elongate agglutinated morphogroup of foraminifera, considered to be opportunistic, is shown to be in antiphase with TOC data at the base of CABGOC 128-3, moving into phase towards the top of the well. A morphologically comparative calcareous group is in antiphase with its agglutinated counterpart and hence moves from a phase relationship into antiphase with regard to TOC up well. This relationship is unprecedented in the foraminiferal literature to date. It is considered to be evidence for an 'dynamic environmental shift' migrating away from food as a primary limiting factor to $O_2$ at a 'critical switch' (Fig. 21). This microhabitat concept was expressed conceptually by Jorissen, et. al. (1995), this is the first report of data to support the theory.

See Appendix 1 for uncorrected page proofs of Preece, et. al. (in press).
8. CONCLUSIONS

"We perceive no beauties that are not sharpened, prinked out, and inflated by artifice. Such as appear in their pure and natural simplicity easily escape a vision as coarse as ours. Theirs is a delicate and hidden beauty; it needs clear and purified sight to discover their secret brightness."

Montaigne, Essays

Examination of 276 samples from three differing Neogene equatorial sites (Eastern Falcon, Northern Venezuela; Cabinda, offshore West Africa; Transylvania Basin, Romania) yielded 575 benthic foraminiferal taxa (234 agglutinating taxa; 341 calcareous taxa). Of these, one is described as a new species. Other previously known taxa are reported for the first time from the Venezuelan and African sites. The physiological responses of equatorial Neogene bathyal benthic foraminifera to low oxygen conditions in the Venezuelan and African material are summarised in figure 29. The following are the main conclusions of this thesis:

• A diverse cosmopolitan benthic fauna, the Agua Salada Fauna, is recovered to varying extents from all sites examined. This fauna is taxonomically re-evaluated and provides a robust systematic catalogue of low latitude, deep water, foraminiferal taxa.

Cabinda, West Africa
• Miocene benthic bathyal foraminifera are taxonomically evaluated from this previously restricted province for the first time. A total of 398 benthic foraminiferal taxa were identified from CABGOC 128-3 and CABGOC 115-1X.
• This fauna is biostratigraphically zoned into a consistent palaeoenvironmental sequence through phylogenetic observation and assemblage evolution.
• The periodic northward extension of the Benguela System in the late early Miocene is observed offshore Cabinda for the first time.
• Tentative identification of the Monterey Excursion is made in the early Burdigalian.
• Correlation based upon the Pavonitininae is established in the upper Burdigalian of offshore Cabinda for the first time.
• Graphic correlation shows an initial slow rate of accumulation to the mid Tortonian, followed by an increased accumulation rate for younger sediments.

Venezuela
• Samples from the El Mene – Pozon type section are re-evaluated taxonomically. The high number of species recovered from this material (272 benthic foraminiferal species in this study, 239 in previous works) is attributed to significant taxonomic refinement.
• *Popovia johnroandi* n.sp. is described from Eastern Falcon, Venezuela. This taxon is observed to follow a trend towards greater complication of the hemisepta arrangement with time between zones N10 and N14, in the mid Miocene of Eastern Falcon, Northern Venezuela.
Romania

- In total, 227 benthic foraminifera taxa were identified from the Miocene of the Transylvania Basin.

Comparison of the Miocene foraminiferal fauna from Cabinda and Venezuela

- Provincialisation of the benthic fauna between the Venezuelan and African localities is apparent. The Alveovalvulinidae and Liebusellinae of Venezuela are largely replaced by the Eggerellininae and Textulariinae at the African sites. *P. johnrolandi* n.sp. at the Venezuelan locality replaces morphologically similar Pavonitinacea common in Cabinda.
- In both Cabinda and Venezuela sea-level is found to have a profound effect on the bathyal benthic fauna. Sea-level falls correlate with intervals of extreme poor preservation and faunal dissolution.

Physiological response of the benthic foraminifera to oxygen minimum conditions

- The Venezuelan material reveals a high productivity zone in the late Serravallian / early Tortonian. It is suggested that the waxing and waning of the fauna during this interval is indicative of the initial raising of the Isthmus of Panama and bottom water restriction.
- Morphological adaptation towards ‘form and function’ are observed in the African material with the co-occurrence of morphologically similar *Textularia earlandi* and *Brizalina alazanensis* dominating samples in marginal conditions.
- The West African assemblages shift between an agglutinating fauna, to a calcareous / mixed fauna, to a poor recovery interval, with the gradual expansion of an Oxygen Minimum Zone.
- *Reticulophragmium crassum* is observed to develop from *Alveolophragmium crassum* in a increasing complexity trend concomitant with an expanding Oxygen Minimum Zone offshore West Africa.
- ‘*Reticulophragmium* rotundidorsatum’ offshore West Africa exhibits a short evolutionary pulse in the Langhian towards greater complexity of the inner structure, returning to a simplification of form in younger sediments.
- *Reticulophragmium venezuelanum* offshore West Africa follows Cope’s Rule in addition to becoming more complex with time.

Response of Miocene bathyal benthic foraminiferal morphogroups to Total Organic Carbon values

- West African assemblages are found to migrate with respect to Total Organic Carbon data, indicating a transition from a food-controlled environment to oxygen-limiting conditions in the early to late Miocene.
8.1 RECOMMENDATIONS FOR FURTHER RESEARCH

- Extend taxonomic database into further bathyal equatorial Neogene localities e.g.: Gulf of Mexico, Trinidad.
- Time slice study across the equatorial Atlantic to address provincilisation of the Neogene benthic foraminiferal assemblage from the East to West.
- Develop a method to examine the internal structure of poorly preserved Cyclamminidae and attempt to reconcile their alveolar evolution within the equatorial Neogene.
- Examine further mid Miocene material from either side of the Isthmus of Panama to establish more exactly the effect of the initial shoaling of the Central American connection on the benthic foraminiferal assemblage.
- Examine further Cabindan material to establish greater foraminiferal biostratigraphic stability. Utilise this data to develop a credible composite standard for the offshore Cabinda area.
- Integrate Cabindan foraminiferal data with additional biostratigraphic, chemostratigraphic, lithostratigraphic, and geophysical data to develop a greater understanding of the region.
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