

TRef 1B





# CARDIGAN BAY RECENT FORAMINIFERA

(CRUISES OF THE R. V. ANTUR, 1962-1964)

J. R. HAYNES



BULLETIN OF  
THE BRITISH MUSEUM (NATURAL HISTORY)  
ZOOLOGY SUPPLEMENT 4  
LONDON : 1973



# CARDIGAN BAY RECENT FORAMINIFERA

(CRUISES OF THE R. V. ANTUR, 1962-1964)

BY

JOHN ROLAND HAYNES

*with assistance from*

TERENCE DAVID ADAMS, KEITH ATKINSON, EMMANUEL ABIODUN  
FAYOSE, DREW HAMAN, KEITH HAVARD JAMES,  
JOAN ANNE JOHNSON & JOHN SCOTT.

33 Plates, 47 Text figures

BULLETIN OF  
THE BRITISH MUSEUM (NATURAL HISTORY)  
ZOOLOGY SUPPLEMENT 4  
LONDON : 1973

THE BULLETIN OF THE BRITISH MUSEUM  
(NATURAL HISTORY), instituted in 1949, is  
issued in five series, corresponding to the Departments  
of the Museum, and an Historical series.

Parts will appear at irregular intervals as they become ready. Volumes will contain about three or four hundred pages, and will not necessarily be completed within one calendar year.

In 1965 a separate supplementary series of longer papers was instituted, numbered serially for each Department.

This paper is Supplement 4 of the Zoological series. The abbreviated titles of periodicals cited follow those of the World List of Scientific Periodicals.

*World List* abbreviation

*Bull. Br. Mus. nat. Hist. (Zool.) Suppl.*

© Trustees of the British Museum (Natural History), 1973

TRUSTEES OF  
THE BRITISH MUSEUM (NATURAL HISTORY)

Issued 12 February, 1973

Price £10.80

# CARDIGAN BAY RECENT FORAMINIFERA

## (CRUISES OF THE R. V. ANTUR, 1962-1964)

By J. R. HAYNES

*with assistance from*

T. D. ADAMS, K. ATKINSON, E. A. FAYOSE, D. HAMAN,  
K. H. JAMES, J. A. JOHNSON & J. SCOTT

### CONTENTS

	<i>Page</i>
I. INTRODUCTION . . . . .	8
II. METHODS . . . . .	10
III. LOCATION OF MATERIAL . . . . .	11
IV. ACKNOWLEDGEMENTS . . . . .	11
V. CLASSIFICATION . . . . .	11
VI. SYSTEMATIC DESCRIPTIONS . . . . .	14
Family ASTRORHIZIDAE Brady . . . . .	14
Genus <i>Halyphysema</i> Bowerbank . . . . .	14
<i>Halyphysema tumanowiczii</i> Bowerbank . . . . .	14
Genus <i>Hippocrepina</i> Parker . . . . .	15
<i>Hippocrepina</i> species A . . . . .	15
Genus <i>Marsipella</i> Norman . . . . .	16
<i>Marsipella elongata</i> Norman . . . . .	16
species A . . . . .	17
species B . . . . .	17
Genus <i>Technitella</i> Norman . . . . .	17
<i>Technitella teivyense</i> Haynes n. sp. . . . .	17
Family SACCAMMINIDAE Brady . . . . .	18
Genus <i>Psammosphaera</i> Schultze . . . . .	18
<i>Psammosphaera parva</i> Flint . . . . .	18
Genus <i>Lagenammina</i> Rhumbler . . . . .	19
<i>Lagenammina arenulata</i> (Skinner) . . . . .	19
cf. <i>hancocki</i> (Cushman & McCulloch) . . . . .	20
Genus <i>Hemisphaerammina</i> Loeblich & Tappan . . . . .	21
<i>Hemisphaerammina bradyi</i> Loeblich & Tappan . . . . .	21
Family HORMOSINIDAE Haekel . . . . .	22
Genus <i>Reophax</i> Montfort . . . . .	22
<i>Reophax arctica</i> Brady . . . . .	22
<i>Reophax fusiformis</i> (Williamson) . . . . .	23
<i>moniliforme</i> Siddall . . . . .	24
Family LITUOLIDAE de Blainville . . . . .	25
Genus <i>Ammobaculites</i> Cushman . . . . .	25
<i>Ammobaculites balkwilli</i> Haynes n. sp. . . . .	25
Genus <i>Haplophragmoides</i> Cushman . . . . .	27

	<i>Page</i>
<i>Haplophragmoides wilberti</i> Anderson . . . . .	27
species A . . . . .	28
Genus <i>Cribrostomoides</i> Cushman . . . . .	29
<i>Cribrostomoides jeffreysii</i> (Williamson) . . . . .	29
Family TEXTULARIIDAE Ehrenberg . . . . .	31
Genus <i>Spiroplectammina</i> Cushman . . . . .	31
<i>Spiroplectammina earlandi</i> (Parker) . . . . .	31
<i>wrightii</i> (Silvestri) . . . . .	32
Family TROCHAMMINIDAE Schwager . . . . .	34
Genus <i>Trochammina</i> Parker & Jones . . . . .	34
<i>Trochammina astrifica</i> (Rhumbler) . . . . .	34
<i>haynesi</i> Atkinson . . . . .	35
<i>globigeriniformis</i> var. <i>pygmaea</i> Hoglund . . . . .	36
<i>inflata</i> (Montagu) . . . . .	37
<i>intermedia?</i> Rhumbler . . . . .	39
<i>ochracea</i> (Williamson) . . . . .	40
Genus <i>Jadammina</i> Bartenstein & Brand . . . . .	41
<i>Jadammina macrescens</i> (Brady) . . . . .	41
Genus <i>Remaneica</i> Rhumbler . . . . .	43
<i>Remaneica helgolandica</i> Rhumbler . . . . .	43
Family ATAXOPHRAGMIIDAE Schwager . . . . .	44
Genus <i>Eggerelloides</i> Haynes n. gen. . . . .	44
<i>Eggerelloides scabrum</i> (Williamson) . . . . .	44
Genus <i>Textilina</i> Norvang . . . . .	47
<i>Textilina bocki</i> (Hoglund) . . . . .	47
Family FISCHERINIDAE Millett . . . . .	48
Genus <i>Cyclogyra</i> Wood . . . . .	48
<i>Cyclogyra selseyensis</i> (Heron-Allen & Earland) . . . . .	48
Family NUBECULARIDAE Jones . . . . .	50
Genus <i>Spirophthalmidium</i> Cushman . . . . .	50
<i>Spirophthalmidium acutimargo</i> var. <i>emaciatum</i> Haynes n. var. . . . .	50
Family MILIOLIDAE Ehrenberg . . . . .	52
Genus <i>Massilina</i> Schlumberger . . . . .	52
<i>Massilina carinata</i> (Fornasini) . . . . .	52
<i>secans</i> (d'Orbigny) . . . . .	53
Genus <i>Miliammina</i> Heron-Allen & Earland . . . . .	54
<i>Miliammina fusca</i> (Brady) . . . . .	54
Genus <i>Miliolinella</i> Wiesner . . . . .	56
<i>Miliolinella subrotunda</i> (Montagu) . . . . .	56
<i>subrotunda pateorid</i> var. . . . .	57
Genus <i>Pyrgo</i> Defrance . . . . .	59
<i>Pyrgo carinata</i> (d'Orbigny) . . . . .	59
cf. <i>constricta</i> Costa . . . . .	60
<i>williamsoni</i> (Silvestri) . . . . .	61
species A . . . . .	62
species B . . . . .	63
Genus <i>Quinqueloculina</i> (d'Orbigny) . . . . .	63
<i>Quinqueloculina aspera</i> d'Orbigny . . . . .	63
<i>auberiana</i> var. A . . . . .	65
var. B . . . . .	66
<i>bicornis</i> (Walker & Jacob) . . . . .	67

	Page
<i>cf. clairensis</i> Heron-Allen & Ear-	
land . . . . .	68
<i>cf. clairensis</i> var. A . . . . .	70
<i>cf. duthiersi</i> (Schlumberger) . . . . .	70
<i>intricata</i> Terquem . . . . .	71
<i>lata</i> Terquem . . . . .	72
<i>mediterranensis</i> Le Calvez & Le	
Calvez . . . . .	73
<i>cf. rugosa</i> d'Orbigny . . . . .	74
<i>seminulum</i> (Linnaeus) . . . . .	74
Genus <i>Scutuloritis</i> Loeblich & Tappan . . . . .	76
<i>Scutuloritis</i> species A . . . . .	76
Genus <i>Sigmoilopsis</i> Finlay . . . . .	77
<i>Sigmoilopsis moyi</i> Atkinson . . . . .	77
Genus <i>Spiroloculina</i> d'Orbigny . . . . .	78
<i>Spiroloculina depressa</i> d'Orbigny . . . . .	78
Genus <i>Triloculina</i> d'Orbigny . . . . .	79
<i>Triloculina trigonula</i> (Lamarck) . . . . .	79
<i>trihedra</i> Loeblich & Tappan . . . . .	80
Family NODOSARIIDAE Ehrenberg . . . . .	80
Genus <i>Dentalina</i> Riso . . . . .	80
<i>Dentalina</i> cf. <i>trondheimensis</i> Feyling-Hanssen . . . . .	80
Genus <i>Lagena</i> Walker & Jacob . . . . .	81
<i>Lagena clavata</i> (d'Orbigny) . . . . .	81
<i>doveyensis</i> Haynes n. sp. . . . .	82
<i>hibernica</i> Haynes n. sp. . . . .	83
<i>laevis</i> (Montagu) . . . . .	84
<i>pacifica</i> Sidebottom . . . . .	85
<i>perlucida</i> (Montagu) . . . . .	86
<i>semistriata</i> (Williamson) . . . . .	87
<i>spicata</i> (Cushman & McCulloch) . . . . .	88
<i>cf. striata</i> (d'Orbigny) . . . . .	89
<i>substriata</i> Williamson . . . . .	89
<i>sulcata</i> (Walker & Jacob) . . . . .	90
<i>sulcata interrupta</i> (Williamson) . . . . .	92
<i>sulcata torquiformis</i> Haynes n. var. . . . .	93
species A . . . . .	94
Family POLYMPORHINIDAE d'Orbigny . . . . .	94
Genus <i>Fissurina</i> Reuss . . . . .	94
<i>Fissurina elliptica</i> (Cushman) . . . . .	94
<i>lucida</i> (Williamson) . . . . .	95
<i>marginata</i> (Walker & Boys) . . . . .	97
species A . . . . .	98
species B . . . . .	99
Genus <i>Globulina</i> d'Orbigny . . . . .	99
<i>Globulina</i> cf. <i>inaequalis</i> Reuss . . . . .	99
Genus <i>Guttulina</i> d'Orbigny . . . . .	100
<i>Guttulina</i> (? <i>Laryngosigma</i> ) <i>harrisi</i> Haynes n. sp. . . . .	100
Genus <i>Laryngosigma</i> Loeblich & Tappan . . . . .	102
<i>Laryngosigma hyalascidia</i> Loeblich & Tappan . . . . .	102
<i>lactea</i> (Walker & Jacob) . . . . .	103
<i>lactea concava</i> (Williamson) . . . . .	104
Genus <i>Oolina</i> d'Orbigny . . . . .	105

	<i>Page</i>
<i>Oolina borealis</i> Loeblich & Tappan . . . . .	105
<i>heronalleni</i> Haynes n. sp. . . . .	106
<i>hexagona</i> (Williamson) . . . . .	107
<i>laevigata</i> d'Orbigny . . . . .	108
<i>lineata</i> (Williamson) . . . . .	109
<i>squamosa</i> (Montagu) . . . . .	110
<i>williamsoni</i> (Alcock) . . . . .	111
Genus <i>Pseudopolymorphina</i> Cushman & Ozawa . . . . .	112
<i>Pseudopolymorphina</i> cf. <i>novangliae</i> (Cushman) . . . . .	112
<i>suboblonga</i> Cushman & Ozawa . . . . .	113
Family TURRILINIDAE Cushman . . . . .	114
Genus <i>Buliminella</i> Cushman . . . . .	114
<i>Buliminella borealis</i> Haynes n. sp. . . . .	114
Family BULIMINIDAE Jones . . . . .	116
Genus <i>Bulimina</i> d'Orbigny . . . . .	116
<i>Bulimina elongata</i> d'Orbigny . . . . .	116
<i>elongata lesleyae</i> Atkinson . . . . .	119
<i>elongata subulata</i> Cushman & Parker . . . . .	120
<i>gibba</i> Fornasini . . . . .	121
<i>marginata</i> d'Orbigny . . . . .	122
Genus <i>Stainforthia</i> Hofker . . . . .	123
<i>Stainforthia concava</i> var. (Feyling-Hanssen) . . . . .	123
' <i>Stainforthia</i> ' <i>fusiformis</i> (Williamson) . . . . .	124
species A . . . . .	126
Family UVIGERINIDAE Haeckel . . . . .	126
Genus <i>Trifarina</i> Cushman . . . . .	126
<i>Trifarina angulosa</i> (Williamson) . . . . .	126
Family BOLIVINITIDAE Cushman . . . . .	128
Genus <i>Bolivina</i> d'Orbigny . . . . .	128
<i>Bolivina britannica</i> Macfadyen . . . . .	128
<i>inflata</i> Heron-Allen & Earland . . . . .	130
<i>minima</i> Phleger & Parker . . . . .	130
cf. <i>minima</i> Phleger & Parker . . . . .	131
<i>ordinaria</i> Phleger & Parker . . . . .	131
<i>pseudoplicata</i> Heron-Allen & Earland . . . . .	132
<i>pseudopunctata</i> Hoglund . . . . .	134
<i>spathulata</i> (Williamson) . . . . .	135
<i>striatula</i> Cushman . . . . .	137
<i>superba</i> Emiliani . . . . .	138
cf. <i>vadescens</i> Cushman <i>sensu</i> Hoglund . . . . .	139
<i>variabilis</i> (Williamson) . . . . .	141
Family SPIRILLINIDAE Reuss . . . . .	142
Genus <i>Patellina</i> Williamson . . . . .	142
<i>Patellina corrugata</i> Williamson . . . . .	142
Genus <i>Spirillina</i> Ehrenberg . . . . .	144
<i>Spirillina perforata</i> (Schultze) . . . . .	144
<i>Spirillina</i> species A . . . . .	144
Genus <i>Turrispirillina</i> Cushman . . . . .	145
<i>Turrispirillina</i> species A . . . . .	145
Family DISCORBIDAE Ehrenberg . . . . .	145
Genus <i>Cancris</i> Montfort . . . . .	145
<i>Cancris oblongus</i> (Williamson) . . . . .	145
Genus <i>Discorbis</i> Lamarck . . . . .	147

	Page
<i>Discorbis wrightii</i> (Brady) . . . . .	147
Genus <i>Discorbinella</i> Cushman & Martin . . . . .	149
<i>Discorbinella</i> species A . . . . .	149
Genus <i>Rosalina</i> d'Orbigny . . . . .	150
<i>Rosalina anomala</i> Terquem . . . . .	150
cf. <i>bradyi</i> (Cushman) . . . . .	153
<i>irregularis</i> Rhumbler . . . . .	154
<i>millettii</i> (Wright) . . . . .	155
<i>neopolitana</i> (Hofker) . . . . .	158
<i>praegeri</i> (Heron-Allen & Earland) . . . . .	159
<i>williamsoni</i> (Chapman & Parr) . . . . .	162
species A . . . . .	163
Family ASTERIGERINIDAE d'Orbigny . . . . .	164
Genus <i>Asterigerinata</i> Bermudez . . . . .	164
<i>Asterigerinata mamilla</i> (Williamson) . . . . .	164
Family SIPHONINIDAE Cushman . . . . .	167
Genus <i>Siphonina</i> Reuss . . . . .	167
<i>Siphonina georgiana</i> Haynes n. sp. . . . .	167
Family EPONIDIDAE Hofker . . . . .	168
Genus <i>Eponides</i> Montfort . . . . .	168
<i>Eponides repandus concameratus</i> (Montagu) . . . . .	168
Family CIBICIDIDAE Cushman . . . . .	171
Genus <i>Cibicides</i> Montfort . . . . .	171
<i>Cibicides fletcheri</i> Galloway & Wissler . . . . .	171
<i>fletcheri sachalinica</i> Vasilenko . . . . .	172
<i>lobatulus</i> (Walker & Jacob) . . . . .	173
Family PLANORBULINIDAE Schwager . . . . .	177
Genus <i>Planorbolina</i> d'Orbigny . . . . .	177
<i>Planorbolina distoma</i> Terquem . . . . .	177
species A . . . . .	180
Family GLOBIGERINIDAE Carpenter, Parker & Jones . . . . .	180
Genus <i>Biorbulina</i> Blow . . . . .	180
<i>Biorbulina bilobata</i> (d'Orbigny) . . . . .	180
Genus <i>Globoquadrina</i> Finlay . . . . .	181
<i>Globoquadrina hexagona</i> (Natland) . . . . .	181
Genus <i>Globorotalia</i> Cushman . . . . .	182
<i>Globorotalia inflata</i> (d'Orbigny) . . . . .	182
Genus <i>Orbulina</i> d'Orbigny . . . . .	184
<i>Orbulina universa</i> d'Orbigny . . . . .	184
Family ROTALIIDAE Ehrenberg . . . . .	184
Genus <i>Ammonia</i> Brunnich . . . . .	184
<i>Ammonia aberdoveyensis</i> Haynes n. sp. . . . .	184
<i>batavus</i> (Hofker) . . . . .	187
<i>limnetes</i> (Todd & Bronnimann) . . . . .	189
<i>tepidia</i> (Cushman) . . . . .	191
Genus <i>Buccella</i> Anderson . . . . .	193
<i>Buccella frigida</i> (Cushman) . . . . .	193
Family CASSIDULINIDAE d'Orbigny . . . . .	194
Genus <i>Cassidulina</i> d'Orbigny . . . . .	194
<i>Cassidulina</i> cf. <i>reniforme</i> (Norvang) . . . . .	194
Family NONIONIDAE Schultze . . . . .	196
Genus <i>Elphidium</i> Montfort . . . . .	197
<i>Elphidium asterotuberculatum</i> (Voorthuysen) . . . . .	197

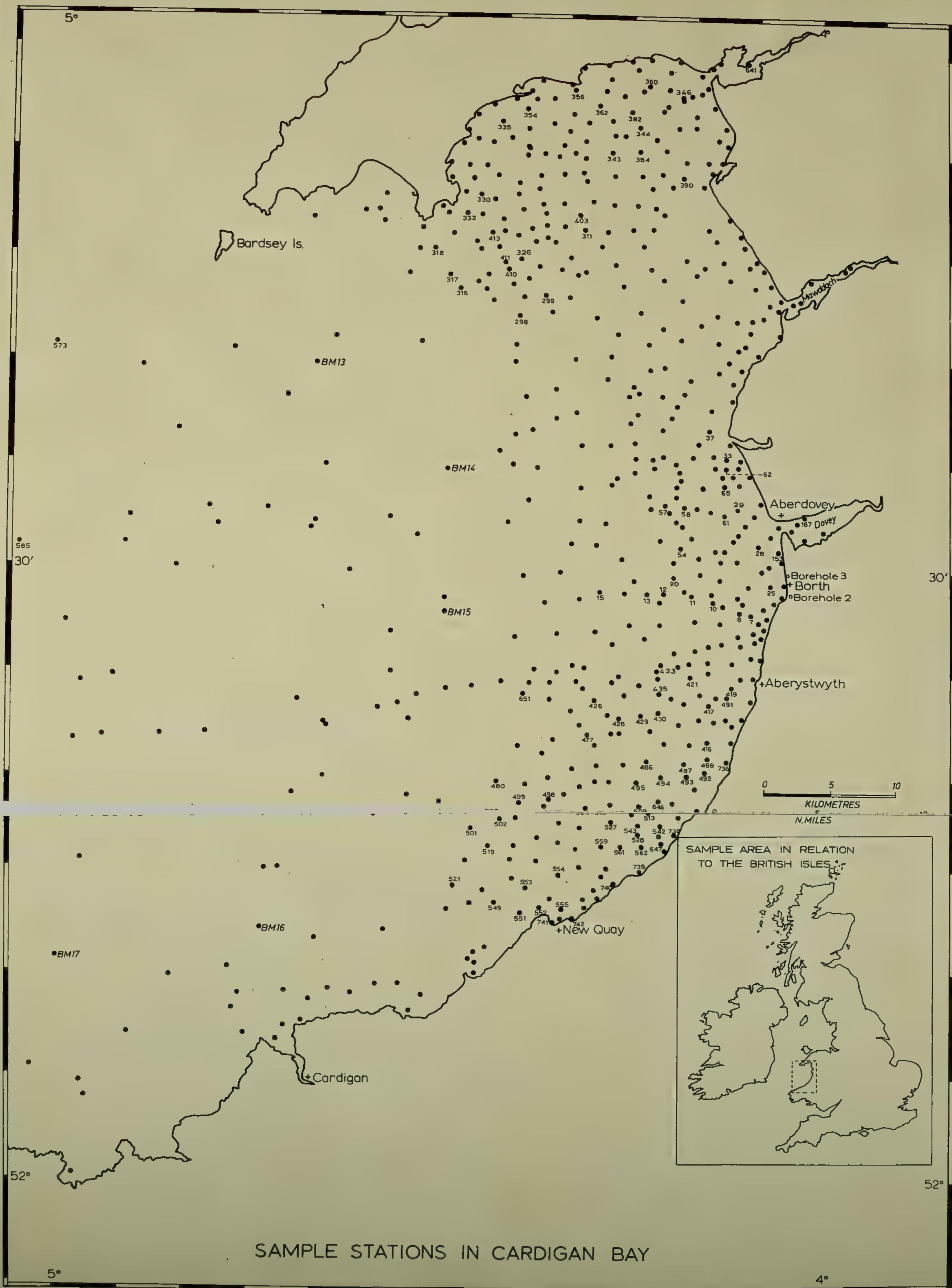
	<i>Page</i>
<i>cuvillieri</i> Lévy . . . . .	197
<i>exoticum</i> Haynes n. sp. . . . .	198
<i>incertum</i> (Williamson) . . . . .	199
<i>macellum</i> (Fichtel & Moll) . . . . .	201
<i>magellanicum</i> Heron-Allen & Earland . . . . .	202
<i>margaritaceum</i> (Cushman) . . . . .	203
<i>selseyense</i> s.l. (Heron-Allen & Earland) . . . . .	204
<i>waddensis</i> (Voorthuysen) . . . . .	206
<i>williamsoni</i> Haynes n. sp. . . . .	207
Genus <i>Nonion</i> Montfort . . . . .	209
<i>Nonion depressulus</i> (Walker & Jacob) . . . . .	209
<i>pauperatum</i> (Balkwill & Wright) . . . . .	210
Genus <i>Nonionella</i> Cushman . . . . .	211
<i>Nonionella auricula</i> Heron-Allen & Earland . . . . .	211
<i>turgida</i> Williamson . . . . .	213
<i>turgida</i> var. <i>digitata</i> Norvang . . . . .	214
species A . . . . .	215
Genus <i>Protelphidium</i> Haynes . . . . .	216
<i>Protelphidium anglicum</i> Murray . . . . .	216
Family UNCERTAIN . . . . .	217
Genus <i>Epistominella</i> Husezima & Maruhasi . . . . .	217
<i>Epistominella naraensis</i> (Kuwano) . . . . .	217
VII. SUMMARY AND CONCLUSIONS . . . . .	219
VIII. REFERENCES . . . . .	221
IX. INDEX TO GENERA, SPECIES AND VARIETIES . . . . .	239
X. ADDENDUM . . . . .	244

### SYNOPSIS

One hundred and sixty five species of foraminifera are described from sediments collected in Cardigan Bay (Wales). These belong to sixty-five genera and twenty-seven families. One genus and twelve species and varieties are renamed or new. This fauna includes most of the abundant shallow water forms on the British List.

### I. INTRODUCTION

*Raison d'être.* Since the publication of '*Testacea minuta rariora nuperrime detecta in arena littoris Sandvicensis*' by Walker & Boys (1784) upwards of 300 papers have been written concerned at least in part with Recent foraminifera from the seas surrounding the British Isles. However, most of these works contain lists only, and the monograph 'On the Recent Foraminifera of Great Britain' by Williamson (1858) is the only comprehensive account, with descriptions as well as illustrations of about 90 species. This was noted by Earland (1902) in his plea for a new 'Williamson', and remains true despite the notable contributions made by Heron-Allen and Earland in their studies of Clare Island (1913b), West of Scotland (1916a) and Plymouth (1930). These works contain figures and descriptions of new species but the other species are only partially illustrated, often by abnormal or unusual specimens.





There is thus an obvious need for an up to date taxonomic study of the British Recent foraminifera. This has been made more pressing by the great expansion in distribution studies being made all over the world, largely a consequence of the application of foraminifera to problems of palaeoecology, particularly in the oil industry. Large numbers of foreign workers are thereby faced with the problem of comparing their material with long established but inadequately described British species.

Our work in Cardigan Bay has led to the recognition of some 200 foraminiferal taxa of which 165 species and varieties are here described. This includes most of the shallow water forms on the British list and presents an ideal opportunity for their redescription and revision. It is hoped to deal with the remaining deeper water forms in a later publication.

*Scope of the study.* This report is concerned with the taxonomy of the foraminifera and with an attempt, where feasible, to establish their world-wide range. As their detailed distribution and ecologic relationships within Cardigan Bay will be dealt with elsewhere the physical setting will not be described here. For present purposes an adequate summary is given by Moore (1968) who, in a paper on the sediments of Northern Cardigan Bay, includes an account of the bathymetry, circulation and climate. Further details for the southern part of Cardigan Bay are given by Whatley & Wall (1969). Information pertaining particularly to the Dovey Estuary area can be found in Haynes & Dobson (1969).

*Material.* The foraminifera have been picked from sediment taken at more than 600 stations made during the years 1962–64 by the research vessel 'Antur' (Text-fig. 1). For convenience, only the samples mentioned in the text are numbered on the map. Most of the samples were taken in depths of less than 15 fathoms (approximately 30 metres) in the inner bay, with a more widely spaced scatter down to depths of 40 fathoms (approximately 80 metres) in the outer bay. The samples thus represent the upper continental shelf and turbulent zone. They have been supplemented by samples collected along the shore between tide marks during the years 1962–1967, in particular from rock pools such as those at Monks Cave, immediately south of Aberystwyth (Atkinson, 1969) and from the Dovey Estuary and marshes. Maps of the sample stations in the Dovey Estuary including the Clettwr Transect and the location of boreholes into the Holocene sediments are given in Adams & Haynes (1965) and Haynes & Dobson (1969). Also shown in Text-fig. 1 are the locations of five small gravity cores taken by the R.V. 'Shackleton' for the British Museum and used in our study, B.M. Cores 13–17.

*Previous work.* This study is a contribution to the Cardigan Bay–Irish Sea Research Project of the Geology Department, University College of Wales, Aberystwyth. The Project was instituted in 1962 and is concerned with the investigation of the geological history of the area, present day sedimentation, faunas and their ecological relationships. Some 2000 sediment samples have now been collected in Cardigan Bay and the Southern Irish Sea (including St Georges Channel). A number of foraminiferal investigations have been carried out under the direction of Dr J. R. Haynes and the results presented as dissertations for the Ph.D. and M.Sc. degrees and the College Diploma in Micropalaeontology. These works which

are available on inter-library loan are as follows in order of date: Adams (1963); James (1965); Johnson (1965); Fayose (1965); Haman (1966a); Scott (1966); Atkinson (1967). In addition the following papers on different aspects of foraminiferal distribution and taxonomy have appeared: Wood, Adams & Haynes (1963); Haynes (1964, 1965); Adams & Haynes<sup>1</sup> (1965); Adams, Haynes & Walker (1965); Haman (1966b, 1967, 1969); Atkinson (1968, 1969); Haynes & Dobson (1969). There had been no previous work on the foraminifera in Cardigan Bay.

At a very early stage in these investigations we faced the difficulty of finding correct names for many of the species. In order to speed the studies of distribution we decided to follow 'accepted British usage' until such times as we had accumulated sufficient good material to justify tackling the knotty nomenclatural problems we knew existed. We were helped at the outset in this by the advantage of having to hand the unpublished thesis of Dr T. J. Harris (1958) on material collected by the 'Goldseeker' off the coasts of Scotland.

We have now arrived at a more mature stage in our researches and the present work may be taken as superseding our previous taxonomic ideas.

## II. METHODS

*Laboratory.* The samples were collected either by means of the Holme Vacuum Grab or by the Van Veen Grab with a number taken by small Gravity Corer. The first 247 stations were fixed by sextant readings of landmarks, the rest by Decca Navigation System. All samples have been stored in glass jars in formalin buffered with borax and the foraminifera picked from 10 ml cuts washed over a 200 mesh screen (Brit. Stand. Aperture 75 microns). Rose Bengal was used as a stain for protoplasm. Flotation in heavy liquids was found an inadequate means of separating the foraminifera from the sediment and particularly inefficient in the coarser fractions. All samples have therefore been picked by hand to allow proper statistical analysis of the results. Foraminifera have also been collected from seaweeds and picked from sediments scraped from cobbles and boulders with a blunt knife.

Most of the species have been illustrated by scanning electron micrographs. In this case the specimens have been cemented to aluminium stubs by 'dag' (a suspension of silver in alcohol) and coated by aluminium in vacuum before scanning and photography. This technique emphasizes surface detail but does not reveal internal characters, indeed it may obscure them, especially where the specimen is lamellar and the septa flush with the external wall. Where necessary, therefore, figures have been drawn by light microscope and camera lucida. These were drawn by Dr J. R. Haynes and carefully inked in by Dr K. Atkinson. A number of thin sections have also been made by a procedure close to that used for preparing thin sections of incoherent sediments used by Moore & Garraway (1963). Photographs of these sections were done by Zeiss Photomicroscope.

*Descriptive.* The synonymies have been restricted to important name changes and to citations from the North Atlantic and North Sea area with both figures and descriptions. In some cases citations with good figures only have been included. Other records are grouped in the distribution sections.

<sup>1</sup> Additional reference in addendum.

A general diagnosis is given for each species as well as a description of a particular specimen. In the descriptions care is taken to distinguish between the chambers visible on the periphery of trochospiral or planispiral forms and the number actually present in the successive whorls counted from the proloculus (as by Haynes, 1956). In biserial and triserial forms the angle of taper from the initial end to the widest part of the adult is given (as by Chamney, 1969).

### III. LOCATION OF MATERIAL

The specimens described are deposited in the collections of the British Museum (Nat. Hist.) and the registered numbers are given in the descriptions. In the case of the specimens illustrated by scanning electron micrographs the stubs have been presented (as removal from the well set 'dag' would undoubtedly cause damage or loss). All the sections illustrated may be found in the collection as well as all the other material, in conventional 'one-hole' slides.

### IV. ACKNOWLEDGEMENTS

We are grateful to Professor Alan Wood for his vision in embarking on the Cardigan Bay Project and for his continued encouragement of our researches. We also owe a debt of gratitude to the U.C.W. and N.E.R.C. for the financial assistance that made this work possible. Thanks also go to the late William (Bill) Lucas, skipper of the 'Antur', and to Dr H. Jones and Dr J. R. Moore for their help at sea with the collection of samples, particularly during the extraordinarily severe winter of 1962/63.

Numerous colleagues in this country and abroad have kindly sent copies of their work and specimens for comparison and special thanks are due to Dr's C. G. Adams and R. H. Hedley for their encouragement and permission to examine collections in the British Museum (Nat. Hist.).

We are indebted to Professor P. C. Sylvester-Bradley for permission to use the scanning electron microscope at the University of Leicester and to Mr G. L. C. McTurk for his skill in taking the photographs.

Finally, we must express our heartfelt thanks for the efforts made on our behalf by members of the technical staff of the U.C.W., to Mr H. Williams for long hours spent in the darkroom and his expertise in making enlargements from the S.E.M. negatives; to Mr S. H. Garraway for making the thin sections; to Mr H. Edwards, Mr D. Jones and Mrs S. Davies for help with the picking, preparing an index of North Atlantic foraminifera and for checking the bibliography. Mrs C. Thomas drafted the location map and inked the figure of *T. haynesi*. Miss M. Hughes, Miss G. Jones and Mrs P. Jones cheerfully coped with the problem of typing the manuscript.

### V. CLASSIFICATION

Among the criteria available for the classification of the foraminifera are: wall structure, chamber arrangement, aperture form and the evidence of ontogeny

and the stratigraphical succession. There has been a continuing debate regarding the relative value of these features but lately the tides of opinion have set strongly in favour of the primary importance of wall structure, despite warnings that the evidence was inconclusive (Wood & Haynes, 1957; Reiss, 1963). Thus Loeblich & Tappan (1964b) state, 'in the classification used by the writers, test mineralogy and wall microstructure are regarded as of primary importance', and in their scheme the suborders and superfamilies are largely recognized on this basis. We believe this goes too far, leading to artificial groupings. Workers have been tempted to treat wall structure as a 'key' to classification, supposing it a non-adaptive character. However, Haynes (1965), has put forward reasons for the possible adaptive significance of changes in wall structure. It must also be remembered that all morphological changes arise initially at the specific or subspecific level and wall structure cannot be exempt from this rule.

Loeblich and Tappans' scheme requires the independent origin of all the different wall structure groups from tectinous ancestors. For this reason optically granular forms are separated from what are considered to be their radial hyaline isomorphs and grouped in three new superfamilies. Thus granular *Cibicides* is separated from radial *Cibicides* and placed in the new superfamily Anomalinacea, despite the fact that what was actually demonstrated by Wood & Haynes (1957) was that forms otherwise identical with *Cibicidoides* s.s. such as *C. pseudoungerianus* were found to be radial, and plano-convex forms otherwise identical with *Cibicides* s.s. were found to be optically granular. Towe & Cifelli (1967) have now shown that the difference between optically granular and radial wall structure is slight. It is the result of calcification on the tectin membrane, preferentially on the basal pinacoid,  $\bar{0}0\bar{1}$  face, in the case of radial forms, and preferentially on the rhomb face,  $10\bar{1}1$ , in the case of granular forms. They believe that these modes of calcification are so similar that it would be relatively easy to derive one from the other. Striking confirmation of this probability appears to be provided by the *Nonion-Elphidium* group. The optically radial, intermediate form *Protelphidium* was described by Haynes (1956). Granular forms of *Elphidium* s.l., *E. incertum* Williamson, were described by Buzas (1966) and in this work we describe beautifully optically granular forms of *Elphidium* s.s., *E. exicum* n. sp. Matoba (1970) has suggested that a new genus should possibly be set up to include granular *E. subincertum* Asano but it is now clear that wall structure changes occur at the specific level in this group.

It is thus obvious that the attempt to recognize the superfamilies Anomalinacea and Nonionacea on the basis of wall structure has to be abandoned. It is also apparent that the 'septal flap' is a gradually acquired, progressive feature in this group, of independent origin from that in the Rotaliidae. For this reason we have decided to tread a conservative path in regard to classification with no attempt to recognize categories above the family level.

The family Discorbidae is also interpreted in the wide sense to include for the time being *Rosalina* s.l. and '*Glabratella*'. There are a number of reasons for taking this course. Loeblich & Tappan (1964a) have figured topotypes of *Discorbis vesicularis* Lamarck, the genoholotype, which show it to be a biconvex form with markedly overlapping umbilical lobes on the ventral side hidden beneath a vesicular mass of

secondary calcite. According to these authors thin sections show the wall structure to be radial and monolamellid, contrary to Reiss (1963) who considered this species bilamellid with tooth plates. Loeblich & Tappan (1964b) follow Reiss in placing *Rosalina* in a separate family (*Rosalinidae*) and accept his statement that *R. globularis*, the genoholotype, is bilamellid. However, although Reiss says that *R. globularis* is unambiguously designated and well known it is clear from his discussion of *Discopulvinulina* Hofker that his specimens are almost certainly not the same as the specimen selected by Loeblich & Tappan as neotype (1964a). He refers to Cushman's view that *R. bradyi* is merely a variety of *R. globularis* which indicates he is following Cushman's conception of the species. As we show below, North Atlantic references to *R. globularis*, including Cushman (1931) and Hofker (1951a), refer to *R. anomala* Terquem. This species appears to be monolamellid but it is difficult to be certain and it has coarse pores on the dorsal side. Specimens we place under *R. irregularis* do appear to be bilamellid but optically granular. At the moment, therefore, the evidence for removing *Rosalina* to another family and superfamily (Orbitoidacea) seems weak, particularly in view of the difficulty of interpreting the wall structure. It is also quite possible that the bilamellid condition first arose as a progressive feature in this group.

Loeblich & Tappan (1964a) have transferred discorbids with umbilical aperture, radial ornament and plastogamic reproduction, to *Glabratella* and the family Glabratellidae. They have transferred the Glabratellidae to the Orbitoidacea because Reiss has found a bilamellid wall in *Conorbella* (considered synonymous with *Glabratella*). But the type of *Glabratella*, *G. crassa* Doreen is Eocene and the wall structure and mode of reproduction are unknown. *Discorbis baccata* (Heron-Allen & Earland) = *D. wrightii* (Brady) is plastogamic and may be bilamellar (Pl. 30, fig. 4) but appears closer to *Discorbis* s.s. than Doreen's species. Until we know more about reproduction in the whole group it is merely confusing to transfer species with radial ornament to *Glabratella*. For instance Le Calvez & Boillot (1967) transfer *Rosalina milletii* (Wright) to *Glabratella* which in Loeblich and Tappans' scheme would put it in another super family, thus separating it completely from the closely related *R. nitida* = *R. williamsoni* (Chapman & Parr).

The genus *Gavelinopsis*, genoholotype *G. praegeri* (Heron-Allen & Earland) is distinguished from *Rosalina* largely on the basis of its prominent umbilical plug. However, as we show below, this is not always present and cannot be considered a basis for sound generic subdivision, particularly as Loeblich & Tappan (1964a) figure species of *Discorbis* with plugs.

For the present, *Asterigerinata*, genoholotype *A. dominicana* Bermudez, is left in the family Asterigerinidae, although Reiss (1963) claims the chamberlets are secondary, not primary as in *Asterigerina* and transfers it to the Conorboidinae (Conorbidae). However, Loeblich & Tappan (1964b) transfer *Conorboides* to the aragonitic, Ceratobulimininae, so further work is required. But we do follow Reiss (1963) in placing *Buccella* in the Rotaliidae and agree that it is close to *Ammonia* but with dense granules obscuring the sutural fissures and giving the appearance of secondary apertures.

It will be seen that our ideas on supra-generic classification in general and

especially on the value of wall structure show something of a return to those of the 'English School'. Williamson (1858) first recognized the three major wall structure groups, in particular the opaque calcareous (porcelainous) wall of the Miliolids, but his caution is well expressed by his statement that these differences 'were at least of specific value'. This caution was well justified in view of the outer, agglutinated wall in many species of *Quinqueloculina*, such as *Q. aspera*, which could be taken to show the trend to *Miliammina*. This genus, with grains bound in the tectin lining, probably first arose as an adaptation to the extensive brackish water areas so typical of Interior North America in the late Jurassic and Cretaceous. It is plain that a rigid application of wall structure leads to a horizontal classification. This may provide convenient pigeon holes but it hinders the study of lines of descent.

## VI. SYSTEMATIC DESCRIPTIONS

### Family ASTRORHIZIDAE Brady, 1881

#### Genus **HALYPHYSEMA** Bowerbank, 1862

##### *Halphysema tumanowiczii* Bowerbank

(Pl. 1, fig. 6; Pl. 3, fig. 13)

*Halphysema tumanowiczii* Bowerbank, 1862 : 1105, pl. 73, fig. 3; Norman, 1878 : 274; Kent, 1878 : 68, pls 4, 5; Lankester, 1879 : 475, pl. 22, figs 1-11; Brady, 1884 : 281, pl. 27A, figs 4, 5; Cushman, 1918 : 87, pl. 33, figs 1, 2; Loeblich & Tappan, 1958 : 124, pl. 1, figs 1, 2 (figs of lectotype); 1964a : C192, figs 108-6, 7.

*Squamulina scopula* Carter, 1870 : 310, pl. 4, figs 1-11.

**DIAGNOSIS.** A species of *Halphysema* in which the test consists of a single column, rising from a disc-like pedestal and gradually expanding to a brush-like head beset with sponge spicules.

**DESCRIPTION.** (Pl. 1, fig. 6; Pl. 3, fig. 13.) Test unilocular, fixed by round, concavo-convex, disc-like pedestal which has bars within, elongate and gradually enlarging to the head which is flattened and has a slight neck, round in section, about five times as long as wide; aperture terminal, apparently single; wall thin, 'collagenous' with closely agglutinated quartz silt and interwoven sponge spicules; spicules subparallel to the wall in the lower part but sticking out at an angle from the head and neck.

**DIMENSIONS.** Length 1.20 mm, maximum width 0.26 mm.

**MATERIAL.** Four specimens.

**VARIATION.** The clavate body chamber may be straight or twisted and the sponge spicules on the head directed forwards or out at various angles as in the specimen described. Rarely, sponge spicules entirely predominate (Lankester, 1879).

**DEPOSITORY.** B.M.(N.H.) Slide 1970 : 11 : 26 : 1-3. Stub 1970 : 11 : 26 : 625.

**PROVENANCE.** Specimen described, CB 647.

**REMARKS.** This remarkable foraminifer, 'bristling with borrowed spicules', as Brady remarked, was originally regarded as a sponge before its true affinities were recognized by Carter. Carter's description includes these interesting details about the soft parts, 'Animal occupying the cavity of the test, consisting of semitransparent yellowish sarcodite charged with granules and oil globules, frustules of Diatomaceae, especially *Melosira*, dark brown bits of *Fucus*, and reproductive cells'. Details of the wall are shown in Pl. 1, fig. 6. It will be noted that in some cases it is the pointed tip in other cases the rounded base of the sponge spicule that sticks out.

Hedley & Wakefield (1967) have shown that the inner lining of the test is of fibrous protein, possibly collagen, imparting a flexibility that may be of adaptive value in the turbulent zone.

**DISTRIBUTION.** This species occurs as a fixed form among weeds in the Laminarian zone. It is possibly widespread around Great Britain and it appeared as a juvenile form on weed covered cobbles gathered from Sarn Cynfelyn and kept in a tank for some months. The original specimens were from Hastings (Sussex) and Carter's specimens came from Budleigh Salterton, Devon, found on Laminarian holdfasts and the fronds of *Phyllophora*. Other British records are Wembury, Devon (Hedley & Wakefield, 1967); Torbay, Devon (Parfitt, 1878); Jersey (Kent, 1878); Dublin Bay (Haddon, 1886); Colwyn Bay and Dee (Siddall, 1878, 1886); Clare Island (Heron-Allen & Earland, 1913b).

Genus **HIPPOCREPINA** Parker, 1870

*Hippocrepina* species A

(Pl. 2, fig. 4; Text-fig. 2, nos 1-4)

**DIAGNOSIS.** A species of *Hippocrepina* with subovate to elongate ovate test, slightly irregular but tending to be widest at the apertural end which is slightly produced and truncate with the aperture within a depression.

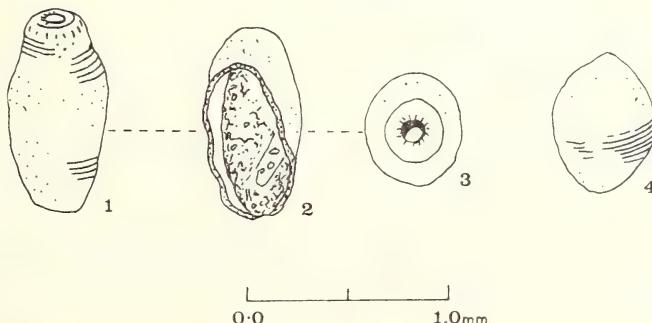


FIG. 2, 1-4. *Hippocrepina* species A. 1-3, views of broken specimen containing dried protoplasm; 4, oval specimen.

DESCRIPTION. (Pl. 2, fig. 4.) Test subovate with truncate ends, round in section and widest above the mid point; apertural end produced into a rounded collar surrounding the small, circular, terminal aperture; wall strongly built, mainly of quartz silt with some mica and dark minerals, smooth exterior coat now partially removed, faint parallel constrictions visible towards the base, grey in colour.

DIMENSIONS. Length 0·8 mm, diameter 0·46 mm.

MATERIAL. About 10 specimens, some collapsed and distorted.

VARIATION. As shown by the text-figure there is a range of shapes from subovate to subcylindrical and the faint grooves are more conspicuous in some specimens. No. 4 shows a collapsed form in which the aperture cannot be made out. These specimens were alive on collection and the broken one illustrated is filled up with a silty mass of protoplasm and dark waste products apparently including diatoms. The wall in this specimen is about 40 microns in thickness.

DEPOSITORY. B.M.(N.H.) Slide 1970 : 11 : 26 : 4-5. Stub 1970 : 11 : 26 : 528.

PROVENANCE. Described specimens, CB 413.

REMARKS. This species differs both in shape as well as in apertural characters from *Hippocrepina pusilla* Heron-Allen & Earland and *Hippocrepina oblonga* Pearcey. There is some resemblance between our specimens and *Hippocrepinella acuta* Hoglund but his specimens are all much smaller, with stronger constrictions and pointed initial ends. The wall is also much thicker and the aperture is not countersunk. Incidentally, Hoglund's specimens should properly be included in *Hippocrepina* as *Hippocrepinella* was diagnosed by Heron-Allen and Earland as possessing double apertures and thin wall.

DISTRIBUTION. All the specimens so far recovered are from Tremadoc Bay in northern Cardigan Bay.

### Genus **MARSIPELLA** Norman, 1878

#### *Marsipella elongata* Norman

(Pl. 3, fig. 14)

*Marsipella elongata* Norman, 1878 : 281, pl. 16, fig. 7; Carpenter, 1881 : 561, figs d, e, f; Brady, 1884 : 264, pl. 24, figs 10-19; Flint, 1899 : 270, pl. 12, fig. 1; Cushman, 1918 : 23, pl. 8, figs 2, 3; Avnimelech, 1952 : 66, fig. 15.

DIAGNOSIS. An irregularly curved species of *Marsipella* tapering towards the extremities which become tubular and are composed of sponge spicules in contrast to the coarse sand grains of the body chamber.

DESCRIPTION. Test broken with tubular extensions lost; unilocular, an irregular tube with roughly agglutinated wall of angular quartz grains up to about 0·3 mm

in maximum diameter; subround in section; original test presumably open at both ends.

DIMENSIONS. Length 3·3 mm.

MATERIAL. Six broken specimens.

DEPOSITORY. B.M.(N.H.) Slide 1970 : II : 26 : 6-8. Stub 1970 : II : 26 : 650-651.

PROVENANCE. Specimen described, CB 318.

REMARKS. According to the original description the wall is of coarse sand grains 'interspersed here and there with a sponge spicule' but the mouth opening is formed by a 'faggot' (bundle) of sponge spicules. However, Brady (1884) found exceptional individuals made up of quartz grains throughout and similar individuals occur in Carpenter's Lightning material in the British Museum which also includes wholly spicular forms and specimens built of the tests of other foraminifera. It is therefore a mute point as to whether our specimens are all broken as they do not show the faggots of spicules and so they are questionably referred to the species.

A number of specimens were also recovered in which the wall is composed of a sheaf of shell fragments (Pl. 3, fig. 15, CB 360) and a single specimen apparently composed of overlapping mica flakes (Pl. 3, fig. 16, CB 15). These are questionably referred to *Marsipella* species A and B, but could be worm tubes.

DISTRIBUTION. This species was described from Porcupine station No. 87, lat. 59°35'N, 9°W and appears to be widespread in the N. Atlantic: Warm Faroe Channel (Brady, 1884; Pearcey, 1890); West of Ireland (Brady, 1884; Wright, 1889); Canaries and Azores (Brady, 1884); Western Atlantic (Cushman, 1918); Caribbean (Flint, 1899).

Other records are: Indian Ocean, off Zanzibar (Stubbings, 1939); Antarctic (Chapman & Parr, 1937); South Atlantic, off Argentina (Boltovskoy, 1961).

#### Genus **TECHNITELLA** Norman, 1878

##### ***Technitella teivyense*** Haynes n. sp.

(Pl. I, figs 1-4)

DESCRIPTION. (Holotype Pl. I, figs 1, 2 and 4.) Test attached, unilocular, roughly cylindrical and rising from an encrusting base, tapering slightly to the large, round aperture; wall an open network of sponge spicules directed forwards at about 45° to the axis of growth and piercing the tectin lining to intrude into the body chamber, markedly brushed forward around the aperture; aperture with internal tectin collar.

DIMENSIONS. Height approximately 0·70 mm.

MATERIAL. Six specimens, or groups of specimens, attached to algae, 14 detached specimens.

VARIATION. This species occurs as a cluster of individuals arising from the encrusting mat-like base or as single individuals. The shape of the body chamber

varies from narrow to stoutly cylindrical, some specimens tapering markedly towards the aperture. There is no evidence of branching of the cylindrical body chamber so the colonies appear to be composed of separate individuals. Specimens up to 2 mm length occur.

DEPOSITORY. B.M.(N.H.) Stub 1970 : 11 : 26 : 741-743 (holotype and paratypes).

PROVENANCE. Holotype, CB 647. Paratypes, CB 647.

REMARKS. In 1967, Haman put forward good grounds for the supposition that *T. legumen* had hitherto been misinterpreted, the former attachment end being mistaken as the aperture and the test figured upside down. Additional collecting in south Cardigan Bay now makes evident that our material is specifically distinct from *T. legumen* and *T. melo*. In particular the rough, open, spicular structure of the wall in our form is quite different from the delicate, close set, warp and weft structure of *T. legumen* and the densely moulded wall of *T. melo*, well described by Norman as resembling the matted, fibrous surface of a coconut. This means that an attached habit in *T. legumen*, although likely, still has to be proved and that our species can be placed in the genus *Technitella* only tentatively. This brings up the question of the possible relationship of our form with *Halyphysema* which also has projecting spicules. However, this genus is also characterized by its definite attachment disc and club shaped head.

DERIVATION OF NAME. Refers to provenance in Cardigan Bay (Bae Aberteifi in Welsh because the River Teivy enters the bay at the port of Cardigan). Pronounced as in neck-tie.

#### Family SACCAMMINIDAE Brady, 1884

#### Genus **PSAMMOSPHAERA** Schultze, 1875

##### *Psammosphaera parva* Flint

(Pl. 2, fig. 13)

*Psammosphaera parva* Flint, 1899 : 268, pl. 9, fig. 1; Cushman, 1918 : 35, pl. 12, figs 4-6.  
*Psammosphaera fusca* Schultze var. *parva* (Flint) Heron-Allen & Earland, 1913a : 17, pl. 2, figs 7, 8.  
*Psammosphaera fusca* Brady, part, 1884 : pl. 18, figs 2-4 only (not Schultze).

DIAGNOSIS. A subspherical, fine grained species of *Psammosphaera* generally built round one or two sponge spicules.

DESCRIPTION. Test free, subspherical, irregular in outline, apparently transfixed with four sponge spicules; unilocular; wall of agglutinated grains of silt up to 60 microns maximum diameter; no aperture but some small, irregular openings between the grains present.

DIMENSIONS. Maximum diameter 0.20 mm.

MATERIAL. Three specimens.

VARIATION. Up to five attached sponge spicules occur.

DEPOSITORY. B.M.(N.H.) Slide 1970 : 11 : 26 : 10. Stub 1970 : 11 : 26 : 686.

PROVENANCE. Specimen described, CB 311.

REMARKS. This species is distinguished from *P. fusca* by its finer wall and by the presence of one or more sponge spicules. Heron-Allen & Earland (1913a) supposed it 'constructs its abode round the spicule in order to obtain the increased support afforded by its projections in supporting itself upon the surface layers of the bottom ooze'.

DISTRIBUTION. This species was first described from deep water, 1019 fathoms off the coast of Brazil. Around the British Isles it has been found in abundance only in Goldseeker Haul 288, Warm Faroes Channel (Heron-Allen & Earland, 1913a). Other records include: N. Atlantic (Cushman, 1918); S. Atlantic, Pernambuco (Brady, 1884); Falklands (Earland, 1934); Antarctic (Chapman & Parr, 1937; Earland, 1936; McKnight, 1962; Wiesner, 1931); Indian Ocean, coast of Madagascar (Braga, 1961); Pacific (Cushman, 1910, 1921).

Thus most records are from high latitudes and deep water.

#### Genus *Lagenammina* Rhumbler, 1911

##### *Lagenammina arenulata* (Skinner)

(Pl. 2, fig. 17; Pl. 8, fig. 12; Text-fig. 3, nos 1-3)

*Reophax diffugiformis* part Brady, 1884 : 289, pl. 30, fig. 5 only; Flint, 1899 : 272, pl. 16, fig. 2.

*Reophax diffugiformis* Brady subsp. *arenulata* Skinner, 1961 : 1239.

*Proteonina diffugiformis* (Brady) Cushman, 1918 : 47, pl. 21, figs 1, 2; Hoglund, 1947 : 53,

pl. 4, fig. 18; Cushman, 1948 : 11, pl. 1, fig. 5; Hofker, 1960 : 235, fig. 7.

*Proteonina atlantica* Parker, 1952a : 393, pl. 1, fig. 2 (not Cushman).

*Reophax atlantica* (Barker) 1960 : 62, pl. 30, fig. 5 (after Brady).

DIAGNOSIS. An irregularly flask-shaped species of *Lagenammina* with slightly produced neck and coarsely agglutinated wall.

DESCRIPTION. (Pl. 2, fig. 17; Pl. 8, fig. 12.) Test damaged with two holes and appearing more bottle-shaped than it is in reality, unilocular, with greatest width

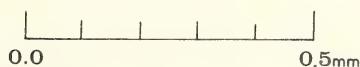


FIG. 3, 1-3. *Lagenammina arenulata*, shape variations.

from mid point to the base, tapering to a slight, stout, neck at the apex, subround in section with flattened base; wall coarsely and roughly agglutinated with angular quartz silt grains and some mica flakes up to 75 microns in diameter in a finer matrix; aperture oval, with slight neck and well formed lip of smoothly cemented smaller grains up to 30 microns in diameter.

**DIMENSIONS.** Maximum length 0·50 mm, width 0·20 mm.

**MATERIAL.** Twenty-three specimens.

**VARIATION.** Most of the specimens are somewhat smaller than the one described above, those illustrated in the text-figures averaging 0·30 mm in length. As shown by Text-fig. no. 1 an occasional large sand grain is attached to the wall. The test although slightly irregular is generally subround at the base and consistently tapers to a rather short, stout aperture from about mid point.

**DEPOSITORY.** B.M.(N.H.) Stub 1970 : 11 : 26 : 644. Slide 1971 : 2 : 16 : 1-4.

**PROVENANCE.** Specimen described, CB 413. Other specimens figured, CB 646.

**REMARKS.** Brady included a number of different forms under *Reophax diffugiformis* in the Challenger Report. Our specimens are close to that shown in fig. 5 which has been distinguished as subspecies *arenulata* by Skinner. As this form differs in shape, wall structure and apertural details from the type of *Reophax diffugiformis* 1879 we have raised the name to specific rank. In fact, apart from the lack of apertural neck, *L. arenulata* is closer to *L. atlantica* Cushman. This is undoubtedly what led Parker and Barker to place Brady's specimen in Cushman's species.

A number of references to *L. diffugiformis* in the N. Atlantic and Arctic belong here though probably not those with long, narrow necks as illustrated by Parker (1952a) and Goës (1894). The specimens illustrated by Flint have necks that are unusually long but stoutly built like that in the type.

**DISTRIBUTION.** The type was discovered at Porcupine Station 47 in the Faroe Channel, N. Atlantic. Other good, figured references are: The Skagerak (Hoglund, 1947); N. Atlantic, common north of Lat. 35° (Cushman, 1918); Arctic, Nova Zembla and off Greenland (Cushman, 1944); New England (Parker, 1952a).

### *Lagenammina cf. hancocki* (Cushman & McCulloch)

(Pl. 2, figs. 11, 12; Pl. 8, fig. 10)

See *Proteonina compressa* Cushman & McCulloch, 1939 : 42, pl. 1, fig. 10 (renamed *hancocki* 1948).

**DESCRIPTION.** Test unilocular, oval with greatest width about midpoint and tapering slightly to the truncated apex, compressed; wall coarsely agglutinated of angular quartz silt up to 60 microns in diameter in a matrix of finer grains, small angular openings between the grains resembling pores about 2 microns in diameter;

aperture large and round with smoothly cemented lip of small grains about 6–8 microns in diameter.

DIMENSIONS. Length 0·23 mm, maximum width 0·15 mm.

MATERIAL. One specimen only.

DEPOSITORY. B.M.(N.H.) Stub 1970 : II : 26 : 573.

PROVENANCE. CB 156, Dovey marshes.

REMARKS. This species resembles *L. hancocki* in its coarse wall, compression and in the form of the aperture but is more elongate oval.

#### Genus ***HEMISPHAERAMMINA*** Loeblich & Tappan, 1961

##### ***Hemisphaerammina bradyi*** Loeblich & Tappan

(Pl. 6, figs 1, 2)

*Webbina hemispherica* Brady, 1884 : 350, pl. 41, fig. 11 (not Parker, Jones & Brady = *Trochammina* (*Webbina*) *irregularis* (d'Orbigny) var. *hemisphaerica*, 1866).

*Hemisphaerammina bradyi* Loeblich & Tappan, 1957 : 224, pl. 72, figs 2a, b.

DIAGNOSIS. A smoothly finished species of *Hemisphaerammina* with almost perfectly hemispherical test.

DESCRIPTION. Test attached to a quartz grain, unilocular, almost perfectly hemispherical in side view, subround in section; wall of fine, angular silt grains in a finer matrix with rare spicules, smoothly finished; no aperture visible although there is a slight circular depression to one side.

DIMENSIONS. Maximum diameter approximately 0·2 mm, maximum height approximately 0·1 mm.

MATERIAL. One specimen only.

DEPOSITORY. B.M.(N.H.) Stub 1970 : II : 26 : 626.

PROVENANCE. CB 61.

REMARKS. Although much smaller our specimen is otherwise identical with the specimens of Brady and Robertson, redescribed by Loeblich and Tappan, range 0·5 to 1·56 mm diameter.

Doubt has recently been thrown on the protozoan, indeed, foraminiferal, affinity of this form as Adegoke *et al.* (1969) have noted *Hemisphaerammina*-like egg cases belonging to a recent gasteropod. Unfortunately our material is too limited to allow us to help solve this question.

DISTRIBUTION. The holotype was dredged with other specimens from two localities, 5 and 7 miles respectively off the Durham coast (North Sea) at about 30 fathoms.

## Family HORMOSINIDAE Haeckel, 1894

Genus *REOPHAX* Montfort, 1808*Reophax arctica* Brady

(Pl. 3, figs 8-12; Pl. 6, figs 4, 5, 7)

*Reophax arctica* Brady, 1881 : 405, pl. 21, figs 2a, b; 1882 : 99, pl. 2, figs 2a, b; Parker, 1952a : 395, pl. 1, figs 6, 7; Loeblich & Tappan, 1953 : 21, pl. 1, figs 19, 20.  
*Bigenerina artica* (Brady) Cushman part, 1948 : 31, pl. 3, fig. 9 only.

**DIAGNOSIS.** A slender, slightly compressed species of *Reophax* with up to 12 chambers, slowly increasing in size and narrow, oval to crescentic aperture.

**DESCRIPTION.** (Pl. 3, figs 10, 11; Pl. 6, figs 4, 5, 7.) Test slender, elongate, almost parallel sided in the last part, initial end pointed, apex slightly produced, slightly compressed, lobate; 10 chambers, the first four after the proloculus increasing rapidly in size as added, the last five very gradually with the final pair almost equal in size, last chamber oval with produced apex, early chambers wider than high, later ones becoming higher than wide; sutures between early chambers indistinct, those between the final three chambers deeply impressed; wall of very fine, angular silt grains with larger grains up to 35 microns maximum diameter in a smoothly cemented finer matrix; scattered, angular pores present about 1 micron in diameter; aperture compressed oval (eye-shaped), terminal at the end of a slight neck with smoothly cemented lip.

**DIMENSIONS.** Length 0.39 mm, maximum width 0.10 mm. Proloculus diameter approx. 20 microns.

**MATERIAL.** Twenty specimens.

**VARIATION.** As shown by the figures (Pl. 3, figs 8, 9) more irregular specimens occur than that described; occasionally with much larger grains in the wall.

**DEPOSITORY.** B.M.(N.H.) Slide 1970 : II : 26 : II. Stub 1970 : II : 26 : 567, 1970 : II : 26 : 705-706.

**PROVENANCE.** Specimen described, CB 498. Others illustrated, CB 428 and CB 555.

**REMARKS.** Brady's original description emphasized the slender and compressed shape of this species but the rather variable, oval to crescentic aperture revealed by our stereoscanner photos has, hitherto, not been noted. Other remarkable characters include the smoothly cemented matrix and apertural lip and the quadrangular pores, well shown in Pl. 6, figs 5 and 7. Our specimens are less compressed but otherwise the same as Brady's specimens examined in the British Museum.

Parker (1952a) has dealt with the erroneous ascription of the species to *Bigenerina* by Cushman in his paper on Arctic foraminifera (1948).

**DISTRIBUTION.** This species was described by Brady from the Novaya-Zemlya Sea. Later records confirm its common Arctic occurrence: off Greenland and in the Canadian Arctic (Cushman, 1948; Leslie, 1963; Loeblich & Tappan, 1953;

Phleger, 1952). Other N. Atlantic records are: off Portsmouth, N. Hampshire (Parker, 1952a); Great Pond, Falmouth, Massachusetts (Said, 1953).

South Atlantic records are: off Argentina (Boltovskoy, 1957, 1963).

North Pacific records are: Bering Sea (Anderson, 1963; Cooper, 1964).

These records indicate a cool or cold water distribution.

### *Reophax fusiformis* (Williamson)

(Pl. 3, figs 3, 4)

*Proteonina fusiformis* Williamson, 1858 : 1, pl. 1, fig. 1; Hoglund, 1947 : 52, pl. 4, fig. 21, text-figs 20, 21; Cushman, 1948 : 11, pl. 1, fig. 6; Feyling-Hanssen, 1964 : 219, pl. 1, fig. 12 (11 in text).

*Reophax fusiformis* (Williamson) Siddall, 1879 : 4; Brady, 1884 : 290, pl. 30, figs 7-10 (not 11); Loeblich & Tappan, 1955 : 7, pl. 1, figs 2 and 3a, b; Barker, 1960 : 62, pl. 30, figs 7-10, not 11 (after Brady).

DIAGNOSIS. An elongate, fusiform species of *Reophax* with strongly overlapping chambers, the septa (internally incomplete) marked externally by constrictions.

DESCRIPTION. (Pl. 3, figs 3, 4.) Test elongate, fusiform with greatest width towards the middle, subround in section; apparently three chambers in all, tapering to the apex and strongly overlapping; septa apparently incomplete marked externally by horizontal constrictions (undercutting); wall roughly agglutinated with large grains up to fine sand size in a matrix of fine silt; some angular pores about 1 micron in diameter; aperture terminal, large and round with lip of more regularly cemented, fine grains.

DIMENSIONS. Length 0.55 mm, maximum width 0.17 mm.

MATERIAL. More than 25 specimens.

VARIATION. Some specimens are more irregular than that described with the occasional very large grain attached to one side.

DEPOSITORY. B.M.(N.H.) Slide 1970 : 11 : 26 : 12-14. Stub 1970 : 11 : 26 : 707.

PROVENANCE. Specimen described, CB 491.

REMARKS. This interesting species, genoholotype of *Proteonina*, was transferred to *Reophax* by Siddall and Brady who noted the incomplete internal septa, marked externally by constrictions. These observations were confirmed by Loeblich and Tappan who chose a lectotype from Williamson's material with three chambers and a paratype apparently having two. However, Barnard (1959) has complained that the selection of the lectotype does not agree with the original specimen described and certainly most of the specimens in the Brady collection at the British Museum appear only partially two-chambered. Feyling-Hanssen (1964) notes that Christiansen found only some of many thousands of specimens examined to have internal septa. This indicates that there are grounds for retention of the genus *Proteonina*,

possibly as a subgenus of *Reophax*, distinguished by incomplete development of the septa. It may be that strong overlapping of the chambers is linked with partial reworking of the previous chamber walls.

**DISTRIBUTION.** This species was first described from Skye, Scotland. Brady's specimens were also from off the west coast of Scotland at Loch Fyne and Cumbrae. It has been widely recorded around the British Isles but in the absence of figures these citations must be treated with reserve apart from Murray (1965a), specimens from Plymouth illustrated by a stereo pair. Brady also recorded it from the Porcupine Station, west of Ireland.

Arctic records include: Cape Fraser (Brady, 1884); off Greenland (Cushman, 1948).

These records indicate a cool to cold water distribution.

### *Reophax moniliforme* Siddall

(Pl. 3, fig. 17; Pl. 6, fig. 8)

*Reophax moniliforme* Siddall, 1886 : 54, pl. 1, fig. 2; Heron-Allen & Earland, 1913b : 43, pl. 2, fig. 12.

*Reophax* sp. Balkwill & Wright, 1885 : 328, pl. 13, figs 9, 22-24.

**DIAGNOSIS.** A subcylindrical species of *Reophax* with up to 12 chambers of about the same size.

**DESCRIPTION.** (Pl. 3, fig. 17; Pl. 6, fig. 8.) Test elongate, slender and subcylindrical, round in section, initial part bulbous; 11 chambers, including the proloculus which is larger than the chamber succeeding it, gradually increasing in size, wider than high with truncate apex (barrel-shaped); sutures not much impressed, horizontal; wall of angular silt grains up to 18 microns diameter in a finer matrix, smooth finish, fragile and weakly cemented, ferruginous, scattered, angular pores up to about half a micron diameter; aperture terminal, large and round with rim of regularly arranged grains.

**DIMENSIONS.** Length 0·64 mm, maximum width 0·11 mm. Proloculus diameter approx. 80 microns.

**MATERIAL.** More than 25 specimens, mostly broken.

**VARIATION.** Many specimens show chambers of almost equal size (like the type figure) or even narrowing in width rather than gradually enlarging as in the specimen described. Many also show a pronounced waist after the proloculus. Chamber number and size appear to be closely related to proloculus diameter but the broken nature of most of the material precludes accurate measurement.

**DEPOSITORY.** B.M.(N.H.) Slide 1970 : 11 : 26 : 15. Stub 1970 : 11 : 26 : 708.

**PROVENANCE.** Specimen described. Station III, Clettwr Transect, Dovey Marshes.

**REMARKS.** This species is remarkable for its regularly built test but, unfortunately, due to its fragility, it is usually found broken. This had previously led us (like Brady before us) to include it under *Protoschista findens* (Adams & Haynes, 1965).

As noted by Heron-Allen and Earland the septation is 'often very obscure' and Siddall's figure, 'gives a very misleading impression on this point'. Both Heron-Allen and Earland as well as Balkwill and Wright describe specimens in which the wall is composed of evenly laid sponge spicules.

We have found the species occurring most abundantly on the intertidal marshes of the Dovey, with considerable numbers living.

**DISTRIBUTION.** This species was originally described from off the Little Orme's Head, near Llandudno, N. Wales. Other British records are: Irish Sea, off Dublin (Balkwill & Wright, 1885); Clare Island, west of Ireland (Heron-Allen & Earland, 1913b); Christchurch, Hampshire (Murray, 1968); Jersey (Halkyard, 1889); Western Approaches (Murray, 1970).

Family **LITUOLIDAE** de Blainville, 1825

Genus **AMMOBACULITES** Cushman, 1910

*Ammobaculites balkwilli* Haynes n. sp.

(Pl. 2, figs 2, 3; Pl. 29, figs 5, 6; Text-fig. 4, nos 1-5)

*Haplophragmium agglutinans* Balkwill & Wright, 1885 : 330, pl. 13, figs 18-20 (not *Spirolina agglutinans* d'Orbigny).

**DIAGNOSIS.** A species of *Ammobaculites* with the uniserial part of 2-5 chambers tending to be built up on top of the initial coil, sub-cylindrical and generally erect

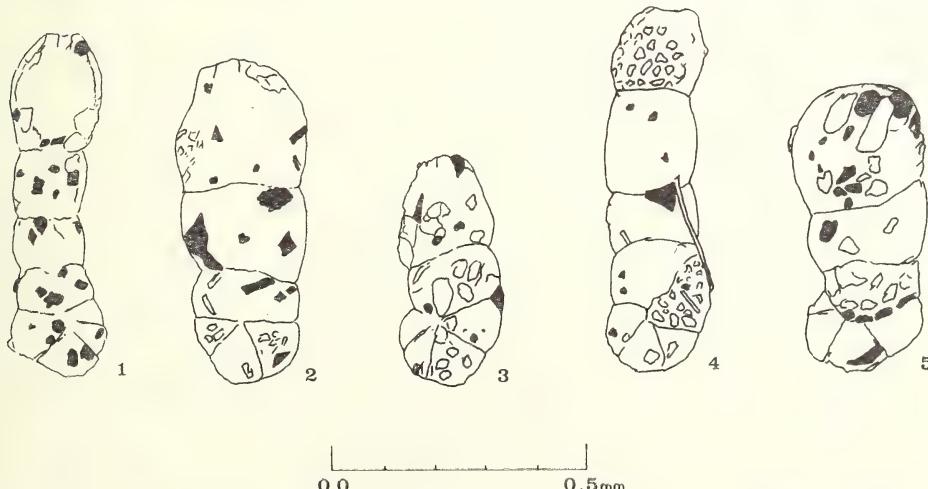


FIG. 4, 1-5. *Ammobaculites balkwilli*. 1, holotype; 2-4, paratypes, all in side view.

with straight peripheral edge. Aperture large and round with lip formed by a ring of angular grains set on end.

DESCRIPTION. (Holotype, Text-fig. no. 1.) Test with last chamber broken open, crozier shaped with the planispiral portion subordinate to the uniserial part and only slightly wider, slightly compressed initially becoming round in section in the linear part and subcylindrical; about five planispiral chambers visible, gradually increasing in size, three uniserial chambers increasing in size only slightly, truncate and subovate in shape; sutures slightly impressed and distinct in the uniserial part, indistinct in the coiled part; aperture terminal, large and round with a protruding ring of elongate grains forming a lip; wall coarsely agglutinated, mainly of angular quartz grains in a white matrix of fine silt, with scattered grains of jasper, biotite and chert, apparently imperforate.

DIMENSIONS. Length 0·67 mm, maximum breadth of uniserial part 0·17 mm, breadth of planispiral part 0·18 mm.

MATERIAL. More than 20 specimens. Abundant in the Dovey Marshes.

VARIATION. There is considerable variation in chamber shape and growth rate in the uniserial part. In some cases the last chamber is smaller, Text-fig. 4 and in others the chambers become inflated and wider than high, Text-fig. 5. However, despite this there is a general tendency for the uniserial part to be straight and cylindrical and built on top of the initial coil (an extreme example being shown in Text-fig. 4 (where there is a switch in growth direction of about 90°). The figures show the variation in grain size with particles of over 0·10 mm being incorporated, including in one case a foraminifer test, diameter 0·15 mm, Pl. 2, fig. 3. The larger grains and the coloured minerals (shown in black) are scattered in a groundmass of rather more constant size, about 15 microns in diameter, in turn embedded in a matrix of the finest silt. This species appears to select darker grains, including tiny fragments of coal, a fact which recalls the former sea borne coal shipments into Aberdovey. There is very little calcareous cement in specimens from the upper estuary and these may be quite fragile.

DEPOSITORY. B.M.(N.H.) Slides 1970 : II : 26 : 16 (holotype), 1970 : II : 26 : 17-21 (paratypes). Stub 1970 : II : 26 : 518; 1970 : II : 26 : 744 (paratypes). Section 1970 : II : 26 : 468 (paratype).

PROVENANCE. Holotype and figured specimens, Station III, Clettwr Transect, Dovey Marshes.

REMARKS. Specimens identical with ours were collected by Balkwill and Wright from the Irish Sea near Dublin and ascribed to *Haplophragmium agglutinans* (d'Orbigny) = *Ammobaculites agglutinans*. One of their drawings showing a specimen with three uniserial chambers is very similar to ours shown in Pl. 3, fig. 2. The other shows a large, erect specimen with five chambers in the uniserial part. The drawings are very good and show the grain size and scattered dark minerals very well.

D'Orbigny's species which is from the Miocene differs in its much larger total size, larger initial coil and more numerous chambers.

The closest relative among species previously described appears to be *A. josephi* of Acosta (1940) from 7 fathoms near Dogs Reef, Cuba. This form is similar to ours in overall size as well as grain size, with small initial coil and four chambers in the uniserial part. However, it differs in growth rate with the final chamber making up more than one-third of the test and in its small aperture without a lip. It also differs in being more irregular and, apparently, in being slightly compressed (although described as 'strongly cemented'). N.B. Dr Ronald Walker of the History Dept., U.C.W. was kind enough to translate Acosta's description from the original Spanish.

**DISTRIBUTION.** This species occurs on both sides of the Irish Sea. It occurs abundantly on the marshes of the Dovey Estuary and its comparative rarity in the open sea may be explained by the rapid break up of the test after death under ordinary marine conditions.

**DERIVATION OF NAME.** In honour of F. P. Balkwill, co-discoverer of this species in 1885 and co-author of the first and only comprehensive and illustrated account of Irish Sea foraminifera.

#### Genus ***HAPLOPHRAGMOIDES*** Cushman, 1910

##### ***Haplophragmoides wilberti*** Anderson

(Pl. 2, fig. 1; Pl. 29, fig. 7; Text-fig. 5, nos 3-7)

*Haplophragmoides wilberti* Anderson, 1953 : 21, pl. 4, figs 7a, b; Todd & Bronnimann, 1957 : 23, pl. 1, figs 28, 29; Todd & Low, 1961 : 13, pl. 1, fig. 5.  
? *Cribrostomoides jeffreysi* Lutze, 1965 : 89, pl. 15, figs 10-13 (not Williamson).

**DIAGNOSIS.** An involute, slightly inflated, smooth species of *Haplophragmoides* with eight or nine chambers gradually increasing in size as added. Small umbilicus on each side filled with the lobed ends of the chambers.

**DESCRIPTION.** (Text-fig. nos 3, 4.) Test with last chamber broken, semi-inflated with slightly flattened sides and slightly irregular outline in equatorial view, lobate with rounded periphery; planispiral and involute with small umbilicus on each side; eight chambers visible only, slowly increasing in size as added, the rounded, lobate ends filling the depressed umbilical area; sutures distinct, slightly depressed, straight to sigmoid at an angle of approximately  $40^{\circ}$  to each other; aperture not present but foramen of penultimate chamber visible as a low, peripheral slit at the basal suture beneath a lip; wall tectinous with very fine silt grains, amber to brownish-white in colour with smooth, glossy finish; slight depressions show a tendency towards collapse.

**DIMENSIONS.** Maximum diameter 0.39 mm, maximum width 0.15 mm.

**MATERIAL.** More than 25 specimens, some collapsed and some distorted.

**VARIATION.** Specimens with seven to nine chambers visible externally occur with a maximum diameter of 0.53 mm. As shown by the text-figures there is considerable variation of outline and distorted specimens occur which appear more

inflated and umbilicate because more depressed. A larger specimen, referred to *Haplophragmoides* species A, is shown in Text-figs 1, 2. This specimen has fewer chambers visible, six and one half only, lacks umbilical lobes and is more globose with faster rate of chamber size increase, showing some resemblance to *H. columbiensis* CUSH. and the smaller *H. bonplandi* Todd & Bronnimann, but more finely arenaceous.

DEPOSITORY. B.M.(N.H.) Slide 1970 : II : 26 : 22-25. Section 1970 : II : 26 : 466. Stub 1970 : II : 26 : 570. *Haplophragmoides* species A, 1971 : 2 : 16 : 8.

PROVENANCE. Figured specimens from the High Marsh Juncetum of the Dovey Estuary, Clettwr IA. *Haplophragmoides* species A (Text-fig. no. 1) CB 641, marshes at Porthmeirion.

REMARKS. Our specimens with their tectinous walls, tendency to eight chambers visible and slight apertural lip seem to fall well within the range of variation given for the species by Anderson, though less well grown and with less marked umbilicus than topotypes in the British Museum collections—Slide 1957 : 7 : 7 : 9 : 75-76. As he noted, this species differs from *H. subinvolutum*, from the Pacific coast of the U.S.A., in lacking the pronounced apertural hood. Also it differs in showing eight

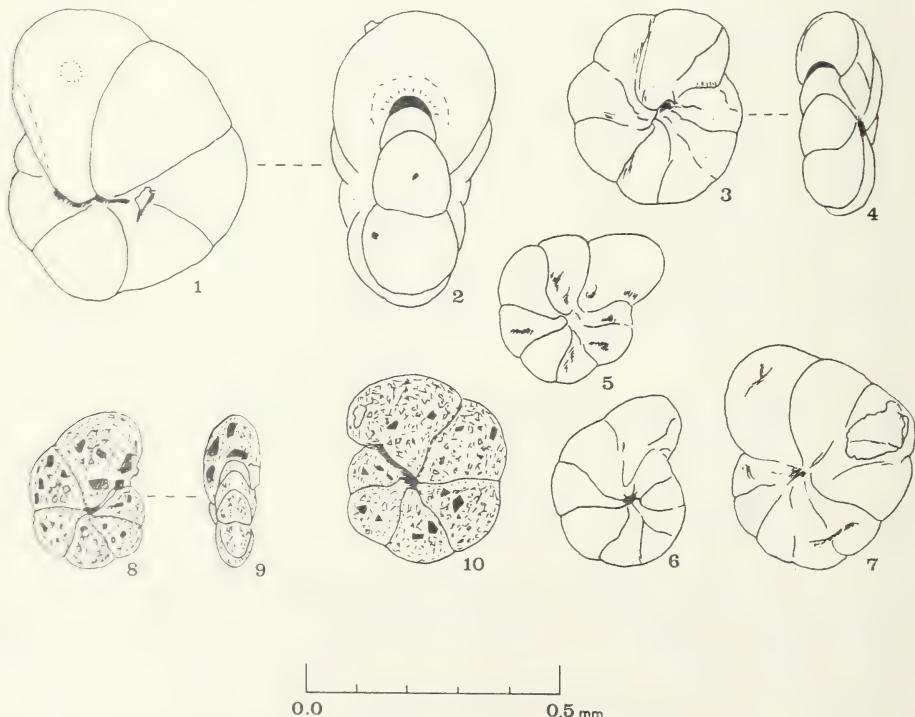


FIG. 5. 1, 2. *Haplophragmoides* species A, side view and apertural view. 3, 4. *Haplophragmoides wilberti*, described specimen, side view and apertural view. 5-7. *Haplophragmoides wilberti*, shape variations. 8, 9. *Cribrostomoides jeffreysii*, described specimen, side view and apertural view. 10. *Cribrostomoides jeffreysii*, larger specimen with overhanging apertural face.

or nine rather than six or seven chambers externally and in being more closely involute. As illustrated by the stereoscaner photo (Pl. 2, fig. 1) the wall structure is seen to be very fine and the surface glossy, the sutures hardly visible by this technique.

**DISTRIBUTION.** This species was first described from brackish water and intertidal environments in Louisiana. The only other records are the Gulf of Paria (Todd & Bronnimann, 1957); Rappahannock River, Virginia (Ellison & Nichols, 1970) and Martha's Vineyard, Massachusetts (Todd & Low, 1961). It is interesting that these authors report joint occurrence with *Jadammina macrescens* which is the situation we find in the Dovey Estuary. If the specimens of Lutze belong here then the range of this form extends into the Baltic area also.

Genus ***CRIBROSTOMOIDES*** Cushman, 1910

***Cribrostomoides jeffreysii*** (Williamson)

(Pl. 2, figs 5, 6; Pl. 8, fig. 9; Pl. 29, fig. 10; Text-fig. 5, nos 8–10)

*Nonionina jeffreysii* Williamson, 1858 : 34, pl. 3, figs 72, 73.

*Haplophragmium jeffreysii* (Williamson) Berthelin, 1878 : 24, no. 20.

*Labrospira jeffreysi* (Williamson) Hoglund, 1947 : 146, pl. 11, fig. 3, text-figs 128, 129; Parker, 1952a : 401, pl. 2, figs 15, 17–20.

*Alveophragmium jeffreysi* (Williamson) Loeblich & Tappan, 1953 : 31, pl. 3, figs 4–7.

*Haplophragmium canariense* Brady (part), 1884 : 310, pl. 35, figs 1–3, 5 (not 4) (not d'Orbigny).

*Haplophragmoides canariense* Cushman, 1920 : 38, pl. 8, fig. 1; Cushman, 1948 : 26, pl. 2, fig. 15.

*Haplophragmoides columbiensis* Cushman, 1944 : 12, pl. 2, fig. 1; Parker, 1948 : 238, pl. 4, fig. 17 (not Cushman, 1925).

**DIAGNOSIS.** A compressed species of *Cribrostomoides* with arcuate and protruding apertural slit. The wall includes angular, glassy grains in a finer matrix and well grown specimens show slight uncoiling and large pseudumbilicus.

**DESCRIPTION.** (Text-fig. nos 8, 9.) Test compressed, lobate with sub-rounded periphery; planispiral and involute with small umbilicus on each side; six chambers visible, increasing gradually in size as added, the last two making up about half the test; septal sutures distinct, impressed, flexuous; wall thin, tectinous with angular glassy, quartz grains set in a finer matrix, fragile, white in colour; aperture areal, a protruding arcuate slit, with a slight neck with upper and lower lips, parallel to the basal suture.

**DIMENSIONS.** Maximum diameter 0·31 mm, maximum width 0·12 mm.

**MATERIAL.** More than 25 specimens but most of them small, less than 0·35 mm diameter.

**VARIATION.** Our material includes specimens up to about 0·40 mm in size, as shown in Text-fig. no. 10, but most are about 0·30 mm in diameter and consistently show six or seven chambers externally with little variation in shape. Authors' figures show much larger specimens, the type is about 0·5 mm in diameter and Parker describes specimens up to 0·83 mm from off New Hampshire. These specimens show a tendency towards uncoiling and with a slower rate of chamber size

increase up to seven or eight chambers at the periphery, the pseudumbilicus revealing the penultimate whorl. The tendency for the aperture to be tucked under the overhanging apertural face also becomes more marked with growth and is reflected in the curve of the septal sutures. Hoglund has been able to distinguish both a microspheric generation (averaging 20 chambers) and a megalospheric generation (averaging about 15 chambers) both showing seven to eight chambers in the second whorl and up to 2½ whorls in all. The colour is variable in our population. The specimen described is white. Others are golden-yellow or even reddish, the Sienna brown of Williamson.

DEPOSITORY. B.M.(N.H.) Slide 1970 : II : 26 : 26-28. Section 1970 : II : 26 : 467. Stub 1970 : II : 26 : 569.

PROVENANCE. Specimen described, CB 555. Additional figured specimen, CB 299.

REMARKS. Our specimens are smaller than the type but are identical in 'the striking contour, arenaceous texture and rich colour' also in the characteristic 'inlaid', quartz grains appearing as 'dark translucent specks' in a finer matrix. Although, as Hoglund noted, Williamson's diagnosis, 'constitutes a brilliant exception from the incomplete descriptions of earlier authors', and makes clear the siphuncular nature of the aperture, this species has been confused with others, in particular with *Haplophragmoides canariense* (d'Orbigny). However, d'Orbigny's type figure shows a peripheral-basal aperture and this is confirmed by the redescription of the species made by Loeblich & Tappan (1964a) based on a specimen from the Philippines.

As d'Orbigny's species is the genotype the generic status of *Nonionina jeffreysii* has also been in doubt with successive transfers to *Labrospira* and *Alveophragmium*. As shown by Loeblich & Tappan (*Ibid.*) the latter must be restricted to species with alveolar wall so our species must be referred to *Cribrostomoides* which includes *Labrospira* as a junior synonym.

Like many specimens referred to *H. canariense* N.W. Atlantic specimens referred to *H. columbiensis* also belong to Williamson's species, as indicated by Parker (1952a). This possibly applies also to the abnormal specimens referred by Heron-Allen & Earland (1913b, 1916a) to *H. canariense*.

DISTRIBUTION. Williamson recorded this species from a number of localities down the western seaboard of Great Britain from the Shetlands to Cornwall, as well as from Davis' Straits in the Arctic. Listed records of *H. canariense* in the same area, such as Siddall (1879) and Worth (1900, 1902) probably refer to this species also. It is listed by Murray from Plymouth (1965a) and Christchurch (1968) and by Atkinson (1970) from the Scillies.

Other records seem to confirm a general temperate to cold water range for this form with a number for the N.W. Atlantic and Arctic: New England (Cushman, 1944; Parker, 1952a); Canadian Arctic (Cushman, 1920, 1922; Loeblich & Tappan, 1953; Vilks, 1969); off Nova Scotia (Barbieri & Medioli, 1969).

South Atlantic records are: Estuary, Rio de la Plata (Boltovskoy, 1957); continental platform between San Tome and Rio de la Plata (Boltovskoy, 1961).

Outside the Atlantic there are records from: Off the Pacific coast of Japan (Uchio, 1962) and Prince Edward Island S. Pacific (Brady, 1884).

Family **TEXTULARIIDAE** Ehrenberg, 1838

Genus **SPIROPLECTAMMINA** Cushman, 1927

*Spiroplectammina earlandi* (Parker)

(Pl. 3, fig. 5; Pl. 8, fig. 11)

*Textularia elegans* Lacroix, 1931 : 14, fig. 11; 1932 : 8, figs 4 and 6, not 5 (not *Plecanium elegans* Hantken).

*Textularia tenuissima* Earland, n. name, 1933 : 95, pl. 3, figs 21-30; Hoglund, 1947 : 176, pl. 13, fig. 1, text-figs 154, 155, 161 (not Hausler).

*Textularia earlandi* Parker, n. name, Thalmann in Phleger, 1952b : 86, pl. 13, figs 22-23; Parker, 1952b : 458 (cf. *tenuissima* in text, new name in footnote); Feyling-Hanssen, 1964 : 238, pl. 3, figs 9, 10.

*Textularia* aff. *earlandi* Phleger, Feyling-Hanssen, 1964 : 236, pl. 3, fig. 8.

*Spiroplectammina elegans* (Lacroix) Norvang, 1966 : 14, pl. 1, fig. 24; pl. 2, fig. 11.

**DIAGNOSIS.** A long slender species of *Spiroplectammina* with up to 15 pairs of chambers which only gradually increase in size as added. Angle of taper between 10 and 20°.

**DESCRIPTION.** (Pl. 3, fig. 5; Pl. 8, fig. 11.) Test broken in transfer to the stub so it appears slightly less regular than in fact it was originally, elongate, slender, with bluntly rounded initial part and apex, periphery rounded, lobate; initial planispiral coil of four chambers followed by 10 pairs of chambers gradually increasing in size as added, oval in shape; sutures distinct, impressed; wall ferruginous, of angular silt grains, including shell material, apparently arranged in a single, flat layer, of varying sizes up to 50 microns in diameter; small angular openings about 1 micron in diameter which may be pores; aperture an arched opening at the basal suture in the median line.

**DIMENSIONS.** Length 0.56 mm, maximum width 0.14 mm. Angle of taper about 18°.

**MATERIAL.** Five specimens.

**VARIATION.** One specimen shows quite markedly the tendency of the chambers to overhang the suture line; slightly shown by the specimen described. The material is insufficient for proper analysis of dimorphism but proloculus diameters appear to be near 20 microns, within the upper limit given by Lacroix.

**DEPOSITORY.** B.M.(N.H.) Slide 1970 : II : 26 : 29-31. Stub 1970 : II : 26 : 721.

**PROVENANCE.** Specimen described, CB 34.

**REMARKS.** The tortuous synonymy shows the difficulties authors have had with naming this form. The chief problem that remains is the question of the exact identity of the Mediterranean material of Lacroix and the South Georgia specimens of Earland. Earland, after exchange of material with Lacroix, considered them

one species but Feyling-Hanssen, after the matter had been raised again by Parker, considered them two different species, one inhabiting cold waters and one, *T. aff. earlandi*, being a temperate to warm water form. However, after examination of the South Georgia specimens in the British Museum we consider there are no grounds for separating them on the basis of wall structure or colour from the boreal forms. Both grey and ferruginous specimens occur in our material; Earland's specimens are brownish. In any case, even if the material were divided, the name *T. earlandi* must be applied to the material of Lacroix and a new name found for Earland's, South Georgia material. Norvang (1966) has attempted to preserve the name *elegans* of Lacroix after transferring the genus to *Spiroplectammina* but this appears to be against the Rules, Article 57. Revival of secondary homonyms, Article 59c, is only allowed for names rejected after 1960 (Stoll *et al.*, 1961). The name *earlandi* is also to be preferred on grounds of stability as '*Plecanium elegans*' could possibly be transferred from *Textularia* to *Spiroplectammina* also.

A specimen from the Humber, referred by Mills (1900) to *T. agglutinans* d'Orb. may also belong here.

DISTRIBUTION. This species was originally described from the Mediterranean. Subsequent records from the N. Atlantic area are: off S.W. Ireland and Faroes (Parr, 1950); Skagerak and Kattegat (Hoglund, 1947); Holocene of Norway (Feyling-Hanssen, 1964); Long Island Sound—Buzzards Bay area (Parker, 1952b); Canadian Arctic (Phleger, 1952b); Western Approaches (Murray, 1970).

Records from the Gulf of Mexico include: N.E. Gulf (Parker, 1954); Mississippi (Lankford, 1959); off Texas and Mexico (Phleger, 1960b).

South Atlantic records include: tide pools along the Patagonia coast (Boltovskoy, 1963); 25 stations around South Georgia (Earland, 1933).

North Pacific records include: off Japan (Matoba, 1970; Uchio, 1959, 1962); California coast (Arnal, 1958; Bandy, 1963; Walton, 1955; Zalesney, 1959).

Antarctic records include: 'widely distributed' (Parr, 1950).

### *Spiroplectammina wrightii* (Silvestri)

(Pl. 3, figs 1, 2)

*Spiroplecta sagittula* Wright, 1891 : 471; 1902a : 211, pl. 3, figs 5–8 (not *Textularia sagittula* Defrance).

*Spiroplecta wrightii* Silvestri, 1903 : 59, text-figs 1–6; Heron-Allen & Earland, 1916b : 42, pl. 6, figs 7–10; Cushman, 1922 : 5, pl. 4, figs 5–8.

*Spiroplectammina wrightii* (Silvestri) Cushman, 1949 : 6, pl. 1, figs 2–4.

*Textularia sagittula* Brady, 1884 : 361, pl. 42, figs 17, 18; Balkwill & Wright, 1885 : 332, pl. 13, figs 15–17; Lacroix, 1929 : 1, text-figs 1–12; Heron-Allen & Earland, 1930 : 72; Hoglund, 1947 : 167, pl. 12, figs 3, 4; text-figs 143–146; Colom, 1952 : 18, pl. 5, figs 41, 42; Feyling-Hanssen, 1964 : 238, pl. 3, figs 4, 5; Norvang, 1966 : 11, pl. 1, figs 9–23; pl. 2, fig. 12 (not Defrance).

*Textularia cuneiformis* Williamson, 1858 : 75, pl. 6, figs 158, 159 (not d'Orbigny).

*Textularia sagittula* Defrance var. *cuneiformis* Goës, 1894 : 36, pl. 7, figs 288–290 (not d'Orbigny).

*Textularia williamsoni* Goës, 1894 : 36, pl. 7, 285–287 (*nomen oblitum*).

DIAGNOSIS. A compressed, carinate species of *Spiroplectammina* reaching about

1 mm in size with up to 14 pairs of chambers in the microspheric generation which is sagittate with angle of taper about 45° and with up to 12 pairs in the megalospheric generation which has a large initial coil and tends to become parallel sided.

**DESCRIPTION.** (Pl. 3, figs 1, 2.) Test compressed with rounded initial part and slight waist before the commencement of the parallel sided adult part, periphery lobate, carinate; initial part planispiral followed by seven pairs of chambers, the first three increasing fairly rapidly in size as added, the last four only gradually, twice as wide as high, sutures distinct, slightly impressed, almost horizontal; wall of angular silt grains set in a tectin lining, including shell material, up to 40 microns diameter, in a finer matrix, smoothly cemented; minute oval to quadrangular openings between the grains about 1 micron in size which may be pores; aperture a low slit at the basal margin of the last chamber in the median line.

**DIMENSIONS.** Length 0.65 mm, width 0.36 mm, thickness about 0.15 mm. Overall angle of taper about 35°.

**MATERIAL.** More than 25 specimens but many damaged, particularly at the initial end in the microspheric generation and in specimens with smaller megalospheres.

**VARIATION.** Specimens up to 1 mm length occur and apart from the tendency for specimens with large megalospheres to become parallel sided many show waisting at different points during growth with sudden expansion in breadth thereafter. This occurs in both generations. Because of the broken nature of the material it is impossible to emulate the exhaustive investigation of dimorphism carried out by Lacroix and Hoglund, but it can be said that the microspheric generation occurs rarely, microsphere about 20 microns diameter, the megalospheric generation much more abundantly, megalosphere between 50 and 80 microns diameter in 10 specimens measured with up to 12 pairs of chambers. An initial planispire of four to five chambers occurs in both generations.

**DEPOSITORY.** B.M.(N.H.) Slide 1970 : II : 26 : 32. Stub 1970 : II : 26 : 722.

**PROVENANCE.** Described specimen, Brit. Mus. Core 13.

**REMARKS.** This species has been persistently confused with *T. sagittula* Defrance although the type figures of that species show a large inflated form, biserial throughout and about 3 mm long. The Defrance collection was apparently destroyed in the attack on Caen during the war (1944) according to Norvang (1966) but specimens which may reasonably be regarded as topotypes have been collected from the Pliocene of Sienna by Loeblich & Tappan (1964a). They are much larger and more inflated than *S. wrightii* and lack the planispiral initial part.

A prime cause of the confusion that has long reigned was the fact that Defrance cited the Mediterranean as an additional locality for his species which led Lacroix to suppose that *S. wrightii* was synonymous with it. There is now no doubt that Lacroix actually was working with *S. wrightii*. This also means that the attempt by Norvang to set up a specimen of '*T. sagittula*' = *S. wrightii*, from the Bay of Villefranche as neotype for Defrance's species is unnecessary as well as offending against the Rules of Nomenclature. According to the Rules neotypes must be

based on material from the type area and as noted by Loeblich and Tappan, *T. sagittula* was originally described as a fossil from Italy which indicates the Pliocene, Sienna or Castel Arquato, localities of Defrance. A further consequence is that Norvang's attempted redefinition of *Textularia* on the basis of its 'calcitic' wall is found to be based not on the genotype but on *S. wrightii*. This would suggest that a new generic name is required for 'calcitic' as against arenaceous species of *Spiroplectammina*. However, we believe these differences to be of specific rather than generic significance, especially as *S. earlandi*, accepted by Norvang in *Spiroplectammina* s.s. has according to our observations calcareous grains in its wall and his own thin section of *T. sagittula* (pl. 2, fig. 12) = *S. wrightii*, includes 'insignificant amounts of quartz grains'. Both may have pores.

*Textularia williamsoni* Goës is apparently a senior synonym of *S. wrightii*. According to Hoglund it probably represents the microspheric generation. However, he found no trace of the specimens in Goës' collection and the name must now lapse as a *nomen oblitum*, being out of use for over fifty years.

Very detailed observations have been made upon this species by Lacroix, Heron-Allen and Earland and Hoglund. These indicate pronounced dimorphism with a strong tendency for two groups of megalospheric individuals, constituting the A1 and A2 generations of Hofker.

It is possible that *Spiroplectammina sagittula* of Hofker (1930) belongs here but there is doubt because he reports areal apertures and foramina in his population.

DISTRIBUTION. British records include: off Rathlin Island, Northern Ireland (Wright, 1902a), South Irish Sea (Balkwill & Wright, 1885); Western Approaches (Le Calvez & Boillot, 1967; Murray, 1970); English Channel (Heron-Allen & Earland, 1916b, 1930; Murray, 1965a); Western coasts of Britain (Williamson, 1858); Scillies (Atkinson, 1970).

Other N.W. European records include: Bay of Biscay (Caralp, Lamy & Pujos, 1970); coast of Galicia (Colom, 1952); N.W. Atlantic (Brady, 1884); Belgian coast (Cushman, 1949); Skagerak (Hoglund, 1947); Holocene of Norway (Feyling-Hanssen, 1964).

Mediterranean records include: Tyrrenian Sea (Silvestri, 1903); off southern France (Lacroix, 1929, 1932; Norvang, 1966).

A marked Lusitanian-Mediterranean concentration appears to be indicated.

#### Family TROCHAMMINIDAE Schwager, 1877

#### Genus **TROCHAMMINA** Parker & Jones, 1859

##### *Trochammina astrifica* (Rhumbler)

(Pl. 4, figs 18-20)

*Trochammina squamata astrifica* Rhumbler, 1938 : 188, figs 29-31.

*Trochammina astrifica* (Rhumbler) Hoglund, 1947 : 206, pl. 15, fig. 2; text-fig. 186.

DIAGNOSIS. A concavo-convex species of *Trochammina* with from five to seven chambers visible ventrally and regularly star shaped umbilical opening.

**DESCRIPTION.** (Pl. 4, fig. 18, description of dorsal side from extra specimen, Pl. 4, figs 19, 20.) Test concavo-convex, compressed, periphery subangular, slightly lobate; chambers arranged in a low, trochoid spiral of about three whorls, all visible on the raised (rather flattened) dorsal side, gradually increasing in size as added and becoming long and low with slightly impressed, swept back sutures, only the last five visible on the concave, involute ventral side, sutures impressed, radial, excavated towards the open umbilicus making a regular, star-shaped figure with blunt points; wall of flat, angular silt grains up to 20 microns diameter (probably shell material) arranged in a neat mosaic parallel to the tectin base; aperture apparently a low slit at the basal suture of the last chamber on the ventral side and communicating with the open umbilicus beneath the chamber lobes.

**DIMENSIONS.** Diameter 0.26 mm, additional specimen 0.19 mm.

**MATERIAL.** Two specimens only.

**DEPOSITORY.** B.M.(N.H.) Stub 1970 : 11 : 26 : 730-731.

**PROVENANCE.** Specimens described, CB 519 and CB 594.

**REMARKS.** Our specimens appear to be close to Rhumbler's types though with five chambers visible on the ventral side rather than six or seven. In this character they more resemble the specimens figured by Hoglund. The ventral sutures are also much straighter. It should be noted that the ventral side in our specimen is much more concave than would appear from the stereoscanner photograph. Although it might be objected that most species of *Trochammina* show a star-shaped umbilicus (as, indeed, do species of *Rosalina* and *Ammonia*) the sutural fissures are particularly geometric in this form, as pointed out by Hoglund.

**DISTRIBUTION.** This species was described by Rhumbler from *Amphioxus* Sand and *Polygordius*—Schill, Helgoland, Germany. Hoglund's material is from the Skagerak and Kattegat. It is also listed from Plymouth (Murray, 1965a).

### *Trochammina haynesi* Atkinson

(Text-fig. 6, nos 1-3)

*Trochammina haynesi* Atkinson, 1969 : 528, fig. 6, nos 1a-c.

? *Trochammina* sp. Lutze, 1965 : 92, pl. 15, figs 21-23; pl. 12, figs 1 and 2.

**DIAGNOSIS.** A concavo-convex species of *Trochammina* with six to nine chambers in the second whorl and final chambers becoming long and low. Umbilicus small with irregular sutural fissures. Early whorls with little agglutinated material, tectin dark brown.

**DESCRIPTION.** (Paratype, Text-fig. nos 1-3.) Test concavo-convex, with sub-round, irregular, lobate periphery; chambers arranged in a sinistral, trochospire, 6 : 9 : 9 : 2—, after the proloculus, very gradually increasing in size as added and becoming twice as long as high by the third whorl, as seen from the raised, evolute, dorsal side, sutures distinct, impressed, swept back; eight chambers visible on the

deeply concave, evolute, ventral side, umbilicus and aperture obscured, sutures sigmoid, impressed; wall of very fine, angular silt grains, first two whorls with very little agglutinated material, the dark brown tectin layer being very striking in dorsal view.

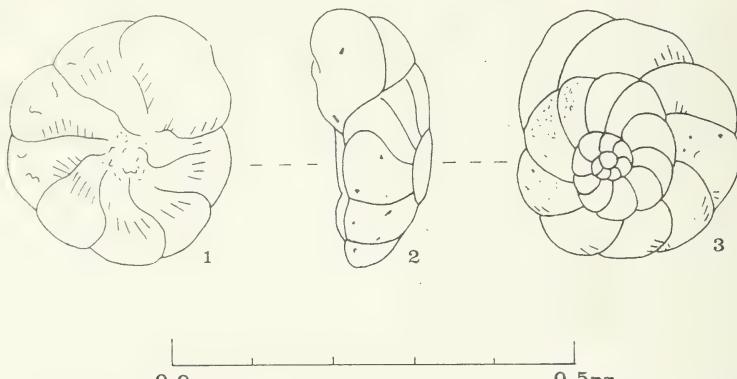


FIG. 6, 1-3. *Trochammina haynesi*, specimen described. 1, ventral view; 2, side view; 3, dorsal view.

**DIMENSIONS.** Diameter 0.31 mm, height 0.15 mm. Proloculus diameter approx. 20 microns.

**MATERIAL.** Paratype from K. Atkinson collection.

**DEPOSITORY.** B.M.(N.H.) Slide 1970 : 11 : 26 : 33.

**PROVENANCE.** CB 417.

**REMARKS.** Although slightly smaller, range of diameters given 0.15–0.21 mm, the specimens reported as *Trochammina* sp. by Lutze appear to show the essential features of Atkinson's species.

**DISTRIBUTION.** This species was described from the littoral and sublittoral of Cardigan Bay where it was found associated with *Dictyota* and *Laminaria*. Lutze's specimens are from the Baltic, Ostsee.

#### *Trochammina globigeriniformis* var. *pygmaea* Hoglund

(Pl. 4, fig. 14)

*Trochammina globigeriniformis* (Parker & Jones) var. *pygmaea* Hoglund, 1947 : 200, pl. 17, fig. 3; text-fig. 182.

**DIAGNOSIS.** A dwarf variety of *T. globigeriniformis* reaching up to about 0.25 mm in diameter.

**DESCRIPTION.** (Pl. 4, fig. 14.) Test globose with convex sides and rounded periphery, lobate; chambers arranged in a sinistral, trochoid spiral, about 11 following the proloculus, all visible on the evolute, dorsal side, only the last 3½ on the involute, ventral side, longer than high and arcuate as seen on the dorsal side,

inflated; sutures distinct, impressed; wall of very fine, angular silt grains (probably shell material) about 10 microns in diameter in a neat, smooth, mosaic, parallel to the tectin base; aperture obscured but, apparently a ventral, basal slit (aperture of previous chamber possibly left open).

DIMENSIONS. Maximum diameter 0·24 mm.

MATERIAL. One specimen only.

DEPOSITORY. B.M.(N.H.) Stub 1970 : 11 : 26 : 728.

PROVENANCE. CB 498.

REMARKS. The specimen described appears to fit well with the dwarf variety of Hoglund, distinguished by its small size from the much larger (up to 2 mm) and more stoutly built, *T. globigeriniformis*.

DISTRIBUTION. This variety was originally recorded as a rare form in the Skagerak, and has also been noted by Murray at Plymouth (1965a); and in the Western Approaches (1970).

### *Trochammina inflata* (Montagu)

(Pl. 4, figs 15–17; Pl. 6, fig. 3)

*Nautilus inflatus* Montagu, 1808 : 81, pl. 18, fig. 3; Brown, 1844 : 1, pl. 1, fig. 4.

*Rotalina inflata* (Montagu) Williamson, 1858 : 50, pl. 4, figs 93, 94.

*Trochammina inflata* (Montagu) Carpenter, 1862 : 141, pl. 11, fig. 5; Brady, 1884 : 338, pl. 41, figs 4a–c; Goës, 1894 : 29, pl. 6, figs 222–224; Cushman, 1944 : 17, pl. 2, fig. 8; 1949 : 18, pl. 3, figs 3, 4; Parker, 1952a : 407, pl. 4, figs 6 and 10; 1952b : 259, pl. 3, figs 1a, b; Todd & Low, 1961 : 15, pl. 1, figs 22, 23; Haake, 1962 : 30, pl. 1, figs 5 and 6; Loeblich & Tappan, 1964a : C259, fig. 173, 1.

DIAGNOSIS. A globose species of *Trochammina* with five or six chambers in each whorl and radial sutures. Wall very finely arenaceous and generally red-brown in colour.

DESCRIPTION. (Pl. 4, fig. 15, description of dorsal side based on additional specimen; Pl. 4, figs 16, 17.) Test globose, biconvex with raised ventral side and flattened dorsal side, periphery broadly rounded, lobate; chambers arranged in a dextral, low trochoid, spiral, with all the whorls visible on the evolute, dorsal side, 14 chambers following the proloculus, 5 : 5 : 4—, in almost three whorls, moderately increasing in size as added, longer than high, rhomboidal, more than doubling in size with each volution, sutures radial, impressed, spiral suture angular; five chambers visible on the involute ventral side with radial sutures; wall of very fine silt grains about 3 microns in diameter, arranged in a neat mosaic parallel to the tectin base, inner lining of proloculus exposed, some minute openings between the grains less than a micron in size; aperture a slit at the basal margin of the final chamber on the ventral side, joining the small, deep, open umbilicus beneath a lip (obscured by debris).

DIMENSIONS. Maximum diameter 0·60 mm, diameter of additional specimen shown in dorsal view 0·45 mm. Diameter of proloculus in this specimen about 25 microns.

MATERIAL. More than 25 specimens.

VARIATION. Specimens up to 0·70 mm maximum diameter were recovered. In 10 specimens examined the proloculus diameter measured approximately 25 microns, with up to 16 chambers developed.

DEPOSITORY. B.M.(N.H.) Slide 1970 : II : 26 : 41-43. Stub 1970 : II : 26 : 732-733.

PROVENANCE. Station IIA, Clettwr Transect, Dovey Marshes, from High Marsh Sward.

REMARKS. This is a typical foraminifer of intertidal marshes and is adapted to lowered salinity and exposure. The chambers of the first whorl are often broken because of the delicate construction of the wall and the tectin lining may be exposed, a point referred to by both Williamson and Brady.

DESCRIPTION. This species was described originally from the coast of Devonshire and it was recorded later by Williamson from both the English Channel and Skye, Scotland. Later records confirm a general near shore and brackish water distribution around the British Isles: Irish Sea, Liverpool Bay (Pearcey, 1891); Dee Estuary (Siddall, 1875); Mersey Estuary (Burgess, 1891); West of Scotland, Firth of Clyde (Robertson, 1877); Western Isles (Heron-Allen & Earland, 1916a; Robertson, 1892); Shetlands (Waller, 1868); Forth (Pearcey, 1902); Northumbrian coasts and estuaries (Brady, 1865, 1870, 1884); English Channel, Christchurch (Murray, 1968); Selsey (Heron-Allen & Earland, 1909, 1911); Exe Estuary (Worth, 1902); Plymouth and Cornwall (Heron-Allen & Earland, 1916b, 1930; Murray, 1965a; Worth, 1904); Western Ireland, Clare Island (Heron-Allen & Earland, 1913b). N.B. Williamson noted the rarity of this species in the sea. Such marine occurrences may be derived forms as suggested by Heron-Allen and Earland for the Selsey specimens which may come from Chichester Harbour and Bosham mud flats.

Other N.W. European records include: Belgian coast (Cushman, 1949); Wadden Sea (Voorthuysen, 1951); Langeoog (Haake, 1962); Baltic (Goës, 1894).

Mediterranean records include: Rhone Delta (Kruit, 1955).

Records for marshes and sounds in the Western Atlantic include: New York Bight (Ronai, 1955); New England (Cushman, 1944); Barnstable Harbour (Phleger & Walton, 1950); New Hampshire (Parker, 1952a); Buzzards Bay (Parker, 1952b); Narragansett (Said, 1951); Great Pond, Massachusetts (Said, 1953); Poponessett (Parker & Athearn, 1959); Bay of Fundy (Harrington, 1955); Martha's Vineyard (Todd & Low, 1961); Canadian and Greenland Arctic (Phleger, 1952); St Lawrence (Dawson, 1870).

Gulf of Mexico and S.E. United States records include: Rappahannock Estuary, Virginia (Ellison & Nichols, 1970); Mason Inlet, N. Carolina (Miller, 1953); North Gulf of Mexico (Phleger, 1960); Louisiana (Warren, 1957); Mississippi Delta (Lankford, 1959; Phleger, 1954, 1955); Texas coast (Lehman, 1957; Parker, Phleger & Peirson, 1953; Phleger, 1956).

South American records include: Southern Brazil (Boltovskoy, 1959); Argentina (Boltovskoy, 1961, 1963); Falklands (Heron-Allen & Earland, 1932).

Pacific records include: general in Pacific coast marshes of N. America from Copper River Delta, Alaska to Mexico (Phleger, 1967); California (Bandy, 1963; Hanna & Church, 1927; Natland, 1933; Phleger, 1965; Walton, 1955); Sunset Bay, Oregon (Detling, 1958).

Other Indo-Pacific records include: Malay Archipelago (Millett, 1899); off Japan (Cushman, 1910); Oyster Harbour, Australia (McKenzie, 1962); Port Hacking, Australia (Albani, 1958); Manukau Harbour, New Zealand (Hulme, 1964).

Antarctic records include: Weddell Sea and Falklands Sector (Earland, 1934) also Wiesner (1931).

These records indicate a world wide distribution in extreme habitats, mainly intertidal, brackish water but also, apparently, including deep, cold water environments.

### *Trochammina intermedia* (Rhumbler)?

(Pl. 4, figs 9-13; Pl. 6, fig. 9)

*Trochammina squamata intermedia* Rhumbler, 1938 : 186, figs 27, a, b.

*Trochammina intermedia* (Rhumbler) Hoglund, 1947 : 206, pl. 16, fig. 1; text-fig. 188.

*Trochammina squamata* Heron-Allen & Earland, 1913b : 50, pl. 3, figs 7, 8 only, cited by Rhumbler (not Jones & Parker).

**DIAGNOSIS.** A concavo-convex species of *Trochammina* with marked peripheral lobes on the ventral side and small to almost closed umbilicus.

**DESCRIPTION.** (Pl. 4, fig. 9, description of dorsal side based on figs 12, 13.) Test with last chamber broken, concavo-convex, compressed, periphery subangular, lobate; chambers arranged in a low trochoid spiral of about three whorls, all visible on the raised, evolute, dorsal side, gradually increasing in size and becoming long and low with impressed swept back sutures, only the last five visible on the concave, involute, ventral side with marked lobes at the periphery; small, open umbilicus; wall of flat angular silt grains up to 20 microns diameter (probably shell material) neatly arranged parallel to the tectin base; aperture not visible.

**DIMENSIONS.** Maximum diameter 0.24 mm, additional specimen 0.17 mm.

**MATERIAL.** Four specimens only.

**VARIATION.** Maximum diameters between 0.13 mm and 0.34 mm.

**DEPOSITORY.** B.M.(N.H.) Stub 1970 : 11 : 26 : 726-727, 734-735.

**PROVENANCE.** Specimens described Low marsh, Clettwr Transect Station VII, Dovey. Additional specimens figured, CB 13 and CB 33.

**REMARKS.** Our specimens appear to show the characters of Rhumbler's species but are much larger. In this respect they are nearer the specimens of Heron-Allen and Earland from off Clare Island. As noted by Hoglund the North Sea material shows the same chamber number in specimens only half the size or less which suggests a genetic difference.

DISTRIBUTION. The species was first described from Helgoland while Hoglund's specimen came from the Skagerak. Heron-Allen and Earland found their specimens, 'almost universally distributed (24 stations)', off Clare Island, W. Ireland.

### *Trochammina ochracea* (Williamson)

(Pl. 5, figs 15-18)

*Rotalina ochracea* Williamson, 1858 : 55, pl. 4, fig. 112; pl. 5, fig. 113.

*Trochammina ochracea* (Williamson) Balkwill & Millett, 1884 : 25, pl. 1, fig. 7; Cushman, 1920 : 75, pl. 15, fig. 3 (after Williamson); 1944 : 19, pl. 2, figs 12, 13; 1949 : 17, pl. 3, fig. 1; Hoglund, 1947 : 211, pl. 16, fig. 2; text-fig. 190; Todd & Low, 1961 : 16, pl. 1, fig. 18; Feyling-Hanssen, 1964 : 240, pl. 3, figs 11, 12; Hedley *et al.*, 1964 : 419, tab. 1, fig. 2, no. 2, fig. 3, no. 2 (syntypes).

*Trochammina ochracea ochracea* (Williamson) Rhumbler, 1938 : 190.

DIAGNOSIS. A scale-like, concavo-convex species of *Trochammina* with eight or nine chambers visible on the ventral side. Dark brown in colour with yellow, limbate sutures and irregularly asteroid umbilicus.

DESCRIPTION. (Pl. 5, figs 15, 16, account of dorsal side based on additional specimen, figs 17, 18.) Test concavo-convex, thin and scale-like, periphery entire, subangular; about three whorls of chambers, all visible on the evolute, raised dorsal side, gradually increasing in size as added and becoming long and low, sutures slightly impressed; eight chambers visible on the concave, involute, ventral side; ventral sutures limbate, slightly raised, incised towards the open umbilicus making an irregularly asteroid figure, markedly flexuous; wall of very fine angular silt grains about 10 microns in diameter, arranged in a neat mosaic parallel to the tectin base; aperture apparently basal at the ventral suture of the last chamber communicating with the open umbilicus beneath the umbilical lobe; colour dark, resinous brown with light yellow septa.

DIMENSIONS. Maximum diameter 0.24 mm, diameter of additional specimen shown in dorsal view 0.16 mm.

MATERIAL. Two specimens only.

DEPOSITORY. B.M.(N.H.) Stub 1970 : 11 : 26 : 736-737.

PROVENANCE. Both specimens illustrated, Station VII, Clettwr Transect, Dovey Marshes.

REMARKS. Our specimens fit well with the syntypes examined in the British Museum as well as with the accurate original description and the beautiful, coloured, type figures which show the dark test and ochraceous septa. These features are, of course, not seen in the stereoscanner photo which emphasizes the elevation of the sutures and the irregularly asteroid umbilicus. As shown by Hedley *et al.* the open umbilicus distinguishes this species from *T. arctica* (= *T. squamata* Parker & Jones, 1865). The last few chambers in our specimen show the tendency to develop lobes at the ventral suture which may indicate a gradation between this form and *Remaneica helgolandica*.

DISTRIBUTION. This species was originally described from Skye, Scotland. Subsequent records for the British Isles include: Firth of Forth (Pearcey, 1902); West of Scotland (Heron-Allen & Earland, 1916a); Clare Island, W. Ireland (Heron-Allen & Earland, 1913b); Galway (Balkwill & Millett, 1884); Scillies (Atkinson, 1970); English Channel, Plymouth (Heron-Allen & Earland, 1930; Murray, 1965a); Western Approaches (Murray, 1970); Jersey (Halkyard, 1889); Belgian coast (Cushman, 1949).

Records for the N.W. Atlantic include: New England, Buzzards Bay and Vineyard Sound (Cushman, 1944); Martha's Vineyard (Todd & Low, 1961).

It has also been recorded from the Late Glacial and Holocene of the Oslofjord area (Feyling-Hanssen, 1964) and from off the coast of Argentina (Boltovskoy & Boltovskoy, 1968).

### Genus *JADAMMINA* Bartenstein & Brand, 1938

#### *Jadammina macrescens* (Brady)

(Pl. 1, fig. 5; Pl. 2, figs 14-16; Text-fig. 7, nos 1-5)

*Trochammina inflata* (Montagu) var. *macrescens* Brady, 1870 : 290, pl. 11, figs 5a-c; Cushman, 1920 : 74, pl. 15, fig. 1 (after Brady); 1949 : 10, pl. 3, figs 5, 6.

*Trochammina macrescens* (Brady) Phleger & Walton, 1950 : 281, pl. 2, figs 6-9; Parker, 1952a : 408, pl. 4, figs 8a, b; 1952b : 260, pl. 3, figs 3a, b; Parker & Athearn, 1959 : 341, pl. 50, figs 23-25; Todd & Low, 1961 : 16, pl. 1, fig. 16.

*Jadammina macrescens* (Brady) Adams & Haynes, 1965 : 30 (list); Murray, 1965a : 503 (list).

*Jadammina polystoma* Bartenstein & Brand, 1938 : 381, text-figs 1-3; Parker & Athearn, 1959 : 341, pl. 50, figs 21, 22, 27; Haake, 1962 : 31, pl. 1, figs 7-9; Feyling-Hanssen, 1964 : 241, pl. 3, figs 13-15; Brodniewicz, 1965 : 200, text-fig. 27.

DIAGNOSIS. A subglobular species of *Jadammina* with about eight chambers visible at the periphery and a variable number of small, round, areal apertures.

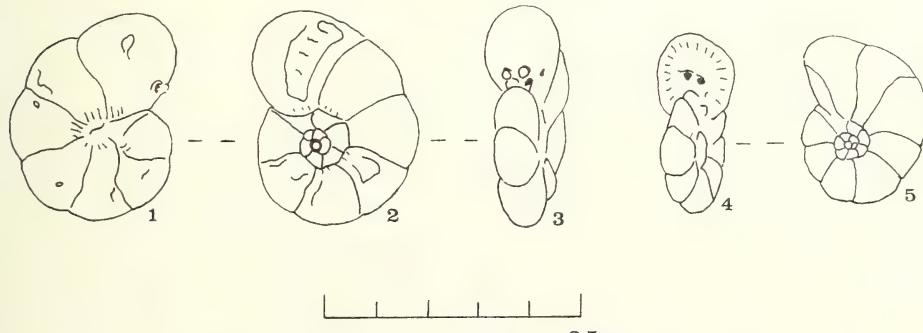


FIG. 7, 1-5. *Jadammina macrescens*. 1, specimen described, ventral view; 2, dorsal view; 3, apertural view; 4, apertural view of specimen with smaller proloculus; 5, ventral view of same.

DESCRIPTION. (Text-fig. nos 1-3.) Test slightly collapsed with damaged final chamber, subglobular with flattened sides, periphery rounded, semilobate; chambers arranged in a low, sinistral trochospire, 5 : 6 : 5—, following the proloculus; seven chambers visible on the involute ventral side with impressed, sinuous sutures meeting in a small, shallow umbilicus; 16 chambers visible on the evolute, dorsal side, gradually increasing in size as added but slightly irregularly, becoming slightly higher than long at the end of the second whorl and showing a tendency to uncoil, septal and spiral sutures impressed, septal sutures backward curving, umbilicus wide and shallow; wall tectinous, golden brown with extremely fine agglutinated silt grains; apertures obscured, but apparently including a long, low opening at the basal suture and at least two, round areal openings in the apertural face, each with a slight neck.

DIMENSIONS. Maximum diameter 0.42 mm, height 0.13 mm. Diameter of proloculus approx. 15 microns.

MATERIAL. More than 25 specimens, mostly collapsed but many apparently showing the original test shape although slightly damaged and distorted.

VARIATION. Generally up to two and a half whorls are developed with five or six chambers in the first, six or seven chambers in the second. From 7-9 chambers are visible on the ventral side. A specimen with smaller proloculus than the specimen described above is also illustrated. In this case the proloculus is about 10 microns in diameter and is followed by successive whorls with 6 : 7 : 5—chambers. This specimen reaches a maximum diameter of 0.34 mm (slightly distorted). Irena Brodniewicz illustrates specimens of almost the same size but with larger proloculus, about 20-25 microns in largest diameter and 11 to 12 chambers only. There is thus a strong indication of variation in chamber number connected with variation in proloculus size. The development of the areal apertures is also variable.

DEPOSITORY. B.M.(N.H.) Slide 1970 : 11 : 26 : 33-40. Stub 1970 : 11 : 26 : 628, 629.

PROVENANCE. Specimen described and others illustrated, High Marsh Sward, Clettwr Transect, Station IIA, Dovey Marshes.

REMARKS. The apertures are frequently obscured in this delicate species which is prone to collapse on drying or burial in sediment. As, in any case, the development of the areal apertures appears to be a variable feature it becomes merely an academic exercise to attempt to distinguish *Trochammina macrescens* from *Jadammina polystoma*. After examination of the excellent material of Brady from Westport in the British Museum we agree with Parker and Athearn who suggested that these species were virtually identical. Bartenstein (1969) has recently shown how they possess a very similar geographical range and morphology apart from the aperture details.

Our stereoscanner photo shows very well the low basal aperture and the beautiful, masonic detail of the grains in the lips of the areal apertures (Pl. 1, fig. 5).

DISTRIBUTION. This species was originally recorded by Brady from brackish water, tidal rivers in Northumberland and Durham (Rivers Wear and Blyth) and

from Loch Grunard and Loch Gilp, Scotland and Westport, Ireland. Later records confirm this distribution: Irish Sea (Balkwill & Wright, 1882, 1885); Mersey (Burgess, 1891); Dee (Siddall, 1878); Southport (Chaster, 1892); Western Ireland (Balkwill & Millett, 1884; Heron-Allen & Earland, 1913b).

English Channel, Cornwall (Clarke, 1906; Heron-Allen & Earland, 1916b, 1930; Murray, 1965a); Hampshire, Christchurch (Murray, 1968); Kent coast (Hedley & Underwood, 1957); Western Scotland, Loch Hourn (Heron-Allen & Earland, 1916a).

Northwest European records include: Belgium (Cushman, 1949); Holland and Germany, Dollart-Ems Estuary (Voorthuysen, 1960); Jade Bay (Bartenstein & Brand, 1938); Langeoog (Haake, 1962); Ostsee (Lutze, 1965); Poland, S. Baltic (Brodniewicz, 1965) as well as the Holocene of Oslofjord (Feyling-Hanssen, 1964).

Records for brackish water areas and marshes in Eastern N. America include: New England, Barnstable (Phleger & Walton, 1950); New Hampshire (Parker, 1952a); Martha's Vineyard (Todd & Low, 1961); Poponesset Bay (Parker & Athearn, 1959); Long Island (Parker, 1952b); Staten Island (Behm & Grekulinski, 1958); Virginia, Rappahannock Estuary (Ellison & Nicols, 1970).

Records for the Gulf of Mexico include: (Phleger, Parker & Peirson, 1953; Phleger, 1960); Galveston Bay, Texas (Phleger, 1965); Lagoa dos Patos (Closs, 1962).

Records for the Pacific Coast include: California (Bandy, 1963; Phleger & Bradshaw, 1966); marshes from Mexico to British Columbia (Phleger, 1967).

South American records include: Puerto Deseado (Boltovskoy, 1963).

A general distribution in cool to warm temperate marshlands is indicated.

Genus **REMANEICA** Rhumbler, 1938

***Remaneica helgolandica*** Rhumbler

(Pl. 5, fig. 19; Pl. 6, fig. 6)

*Remaneica helgolandica* Rhumbler, 1938 : 195, text-figs 38-45.

DIAGNOSIS. A species of *Remaneica* with well marked lobes along the ventral chamber sutures and only weak plication at the periphery.

DESCRIPTION. (Pl. 5, fig. 19.) Test scale-like, wafer thin, concavo-convex, periphery acute, lobulate; about three whorls of chambers, all visible on the raised, evolute dorsal side, gradually increasing in size as added, becoming long and low, arcuate, plicated at the periphery with development of partial internal partitions; eight chambers visible on the ventral side with marked lobes developed along the sutures, with septal openings between 1-2 microns diameter; wall of minute silt grains, between 1 and 2 microns average size, embedded in a tectin base, brown in colour; aperture apparently a ventral, basal, slit; umbilicus apparently closed.

DIMENSIONS. Maximum diameter 0.15 mm.

MATERIAL. One specimen only.

DEPOSITORY. B.M.(N.H.) Stub 1970 : 11 : 26 : 729.

PROVENANCE. CB 33.

REMARKS. Unfortunately, we have only one specimen of this interesting little species. In size, chamber number and in the development of the lobes along the ventral sutures it appears close to Rhumbler's form. There is some doubt whether *Trochammina (Remaneica) helgolandica* sensu Hoglund (1947) really belongs here because his drawings appear to show a more strongly plicate species, without rounded ventral lobes, in this respect nearer the six chambered *R. plicata* (Terquem). Hoglund's figures were used to illustrate the genus by Loeblich & Tappan (1964a: C266, fig. 178, nos 1 and 2).

DISTRIBUTION. This species was described by Rhumbler from *Amphioxus* Sand and *Polygordius*—Schill, Helgoland, Germany.

### Family ATAXOPHRAGMIIDAE Schwager, 1877

Genus ***EGGERELLOIDES*** Haynes n. gen.

Genotype ***Eggerelloides scabrum*** (Williamson)

GENERIC CHARACTERS. The genus *Eggerelloides* includes members of the Ataxophragmiidae with trochospiral initial part, at least in the microspheric generation, and triserial adult part. The aperture extends from the basal suture of the last chamber into the apertural face in a high arch or loop shape. There is a lip all round and the proximal border is inturned to make a connection with the previous foramen.

The genus differs from *Eggerella* in its high, loop-shaped aperture and from *Eggerellina* in its trough-like internal tooth plate and multilocular initial part. The wall of *E. scabrum* with large quartz grains set in a matrix of much smaller grains is also distinctly different from the smooth, finely calcarenitic wall of the described Cretaceous species of *Eggerellina*.

### *Eggerelloides scabrum* (Williamson)

(Pl. 2, figs 7, 8; Pl. 19, figs 10, 11; Text-fig. 8, nos 1-4)

*Bulimina scabra* Williamson, 1858 : 65, pl. 5, figs 136, 137 (*B. arenacea* on plate).

*Textularia scabra* (Williamson) Fischer, 1870 : 393.

*Verneuilina scabra* (Williamson) Cushman, 1922 : 55, pl. 10, figs 5, 6; Rhumbler, 1936 : 236, figs 234-246.

*Eggerella scabra* (Williamson) Cushman, 1937a : 50, pl. 5, figs 10, 11; Hoglund, 1947 : 191, pl. 13, figs 12-14; text-figs 162-165; Cushman, 1949 : 7, pl. 1, fig. 6; Colom, 1952 : 19, pl. 3, figs 8-10; Feyling-Hanssen, 1964 : 243, pl. 4, figs 4-6; Lutze, 1965 : 92, pl. 15, figs 24-29; pl. 12, figs 3-12.

*Verneuilina polystropha* Brady, 1884 : 386, pl. 47, figs 15-17; Goës, 1894 : 32, pl. 7, figs 247-255; Heron-Allen & Earland, 1913b : 55, pl. 4, figs 1 and 2 only (not Reuss).

**DIAGNOSIS.** An elongate, slightly irregular species of *Eggerelloides* with over 20 chambers developed in the microspheric generation which has an irregular, multilocular initial part and the last one or two whorls rapidly expanding in size. The megalospheric generation develops up to about 16 chambers and is more regularly triserial throughout, tending to become parallel sided although the initial chamber is often offset.

**DESCRIPTION.** (Text-fig. no. 1.) Test elongate with pointed initial end and subglobular distal end; about 25 chambers, the initial part irregularly trochospiral with the initial chamber hidden by later ones, the adult part triserial with the chambers in regular vertical rows, increasing slowly in size until the last whorl which is double the penultimate and subglobular; sutures impressed, spiral suture not marked; aperture a high arch at the basal suture of the last chamber in the centre of the flattened, slightly excavated apertural face, with delicate lip of small grains, proximal border inturned as a trough-like tooth plate connecting with the previous foramen; wall of angular quartz silt grains up to about 70 microns in diameter in a matrix of small grains about 5–10 microns in diameter, cement apparently organic.

**DIMENSIONS.** Length 0·80 mm, maximum width 0·43 mm; diameter of proloculus (microsphere) apparently about 10 microns (in xylene). Angle of taper 45°.

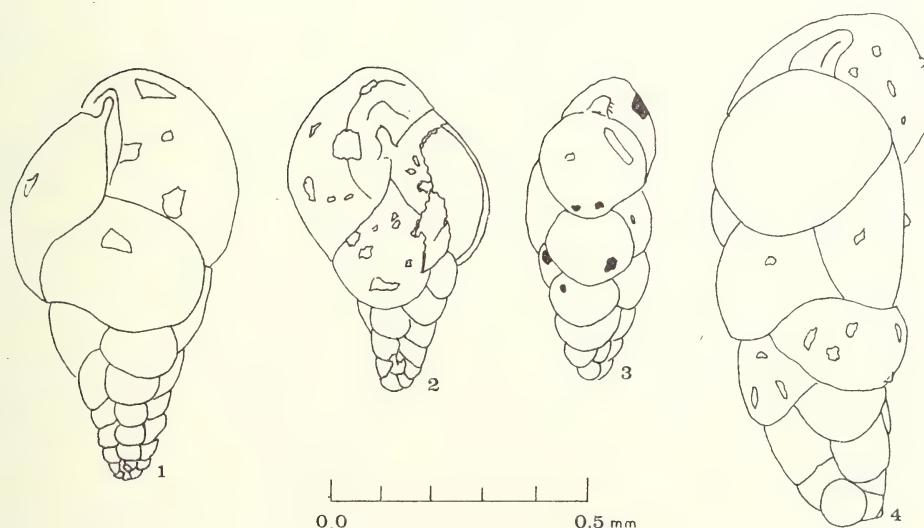


FIG. 8, 1–4. *Eggerelloides scabrum*. 1, specimen described; 2, 3, microspheric and megalospheric specimens from Cardigan Bay; 4, megalospheric specimen from the Shetlands.

MATERIAL. More than 25 specimens.

VARIATION. The Cardigan Bay material includes microspheric individuals with very small proloculus diameters near 10 microns, tending to have more than 20 chambers in the adult and megalospheric individuals with proloculus diameters between 30–60 microns with about 16 chambers. These figures correspond to Hoglund's observations on material from the Gulmar Fjord. Specimens examined from Goldseeker dredgings off the Shetlands show a greater range of megalosphere sizes, some reaching 100 microns. Specimens up to 1 mm total length occur in this material also.

Megalospheric individuals tend to become parallel sided with angle of taper about 40°. Some microspheric individuals with markedly expanded last whorl (Text-fig. no. 2) have an angle of taper as much as 55°. Hoglund found a general correlation between grain size and depth with the coarsest forms in deeper water. Our material appears to be similar to that from the Shetlands with large grains up to about 70 microns diameter in a matrix of smaller material (Pl. 19, figs 10, 11). The occasional specimen occurs with a much larger grain built into the test. Some specimens are a ferruginous yellow-brown colour, others are white. Quite often the last chamber only is white.

DEPOSITORY. B.M.(N.H.) Slide 1970 : 11 : 26 : 44–48. Stub 1970 : 11 : 26 : 591–592.

PROVENANCE. Specimen described, Goldseeker Haul 91, Shetlands. Specimens illustrated by stereoscanner, CB 13. Text-fig. no. 4, Goldseeker Haul 91, nos 2, 3, CB 298.

REMARKS. The original diagnosis of Williamson was based on material which included specimens from Dublin Bay as well as the Shetlands. In particular he noted the obtuse shape and tumid distal end, the roughly agglutinated wall with its organic cement and the 'involved' aperture. Our specimens are identical with specimens examined in the Williamson collection at the British Museum. The form of the aperture disposed Williamson to place this species with *Bulimina* and it was in fact called *B. arenacea* on the plate explanation. The difficulties experienced by later authors in this regard have led to it being successively placed in *Textularia*, *Verneuilina* and *Eggerella*. However, as our plates show, the apertural characters which are remarkably like those of *Bulimina* exclude it from these generic groups.

DISTRIBUTION. This species was originally described as generally distributed around the coasts of Great Britain and Ireland. This being confirmed by later records such as those for Clare Island (Heron-Allen & Earland, 1913b); the Clyde (Brady, 1884); Kent coast (Hedley & Underwood, 1957); Plymouth (Murray, 1965a); Christchurch (Murray, 1968); Western Approaches (Le Calvez & Boillot, 1967; Murray, 1970).

Other N.W. European and Lusitanian records include: Gulmar Fjord (Goës, 1894; Hoglund, 1947); coast of Norway (Sars, 1865); Baltic (Lutze, 1965); Belgian coast (Cushman, 1949); off Spain (Brady, 1884; Colom, 1952).

Arctic and cold water records (Cushman, 1922) may result from confusion with *Eggerella advena*.

Genus ***TEXTILINA*** Norvang, 1966***Textilina bocki*** (Hoglund)

(Pl. 3, figs 6, 7; Pl. 8, fig. 8)

*Textularia bocki* Hoglund, 1947 : 171, pl. 12, figs 5–7, text-figs 152, 153; Le Calvez, 1958 : 150, pl. 1, fig. 4; Feyling-Hanssen, 1964 : 234, pl. 3, figs 6, 7.

*Textularia agglutinans* Goës, 1894 : 35, pl. 7, figs 281–284, 294–296 (not d'Orbigny).

*Textularia gramen* Balkwill & Wright, 1885 : 332, pl. 13, figs 13, 14 (not d'Orbigny).

**DIAGNOSIS.** A species of *Textilina* with compressed, subcarinate, juvenile part with angle of taper about 60°, becoming inflated with rounded periphery in the adult with overall angle of taper from 35–45°. Advanced forms becoming thicker than wide.

**DESCRIPTION.** (Pl. 3, figs 6, 7; Pl. 8, fig. 8.) Test with initial part broken, compressed, evenly wedge-shaped with a drop in the angle of taper in the adult part, periphery lobate, initially subcarinate, later rounded; chambers biserially arranged (initial, part with proloculus broken), about eight pairs, gradually increasing in size, wider than high; sutures distinct, impressed in the adult; wall of angular silt grains, including shell fragments, up to 25 microns diameter, smoothly set in a very fine matrix, small round to quadrangular openings between the grains may be pores; aperture a short, narrow, slit-like opening at the basal suture of the final chamber in the median line, with slight, sharp, upper lip.

**DIMENSIONS.** Length 1·0 mm, maximum width approx. 0·55 mm, thickness 0·32 mm at last pair of chambers. Angle of taper approx. 35°.

**MATERIAL.** More than 25 specimens but most damaged, particularly at the initial end; many juveniles also.

**VARIATION.** There is variation in compression which appears to be genetic as well as a factor of growth. However, none reach the striking thickness exhibited by one of Hoglund's paratypes.

**DEPOSITORY.** B.M.(N.H.) Slide 1970 : II : 26 : 49. Stub 1970 : II : 26 : 720.

**PROVENANCE.** Specimen described, Brit. Mus. Core 16.

**REMARKS.** Our specimens fit well with Hoglund's material both in the changing angle of taper and in the contour of the periphery. This species differs from *T. agglutinans* d'Orbigny in its carinate initial part and from *T. gramen* d'Orbigny and *T. pseudogramen* Chapman & Parr by becoming rounded in the adult. Care must obviously be taken in the attempt to place juveniles of these species. Many listed references to *T. agglutinans* and *T. gramen* from around British coasts probably belong here. (Note, these species are transferred to *Textilina* by Norvang as the initial part is considered triserial.)

**DISTRIBUTION.** This species was described from the Gullmar Fjord, Skagerak and Kattegat. It is also recorded from the south Irish Sea, off Dublin (Balkwill & Wright, 1885) and in the north Irish Sea (Bruce, Coleman & Jones, 1963). A Celtic Sea record is given by Le Calvez (1958), and it is noted for the Scillies by Atkinson (1970), as well as in the Bay of Biscay (Caralp, Lamy & Pujos, 1970).

## Family FISCHERINIDAE Millett, 1898

## Genus CYCLOGYRA Wood, 1842

*Cyclogyra selseyensis* (Heron-Allen & Earland)

(Pl. 9, fig. 15; Pl. 29, fig. 4; Text-fig. 9, nos 1-6)

*Cornuspira selseyensis* Heron-Allen & Earland, 1909 : 319, pl. 15, figs 9-11; Cushman, 1929 : 82, pl. 20, figs 9a-c, after Heron-Allen & Earland.

DIAGNOSIS. A depressed, involute, corrugated species of *Cyclogyra* in which the last whorl in well grown, megalospheric specimens makes up most of the test.

DESCRIPTION. (Text-fig. nos 1, 2.) Test with damaged apertural end, circular in side view, with uneven, rounded periphery, depressed as seen in apertural view; proloculus globular and followed by a planispiral chamber arranged in three or four whorls, gradually increasing in size, each by about half to two-thirds as much again as the previous one in height and becoming more and more overlapping, almost completely by the final turn; deep umbilicus on each side with slightly protruding proloculus, spiral suture marked but irregular, excavated; wall porcelaneous, thin and translucent, without pores, a rich amber in transmitted light; aperture damaged, apparently formed by the open end of the tube, wider than high; surface marked by numerous growth lines.

DIMENSIONS. Maximum diameter 0.37 mm, width 0.13 mm.

MATERIAL. More than 25 specimens but mostly small, less than 0.20 mm diameter, and showing juvenile characters only.

VARIATION. The text-figures given an idea of the range of form in the Cardigan

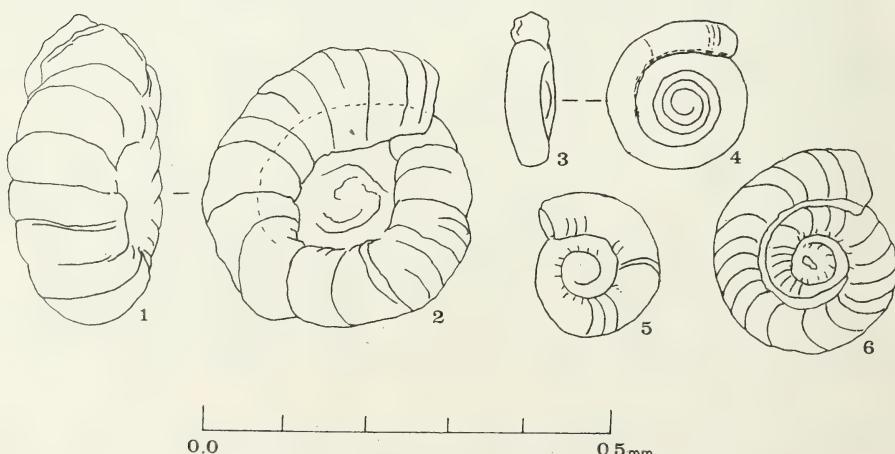


FIG. 9, 1-6. *Cyclogyra selseyensis*. 1, 2, well grown specimen showing corrugated and enveloping last whorl; 3, 4, juvenile with small proloculus and almost evolute whorls, resembling *C. involvens* of authors; 5, 6, juveniles with larger proloculus.

Bay population. The specimen with smallest proloculus (Text-fig. no. 4) about 25 microns, has four whorls. This individual may be microspheric or at the lower end of the megalosphere size range. In Text-fig. no. 5 we illustrate a larger specimen with proloculus diameter about 38 microns and two whorls increasing more rapidly in height, more than half as much again but not quite doubling in size. The specimen illustrated (Text-fig. no. 6) with largest megalosphere, about 50 microns, has a similar growth rate, prominent growth lines and excavated spiral suture and closely resembles the inner whorls of the specimen described (Text-fig. nos 1, 2). The test, therefore, becomes more involute, depressed and corrugated with growth. It is interesting to note that the characters shown by advanced megalospheric individuals are only slightly shown by the specimens with small proloculus; indicating the need for caution when dealing with juveniles and microspheric individuals in this group. N.B. The full range of variation is shown by the living population on the Dovey marshes.

DEPOSITORY. B.M.(N.H.) Slides 1970 : II : 26 : 50-55, 1970 : II : 26 : 56-58. Section 1970 : II : 26 : 468. Stub 1970 : II : 26 : 568.

PROVENANCE. Described specimen, Station III, Clettwr Transect, Dovey Marshes, live when taken.

REMARKS. This species has not been refigured since the original description of Heron-Allen & Earland in 1909, or recorded elsewhere by other workers. Cushman merely repeated the original figures in his Atlantic Monograph. Well grown megalospheric specimens from the Dovey marshes such as the one we describe come close to these original figures in size (about 0.3 mm) and in the number and involution of the whorls. However, they do show a more depressed whorl shape which might be expected as they are slightly larger and better developed.

Heron-Allen and Earland supposed that 'this form may eventually prove to be a merely megalospheric type of *C. involvens* (Reuss)'. However, *C. involvens* as first figured is larger, between 1 and 2 mm with truncate periphery and about seven whorls. Our specimens also seem to be quite different from *C. involvens* as interpreted by later workers. Cushman (1929) illustrated what may be the microspheric generation showing a specimen with about 11 whorls and a total diameter near 1 mm. What appear to be well developed examples of the megalospheric generation are illustrated by Loeblich & Tappan (1953). These specimens show seven or eight whorls and reach more than 2 mm in diameter. Our specimens are similarly, smaller, with less whorls and more involute and more depressed than *C. incerta* (d'Orb.), *C. lajolhensis* (Uchio) and *C. tasmanica* (Parr).

DISTRIBUTION. This species was originally described from the shore sands at Selsey and Bognor in the English Channel and recorded as occurring in the North Sea. Our discoveries indicate a wider distribution, possibly obscured hitherto by the tendency of authors to lump it under other names. For instance, the specimens figured as *C. involvens* by Balkwill & Millett (1884) from Galway and Balkwill & Wright (1885) from Lambay Deep, Dublin may well be juvenile forms of *C. selseyensis*. On the other hand the world-wide records given by Heron-Allen and Earland, quoted by Cushman, are more doubtful and probably refer to other species.

It occurs living very abundantly on the marshes of the Dovey Estuary and also in tide pools along the Cardigan Bay coast. The same habitat of 'half tide pools' was noted by Balkwill and Millett for '*C. involvens*' in Galway.

Family NUBECULARIIDAE Jones, 1875

Genus ***SPIROPTHALMIDIUM***<sup>1</sup> Cushman, 1927

*Spirothalmidium acutimargo* var. *emaciatum* Haynes n. var.

(Pl. 5, fig. 11; Pl. 9, fig. 16; Text-fig. 10, nos 1-4)

*Spiroloculina acutimargo* Brady, 1884 : 154, pl. 10, fig. 14; Balkwill & Wright, 1885 : 323, fig. 1; Heron-Allen & Earland, 1913b : 24, pl. 1, fig. 8 (not Brady, fig. 13).

*Spirophthalmidium acutimargo* Cushman, 1949 : 16, pl. 2, figs 14, 15; Voorhuisen, 1960 : 246, pl. 10, fig. 8.

? *Spiroloculina* sp. abnorm. Barker, 1960 : 20, pl. 10, fig. 14.

DIAGNOSIS. An elongate variety of *Spirothalmidium acutimargo* up to four times as long as wide. Lateral chambers overlapping with slightly raised flaps. Aperture produced and tubular with phialine lip.

DESCRIPTION. (Holotype, Pl. 5, fig. 11; Pl. 9, fig. 16.) Test elongate-ovate, almost parallel sided with narrow tubular apex, much compressed and blade-like, periphery produced into a wide keel, about three times as long as wide; chambers arranged in a spiroloculine spiral after an initial, undivided, tubular portion, increasing moderately in size and becoming strongly embracing as added, wrapped

<sup>1</sup> Original spelling by Cushman.

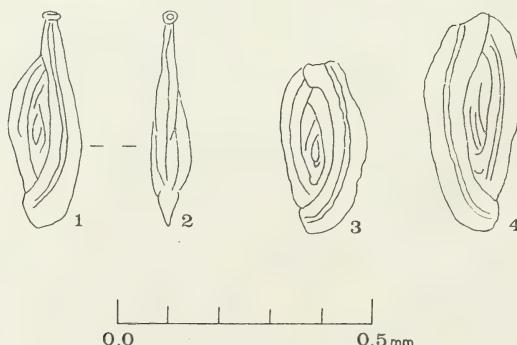


FIG. 10, 1-4. *Spirothalmidium acutimargo* var. *emaciatum*. 1, 2, side and edge view of slender specimen showing considerable taper to the apex; 3, 4, specimens with apertures broken.

round at the base, about seven visible (actual body chamber extremely narrow due to size of keel); sutures hidden beneath the slightly raised and thickened flaps produced along the overlapping edges of the chambers; wall thin, translucent and pearly, imperforate porcelaneous; aperture with a reflexed, round lip at the end of a tubular neck, no tooth structure.

DIMENSIONS. Length 0·43 mm, maximum width 0·14 mm, thickness approx. 0·04 mm.

MATERIAL. Eight specimens, five with apertures broken off.

VARIATION. As shown by the text-figures there is some irregularity in shape with variation in size up to 0·75 mm maximum length. One of our specimens has a straight edge and this is also a feature of one of Cushman's specimens from the Belgian coast (1949). The tendency for the chambers to wrap round strongly at the base and narrow towards the apex appears to be a constant feature.

DEPOSITORY. B.M.(N.H.) Slide 1970 : 11 : 26 : 59-62 (paratypes). Stub 1970 : 11 : 26 : 677 (holotype).

PROVENANCE. Specimen described, CB 488. Additional specimens figured, nos 1 and 2, Brit. Mus. core 16; no. 3, Brit. Mus. core 16.

REMARKS. The type specimen of *S. acutimargo* from the South Atlantic is oval, less than twice as long as wide and apparently less produced at the apex. It is probable that the aperture is broken off as this occurs commonly in our material. On the other hand the topotype figured by Loeblich & Tappan (1964a) and the Pacific specimen figured by Wood & Barnard (1946) show compressed apertures, only slightly if at all produced, like Brady's form.

Brady's material from Fiji and Raine Island, Torres Strait includes specimens like the type from Pernambuco as well as var. *emaciatum*. Variation is shown in compression as well as in the thickness and elevation of the flaps along the edges of the chambers, leaving little doubt that this group forms a series (including *S. elevata* of Wiesner). However, it seems worthwhile to distinguish the elongate variety by name as it is the form present in the northern hemisphere. The specimens figured by Balkwill and Wright, Heron-Allen and Earland and Cushman being identical with ours in shape, size, overlap of the chambers and in the strongly produced tubular character of the aperture, particularly well shown in the woodcuts of Balkwill and Wright. This strongly suggests that the variety behaves in this region as a boreal subspecies of *S. acutimargo*.

Loeblich & Tappan (1964a) followed Macfadyen (1939) in suppressing *Spirophthalmidium* as identical with *Ophthalmidium*. However, Wood & Barnard (1946) retain the name for species in which spiroloculine arrangement is reached relatively quickly after the initial, planispiral undivided tubular stage. Probably '*Spiroloculina*' species without apertural tooth belong here, i.e. those not descended from *Massilina*. The name is therefore retained but with the original spelling of Cushman (1927, 1929) rather than the 'corrected' spelling, *Spirophthalmidium*.

DISTRIBUTION. This variety occurs widely in the seas off N.W. Europe possibly as a distinct subspecies: Irish Sea, Dublin coast (Balkwill & Wright, 1885); Western

Ireland, Clare Island (Heron-Allen & Earland, 1913b); Belgian coast (Cushman, 1949); Netherlands, Dollart-Ems Estuary (Voorthuysen, 1960).

In the South Pacific it occurs as a variant in populations of *S. acutimargo* (Brady, 1884).

Family **MILIOLIDAE** Ehrenberg, 1839

Genus **MASSILINA** Schlumberger, 1893

***Massilina carinata*** (Fornasini)

(Pl. 5, figs 1, 2)

*Spiroloculina nitida* Brady, 1884 : 149, pl. 9, figs 9, 10; part Millett, 1898 : 265, pl. 5, fig. 13, as var. (not d'Orbigny).

*Spiroloculina nitida* d'Orbigny var. *carinata* Fornasini, 1905 : 389.

*Spiroloculina milletti* Wiesner, 1912 : 207.

*Massilina milletti* (Wiesner) Boltovskoy, 1954 : 261, pl. 22, fig. 6; Barker, 1960 : 18, pl. 9, figs 9, 10 (after Brady).

*Massilina carinata* (Fornasini) Atkinson, 1968<sup>1</sup> : 166, text-figs 1, 2, 3 (2 and 3 after Brady).

DIAGNOSIS. A flat species of *Massilina* with truncate periphery becoming carinate at the last chamber.

DESCRIPTION. Test oval, compressed, slightly produced at the apex, flattened with shallow umbilicus on each side, periphery truncate and passing into a single keel at the last chamber; at least six chambers arranged in a quinqueloculine to evolute spiroloculine spiral, increasing moderately in size as added; sutures impressed; wall thick, porcelaneous, rough not polished, imperforate; aperture produced oblong-oval, reflecting the chamber shape, with narrow lip and marked tooth with expanded, wedge-shaped, free edge, external keel marked by an internal ridge on the margin opposite to the tooth.

DIMENSIONS. Length 0.87 mm, maximum breadth 0.66 mm, maximum width 0.17 mm.

MATERIAL. Two specimens only.

DEPOSITORY. B.M.(N.H.) Stub 1970 : 11 : 26 : 652 (paratype).

PROVENANCE. Specimen illustrated, CB 426.

REMARKS. Atkinson (1968) has explained how Fornasini's name *carinata* takes precedence over Wiesner's name *milletti* for this species, first recovered by Brady and placed under *S. nitida*. We have now illustrated by stereoscanner photo the specimen from Cardigan Bay drawn by Dr Atkinson.

DISTRIBUTION. The types are from off Japan and from Torres Strait. Further Pacific references are: Malay Archipelago (Millett, 1898); Honolulu and Hawaii (Cushman, 1917); West Australia, Oyster Harbour (McKenzie, 1962); New Zealand, Manukau Harbour (Hulme, 1964); Matsushima Bay, North-east Japan (Matoba, 1970).

There is also a South Atlantic record, Argentina (Boltovskoy, 1954).

<sup>1</sup> See addendum.

*Massilina secans* (d'Orbigny)

(Pl. 5, figs 3, 4; Pl. 8, fig. 6; Pl. 32, fig. 4)

*Quinqueloculina secans* d'Orbigny, 1826 : 303, no. 43, modèle 96.*Miliolina secans* Brady, 1884 : 167, pl. 6, figs 1, 2 (not d'Orbigny).*Miliolina secans* (d'Orbigny) Mills, 1900 : 143, pl. 10, fig. 18.*Sigmoilina secans* (d'Orbigny) Schlumberger, 1887 : 118.*Massilina secans* (d'Orbigny) Schlumberger, 1893 : 218, pl. 4, figs 82, 83, text-figs 31-33; Goës, 1894 : 112, pl. 20, figs 856-856g; Cushman, 1929 : 37, pl. 7, figs 3, 4; 1949 : 11, pl. 2, fig. 4; Feyling-Hanssen, 1964 : 254, pl. 6, figs 2, 3.

**DIAGNOSIS.** An almost round to elongate-ovate species of *Massilina* with subacute to keeled periphery, crenulate in the adult.

**DESCRIPTION.** (Pl. 5, figs 3, 4; Pl. 8, fig. 6.) Test oval to almost circular in outline, compressed elliptical in section, periphery subacute; chambers arranged in a flattened quinqueloculine to evolute spiroloculine spiral, four visible externally, increasing moderately in size as added; sutures depressed; wall thick, porcelaneous, imperforate; aperture large, oval with rounded lip and long tooth with expanded, wedge-shaped free edge.

**DIMENSIONS.** Maximum length 1·4 mm, breadth 1·27 mm, width approx. 0·33 mm.

**MATERIAL.** More than 25 specimens.

**VARIATION.** Juveniles tend to be more elongate and the periphery may be sub-round rather than acute or keeled. The truncate aperture appears to be a constant feature.

**DEPOSITORY.** B.M.(N.H.) Slide 1970 : 11 : 26 : 63, 64. Section 1970 : 11 : 26 : 474. Stub 1970 : 11 : 26 : 653.

**PROVENANCE.** Specimen described, CB 12.

**REMARKS.** D'Orbigny's model shows the typical features of this species very well including the crenulations which tend to develop on the final chambers—these are well shown also in the figures of Goës. It is not quite certain if *Miliolina seminulum* var. *disciformis* sensu Williamson (1858) belongs here because although described as compressed the figures resemble large specimens of *Miliolinella subrotunda*.

**DISTRIBUTION.** This species which was described from the Mediterranean is widespread in shallow water around the British Isles: Irish Sea (Balkwill & Wright, 1885; Chaster, 1892; Siddall, 1876); West of Scotland, Clyde (Robertson, 1877); Portree (Robertson, 1892); Oban (Burgess, 1889); Jura (Heron-Allen & Earland, 1916a); Shetlands (Waller, 1868); Ireland, Dogs Bay, Rathlin and Lambay (Wright, 1900, 1902, 1907); North Sea, Forth (Pearcey, 1902); Coasts of Northumberland and Durham (Brady, 1870; Brady & Robertson, 1876); Humber (Mills, 1900); Scillies (Atkinson, 1970); English Channel, Cornwall (Heron-Allen & Earland, 1916b); Plymouth (Heron-Allen & Earland, 1930; Worth, 1904); Selsey (Heron-Allen & Earland, 1909, 1910); Christchurch (Murray, 1968); Western Approaches (Murray, 1970).

Further North Sea records include: Belgian coast (Cushman, 1949); Norwegian coast (Norvang, 1945); Holocene of Oslofjord (Feyling-Hanssen, 1964).

It appears not to have been noted in the Western North Atlantic but, there is a Florida Bay record (Lynts, 1962).

South Atlantic records include: Quenquen shore sands, Buenos Aires (Boltovskoy, 1955); Rio de la Plata and off Argentina (Boltovskoy, 1957, 1959, 1961); South Brazil (Closs & Barbarena, 1962).

Further scattered records include one for the Indian Ocean, Mozambique (Braga, 1961); an Australasian record, Oyster Harbour, W. Australia (McKenzie, 1962) and several from the N. Pacific (Cushman, 1917; Matoba, 1970); Malay Archipelago (Millett, 1898); Ceram (Rutten & Holtz, 1946). These may refer to *M. secans tropicalis* Collins, first described from the Great Barrier Reef (1958).

### Genus *MILIAMMINA* Heron-Allen & Earland, 1930

#### *Miliammina fusca* (Brady)

(Pl. 2, figs 9, 10; Pl. 31, figs 6, 7)

*Quinqueloculina fusca* Brady, 1870 : 286, pl. 11, figs 2a-c; Cushman, 1929 : 23, pl. 1, figs 4a-c; Bartenstein, 1938 : 391, text-fig. II.

*Miliolina fusca* (Brady) Balkwill & Millett, 1884 : 6.

*Miliammina fusca* (Brady) Rhumbler, 1936 : 209; Parker, 1952a : 404, pl. 3, figs 15, 16; 1952b : 452, pl. 2, figs 6a, b; Todd & Low, 1961 : 14, pl. 1, fig. 6; Feyling-Hanssen, 1964 : 224, pl. 2, figs 1, 2; Brodniewicz, 1965 : 195, pl. 8, figs 3, 4; Lutze, 1965 : 88, pl. 15, figs 1-9.

*Quinqueloculina agglutinans* Brady, 1867 : 95 (not d'Orbigny).

**DIAGNOSIS.** An elongate-ovate species of *Miliammina* with roughly agglutinated wall of quartz silt grains, aperture truncate with thick lip and bar-like tooth.

**DESCRIPTION.** Test elongate-ovate, slightly compressed, with rounded base and truncate apex, twice as long as wide, oval in section; chambers arranged in a quinqueloculine spiral, six visible externally, gradually increasing in size as added; sutures impressed; aperture truncating the apex, large, equal to chamber diameter, circular with thick lip, interrupted on the inside edge by simple, bar-like tooth; wall tectinous with agglutinated grains of angular quartz silt, rough finish, brownish-grey in colour.

**DIMENSIONS.** Maximum length 0.45 mm, width 0.22 mm, thickness approx. 0.15 mm.

**MATERIAL.** More than 25 specimens.

**VARIATION.** Most specimens are smaller than the one described and in some of them the chambers are distorted and twisted, the last one sometimes more inflated. In many cases the test is more parallel sided or oblong.

**DEPOSITORY.** B.M.(N.H.) Stub 1970 : 11 : 26 : 654. Section 1970 : 11 : 26 : 476.

**PROVENANCE.** Specimen described Station I, Clettwr Transect, Dovey Marshes (Juncetum).

REMARKS. Our specimens conform well with the type figure and with specimens in the Brady Collection at the British Museum from Seaton Sluice in general proportions and in the truncation of the apex by the large, thick lipped aperture. However, the best developed specimens show a bar-like tooth not apparent in the type figure. Feyling-Hanssen (1964) has discussed the problem raised because authors' figures often do not show this feature. As toothed forms apparently have the same range as those without a tooth it may be assumed to be a matter of preservation.

*Miliammina earlandi* (Loeblich & Tappan) has been put in synonymy with *M. fusca* by Lutze (1965) but appears to differ in possessing a more parallel sided test, an apertural neck and smooth, fine grained wall. It is also a marine rather than brackish, intertidal species. *Miliammina obliqua* Heron-Allen & Earland has chambers placed at a much greater angle to the main axis of the test and is again marine.

DISTRIBUTION. This species was originally described as common in estuarine pools along the coast of Northumberland and Durham and in the brackish shallows of lochs on the west of Scotland and Ireland and as much less frequent in more marine estuaries and bays. Subsequent records confirm this distribution: Irish Sea area (Balkwill & Wright, 1885); Dee Estuary (Siddall, 1876); Mersey (Burgess, 1891); Southport (Chaster, 1892). West of Scotland, Portree Harbour (Robertson, 1892); Firth of Clyde (Robertson, 1877). Ireland, brackish water areas: Clare Island (Heron-Allen & Earland, 1913b); Galway (Balkwill & Millett, 1884); Connemara (Lees *et al.*, 1969). English Channel, Cornwall (Heron-Allen & Earland, 1916b, 1930); Selsey (Heron-Allen & Earland, 1909, 1911); Tamar and Christchurch (Murray, 1965a; 1968); Jersey (Halkyard, 1889).

Other N.W. European records include, interestingly, the Baltic (Brodniewicz, 1965; Lutze, 1965); Langeoog (Haake, 1962); the Netherlands, Wadden Sea (Voorhuijsen, 1951); Villefranche Bay (Le Calvez & Le Calvez, 1958) and the brackish water Holocene of Oslofjord (Feyling-Hanssen, 1964).

It is a common species in marshes and estuaries along the N.E. seaboard of North America: Barnstable Bay (Phleger & Walton, 1950); Narragansett Bay (Said, 1951); New Hampshire and Buzzards Bay (Parker, 1952a, b); Falmouth (Said, 1953); New York Bight (Ronai, 1955); Popponesset (Parker & Athearn, 1959); Martha's Vineyard (Todd & Low, 1961); Nova Scotia (Bartlett, 1964).

Records for nearshore areas and marshes on the S.E. seaboard of N. America and the Gulf of Mexico include: N. Carolina, Mason Inlet (Miller, 1953); Virginia, Rappahannock (Ellison & Nicols, 1970); Mississippi Delta and Sounds (Phleger, 1954, 1955, 1960; Lankford, 1959; Warren, 1957); Texas coast, Grassy Island (Phleger, Parker & Peirson, 1953); Central coast (Phleger, 1956; Lehman, 1957); Central Bays (Phleger & Lankford, 1957); Trinidad, Maracas Bay (Saunders, 1958); Gulf of Paria (Todd & Bronnimann, 1957); Mexico, Laguna de Terminos (Ayala-Castanares, 1963).

South Atlantic records include: Argentina, Gulf of San Jorge (Boltovskoy, 1954); Puerto Deseado (Boltovskoy, 1963).

It has also been recorded as an abundant marsh species on the Pacific Coast of N. America: Gulf of California (Bandy, 1963); Guerrero Negro Lagoon, California (Phleger, 1965); Marshes from British Columbia to Mission Bay, California (Phleger, 1967); Bering Sea (Anderson, 1963).

An Australian record is: Port Hacking, N. South Wales (Albani, 1968).

Deep water records in the Atlantic and Pacific are doubtful and probably refer to other species.

### Genus *MILIOLINELLA* Wiesner, 1931

#### *Miliolinella subrotunda* (Montagu)

(Pl. 5, figs 5, 6, 12, 13; Pl. 31, figs 8, 9; Text-fig. 11, nos 1-4; Text-fig. 12, nos 1-11)

*Serpula subrotunda dorso elevata* Walker & Boys, 1784 : 2, pl. 1, fig. 4.

*Vermiculum subrotundum* Montagu, 1803 : 521.

*Quinqueloculina subrotunda* (Montagu) d'Orbigny, 1826 : 302; Brady, 1867 : 94, pl. 12, fig. 2; Cushman? 1929 : 25, pl. 2, fig. 4 (after Brady); ? 1948 : 35, pl. 3, figs 20, 21; pl. 4, fig. 1; 1949 : 9, pl. 1, fig. 8; Parker, 1952a : 406, pl. 4, figs 4a, b; 1952b : 456, pl. 2, figs 9a, b; 19a, b; Todd & Low, 1961 : 15, pl. 1, fig. 8.

*Miliolina subrotunda* (Montagu) Fischer, 1870 : 386; Parker & Jones, 1865 : 411, pl. 15, figs 38a, 38b; Balkwill & Wright, 1885 : 324, pl. 12, figs 8, 9; Goës, 1894 : 109, pl. 19, figs 846, 847; Mills, 1900 : pl. 10, fig. 16.

*Miliolinella subrotunda* (Montagu) Wiesner, 1931 : 63; Phleger, 1960 : 77, pl. 5, fig. 19; Adams & Frampton, 1965 : 57, pl. 5, fig. 15.

*Miliolinella* cf. *subrotundum* (Montagu) Feyling-Hanssen, 1964 : 262, pl. 7, fig. 1.

*Miliolina seminulum* var. *disciformis* (Macgillivray) Williamson, 1858 : 86, pl. 7, figs 188, 189.

*Quinqueloculina disciformis* (Macgillivray) Cushman, 1944 : 15, pl. 2, figs 17, 18.

*Triloculina subrotundum* (Montagu) Boltovskoy, 1954 : 127, pl. 1, figs 8, 9; pl. 2, figs 11, 12; 1957 : 262, pl. 21, figs 5, 7, 15.

**DIAGNOSIS.** An ovate or circular to depressed species of *Miliolinella*, oval to compressed in section. Chambers arranged in a flattened quinqueloculine to triloculine spiral, the last two chambers often being added almost in one plane revealing the earlier ones. Thin walled, often with growth corrugations, tending to become irregular and tubular without apertural flap.

**DESCRIPTION.** (Text-fig. nos 1-3.) Test subglobose, almost round in outline, slightly compressed and oval in section; chambers arranged in a quinqueloculine to triloculine spiral, the last two almost opposite each other, inflated, rounded, increasing moderately in size as added, embracing with overlapping flanges, four visible on one side, only the final two on the other; wall thin, translucent and pearly, imperforate; aperture with marked lip and rounded flap on the internal border.

**DIMENSIONS.** Maximum length 0.39 mm, width 0.33 mm, thickness 0.25 mm.

**MATERIAL.** More than 25 specimens, all growth stages.

**VARIATION.** As shown by the figures, triloculine forms occur which resemble the type figure (Text-fig. nos 3-5) and also quinqueloculine to triloculine forms with five to six chambers visible externally, some of these being quite flattened (Text-fig. nos 6-8); all together in the same sample, often without apertural flap.

The aperture becomes more central as the chamber arrangement becomes more spiroloculine. In many specimens the later chambers become tubular and irregular (Text-fig. no. 4) showing the trend towards '*Pateoris*', retaining the lip but losing the apertural plate (Pl. 5, figs 12, 13).

DEPOSITORY. B.M.(N.H.) Slide 1970 : II : 26 : 65-68. Section 1970 : II : 26 : 475. Stub 1970 : II : 26 : 657. Pateorid variety Slide 1970 : II : 26 : 69-72. Stub 1970 : II : 26 : 680.

PROVENANCE. Specimen described and variations shown in the text-figures, Brit. Mus. Cat. 16. Specimen illustrated by stereoscan photo, CB 416, pateorid variety, CB 486.

REMARKS. Previous authors such as Loeblich & Tappan (1953) and Feyling-Hanssen (1964) have attempted to restrict the diagnosis of this species to include triloculine forms only, like the type figure, and thus to exclude quinqueloculine and biloculine forms both from the species and the genus, *Miliolinella*. However, our material includes not only specimens like the type figure but also, more commonly, specimens like that described with five or even six chambers visible externally (close to the one first figured by Brady from the Northumberland coast, 1867) and to specimens in the British Museum from Wansbeck and the estuary of the Tees. We feel bound to include these forms in one species. Thus supporting the broad view of Wiesner. It would seem altogether inappropriate to separate some as *Miliolinella*, some as *Scutuloritis* and to dispatch the irregular, wild growing, hauerinid forms into a separate genus and even subfamily.

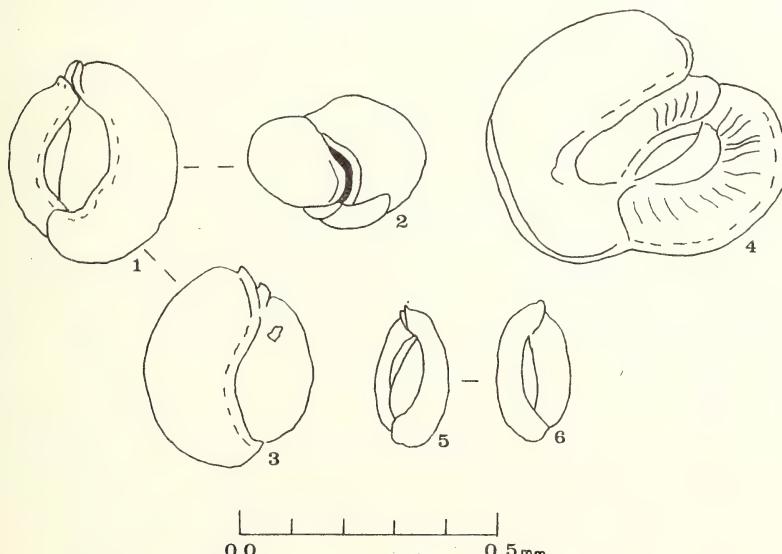


FIG. 11.1-3. *Miliolinella subrotunda*, specimen described. 1, side view showing early chambers; 2, apertural view; 3, other side. 4. *Miliolinella subrotunda* hauerinid variety. 5, 6. *Scutuloritis* sp., possible juvenile *Miliolinella* sp., view of each side.

DISTRIBUTION. There are a very large number of records of this species. Although some may be untrustworthy it seems worthwhile to give them because they reveal a cosmopolitan distribution but with large areas, such as the Mediterranean and Gulf of Mexico where it is rare or unknown.

It appears to be particularly abundant on the western side of the British Isles: Irish Sea, Dublin coast (Balkwill & Wright, 1885); Caernarvon Bay and Menai

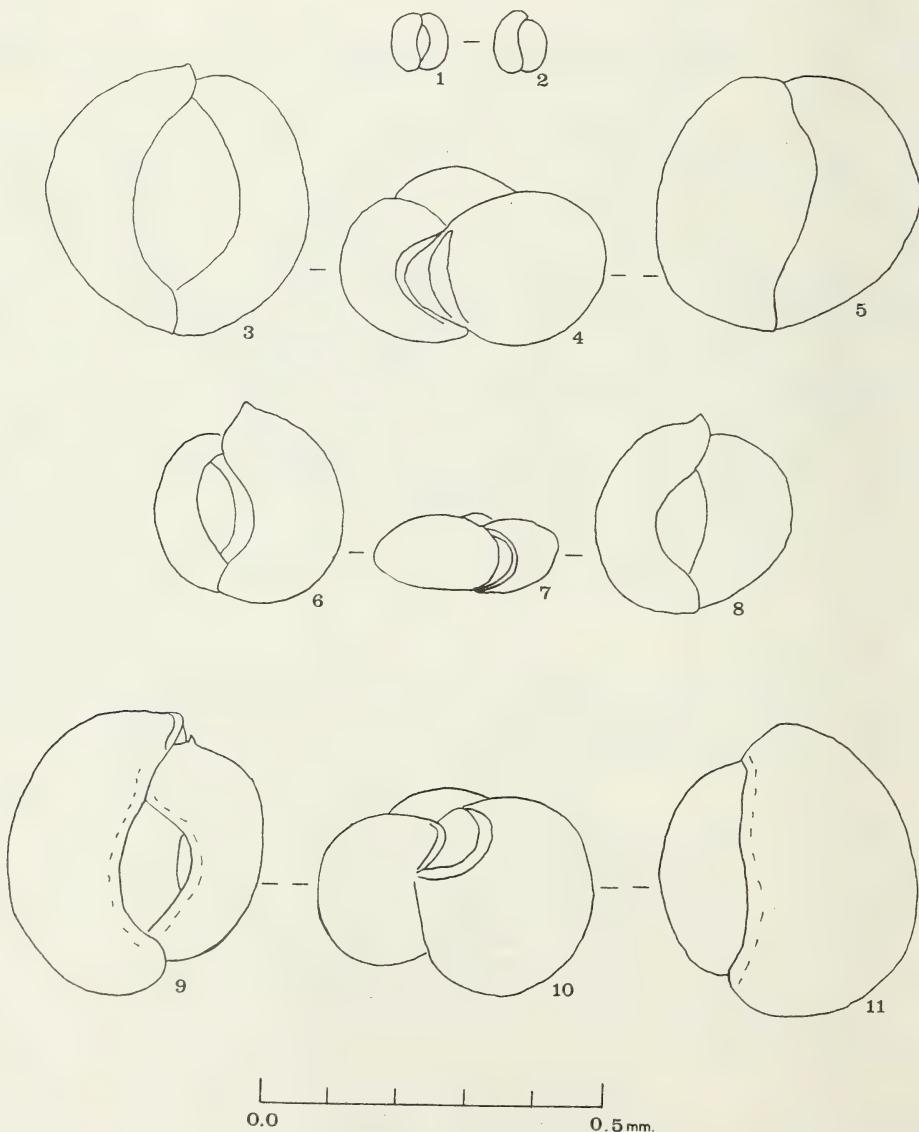


FIG. 12, I-II. *Miliolinella subrotunda*. 1, 2, copy of type figures; 3-5, views of triloculine specimen; 6-8, views of compressed quinqueloculine to planispiral specimen without a lip; 9-11, views of quinqueloculine specimen. Drawings from Adams (1963).

Straits (Pearcey, 1891); Lambay (Wright, 1907); Mersey (Burgess, 1891); Dee (Siddall, 1878); Isle of Man (Heron-Allen & Earland, 1915; Bruce *et al.*, 1963); West of Scotland, Shetlands (Waller, 1868); Portree (Robertson, 1892); Oban (Burgess, 1889); Mull and Jura (Heron-Allen & Earland, 1914a, 1916a); The Clyde (Robertson, 1877); West of Ireland, Dogs Bay (Wright, 1895); S.W. of Ireland (Wright, 1890); Clare Island (Heron-Allen & Earland, 1913b); Scillies (Atkinson, 1970); English Channel, Cornwall and Plymouth (Heron-Allen & Earland, 1916b, 1930; Murray, 1965a; Worth, 1904); Selsey Bill and Christchurch (Heron-Allen & Earland, 1909, 1911; Murray, 1968); North Sea, Kent coast (Hedley & Underwood, 1957); Durham coast (Brady, 1867); Humber (Mills, 1900); Jersey (Halkyard, 1889).

Other records for N.W. Europe are: Belgian coast (Cushman, 1949); Wadden Sea (Voorthuysen, 1951); Germany, Langeoog (Haake, 1962); Holocene of Oslofjord (Feyling-Hanssen, 1964); Poland, Baltic (Brodniewicz, 1965).

Arctic and N.E. North America records are: Davis' Strait (Parker & Jones, 1865); Iceland (Norvang, 1945); Hudson Bay (Cushman, 1948); New England, Portsmouth (Parker, 1952a); Buzzards Bay (Parker, 1952b); Martha's Vineyard (Todd & Low, 1961); St Lawrence (Dawson, 1870).

South Atlantic records include: Falklands (Heron-Allen & Earland, 1932); Argentina coast (Boltovskoy, 1954, 1955, 1957, 1959, 1961, 1963).

Antarctic records include: (Chapman & Parr, 1937; Parr, 1950; Wiesner, 1931).

Records for the Pacific and tropical latitudes in general are less concentrated: N. Pacific (Cushman, 1917); Malay Archipelago (Millett, 1898); Funafuti (Chapman, 1899, 1890); Trinidad (Drooger & Kaasscheiter, 1958).

This species appears to be a shallow water form mainly favouring high latitudes.

#### Genus *PYRGO* Defrance, 1824

##### *Pyrgo carinata* (d'Orbigny)

(Pl. 9, fig. 17; Text-fig. 13)

*Biloculina carinata* d'Orbigny, 1839a : 164, pl. 8, fig. 24; pl. 9, figs 1, 2; Terquem, 1876 : 442, pl. 5, figs 16a, b.

*Biloculina ringens* var. *carinata* Williamson, 1858 : 79, pl. 7, figs 172-174.

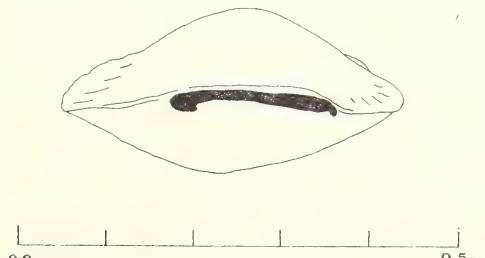


FIG. 13. *Pyrgo carinata*, apertural view.

DIAGNOSIS. An elongate ovate, compressed *Pyrgo* with marked peripheral carina.

DESCRIPTION. Test elongate ovate with slightly irregular outline, compressed in section being twice as wide as high; periphery with wide, thin keel, slightly produced at the base; chambers biloculine, the last one overlapping the previous one all round and more so at the base, junction marked by carina of previous chamber; aperture terminal, an elongate slit with projecting lips and flat tooth giving a key-hole appearance; wall porcelaneous, imperforate, smooth.

DIMENSIONS. Length 0·46 mm, width 0·37 mm, height between chambers 0·17 mm.

MATERIAL. Two specimens only, one apparently a juvenile.

DEPOSITORY. B.M.(N.H.) Slide 1970 : 11 : 26 : 73. Stub 1970 : 11 : 26 : 529.

PROVENANCE. Described specimen, CB 502.

REMARKS. This species was first described from Cuba by d'Orbigny who clearly distinguished it from his *Biloculina depressa* on the grounds of its elongate ovate shape and presence of a marked carina. An examination of d'Orbigny's model of *B. depressa* confirms this distinction. Nevertheless, many later authors have put these two forms in synonymy. In particular, some of the specimens placed under *B. depressa* by Brady (1884), i.e. those illustrated in Pl. 3, figs 1, 2, from the Porcupine Station AA, west of Skye, Scotland and by Cushman (1949) from the Belgian coast, appear to come within d'Orbigny's concept of *B. carinata*.

DISTRIBUTION. Owing to confusion with *B. depressa* this remains to be worked out. Probably widespread in the North Atlantic.

### *Pyrgo* cf. *constricta* Costa, 1856

(Pl. 9, figs 11, 12)

DESCRIPTION. Test globose, oval in outline and almost round in section, base with short, wide, truncate caudal projection; chambers arranged in an embracing biloculine series, the last one clasping the penultimate one all round, with a bevelled edge (the caudal projection arises from this bevelled edge) the amount of overlap greater at the base, bevelled edge produced slightly and keel like towards the aperture and towards the base; wall imperforate porcelaneous, smooth; aperture terminal, arched (possibly damaged) with a flat tooth structure.

DIMENSIONS. Length 0·67 mm, maximum width 0·48 mm, maximum thickness 0·44 mm.

MATERIAL. One specimen only.

DEPOSITORY. B.M.(N.H.) Stub 1970 : 11 : 26 : 688.

PROVENANCE. Brit. Mus. Core 14.

REMARKS. Our specimen comes very near to *P. constricta* but with slightly less projecting apex and with the penultimate and final chambers showing more difference

in size. *P. appendiculata* (Eichwald) is more compressed with narrow, ribbed caudal projection. Unfortunately, we cannot be certain of the apertural characters in our specimen.

***Pyrgo williamsoni* (Silvestri)**

(Text-fig. 14, nos 1-3)

*Biloculina ringens, typica* Williamson, 1858 : 79, pl. 6, figs 169, 170; pl. 7, fig. 171 (not *Miliolites ringens* Lamarck).

*Biloculina williamsoni* Silvestri, 1923 : 73.

*Pyrgo williamsoni* (Silvestri) Loeblich & Tappan, 1953 : 48, pl. 6, figs 1-4, ? 2; Feyling-Hanssen, 1964 : 264, pl. 7, figs 5, 6; pl. 8, figs 3-5.

**DIAGNOSIS.** A globose, ovate species of *Pyrgo* in which the penultimate chamber protrudes from the final chamber which clasps it all round. Tooth strongly bifid with long, divergent tines.

**DESCRIPTION.** Test globose, ovate in outline, thicker than wide and somewhat square in section; chambers arranged in an embracing spiroloculine series the final one clasping the penultimate all round and much larger; penultimate chamber protruding; suture distinct, impressed, the sides of the chambers flattened towards it at midpoint; wall imperforate porcelaneous, smooth; aperture terminal, oval,

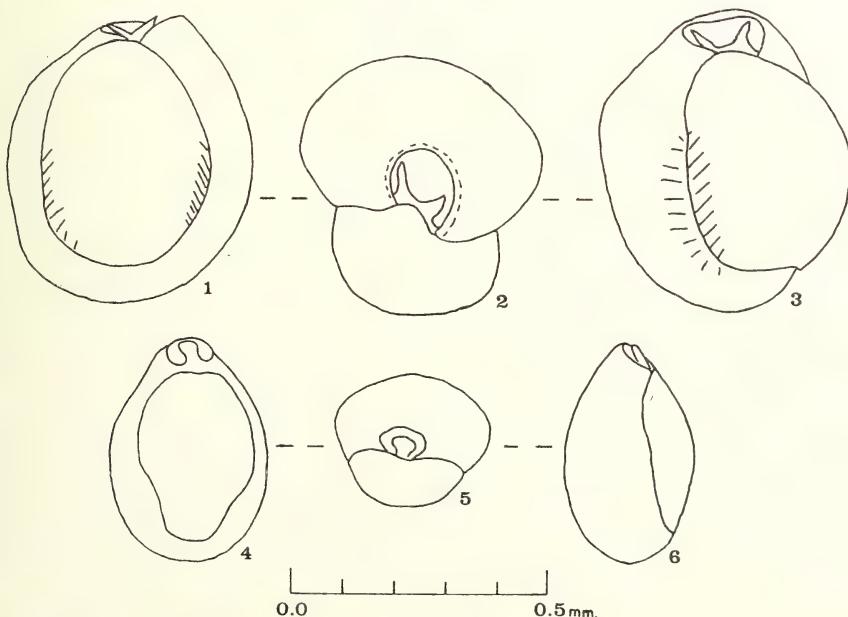


FIG. 14. 1-3. *Pyrgo williamsoni*. 1, side view; 2, apertural (top) view; 3, oblique side view. 4-6. *Pyrgo* species A. 4, side view; 5, apertural view; 6, edge view.

slightly skewed with narrow, smooth lip and low tooth at the inner edge with long, divergent tines.

**DIMENSIONS.** Length 0·59 mm, width 0·48 mm, thickness 0·50 mm.

**MATERIAL.** Two specimens.

**DEPOSITORY.** B.M.(N.H.) Slide 1970 : 11 : 26 : 74.

**PROVENANCE.** Specimen described, CB 561.

**REMARKS.** Loeblich & Tappan (1953) figure specimens like ours with rather square section and low tooth with widely divergent tines and also rounder forms in which the tooth has a narrower base and the tines diverge almost at right angles (more like Williamson's type figure). Further work is required to evaluate the importance of these variations and also the relationships with allied species such as *P. elongata* d'Orbigny.

**DISTRIBUTION.** Because of confusion between this and other species this remains to be worked out. Following the description of Loeblich and Tappan there have been a number of further records for the Arctic including: Hudson Bay (Leslie, 1963); Continental Shelf (Wagner, 1963). Also, records for the Late Pleistocene and Holocene of Oslofjord (Feyling-Hanssen, 1964; Risdal, 1963). There is therefore a cold water indication.

### *Pyrgo* species A

(Pl. 9, figs 10, 13; Text-fig. 14, nos 4-6)

**DESCRIPTION.** (Pl. 9, figs 10, 13.) Test globular with irregularly ovate outline and produced apex, almost round in section, very slightly thicker than wide; chambers arranged in an embracing biloculine series, final one clasping the penultimate all round with slightly bevelled edge towards the base but with almost no change of contour towards the middle and apex, outline of penultimate chamber defined by the suture tapering to the base and slightly irregular, final chamber much larger; suture distinct and impressed; wall imperforate porcelaneous, smooth; aperture terminal, produced with hood-like outer lip and round spoon-shaped process rising from a narrow base at the inner border, not filling the apertural opening.

**DIMENSIONS.** Length 0·45 mm, width 0·27 mm, thickness 0·28 mm.

**MATERIAL.** Three specimens, one broken.

**VARIATION.** The other complete specimen recovered is slightly less round in section but shows the same apertural characters and the same shaped penultimate chamber (Text-fig. nos 5-6).

**DEPOSITORY.** B.M.(N.H.) Slide 1970 : 11 : 26 : 75. Stub 1970 : 11 : 26 : 690.

**PROVENANCE.** Specimen described, Brit. Mus. Core 14. Additional specimen illustrated in Text-fig. nos 4-6, CB 317.

REMARKS. This form differs from *Pyrgo williamsoni* in its spoon-shaped tooth and almost perfectly round sectional contour, being without the markedly protruding penultimate chamber of that species. We have not found an account of any quite like it in the literature. Possibly it has been considered merely a juvenile form of *P. williamsoni* or *P. elongata* d'Orbigny, hitherto. *P. elongata* sensu Brady, 1884, pl. 2, figs 9a, b, has a similar tooth but is more elongate.

***Pyrgo* species B**

(Pl. 9, figs 8, 9)

DESCRIPTION. Test compressed and carinate, ovate to subquadrate in outline with marked triangular caudal projection; chambers arranged in an embracing biloculine series the final one clasping the penultimate all round with a broad bevelled edge (caudal projection rising from this bevel) and considerably larger; suture not marked; wall imperforate, porcelaneous, smooth; aperture terminal, an elongate slit with narrow lip and broad low tooth on the inner margin.

DIMENSIONS. Length 0·41 mm, width 0·28 mm, thickness approx. 0·16 mm.

MATERIAL. One specimen only.

DEPOSITORY. B.M.(N.H.) Stub 1970 : 11 : 26 : 689.

PROVENANCE. Brit. Mus. Core 16.

REMARKS. This striking little species appears to have no counterpart in the literature with a similar caudal appendage. In general chamber form it resembles *P. carinata* but with more inflated and neatly demarcated penultimate chamber.

Genus ***QUINQUELOCULINA*** d'Orbigny, 1826

***Quinqueloculina aspera*** d'Orbigny

(Pl. 7, figs 1-3; Pl. 8, fig. 2; Pl. 31, figs 1-5; Text-fig. 15, nos 1-4)

*Quinqueloculina aspera* d'Orbigny, 1826 : 301, type figures in Parker, Jones & Brady, 1871 : pl. 8, fig. 11, also Fornasini, 1905 : 9, pl. 3, fig. 1; Le Calvez & Le Calvez, 1958 : 168, pl. 9, figs 101, 102.

*Miliola (Quinqueloculina) agglutinans* Parker & Jones, 1865 : 410, pl. 15, figs 37a, 37b; Goës, 1894 : 110, pl. 19, fig. 848, not pl. 20, fig. 849 (not *Q. agglutinans* d'Orbigny).

*Miliolina sclerotica* Balkwill & Millett, 1884 : 24, pl. 1, fig. 2 (not Karrer).

*Quinqueloculina agglutinata* Cushman, 1948 : 33, pl. 3, fig. 13; Loeblich & Tappan, 1953 : 39, pl. 5, figs 1-4; Feyling-Hanssen, 1964 : 247, pl. 4, fig. 11 (? *Q. agglutinata* Cushman, 1917).

DIAGNOSIS. A species of *Quinqueloculina* with rather well sorted silt grains built into the wall, round to subquadrate chambers and truncate aperture with prominent, rounded lip and short tooth with widespread tines.

DESCRIPTION. (Pl. 7, figs 2, 3.) Test elongate-ovate, subtrigonal in section, truncate at the apex; chambers arranged in a quinqueloculine spiral, five visible

at the exterior, increasing slowly in size as added, subround in section; sutures distinct and impressed; wall of agglutinated silt grains about 10 microns in diameter, with occasional larger ones, apparently organically cemented to an inner calcareous layer; aperture large, almost equal to the chamber diameter, truncating the apex with marked, rounded lip, tooth at inner border with thin stem and flat tines.

**DIMENSIONS.** Length 0.71 mm, maximum width 0.43 mm, thickness 0.31 mm.

**MATERIAL.** More than 25 specimens.

**VARIATION.** The chief variation is towards flattening at the periphery with the production of subquadrate chamber shapes, the angles, however, remaining rounded, as shown in Text-fig. nos 1-4. Some specimens also show a tendency to irregular coiling (Pl. 7, fig. 1) with the final chamber wrapping over the apex, or sometimes not reaching it. Specimens occur up to 1 mm in size.

**DEPOSITORY.** B.M.(N.H.) Slide 1970 : II : 26 : 76-79. Stub 1970 : II : 26 : 754. Section 1970 : II : 26 : 470.

**PROVENANCE.** Specimen described and irregular specimen shown by stereoscanner photograph, CB 8. Specimen illustrated by text figures, CB 651.

**REMARKS.** Jean & Yolande Le Calvez (1958) after examination of type material were able to re-illustrate *Q. aspera* and to show that N. Atlantic references to *Q. agglutinata* Cushman, at least, are synonymous. Cushman's type from off Alaska appears to be different with very broad, angled chambers and rather small aperture.

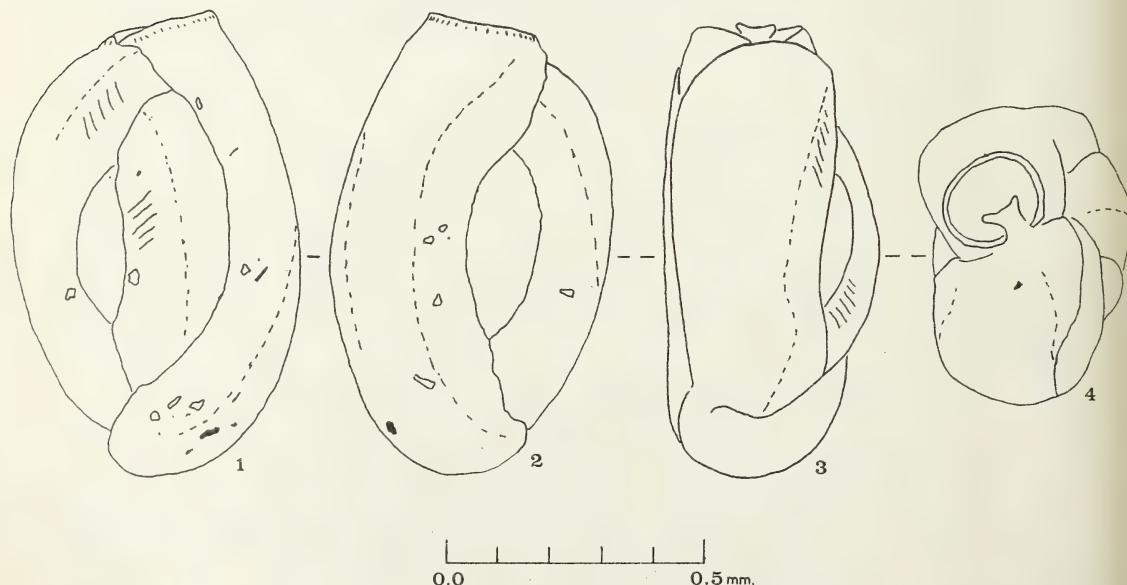


FIG. 15, 1-4. *Quinqueloculina aspera*, variety with subquadrate chambers. 1, frontal view showing four chambers; 2, rear view; 3, edge view; 4, apertural view.

In this connection it is of interest that Balkwill & Wright (1885) illustrated a similar form, as *Miliolina ferussacii* d'Orb. sp. var. from off the Dublin coast, but with sharp angles to the chambers. Our material from Cardigan Bay shows both rounded and sub-quadrata specimens (as illustrated) that fit well with *Q. aspera* as redefined. *Miliola (Quinqueloculina) agglutinans* of Parker & Jones and of Goës belong here also, as does *Milionina sclerotica* sensu Balkwill & Millett, a sub-quadrangular form. It should also be noted that Loeblich and Tappan illustrate a number of irregular specimens like those that occur in the Cardigan Bay material.

A close-up of the remarkable, round aperture is shown in Pl. 8, fig. 2. The lip is not always quite complete at the inner border and may appear as in Text-fig. no. 4. The stereoscanner photo also shows the character of the wall, with its rather well sorted silt grains, apparently with small irregular openings between. The thought that these might be pores is checked by the observation that the aperture is filled by material of the same size as that in the wall with the same small openings (unless the aperture was filled at the same time the wall was coated).

**DISTRIBUTION.** This species was first described from the Mediterranean and is confirmed in the Bay of Villefranche (Le Calvez & Le Calvez, 1958).

Records for the North Sea area include: Baltic and Norwegian coast (Goës, 1894); ? Zuidersee (Hofker, 1922); Late Pleistocene and Holocene of Norway (Feyling-Hanssen, 1964).

North Atlantic: West coast of Ireland (Balkwill & Millett, 1884); Spitzbergen (Feyling-Hanssen, 1964; Goës, 1894); Greenland and Canadian Arctic (Cushman, 1948; Loeblich & Tappan, 1953; Parker & Jones, 1865).

These records show a temperate to cold water distribution with an apparent concentration in the Arctic.

### *Quinqueloculina auberiana* d'Orbigny var. A

(Pl. 7, fig. 15; Text-fig. 17, no. 5)

**DIAGNOSIS.** A variety of *Quinqueloculina auberiana* with final chambers sub-angular to subround rather than carinate and tending to be finely striate.

**DESCRIPTION.** Test irregularly heart-shaped in outline not much longer than wide, base protruding, apex truncate, sub-quadrangular in section; chambers arranged in a moderately embracing quinqueloculine series, increasing moderately in size as added and becoming sub-angular in shape, wrapping round markedly at the base; sutures slightly impressed; wall imperforate porcelaneous, covered with fine, anastomosing striae; aperture terminal, truncated, shield shaped with a slight lip and elongate, flat ended, wedge shaped (spatulate) tooth on the straight inner border.

**DIMENSIONS.** Length 0.53 mm, maximum width 0.47 mm.

**MATERIAL.** Eight specimens including juveniles.

DEPOSITORY. B.M.(N.H.) Slide 1970 : II : 26 : 80-83. Stub 1970 : II : 26 : 696.

PROVENANCE. Specimen described, CB 429.

REMARKS. Our material is close to *Q. auberiana* as defined by d'Orbigny in size, general shape and apertural characters but the later chambers become sub-rounded rather than sharply angled or carinate. It is doubtful how important the external striation is taxonomically because although emphasized by the stereoscanner photograph this feature is only shown slightly by some of our specimens as viewed by light microscope. Brady (1884) placed a very large specimen with similar striae in *Q. auberiana* but it had sharply angled chambers. Incidentally, *Q. auberiana* has been much confused in the literature with its close relatives *Q. lamarckiana*, *Q. vulgaris*, and *Q. cuvieriana*. According to the original figures and diagnoses of d'Orbigny *Q. lamarckiana* has produced aperture and simple tooth (*Q. vulgaris* sensu Norvang, 1945; Cushman, 1948); *Q. vulgaris* has slender bifid tooth and produced keels (*Q. vulgaris* sensu Colom, 1952 = *Q. auberiana*); *Q. cuvieriana* has costations parallel to the keels (*Q. cuvieriana* (Brady) = *Q. auberiana*). Excellent figures of the Mediterranean species *Q. vulgaris* are given by Le Calvez & Le Calvez (1958).

### *Quinqueloculina auberiana* d'Orbigny var. B

(Pl. 7, figs 6 and 7)

DIAGNOSIS. A variety of *Q. auberiana* with final chambers subround rather than carinate and with spoon-shaped tooth.

DESCRIPTION. Test irregularly heart-shaped in outline, not much wider than high, with obtusely pointed base and truncate apex, subtrigonal in section; chambers arranged in a moderately embracing, alternating quinqueloculine spiral, increasing moderately in size as added and becoming subround at the periphery; sutures slightly impressed; wall imperforate porcelaneous, smooth; aperture terminal, truncating the apex, shield-shaped with a thin lip and with a spoon-shaped, (hollowed out) tooth at the straight inner border.

DIMENSIONS. Maximum length 0.64 mm, width 0.54 mm.

MATERIAL. One adult specimen, possibly two juveniles.

DEPOSITORY. B.M.(N.H.) Stub 1970 : II : 26 : 689.

PROVENANCE. Specimen described, CB 736.

REMARKS. The propriety of including this variety within *Q. auberiana* is doubtful as it falls outside that species as strictly defined. However, the shape and proportions are much the same although the later chambers become subrounded. The tooth is strikingly different. As there is only one definite adult specimen it is grouped with *Q. auberiana* for the time being.

*Quinqueloculina bicornis* (Walker & Jacob) emend

(Pl. 7, fig. 18; Text-fig. 16, nos 1-3)

'*Serpula bicornis ventricosa*' Walker & Boys, 1784 : 1, pl. 1, fig. 2.*Serpula bicornis* Walker & Jacob, 1798 : 633, pl. 14, fig. 2.*Miliolina bicornis* (Walker & Jacob) Brady, 1884 : 171, pl. 6, fig. 9 only.*Quinqueloculina bicornis* (Walker & Jacob) Terquem, 1875 : 443, pl. 6, fig. 6; Cushman, 1929 : 32, pl. 5, figs 1 and 2 only; Le Calvez & Le Calvez, 1958 : 180, pl. 4, figs 28 and 32; Le Calvez, 1958 : 157, pl. 1, figs 8, 9; Feyling-Hanssen, 1964 : 248, pl. 5, figs 1, 2.

**DIAGNOSIS.** A globose species of *Quinqueloculina*, oval in outline and finely incised with longitudinal grooves. Aperture rectangular with long, narrow, simple tooth.

**DESCRIPTION.** (Neotype, Pl. 7, fig. 18; Text-fig. no. 2.) Test globose, oval in outline, not much longer than wide and almost circular, periphery broadly rounded, subtrigonal in section; chambers arranged in a slightly embracing, alternating, quinqueloculine series, five visible, inflated with rounded periphery (sides showing slight flattening but outline in apertural view rounded) increasing slowly in size as added; sutures distinct, impressed; wall stoutly built, imperforate porcelaneous; aperture terminal, pinched rectangular (key-hole shaped), rounded and protruding in side view with thin bordering lip and straight inner border from which arises a long, thin, bar-like tooth; ornament of longitudinal grooves with intervening areas slightly raised as broad costae (about 20 microns wide).

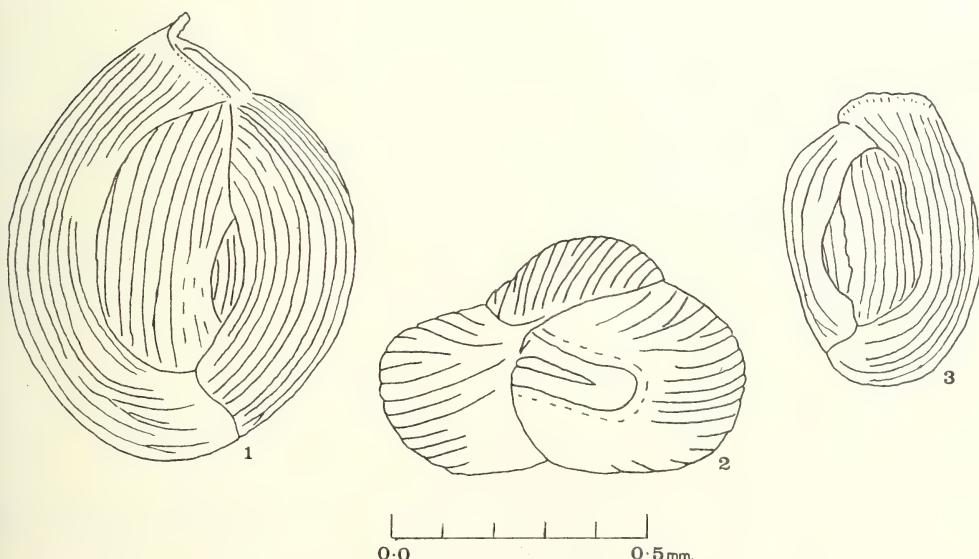


FIG. 16, 1-3. *Quinqueloculina bicornis*. 1, front view of large almost circular specimen (last chamber broken off); 2, apertural view of neotype (N.B.  $\frac{1}{2}$  scale); 3, front view of slightly irregular, rather quadrangular, juvenile.

DIMENSIONS. Length 0·67 mm, width 0·53 mm, maximum thickness about 0·40 mm.

MATERIAL. More than 25 specimens.

VARIATION. As shown by the text-figures well grown specimens reach up to about a millimetre in length and become almost circular in outline. Juveniles and young specimens are more elongate and rectangular.

DEPOSITORY. B.M.(N.H.) Slide 1970 : II : 26 : 84 (neoholotype), 1970 : II : 26 : 85-90 (neoparatypes), Stub 1970 : II : 26 : 693 (neoparatype).

PROVENANCE. Neotype and other specimens figured, CB 15.

REMARKS. No trace can be found of the type specimen and the type figure shows only the milioline juvenarium and the first chamber of the following quinqueloculine series. This unsatisfactory situation has led to confusion especially as to the limits to be set between *Q. bicornis* and *Q. angulata* (Williamson). We follow Le Calvez and Le Calvez in basing the concept of *Q. bicornis* on Brady (1884, pl. 5, fig. 9) and have selected as neotype a Cardigan Bay specimen that corresponds closely with his N. Atlantic specimens. *Q. angulata* is distinguished by its elongate outline and quadrangular chambers becoming smooth and bicariniate in extreme cases. It was well figured as *Miliolina ferussacii* by Heron-Allen & Earland from the West of Scotland (1916a) but re-identified as Williamson's species in the Plymouth monograph (1930). The specimens identified as *Miliolina bicornis* typica by Williamson, 1858, are intermediate in character between *Q. bicornis* and *Q. angulata* and should probably be separately distinguished, together with similar specimens identified as *Q. bicornis* by Flint (1899) and Cushman (1949).

DISTRIBUTION. North Atlantic records include: off Skye, Scotland, Porcupine Station AA (Brady, 1884); S.W. of Ireland (Cushman, 1929); Celtic Sea (Le Calvez, 1958); Scillies (Atkinson, 1970); Western Approaches (Le Calvez & Boillot, 1967; Murray, 1970).

English Channel: N. France, shore sands, Dunkirk (Terquem, 1875); off Plymouth (Heron-Allen & Earland, 1930).

Mediterranean: Bay of Villefranche (Le Calvez & Le Calvez, 1958); Majorca (Mateu, 1968).

This species has also been recorded from the Holocene of Oslofjord (Feyling-Hanssen, 1964).

### *Quinqueloculina* cf. *cliarensis* Heron-Allen & Earland, 1930

(Pl. 7, figs 8, 9; Text-fig. 17, nos 1-4)

*Quinqueloculina cliarensis* Cushman, 1949 : 9, pl. 1, figs 10a-c; ? Le Calvez & Le Calvez, 1958 : 186, pl. 5, figs 40, 41; ? Le Calvez, 1958 : 157, pl. 1, figs 10, 11 (figure after Le Calvez & Le Calvez, 1958) (not Heron-Allen & Earland).

DESCRIPTION. (Text-fig. nos 1-3.) Test compressed, elongate with produced tubular apex, periphery angular; chambers arranged in a slightly embracing, alter-

nating quinqueloculine series, increasing moderately in size as added, flattened with angular periphery but rounded towards the apex, four visible in front, two at the rear; sutures slightly impressed; wall stoutly built, imperforate porcelaneous, smooth; aperture terminal at the end of a tubular neck, round with short, wedge-shaped tooth with flat end.

**DIMENSIONS.** Length 0·81 mm, width 0·30 mm, thickness approx. 0·18 mm.

**MATERIAL.** Five specimens.

**VARIATION.** The specimen illustrated by stereoscanner photo is broader than the one described and like the other specimens recovered shows a third chamber peeping through on the reverse side, as in the small specimen figured (Text-fig. no. 4).

**DEPOSITORY.** B.M.(N.H.) Slide 1970 : II : 26 : 91-92. Stub 1970 : II : 26 : 698.

**PROVENANCE.** Specimen described, CB 21, additional small specimen figured, CB 527, specimen illustrated by stereoscanner, CB 332.

**REMARKS.** As originally defined (Heron-Allen & Earland, 1930) on the basis of specimens from both Clare Island (1913b) and the West of Scotland (1916a) *Q. clairensis* includes small specimens, up to 0·45 mm in length with compressed necks and the aperture 'a straight edged slit with tooth'. Our specimens are much larger, up to 0·81 mm in length with tubular neck, round aperture and short tooth. They are clearly different from the Clare Island material and also from the West of Scotland specimens described (1930) as 'a well marked variety characterized by the acute edges of the chambers and by sunken sutures'. On the other hand they are close to the specimens referred to *Q. clairensis* by Cushman from the Belgian coast (1949), both in size and apertural characters. The specimens of Le Calvez and Le Calvez (Bay of Villefranche) may also be the same as ours as their figured specimen is

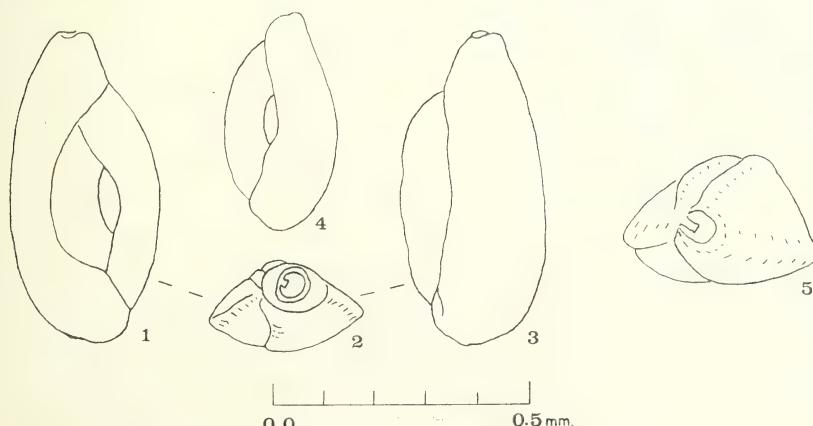


FIG. 17. 1-4. *Quinqueloculina* cf. *clairensis*. 1, front view specimen described; 2, apertural view; 3, rear view; 4, rear view of juvenile. 5. *Quinqueloculina auberiana* var. A, apertural view.

1·0 mm in length, though, unfortunately, the aperture is not illustrated. According to Le Calvez and Le Calvez their specimen is identical to the holotype of *Quinqueloculina lyra* d'Orbigny, 1826. Unhappily, this species has been interpreted on the basis of modèle no. 8 (Parker, Jones & Brady, 1865) which Le Calvez and Le Calvez say is different. So presumably this name is not available for our material even if it is the same as the specimens from Villefranche.

DISTRIBUTION. Possibly widespread in the English Channel and the Celtic Sea as well as the Mediterranean.

*Quinqueloculina* cf. *cliarensis* var. A

(Pl. 9, fig. 5)

DESCRIPTION. Test compressed, elongate with produced tubular apex, periphery rounded; chambers arranged in a slightly embracing, alternating quinqueloculine series, increasing moderately in size as added, with a slight sigmoid twist, three visible on each side; sutures distinct, impressed; wall imperforate, porcelaneous with very faint longitudinal grooves; aperture terminal, round with smooth lip and short tooth with long, wide angled tines (almost at 180°).

DIMENSIONS. Length 0·88 mm, width 0·38 mm.

MATERIAL. Three specimens.

DEPOSITORY. B.M.(N.H.) Slide 1970 : 11 : 26 : 93. Stub 1970 : 11 : 26 : 723.

PROVENANCE. Specimen described, CB 354.

REMARKS. This is a variety of *Q. cf. cliarensis* differing in its rounded periphery and tooth structure, possibly also in its faint striae, revealed by the stereoscanner. In side view it resembles *Triloculina dubia* but differs in that it also shows three chambers on the reverse side.

*Quinqueloculina* cf. *duthiersi* (Schlumberger), 1886

(Pl. 7, figs 22, 23)

DESCRIPTION. Test elongate-ovate with pointed, projecting base and produced apex, angular in section with strong, slightly flattened keels separated by broad sulci; chambers arranged in a slightly embracing, alternating quinqueloculine spiral, increasing moderately in size as added; sutures indistinct, slightly impressed; wall stoutly built, imperforate porcelaneous; aperture produced, round, lip truncate, tooth apparently short and rounded at the inner border; the final chambers show three complete keels and fine longitudinal striae which are most evident in the sulci but are also apparent on the keels.

DIMENSIONS. Length 1.80 mm, width 1.10 mm, maximum thickness about 0.60 mm.

MATERIAL. One specimen only.

DEPOSITORY. B.M.(N.H.) Stub 1970 : 11 : 26 : 699.

PROVENANCE. CB 332.

REMARKS. Our specimen resembles *Q. duthiersi* (Schlumberger) in shape and ornament but the keels are stronger and flatter than in the types and in the specimens of Brady (1884, pl. 6, figs 13, 14) cited by Schlumberger. The character of the fine ornament which occurs on the keels and the aperture with its short tooth are the same. *Q. granulocostata* Germaraad, (type figures Brady 1884, pl. 6, figs 15-20) has up to six, sharp keels on the final chambers and the sulci are granulate not striate and the tooth long, thin and bifid.

### *Quinqueloculina intricata* Terquem

(Pl. 7, figs 16, 17)

*Quinqueloculina intricata* Terquem, 1878 : 73, pl. 8, figs 16-21; Le Calvez & Le Calvez, 1958: 176, pl. 5, figs 38 and 39; Barker, 1960 : pl. 6, figs 11, 12 (after Brady).

*Quinqueloculina bicornis* Brady part, 1884 : 171, pl. 6, figs 11 and 12 only (not *Serpula bicornis* Walker & Jacob).

*Quinqueloculina semilunaris* Terquem, 1880 : 58, pl. 17, figs 14a-c.

DIAGNOSIS. An elongate-ovate species of *Quinqueloculina* with well developed longitudinal costae. Early chambers with single keel, later chambers rounded to sub-angular, sometimes with one or two keels. Very large, well developed specimens becoming irregular.

DESCRIPTION. (Pl. 7, fig. 16.) Test elongate-ovate with rounded base and produced apex, section sub-trigonal; chambers arranged in a slightly embracing quinqueloculine spiral, increasing moderately in size as added, wrapping round at the base and tapering to the aperture, keeled at first, final chamber sub-round; wall imperforate procelaneous with fine longitudinal costae, parallel to the periphery; aperture terminal, at the end of a tubular neck, round with thin lip and short, wedge-shaped tooth at inner margin.

DIMENSIONS. Length 1.0 mm, maximum width 0.50 mm.

MATERIAL. Nineteen specimens.

VARIATION. The material includes all growth forms down to juveniles that consist of retort-like juvenarium only or with only the first chamber of the quinqueloculine series following it, as illustrated (Pl. 7, fig. 17). Juveniles with small juvenarium may show one or two smooth early chambers. One or two keels may be shown by adult chambers or a subangular to subround periphery, as in the specimen described. This species is probably part of a morphological series that leads by increase in number and strength of the keels through *Q. colomi* to *Q. duthiersi* and by adoption of bicarinate, quadrangular chambers to *Q. mediterranensis*.

DEPOSITORY. B.M.(N.H.) Slide 1970 : II : 26 : 94-100. Stub 1970 : II : 26 : 694-695.

PROVENANCE. Specimen described and additional specimen illustrated, CB 13.

REMARKS. Our material is close to that from the Porcupine Station AA figured by Brady (1884) as *M. bicornis*. Brady's specimens were considered to belong to *Q. intricata* by Thalmann (1932) and this view is supported by Le Calvez & Le Calvez (1958) after examination of Terquem's type material. We therefore identify our material as *Q. intricata* also, although the type figures show more irregularity of form.

Juveniles in our material closely resemble *Q. semilunaris* Terquem described from Dunkirk shore sands so this name is put in synonymy.

DISTRIBUTION. This species was first described from the Pliocene of the Island of Rhodes. Additional records for the Mediterranean are: Bay of Villefranche (Le Calvez & Le Calvez, 1958); Adriatic (Wiesner, 1923).

North Atlantic: Off Skye, Scotland (Brady, 1884).

### *Quinqueloculina lata* Terquem

(Pl. 7, figs 10-13)

*Quinqueloculina lata* Terquem, 1876 : 82; 1877 : 173, pl. II, figs 8a, b; Cushman, 1949 : 10  
pl. 2, fig. 1; Le Calvez, 1958 : 158, pl. 2, figs 26, 27, 28.

*Miliolina oblonga* var. *lata* (Terquem) Heron-Allen & Earland, 1930 : 55, pl. 2, figs 12-15.

DIAGNOSIS. An elongate-ovate to oblong species of *Quinqueloculina* about twice as long as wide, oval in outline with keyhole-shaped aperture and simple, spatulate tooth.

DESCRIPTION. (Pl. 7, figs 12, 13.) Test elongate-oblong in outline with broadly rounded base and truncate apex, sides sub-parallel, periphery broadly rounded, section oval; chambers arranged in an embracing, quinqueloculine spiral, wrapping round markedly at the base, slightly twisted about the axis of growth, increasing gradually in size as added; sutures distinct, impressed; wall imperforate porcelaneous, smooth and vitreous; aperture sub-rectangular (keyhole-shaped with pinched sides and straight inner border) with thin bordering lip and simple bar-like tooth that appears spatulate in end view and rounded in side view being clearly visible protruding beyond the lips.

DIMENSIONS. Length 0.95 mm, width 0.40 mm.

MATERIAL. More than 25 specimens.

VARIATION. A small, translucent, thin walled form occurs abundantly on the Dovey Marshes. These are considered juveniles (Pl. 7, figs 10, 11).

DEPOSITORY. B.M.(N.H.) Slides 1970 : II : 26 : 101-102, 1970 : II : 26 : 103-112. Stubs 1970 : II : 26 : 700, 704, 1970 : II : 26 : 756.

PROVENANCE. Specimen described, Holocene Grey Sands, Borehole 2, Sample D16, Borth. Juvenile, Clettwr Transect, Station VII, Dovey Marshes.

**REMARKS.** Our specimens appear to fit well with the types although the aperture is elongate rather than simply rounded as stated in Terquem's description; size is the same. The specimens figured by Heron-Allen and Earland and Le Calvez are very close to our material but references to this species from the Western Atlantic appear to be in error (Cushman, 1944; Todd & Low, 1961).

**DISTRIBUTION.** This species was first described from shore sands at Dunkirk, France and other well founded references are apparently restricted to this general area: Belgian coast (Cushman, 1949); off Plymouth (Heron-Allen & Earland, 1930); Celtic Sea (Le Calvez, 1958). It also occurs abundantly in Goldseeker samples from the Moray Firth, Scotland.

### *Quinqueloculina mediterranensis* Le Calvez & Le Calvez

(Pl. 7, figs 4, 5; Pl. 8, fig. 1)

*Quinqueloculina mediterranensis* Le Calvez & Le Calvez, 1958 : 177, pl. 4, figs 29-31.  
*Miliolina bicornis* Sidebottom, 1904 : 14, pl. 4, figs 13, 14 (not Walker & Jacob).

**DIAGNOSIS.** A species of *Quinqueloculina* with quadrangular, bicarinate chambers increasing rapidly in size as added with regular costae parallel to the periphery.

**DESCRIPTION.** Test elongate-ovate in outline with projecting base and produced apex, subquadrangular in section, bicarinate, not quite twice as long as wide; chambers arranged in an alternating, slightly embracing quinqueloculine spiral, five visible, subquadrate with flattened periphery in the adult part, the outer edges developed as strong keels, increasing rapidly in size and overlapping markedly at either end of the test as added, final chamber much expanded in thickness towards the periphery; sutures distinct, slightly impressed; wall stoutly built, imperforate porcelaneous with strong costae running the length of the chambers parallel to the periphery; aperture terminal, subquadrate in shape at the end of a slightly tapering neck with a short, flat, wedge-shaped tooth structure at the inner margin and slight, rounded lip.

**DIMENSIONS.** Length 0·96 mm, width 0·57 mm, maximum thickness about 0·40 mm.

**MATERIAL.** Nine specimens.

**VARIATION.** The bicarinate condition appears to be attained by the third or fourth quinqueloculine chamber, earlier ones being acute. One specimen slightly longer than 1 mm was recovered.

**DEPOSITORY.** B.M.(N.H.) Slide 1970 : 11 : 26 : 113-114. Stub 1970 : 11 : 26 : 692.

**PROVENANCE.** Specimen described, CB 551.

**REMARKS.** This robust species, characteristically expanded at the periphery, can be distinguished from the related, Pacific form *Q. angulostriata* Cushman & Valentine (1930) by its wider, thicker chambers and greater rate of size increase. It

was first figured as *Miliolina bicornis* by Sidebottom. Our specimens are slightly smaller than the type which is 1·6 mm long and 0·9 mm wide, but show the same proportions. It is possible that the specimen figured as *M. bicornis* by Brady (1884, pl. 5, figs 11a, b) belongs here.

DISTRIBUTION. Described from the Mediterranean, Bay of Villefranche at 10 to 100 metres. Another record is the Isle of Delos (Sidebottom, 1904).

*Quinqueloculina* cf. *rugosa* d'Orbigny, 1826

(Pl. 7, figs 20, 21)

DESCRIPTION. Test elongate-ovate with slightly produced apex, compressed, periphery flattened; chambers arranged in a slightly embracing, alternating quinqueloculine series, four visible in the front, three at the rear, increasing moderately in size as added, wrapping round markedly at the base, final chamber quadrate and slightly keeled at the angles of its exterior margin; sutures distinct, impressed; wall rough and pitted, imperforate porcelaneous; aperture oval with depressed outer margin, narrow lip and long, wedge-shaped tooth arising from the inner margin.

DIMENSIONS. Length 0·52 mm, width 0·25 mm.

MATERIAL. One specimen only.

DEPOSITORY. B.M.(N.H.) Stub 1970 : 11 : 26 : 702.

PROVENANCE. CB 167, Dovey Estuary (main channel at Aberdovey).

REMARKS. Our specimen bears considerable resemblance to *Q. rugosa* d'Orbigny, 1826, which, as figured by Fornasini (1905) shows quadrate, bicarinata chambers and pitted wall. Specimens referred to *Q. rugosa* by Le Calvez & Le Calvez (1958) are much larger with flattened rather than bicarinata chambers and short, rounded tooth.

*Quinqueloculina seminulum* (Linnaeus)

(Pl. 7, figs 14, 19; Pl. 8, fig. 3; Pl. 32, figs 1-3; Text-fig. 18, nos 1-4)

*Serpula seminulum* Linnaeus, 1767 : 1264.

*Quinqueloculina seminulum* (Linnaeus) d'Orbigny, 1826 : 303; Cushman, 1929 : 24, pl. 2, figs 2a-c only; 1944 : 13, pl. 2, fig. 14; 1948 : 34, pl. 3, figs 14, 15; 1949 : 8, pl. 1, fig. 7; Parker, 1952a : 406, pl. 3, figs 21a, b, 22a, b; pl. 4, figs 1, 2; 1952b : 456, pl. 2, figs 7a, b; Haake, 1962 : 31, pl. 1, figs 13, 14; Feyling-Hanssen, 1964 : 252, pl. 6, fig. 1; Lutze, 1965 : 94, pl. 15, figs 34, 35.

*Miliolina seminulum* (Linnaeus) ? Williamson, 1858 : 85, pl. 7, figs 183-185; Brady, 1884 : 157, pl. 5, figs 6a-c.

DIAGNOSIS. An ovate species of *Quinqueloculina* about one and a half times as long as wide, subtriangular in section, with small aperture and thin, bar-like tooth with incipiently bifid margin.

**DESCRIPTION.** (Text-fig. nos 1-3.) Test ovate, regularly egg-shaped, a little less than one and a half times as long as wide, apex truncated, subtrigonal in section; chambers arranged in a moderately embracing, alternating quinqueloculine spiral, inflated, increasing slowly in size with subrounded periphery tapering to the aperture, four visible at the front, three at the rear, where the fourth chamber (third from last) just peeps through in the centre; sutures indistinct, only slightly impressed; wall smooth, vitreous, imperforate porcelaneous; aperture terminal, oval with broad margin and thin lip, tooth a thin, bar-like structure with very short, bifid free margin, rounded summit protruding through and clearly seen in side view.

**DIMENSIONS.** Length 0.70 mm, maximum width 0.50 mm, thickness 0.36 mm.

**MATERIAL.** More than 25 specimens.

**VARIATION.** More elongate forms occur showing the trend to *Q. lata*.

**DEPOSITORY.** B.M.(N.H.) Slide 1970 : II : 26 : 115-117. Stubs 1970 : II : 26 : 516, 1970 : II : 26 : 701, 703, 1970 : II : 26 : 755. Slides 1970 : II : 26 : 471, 1970 : II : 26 : 472.

**PROVENANCE.** Specimen described and others figured and photographed, CB 8.

**REMARKS.** This gibbous, vitreous form with its smoothly embracing chambers proved a difficult subject for the stereoscaner which failed to pick out the sutures of specimens presented in side view. Details of the aperture with its exquisite tooth structure are, on the other hand, very well shown (Pl. 8, fig. 3).

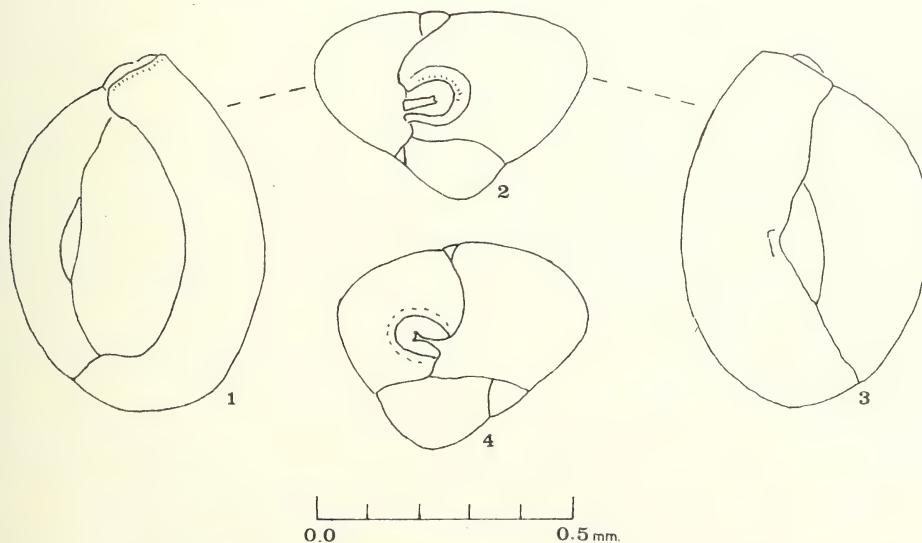


FIG. 18, 1-3. *Quinqueloculina seminulum*, specimen described. 1, front view; 2, apertural view; 3, rear view; 4, apertural view of rounder specimen.

There is apparently continuous variation from this species through to *Q. lata* which is oblong in outline and oval in section and in the other direction to *Q. dunkerquiana* which is short with angled chambers. Failure to distinguish between these forms has led to considerable confusion in the literature.

Williamson's reference to *Miolina* is quoted in synonymy as this appears to be the first reference to that genus but his figure appears to show a specimen nearer *Massilina secans* (copied by Cushman in the Atlantic Monograph, 1929). Young specimens of *M. secans* can be distinguished from *Q. seminulum* by their angular chambers.

**DISTRIBUTION.** Records give a cosmopolitan distribution, to a large extent because authors have used the name as a dustbin and catch-all for ovate quinqueloculines from the Lias upwards. We restrict ourselves to Atlantic records which agree with the species concept put forward here: North Sea, Langeoog (Haake, 1962); Baltic, Ostsee (Lutze, 1965); Holocene of Oslofjord (Feyling-Hanssen, 1964); Belgian coast (Cushman, 1949).

Eastern Atlantic: off Skye, Scotland (Porcupine Station AA, Brady, 1884); S.W. of Ireland (Cushman, 1929); Western Approaches (Murray, 1970).

Western Atlantic: New England (Cushman, 1944); off New Hampshire (Parker, 1952a); Long Island—Buzzard's Bay (Parker, 1952b).

Arctic: Hudson Bay, Davis' Straits (Cushman, 1948).

### Genus ***SCUTULORIS*** Loeblich & Tappan, 1953

#### *Scutuloris* species A

(Pl. 9, fig. 14)

**DESCRIPTION.** Test oblong-ovate, ovate in transverse section, sub-globose; chambers arranged in a quinqueloculine series, inflated and increasing moderately in size as added, four visible one side and another one between the two final ones on the other side, added slightly obliquely to the perpendicular axis; sutures distinct, impressed; wall thick, porcelaneous, imperforate, smooth; aperture large, formed by the open end of the chamber, with a narrow lip and a broad lunate flap rising from the interior margin, flap protruding slightly in side view.

**DIMENSIONS.** Maximum length 0·46 mm, width 0·27 mm, thickness 0·25 mm.

**MATERIAL.** Two specimens.

**DEPOSITORY.** B.M.(N.H.) 1970 : 11 : 26 : 655.

**PROVENANCE.** Specimen described, CB 491.

**REMARKS.** Our specimens are smaller, more elongate-ovate and less compressed in section than *S. tegminis* Loeblich & Tappan. Apart from chamber arrangement they closely resemble *Miliolinella chuckchiensis* Loeblich & Tappan and being much smaller they could conceivably be juveniles of that species. In that case

they might be expected to show initial quinqueloculine arrangement. However, as this cannot at present be proven, following strict lines of classification we place these specimens in *Scutuloris*.

Genus ***SIGMOILOPSIS*** Finlay, 1947

***Sigmoilopsis moyi*** Atkinson emend

(Pl. 4, figs 1-8; Pl. 8, figs 5 and 7)

*Sigmoilopsis moyi* Atkinson, 1968 : 161, pl. 18, figs 3a-d.

*Sigmoilopsis schlumbergeri* Atkinson, 1968 : 160, pl. 18, figs 1a-c (not *Sigmoilina schlumbergeri* Silvestri).

*Sigmoilopsis wanganuiensis* Atkinson, 1968 : 161, pl. 18, figs 2a-c (not Vella).

*Sigmoilopsis woodi* Atkinson, 1968 : 161, pl. 18, figs 4a-d.

*Miliolina agglutinans* Balkwill & Wright, 1885 : 325, pl. 13, figs 1-3 (not d'Orbigny).

**DIAGNOSIS.** A small, coarsely agglutinated species of *Sigmoilopsis*, oval to subcircular in outline with subround to angular chambers and aperture with short neck, marked lip and short, broadly bifid tooth.

**DESCRIPTION.** (Pl. 4, figs 1, 2; Pl. 8, figs 5, 7.) Test ovate in outline, subtriangular in section, apex only slightly produced; chambers arranged in a sigmoid, milioline spiral, increasing slowly in size, last chamber not projecting beyond the others at the base; sutures very indistinct; wall roughly agglutinated of angular silt grains up to about 80 microns in diameter and including dark minerals; scattered angular 'pores' up to 5 microns in diameter; aperture terminal, at the end of a short neck, oval with rounded lip and broad, bifid tooth at the inner margin.

**DIMENSIONS.** Length 0.56 mm, maximum width 0.40 mm.

**MATERIAL.** Eleven specimens.

**VARIATION.** As shown by the illustrations the chambers vary from subrounded to angular and the test section from compressed oval to subtriangular.

**DEPOSITORY.** B.M.(N.H.) Stub 1970 : 11 : 26 : 710-713.

**PROVENANCE.** Specimen described CB 421. Other specimens figured as *S. moyi*, CB 502, as *S. wanganuiensis*, CB 513, as *S. schlumbergeri*, CB 740.

**REMARKS.** This species shows considerable variation in chamber shape and outline. This led Atkinson (1968) to attempt to distinguish the main kinds as species, two as new, *S. moyi* and *S. woodi* and two ascribed to *S. schlumbergeri* and *S. wanganuiensis*. We now group these all together under *S. moyi* (holotype in British Museum collections). The specimen described is a paratype of '*S. woodi*', chosen because it shows the apertural characters better than the paratype of *S. moyi* in our collections.

The species appears to be most closely related to *S. wanganuiensis* but differs in its more oval outline, tendency to angular chambers and in its apertural characters.

These morphological features would also appear to preclude the possibility that this small form is the juvenile of the much larger, more elongate *S. schlumbergeri*.

Genus ***SPIROLOCULINA*** d'Orbigny, 1826

***Spiroloculina depressa*** d'Orbigny

(Pl. 9, figs 6, 7)

*Frumentaria sigma et rhombos* Soldani, 1795 : 229, pl. 155, fig. kk.

*Spiroloculina depressa* d'Orbigny, 1826 : 298, modèle 92; Parker & Jones, 1863 : 33, pl. 1, fig. 6;

Parker, Jones & Brady, 1871 : 248, pl. 8, fig. 23 (figure after Soldani); Fornasini, 1904 : 3, pl. 1, fig. 1; Cushman, 1929 : 44, pl. 9, figs 8 and 9 (8 after Brady); Colom, 1952 : 21, pl. 5, figs 16, 17; Loeblich & Tappan, 1964a : C453, fig. 343—1a, b.

*Spiroloculina limbata* Brady part, 1884 : 150, pl. 9, fig. 17 only (not d'Orbigny).

DIAGNOSIS. An elongate, eye-shaped species of *Spiroloculina* with flat, smoothly depressed sides and truncate periphery.

DESCRIPTION. (Pl. 9, figs 6, 7.) Test elongate, eye-shaped with greatest width towards midpoint and tapering to the ends, bi-umbilicate with flattened sides, periphery truncate with rounded corners; chambers arranged in a spiroloculine series throughout, eight following the proloculus, quadrangular in shape, increasing moderately in size as added, each whorl stepped slightly above the preceding one; sutures distinct, impressed; wall imperforate porcelaneous with very slight longitudinal grooving just apparent; aperture slightly produced, terminal, round, without a lip but with straight, peg-like tooth at the inner margin.

DIMENSIONS. Length 0.70 mm, width 0.42 mm, maximum thickness about 0.12 mm.

MATERIAL. Three specimens.

DEPOSITORY. B.M.(N.H.) Slide 1970 : 11 : 26 : 118-119. Stub 1970 : 11 : 26 : 719.

PROVENANCE. CB 428.

REMARKS. The specimen described is almost identical to d'Orbigny's model showing the characteristic truncate periphery and flattened sides without keels or raised chamber borders. It is also very close to the topotype from Castel Arquato figured by Loeblich and Tappan.

Specimens figured as *S. depressa* by Williamson (1858) and Terquem (1875) do not belong here but show close similarity to *S. limbata* d'Orbigny. On the other hand specimens included by Brady under *S. limbata* do belong here, in part.

DISTRIBUTION. Because this species has been confused with others, particularly *S. limbata*, listed records must be treated with reserve. It was first described from the Pliocene of Castel Arquato, Italy and from the Mediterranean Recent. Its Mediterranean occurrence is confirmed by the following records: Gulf of Marseilles (Schlumberger, 1893); Bay of Palma, Majorca (Colom, 1942); Bay of Naples (Hofker, 1932).

N.W. European records include: off Skye, Scotland (Brady, 1884); off Plymouth (Cushman, 1929; Murray, 1965a); Western Approaches (Murray, 1970); coast of Galicia (Colom, 1952).

Genus ***TRILOCULINA*** d'Orbigny, 1826

***Triloculina trigonula*** (Lamarck)

(Pl. 9, figs 1, 2; Pl. 32, fig. 5)

*Miliolites trigonula* Lamarck, 1804 : 351, pl. 17, fig. 4.

*Triloculina trigonula* (Lamarck) d'Orbigny, 1826 : 299, pl. 16, figs 5-9, modèle 93; Cushman, 1929 : 56, pl. 12, figs 10, 11; pl. 13, figs 1, 2; Le Calvez & Le Calvez, 1958 : 190, pl. 6, figs 49 and 50; Feyling-Hanssen, 1964 : 257, pl. 6, figs 11-13.

*Miliolina trigonula* (Lamarck) Williamson, 1858 : 84, pl. 7, figs 180-182; Brady, 1884 : 164, pl. 3, figs 15, 16; Goës, 1894 : 115, pl. 22, fig. 870; Flint, 1899 : 298, pl. 44, fig. 3.

DIAGNOSIS. A rotund species of *Triloculina* with depressed chambers having rounded sides.

DESCRIPTION. (Pl. 9, figs 1, 2.) Test oval in side view with rounded base and truncated apex, trigonal in section, lobate; chambers arranged in a moderately embracing, alternating, triloculine spiral, gradually increasing in size, depressed, becoming more flattened as added, much wider than high with rounded sides; sutures distinct, impressed; wall imperforate porcelaneous, smooth; aperture terminal with horseshoe-shaped lip and wedge-shaped tooth at interior border.

DIMENSIONS. Length 0·42 mm, width 0·30 mm.

MATERIAL. Fifteen specimens.

VARIATION. Some specimens show less flattened chambers and short, wide angled tines at the inner edge of the tooth.

DEPOSITORY. B.M.(N.H.) Section 1970 : 11 : 26 : 473. Stub 1970 : 11 : 26 : 725.

PROVENANCE. Specimen described, CB 13.

REMARKS. The cosmopolitan records for this species from the Eocene to the present day are in large part due to confusion with other species. In fact, there is doubt concerning the specific identity of Lamarck's form with Recent material. However, our specimens agree well with the figures of Cushman, Goës and Le Calvez and Le Calvez, especially with the more depressed forms. As pointed out by Loeblich and Tappan many records for northern waters refer to *T. trihedra*.

DISTRIBUTION. Well figured references for the North Atlantic area include: British coasts (Williamson, 1858); Porcupine Station 23, N.W. of Ireland and Station AA, off Skye, Scotland (Brady, 1884); off Scandinavia (Goës, 1894); Gulf of Mexico (Cushman, 1929; Flint, 1899).

*Triloculina trihedra* Loeblich & Tappan

(Pl. 9, figs 3, 4)

*Triloculina trihedra* Loeblich & Tappan, 1953 : 45, pl. 4, fig. 10; Feyling-Hanssen, 1964 : 258, pl. 6, fig. 6.

DIAGNOSIS. A small species of *Triloculina* with triangular section, subround to subacute angles and slightly convex sides.

DESCRIPTION. (Pl. 9, figs 3, 4.) Test broken, apparently with the last chamber removed; oval in side view, apex truncate, triangular in section, angles acute to sub-round, sides slightly raised; chambers arranged in an alternating, triloculine series, triangular, slightly pinched towards the keeled periphery, only gradually increasing in size, three visible externally; sutures strongly marked, impressed, slightly sinuous; wall imperforate, porcelaneous, smooth, vitreous; aperture broken, apparently rather elongate.

DIMENSIONS. Length 0.27 mm, maximum width 0.18 mm.

MATERIAL. Twelve specimens, all small and damaged.

DEPOSITORY. B.M.(N.H.) Stub 1970 : 11 : 26 : 724.

PROVENANCE. Specimen described, Low Marsh, Clettwr Transect, Dovey Marshes.

REMARKS. Many of the references in the literature to *T. tricarinata* probably belong here. Loeblich and Tappan believe that the majority of references to *T. tricarinata* and *T. trigonula* in Arctic and boreal waters are really to this species. It is intermediate in form between these two species, being much less sharply carinate and geometrically triangular than *T. tricarinata* but nevertheless keeled in contrast to the broadly rounded form of *T. trigonula* which has rather flattened, depressed chambers.

DISTRIBUTION. Because this species has been confused with its relatives its true range remains to be worked out. It was described from the Arctic and is recorded by Feyling-Hanssen from the Late Pleistocene and early Holocene of Oslofjord.

Family **NODOSARIIDAE** Ehrenberg, 1838Genus **DENTALINA** Risso, 1826*Dentalina* cf. *trondheimensis* Feyling-Hanssen

(Pl. 16, fig. 11)

See *Dentalina trondheimensis* Feyling-Hanssen, 1964 : 275, pl. 9, figs 3-7.

Also *Nodosaria communis* Heron-Allen & Earland, 1916a : 256, pl. 42, figs 1, 2 (not d'Orbigny). And *Dentalina subarcuata* Williamson, 1858 : 19, pl. 3, figs 40, 41 (not Montagu).

DESCRIPTION. Test elongate, recurved, with entire peripheral edge and lobate, umbilical edge, initial subglobular and the subsequent part slightly compressed, oval in section, not increasing much in width with growth, proloculus subglobular

and elongate-ovate followed by five uniserial, slightly compressed, elongate-ovate chambers with pointed apex, increasing only very slowly in size, each overlapping the former by about one-third; sutures distinct, broadly impressed, oblique at about  $30^{\circ}$  to the vertical axis, showing clear areas towards the peripheral edge (under the light microscope); wall radial, translucent and densely perforated with minute, funnel-shaped pores, about half a micron diameter at the exterior and narrowing internally to less than a fifth of a micron; aperture terminal and peripheral, produced, with complex trematophore composed of seven radial ridges with irregular, oval, openings between; with thorn-shaped basal spine.

**DIMENSIONS.** Length 1.13 mm, maximum width 0.18 mm. Maximum width of proloculus, approx. 150 microns.

**MATERIAL.** Two specimens only.

**DEPOSITORY.** B.M.(N.H.) 1970 : II : 26 : 572.

**PROVENANCE.** Specimen described, CB 492.

**REMARKS.** Our specimens come close to Feyling-Hanssen's species in possessing subglobular proloculus, vaginuline later part and straight, recurved peripheral edge. They differ in being almost double the size for an equivalent number of chambers.

It should be noted here that specimens referred to *Nodosaria communis* by Heron-Allen & Earland (1916a) are identical with *D. trondheimensis*. Copies of the figures of these specimens were included by Cushman in the 'Atlantic Monograph', again as *N. communis* (1923 : 75, pl. 12, figs 3, 4). The other specimens illustrated as *N. communis* by Cushman, figs 15-17, like most other N. Atlantic references of authors should be included under *Dentalina inornata bradyensis*, as pointed out by Feyling-Hanssen (*ibid.*). Confusion about *N. communis* arises because whereas d'Orbigny collected the type from the Adriatic his first description and figure are of a Cretaceous specimen. If the original type cannot be found and redescribed the name should be restricted to the Cretaceous form which shows elongate, pointed chambers each overlapping more than half the previous one and bulbous, spined proloculus.

It is possible that the species illustrated by Williamson (1858) as *Dentalina subarculata*, also belongs to the *D. trondheimensis* group.

### Genus **LAGENA** Walker & Jacob, 1798

#### **Lagena clavata** (d'Orbigny)

(Pl. 12, fig. 1; Pl. 13, fig. 1)

*Oolina clavata* d'Orbigny, 1846 : 24, pl. 1, figs 2, 3.

*Lagena vulgaris* Williamson var. *clavata* (d'Orbigny) Williamson, 1858 : 5, pl. 1, fig. 6.

*Lagena clavata* (d'Orbigny) Goës, 1894 : 75, pl. 13, figs 725-727; Wright in Reade, 1900 : 100, pl. 5, fig. 13; Cushman, 1923 : 10, pl. 1, fig. 15; 1944 : 21, pl. 3, fig. 6; 1949 : 22, pl. 4, fig. 9; Voorthuysen, 1950 : 55, pl. 1, fig. 11; Feyling-Hanssen, 1964 : 286, pl. 11, fig. 4.

*Lagena laevis* (Montagu) var. *amphora* Williamson, 1848 : 12, pl. 1, figs 3, 4.

*Lagena gracillima* (Seguenza) Mills, 1900 : 146, pl. 10, fig. 19.

**DIAGNOSIS.** A smooth *Lagena* shaped like a slender Greek amphora, up to five times as long as wide with the maximum diameter below the middle line.

**DESCRIPTION.** Test elongate, about five times as long as wide, round in section with greatest width below midpoint, summit produced and acuminate, base mucronate; aperture at the end of a long slender neck, narrow with frilled, everted lip; wall radial, lamellar and finely perforate with very small circular pores.

**DIMENSIONS.** Length 0·50 mm, breadth 0·10 mm. Length of neck 0·10 mm.

**MATERIAL.** More than 25 specimens.

**VARIATION.** Specimens occur from about three times as long as broad to five times as long as broad.

**DEPOSITORY.** B.M.(N.H.) Slide 1970 : II : 26 : 120-133. Stub 1970 : II : 26 : 630.

**PROVENANCE.** Described specimen Holocene, Scrobicularia Clays, Borth.

**REMARKS.** *Lagena clavata* has always been distinguished from *L. laevis* by its basal spine or mucro. It is therefore of interest that thin sections show a lamellar structure with the spine formed by the outer layer only. This may indicate either that the spine is formed late in growth or that it is resorbed and reformed as each lamella is added. There is therefore a possibility that *L. laevis* is synonymous with *L. clavata*. However, against this is the general tendency for *L. laevis* to be shorter and more globose as well as destitute of basal mucro.

**DISTRIBUTION.** This species which was first described from the Miocene of the Vienna Basin is widely distributed around the British Isles. Irish Sea (Pearcey, 1891; Williamson, 1858); West of Ireland (Alcock, 1865; Cushman, 1923; Heron-Allen & Earland, 1913b); West of Scotland (Burgess, 1889; Heron-Allen & Earland, 1916a; Williamson, 1858); English Channel (Heron-Allen & Earland, 1911, 1916b, 1930; Williamson, 1858); Jersey (Halkyard, 1889); North Sea (Cushman, 1949; Goës, 1894; Heron-Allen & Earland, 1913c; Mills, 1900).

Outside the British area it has a scattered but cosmopolitan distribution: Arctic (Bartlett, 1964; Goës, 1894; Norvang, 1945); West Atlantic (Cushman, 1944); South Atlantic (Boltovskoy, 1954, 1959; Heron-Allen & Earland, 1932); Pacific (Chapman & Todd, 1947); Australasia (Chapman, 1941).

It is noteworthy that although worldwide these references are mainly from high latitudes; Todd & Bronnimann (1957) however, give a sub-tropical Caribbean occurrence.

### *Lagena dovevensis* Haynes n. sp.

(Pl. 12, figs 7, 8)

*Lagena vulgaris* Williamson var. *perlucida* Williamson, 1858 : 5, pl. 1, fig. 7 (part) (not Montagu).  
*Lagena perlucida* Cushman, 1923 : 46, pl. 8, fig. 12; Cushman, 1949 : 22, pl. 4, fig. 10 (not Montagu).

*Lagena semilineata* Feyling-Hanssen, 1964 : 292, pl. 12, fig. 2 (not Wright).

**DIAGNOSIS.** An elongate-ovate *Lagena* with about 20 fine striae on the lower third of the test, not quite reaching the base.

**DESCRIPTION.** (Holotype.) Test elongate-ovate, round in section with the greatest width below the midpoint, summit produced and acuminate, base rounded; with 20 striae (fine ribs) on the lower part, disappearing about one-third of the way to the summit, not quite reaching the base which is rough, alternate ribs reaching further; neck less than half the length of the rest of the test, tapering; aperture narrow with everted lip; wall radial and minutely perforated.

**DIMENSIONS.** Length 0.25 mm, breadth 0.08 mm.

**MATERIAL.** Six specimens. Also two in the Williamson collection, Brit. Mus. Slide 96.8.13.70.

**DEPOSITORY.** B.M.(N.H.) Slide 1970 : II : 26 : 134-136 (Paratypes). Stub 1970 : II : 26 : 635 (holotype).

**PROVENANCE.** Described specimen CB 156 (Dovey Estuary).

**REMARKS.** This species has been confused in the past with *L. perlucida* which has fewer and stronger ribs and also a different shape, resembling a wine decanter with a flattened base. *L. dovevensis* differs from *L. semilineata* Wright in being striate, not deeply grooved. It also lacks the typical basal spine of that species. Feyling-Hanssen's photograph shows a specimen very close to ours, though larger. The broken spine base mentioned may refer to the roughened area seen in the Dovey specimens.

Of similar species described in the literature, *Lagena striata* var. *semiornata* Reuss, from the early Tertiary, comes closest, but the striae or riblets are more numerous and reach over the equator. *Lagena semi-ornata* Terquem & Terquem is without neck and possesses a spined, acuminate base.

**DISTRIBUTION.** Apart from the British area this species has so far only been noted in the late Quaternary of Oslo fjord, Norway (Feyling-Hanssen, 1964).

**DERIVATION OF NAME.** Refers to provenance in the Dovey Estuary.

### *Lagena hibernica* Haynes n. sp.

(Pl. 12, figs 16, 17)

*Lagena aspera* Balkwill & Millett, 1884 : 78, pl. 2, fig. 1 (not Reuss).

*Lagena hispida* Wright, 1877 : 104, pl. 4, fig. 7 (not Reuss).

**DIAGNOSIS.** A *Lagena* with discontinuous, strongly tuberculate ribs and stout, cylindrical apertural neck.

**DESCRIPTION.** (Holotype.) Test irregularly ovate, round in section; with about 15 discontinuous spiral ribs and lines of tubercles, occasionally developed as spines, particularly towards the base; aperture narrow, with rounded lip and stout, smooth cylindrical neck that rises abruptly, like a gun barrel, from the summit of the test; wall presumably radial and densely perforated with minute pores.

**DIMENSIONS.** Length 0.18 mm, breadth 0.14 mm.

**MATERIAL.** Four specimens.

VARIATION. The test may be more elongate-ovate and there are considerable differences in the strength of development and inclination of the ribs and the number of isolated tubercles or spines as seen in authors' figures.

DEPOSITORY. B.M.(N.H.) Stub 1970 : 11 : 26 : 631.

PROVENANCE. Described specimen, CB 552.

REMARKS. The specimen described as *Lagena aspera* by Balkwill and Millett, from Galway, belongs almost certainly to this species as the tubercles are described as 'formed of lines and dots as if from imperfectly developed ribs', although not shown in their figure.

*Lagena aspera* Reuss was described from the Cretaceous and the type figure shows no apertural neck. References to this species in Recent material are therefore probably incorrect. It is interesting that one of the specimens from the Pacific referred by Brady to *L. aspera*, 1884, pl. 5; fig. 11, shows vertical lines of tubercles tending to coalesce, though the neck is wider. Specimens described as abnormal forms of *L. aspera* by Balkwill & Wright, 1885, from near Dublin in the Irish Sea come very near to *L. hibernica* but with the discontinuous ribs in vertical rows. Further work is required to see if they fall within the range of variation of the species (and also if there is a possible relationship with *Amphicoryna* species).

Among closely related species *L. hispida* Reuss, Oligocene, has a dense pile of fine spines; *L. tuberosa* Matthes, Oligocene, has small scattered spines; *L. vikensis* Hessland, Pleistocene, has vertical rows of small spines. In the Recent species with spiral ornament, *L. spiralis* Brady, the ribs are few in number and regular with marked perforations.

DISTRIBUTION. Irish Sea and west coast of Ireland.

DERIVATION OF NAME. Refers to distribution in the seas off Ireland.

### *Lagena laevis* (Montagu)

(Pl. 12, fig. 2)

*Vermiculum laeve* Montagu, 1803 : 524, pl. 1, fig. 9.

*Lagena laevis* (Montagu) Williamson, 1848 : 12, pl. 1, figs 1, 2; Goës, 1894 : 74, pl. 13, 720-722 (not 719); Flint, 1899 : 306, pl. 53, fig. 6 (part); Mills, 1900 : 146, pl. 11, fig. 28; Cushman, 1949 : 22, pl. 4, fig. 8; Loeblich & Tappan, 1953 : 61, pl. 11, figs 5-8; Voorthuysen, 1960 : 246, pl. 10, fig. 10; Haake, 1962 : 33, pl. 1, figs 16, 17 (not 15); Feyling-Hanssen, 1964 : 289 pl. 11, figs 13-15.

*Lagena sulcata* Walker & Jacob var. *laevis* (Montagu) Parker & Jones, 1865 : 349, pl. 13, fig. 22 (*Lagena laevis* in plate description).

*Lagena vulgaris* Williamson, 1858 : 4, pl. 1, fig. 5, 5a (as 'typica').

DIAGNOSIS. A smooth, club-shaped *Lagena* with strongly produced apertural end and greatest width below the middle line.

DESCRIPTION. Test ovate-acuminate, round in section and twice as long as wide

with greatest breadth below midpoint, summit produced and acuminate, base broadly rounded; aperture at the end of a long neck, broken off in this specimen; wall radial, lamellar and minutely perforated with round pores.

DIMENSIONS. Length 0·28 mm, breadth 0·14 mm.

MATERIAL. Fifteen specimens.

VARIATION. Specimens occur which vary between twice and three times as long as wide, excluding the neck.

DEPOSITORY. B.M.(N.H.) Slide 1970 : 11 : 26 : 137. Stub 1970 : 11 : 26 : 632.

PROVENANCE. Described specimen Holocene, Scrobicularia Clays, Borth.

REMARKS. This species has been widely reported but many of the references are suspect. Thus both Goës (1894) and Flint (1899) include globose specimens which appear to belong to other species, possibly *L. flatulenta* Loeblich & Tappan as does *L. laevis* Cushman (1948). *L. laevis* in the sense of Heron-Allen and Earland is again quite unlike the type figure or the excellent illustrations of Williamson. None of the specimens figured by Brady (1884) resemble the type figure.

Williamson (1858) proposed the name *L. vulgaris* so that ornamented forms could be brought into the 'laevis' category without producing contradictory varietal names like *L. laevis* var. *striata*. As pointed out by Loeblich and Tappan *L. vulgaris* is therefore an objective synonym.

DISTRIBUTION. When doubtful forms are eliminated from the list typical specimens appear to be largely concentrated around the British Isles and in the N. Atlantic: Irish Sea (Wright, 1900); North Sea (Cushman, 1949; Haake, 1962; Voorthuysen, 1960); North Atlantic and Arctic (Goës, 1894; Flint, 1899; Loeblich & Tappan, 1953). The very large list of citations from all over the world requires validation before we can be certain this species has a truly cosmopolitan distribution.

### *Lagena pacifica* Sidebottom

(Pl. 12, fig. 15: Pl. 13, figs 2, 3)

*Lagena pacifica* Sidebottom, 1912 : 398, pl. 16, fig. 29.

*Lagena spumosa* Heron-Allen & Earland, 1916a : 245, pl. 41, figs 19, 20; Cushman, 1923 : 51, pl. 10, figs 1, 2 (copies from Heron-Allen & Earland), (not *L. spumosa* Millett).

DIAGNOSIS. An elongate, acuminate *Lagena* with coarsely perforate outer lamella, the pores set alternately.

DESCRIPTION. Test elongate and about three times as long as wide with greatest width towards the base and acute summit, slightly irregular but round in section; with outer lamella breached in places but showing coarse pores set alternately in slight depressions producing a honeycomb-like dimpling of the surface; aperture narrow, with short, cylindrical neck and smooth rim.

DIMENSIONS. Length 0·26 mm, breadth 0·08 mm.

MATERIAL. One specimen only.

VARIATION. There is some irregularity in shape and in the angle of the apertural neck, as seen in authors' figures.

DEPOSITORY. B.M.(N.H.) Stub 1970 : 11 : 26 : 638.

PROVENANCE. Described specimen, CB 528.

REMARKS. Our specimen is the same size as that of Sidebottom which was described as possessing compound wall and 'marked all over with irregular depressions'. It is thus distinguished from *L. hertwiggiana* var. *undulata* Sidebottom which has rows of punctae between longitudinal ridges. *L. punctulata* Cushman is larger and more globose with phialine lip.

Heron-Allen and Earland figure two specimens very close to ours from the deep water of the Faroe Channel, N.W. of Scotland as *L. spumosa*. Millett's species is, however, quite different with spongy outer lamella, conical aperture and basal umbo. This identification was undoubtedly a *lapsus calami* which may well have arisen because Sidebottom figured these two species side by side in his monograph on the 'Lagenae' from the S.W. Pacific. Heron-Allen and Earland then mistook one for the other, an error perpetuated by Cushman.

DISTRIBUTION. Originally described as vary rare at a few stations in the S.W. Pacific. Authentic records elsewhere must now be considered as limited to Cardigan Bay and the West of Scotland. Confusion with Millett's species makes Heron-Allen and Earland's Pacific and Mediterranean records suspect.

### *Lagena perlucida* (Montagu)

(Pl. 12, fig. 5; Pl. 13, fig. 5)

*Vermiculum perlucidum* Montagu, 1803 : 525, pl. 14, fig. 3.

*Lagena perlucida* (Montagu) Brown, 1844 : 3, pl. 56, fig. 29.

*Lagena vulgaris* Williamson var. *semistriata* Williamson, 1858 : 6, pl. 1, fig. 9 (not *Lagena striata* (Montagu) var. B *semistriata* Williamson).

*Lagena semistriata* (Williamson) Cushman, 1923 : 50, pl. 9, fig. 15.

*Lagena striata* var. *perlucida* (Montagu) Williamson, 1848 : 15, pl. 1, fig. 11, ? part.

DIAGNOSIS. A pear-shaped *Lagena* with flattened base and up to 13 strong longitudinal ribs, most of which tend to disappear above the midpoint of the test but reappear as fine costae on the neck.

DESCRIPTION. Test pear-shaped and total length, including the neck, twice the width, round in section with the maximum width below the midpoint, summit produced and acuminate, base slightly flattened; with 10 strong ribs that tend to die out above the midpoint and become denticulate towards the base leaving a small, clear area, some ribs short and restricted to the equator; neck equal in length to the rest of the test and gradually tapering, ornamented with fine, spiral costae; aperture with everted lip, narrow with irregular radiate grooves; wall radial, lamellar and minutely porous.

DIMENSIONS. Length 0.38 mm, breadth 0.19 mm.

MATERIAL. Ten specimens.

VARIATION. Between 8 and 13 ribs may be developed, some of which reach as far as the base of the neck. Specimens differ in the amount of flattening of the base and also in the length of the neck which may be twice as long as the rest of the test.

DEPOSITORY. B.M.(N.H.) Slide 1970 : 11 : 26 : 138-139. Stub 1970 : 11 : 26 : 636.

PROVENANCE. Described specimen, CB 527.

REMARKS. There is a great deal of confusion in the literature between *Lagena perlucida* and *Lagena semistriata*. This is because the figure given by Williamson of *Lagena vulgaris* var. *semistriata* in 1858 is different from the types of 1848 and almost certainly represents a specimen very near *L. perlucida*. The ribs are described as terminating abruptly at their upper extremity whereas the type figure of *L. perlucida* shows a specimen with six ribs, all reaching the neck. However, as our material shows, this is a variable feature. We also find that the denticulations at the base can give the appearance of a small knob, as in Montagu's figure. This was noted by Williamson in 1848 in his discussion of *Lagena striata* var. *perlucida* where he took a wide view of the shape variation in the species. His concept therefore appears to coincide with ours only in part. (See further under *Lagena dovevensis* and *L. semistriata*.)

DISTRIBUTION. This species was described from the Kent coast and there are as yet no good records outside the British Isles area.

### *Lagena semistriata* (Williamson)

(Pl. 12, fig. 6; Pl. 13, fig. 4)

*Lagena striata* (Montagu) var.  $\beta$  *semistriata* Williamson, 1848 : 14, pl. 1, figs 9, 10.

*Lagena semistriata* (Williamson) Goës, 1894 : 76, pl. 13, fig. 737.

*Lagena sulcata* Mills, 1900 : 146, pl. 10, fig. 22 (not Walker & Jacob).

*Lagena sulcata* (Walker & Jacob) var. *semistriata* (Williamson) Voorthuysen, 1960 : 246, pl. 10, fig. 13; Haake, 1962 : 33, pl. 1, fig. 21.

DIAGNOSIS. An ovate *Lagena* with up to 15 longitudinal costae arising from the base and tending to disappear irregularly between a third and half way to the summit.

DESCRIPTION. Test ovate and round in section with greatest width at midpoint, summit produced and acuminate; with about 10 weak costae which disappear about one-third of the way to the summit, reaching back slightly beyond the base as blunt projections; neck tapering and about half the length of the rest of the test; aperture narrow, with marked everted lip which overhangs both internally and externally; wall radial, finely perforate with circular pores.

DIMENSIONS. Length 0.31 mm, breadth 0.15 mm.

MATERIAL. Six specimens.

VARIATION. Occasional ribs may extend further towards the summit.

DEPOSITORY. B.M.(N.H.) Slide 1970 : 11 : 26 : 140. Stub 1970 : 11 : 26 : 634.

PROVENANCE. Described specimen, CB 527.

**REMARKS.** In the past this species has been confused with *L. perlucida* from which it differs in its oval shape and smooth neck. The specimen figured by Williamson (1858) and reproduced by Cushman (1923) does not belong here but in *L. perlucida*. (See further under *L. dovevensis* and *L. perlucida*.)

**DISTRIBUTION.** Apart from the original records of Williamson from the British coast, Pembrokeshire and Scarborough, other records for this species are restricted to Plymouth (Murray, 1965a); the North Sea (Voorthuysen, 1960; Haake, 1962) and to the Arctic and Skagerak (Goës, 1894).

***Lagena spicata* (Cushman & McCulloch)**

(Pl. 12, fig. 13)

*Lagena sulcata* (Walker & Jacob) var. *apiculata* Cushman, 1913 : 23, pl. 9, figs 3a, b (not Silvestri).  
*Lagena sulcata* (Walker & Jacob) var. *spicata* Cushman & McCulloch, new name, 1950 : 360, pl. 48, figs 4-7, ? 3.

**DIAGNOSIS.** A subspherical to ovate *Lagena* with up to 30 longitudinal costae, basal spine and smooth, waisted neck with flared, apertural lip.

**DESCRIPTION.** Test ovate, not much longer than wide, round in section, base obtuse, with spine (almost completely broken off), apex tapering into a smooth neck; with 28 broad costae which originate near the base, are strongly marked over the equator and faintly discernible to the base of the neck; the neck is without ornament and expands from a narrow waist towards the apertural end; aperture with flared lip and short radiate grooves (giving the appearance of a ring of teeth inside the lip).

**DIMENSIONS.** Length 0.27 mm (excl. neck), breadth 0.22 mm.

**MATERIAL.** One specimen only.

**DEPOSITORY.** B.M.(N.H.) Stub 1970 : 11 : 26 : 633.

**PROVENANCE.** Described specimen Holocene, Scrobicularia Clays, Borth.

**REMARKS.** *L. spicata* differs from *L. lyellii* (Seguenza) in possessing a smooth neck without the numerous collars typical of that species. This is clearly shown by Cushman's type figure of 1913, though doubt is introduced by the figures that accompany the 1950 citation as they show marks which could be interpreted as rings of ornament. However, Cushman and McCulloch state, neck 'usually without other ornamentation'. Figure 3 of the 1950 series shows a disparate specimen with only a few costae and a cylindrical neck. In 1870 Brady recognized *L. lyellii* in dredgings from off the West of Scotland and from Scottish tidal rivers but later changed his mind and decided such specimens were either an apiculate variety of *L. sulcata* or joints of *Nodosaria scalaris* var. *separans*. This view was not followed by Balkwill & Millett who illustrated a fine specimen of *L. lyellii* in 1884 from the West of Ireland with rings as well as longitudinal striae on the neck. *L. lyellii* of Heron-Allen & Earland (1913b) from Clare Island, does possess a smooth aperture, figure copied by Cushman (1923) but is almost certainly another species altogether.

*L. lyellii* would appear to bear the same relationship to *L. spicata* as *L. sulcata*

var. *torquiformis* to *L. sulcata* s.s. N.B. Silvestri (1896) included the forms considered here in his *L. sulcata* var. *apiculata* but based his diagnosis on a specimen of Soldani with branching ornament. Both his name and Cushman's of 1913 are homonyms of *Lagena apiculata* (Reuss), as pointed out in the Ellis & Messina Catalogue.

DISTRIBUTION. Described as common in the Pacific in fairly deep water, particularly near the Galapagos. A cosmopolitan distribution is therefore indicated.

***Lagena* cf. *striata* (d'Orbigny) 1839**

(Pl. 12, fig. 12; Pl. 13, figs 7, 8)

DESCRIPTION. Test elongate-ovate, about half as long again as wide; round in section, base rounded, apex pointed; with about 45 longitudinal striae, not all reaching the base, some running onto the neck but only six reaching the apertural end of the neck, each bearing a double row of denticles; neck cylindrical, apparently hexagonal in apertural view due to striae reaching the lip; aperture narrow; wall radial and minutely perforate.

DIMENSIONS. Length 0·26 mm, breadth 0·15 mm.

MATERIAL. One specimen only.

DEPOSITORY. B.M.(N.H.) Stub 1970 : 11 : 26 : 639.

PROVENANCE. Described specimen Holocene, Scrobicularia Clays, Borth.

REMARKS. *Lagena striata* (d'Orbigny) was described from the Falkland Isles (1839c) and is characteristically sub-spherical with many striae. Heron-Allen & Earland (1932) give good figures which show specimens with striae running onto the neck and twisting round it. These are also mentioned by Feyling-Hanssen (1964) who gives the best figures from North Atlantic material, though his specimens are less spherical and more ovate than the type. Both publications mention specimens intermediate with *L. substriata* (Williamson). Our specimen may belong with this group supposing they also possess denticulate striae.

As shown by Feyling-Hanssen, *L. striata* in the sense of Williamson (1858) and Cushman (1923) is *Lagena filicosta* Reuss. This means that the many listed references given for this species round the British Isles are doubtful and cannot be trusted. However, *L. striata* of Mills, 1900, may be the same as our species.

*Lagena striata* in the sense of Brown (1844) = *Vermiculum striatum* Montagu (1803) does not belong here at all but refers to *Lagena sulcata*. For further information on this nomenclatorial problem see further under that species.

***Lagena substriata* Williamson**

(Pl. 12, fig. 11; Pl. 13, figs 6 and 11)

*Lagena substriata* Williamson, 1848 : 15, pl. 2, fig. 12; Cushman, 1923 : 56, pl. 10, fig. 11.

*Lagena vulgaris* Williamson var. *substriata* (Williamson) 1858 : 7, pl. 1, fig. 14.

*Lagena sulcata* Haake, part, 1962 : 32, pl. 1, figs 18, 19 (not Walker & Jacob).

*Lagena striata* (d'Orbigny) forma *substriata* (Williamson) Feyling-Hanssen, 1964 : 294, pl. 12, fig. 6.

**DIAGNOSIS.** An elongate-ovate *Lagena* about twice as long as wide, with up to 60 delicate longitudinal striae, some of which run up on to the neck.

**DESCRIPTION.** Test elongate-ovate with greatest width near the base, round in section, tapering to the summit; with about 50 delicate, smooth, longitudinal striae, six of which continue onto the neck while the rest die out at or below the neck, some restricted to the equator; neck cylindrical; aperture with smooth rim and hexagonal outline due to continuation of ornament up the neck; wall radial, lamellar with the striae in optical continuity with the rest of the wall, pores minute.

**DIMENSIONS.** Length 0·45 mm (inc. neck), breadth 0·14 mm.

**MATERIAL.** Four specimens.

**VARIATION.** Specimens vary from just under twice as long as wide to almost three times as long as wide.

**DEPOSITORY.** B.M.(N.H.) Slide 1970 : 11 : 26 : 141. Stub 1970 : 11 : 26 : 640.

**PROVENANCE.** Described specimen, CB 543.

**REMARKS.** In his original description Williamson refers to the 'exquisitely delicate parallel longitudinal striae' and also states that in an examination of at least 20 specimens he found this ornament constant and the test more ovate and elongated than in *L. striata*. He took care to emphasize that the type figure represented the least elongated form and measurements given of two other specimens show dimensions more like ours and the specimen he illustrated in 1858. However, by 1858 he had decided that there was only one British species of *Lagena*. This shows the influence of the changing climate of opinion about species towards the extreme lumping of the 'English School' in the late nineteenth Century. We find that *L. substriata* is not only distinguished by its shape from our *L. cf. striata* but also by possessing smooth striae rather than double rows of denticulations.

Haake's figures appear to show *L. substriata* in part. Feyling-Hanssen's specimen is like ours but more elongate and with longer neck. So far we have not found a specimen with the apertural lip shown in the type figure of Williamson.

**DISTRIBUTION.** This species was recorded from various localities off the west coast of England and Wales by Williamson who mentioned that the finest specimens came from the Irish Sea. According to Cushman it is rare in the Western Atlantic. There are scattered records from elsewhere but these are doubtful in the absence of good figures.

### *Lagena sulcata* (Walker & Jacob)

(Pl. 12, fig. 9; Pl. 13, fig. 10)

*Serpula (Lagena) striata sulcata rotunda* Walker & Boys, 1784 : 2, pl. 1, fig. 6.

*Serpula Lagena Sulcata* Walker & Jacob, 1798 : 634, pl. 14, fig. 5.

*Lagena sulcata* (Walker & Jacob) Parker & Jones, 1865 : 351, pl. 13, figs 24, 28-32, pl. 16 figs 6, 7 (? mainly *O. borealis*); ? Flint, 1899 : 307, pl. 53, fig. 7; ? Cushman, 1948 : 46, pl. 5, fig. 12; ? Cushman, 1949 : 23, pl. 4, fig. 13; Voorhuyzen, 1960 : 246, pl. 10, figs 11, 12.

*Vermiculum striatum* Montagu, 1803 : 523.

*Lagena striata* (Montagu) Brown, 1844 : 3, pl. 56, fig. 36; Williamson, 1848 : 13, pl. 1, figs 6, 8.

**DIAGNOSIS.** An ovate *Lagena* with about 25 narrow, blade-like costae which

are denticulate near the base where they commence and smooth with flat tops over the equator and towards the summit. About six costae continue straight up the neck.

**DESCRIPTION.** Test ovate, not much longer than wide with greatest width below the midline, slightly compressed in section, base rounded, summit acute; with 24 strong longitudinal ribs which commence near the base, two short and restricted to the equator, the others denticulate near the base, blade-like with smooth, flattened edge towards the apex; base minutely tuberculate; neck stout and cylindrical with about six ribs continuing straight up to the lip of the aperture; aperture plugged; wall radial and minutely perforated.

**DIMENSIONS.** Length 0·38 mm (inc. neck), breadth 0·20 mm.

**MATERIAL.** Nineteen specimens.

**VARIATION.** There is variation in the number of short ribs developed over the ambitus and in the distance the other costae continue towards the base and neck.

**DEPOSITORY.** B.M.(N.H.) Slide 1970 : II : 26 : 142-149. Stub 1970 : II : 26 : 641.

**PROVENANCE.** Described specimen, CB 13.

**REMARKS.** Thin sections show that the wall is lamellar with the costae in optical continuity. The pores are circular and penetrate normal to the surface. The aperture is narrow and also circular.

Although the type figure does not show costae running onto the neck it does show about the same number of flattened blade-like ribs as our specimen (indicated by double lines in the 1798 drawing) and the general shape and proportions are very similar. As the type is lost it seems reasonable to interpret our specimen as near the central type of *L. sulcata*.

This species is one of those first described by Walker & Boys (1784) then re-described in 1798 with valid binomial nomenclature. Oddly enough in this one case trinomial nomenclature was still used but it is clear from the description that '*Lagena*' is to be regarded as a subgeneric designation. This view was taken by Parker & Jones (1859, 1865) and Brady (1884). This means that the naming of the species as *Vermiculum striatum* by Montagu (1803) = *Lagena striata* Brown (1827, 1844) which refers back to the 1784 citation was incorrect. In any case this name should now be considered a 'nomen oblitum' under the Rules of Nomenclature so presumably *Lagena striata* (d'Orbigny) 1839 is not prejudiced.

Well founded records for this species in the North Atlantic region are remarkably few. Many, such as those of Parker & Jones (1865) and Goës (1894) refer at least in part to *Oolina borealis*. The figure given by Balkwill & Wright (1884) is of *L. sulcata* var. *torquiformis* and this is the figure repeated by Cushman in his 'Atlantic Monograph' (1923). Flint's specimen may be near the central type but Cushman's specimen from the Arctic (1948) shows only 12 costae and a small apertural neck. Similarly, Cushman's Belgian specimen (1949) appears to be different. Voorthuysen's specimen is quite like ours with costae running straight onto the neck.

**DISTRIBUTION.** This species has been widely reported around the British Isles but listed references must be regarded as suspect. However, the photomicrograph

of Reade & Wright (1900) shows that the central type occurs in the Holocene of Lancashire. World wide references are equally dubious. For instance the Pacific citations of Brady (1884) may include var. *torquiformis* but not *L. sulcata* s.s. Again *L. sulcata* of Heron-Allen & Earland from the Falkland Isles (1932) is another species group with flanged apertural necks.

*Lagena sulcata* (Walker & Jacob) var. *interrupta* (Williamson)  
(Pl. 12, fig. 10)

*Lagena striata* (Montagu) var.  $\alpha$ , *interrupta* Williamson, 1848 : 14, pl. 1, fig. 7.

*Lagena vulgaris* Williamson var. *interrupta* Williamson, 1858 : 7, pl. 1, fig. 11.

*Lagena sulcata* var. *interrupta* Brady, 1884 : 483, pl. 57, figs 25, 27 (? var. *torquiformis*).  
non *Lagena interrupta* Boltovskoy, 1954 : 152, pl. 6, figs 5, 6; 1959 : 68, pl. 9, fig. 21.

DIAGNOSIS. A variety of *Lagena sulcata* with interdigitating costae of unequal length.

DESCRIPTION. Test elongate-ovate, about one and a half times as long as broad, widest at midpoint, round in section with slightly flattened base; with 26 blade-like longitudinal costae, 14 commence near the base and apart from one short rib continue to just below the summit, the rest commence at about one-third of the distance from the base and continue to the base of the neck, four running up the neck, with flat, smooth tops but becoming denticulate near the base; neck slightly offset, possibly broken, stout and quadrangular due to ornament, slightly tapering; aperture narrow, round; wall radial and minutely perforate.

DIMENSIONS. Length 0.35 mm (excl. neck), breadth 0.23 mm.

MATERIAL. Five specimens.

VARIATION. There is variation in the length of the interdigitating ribs and in the number reaching the base and the summit.

DEPOSITORY. B.M.(N.H.) Slide 1970 : II : 26 : 150-151. Stub 1970 : II : 26 : 643.

PROVENANCE. Described specimen, CB 345.

REMARKS. As well as differing in its ornament this variety is slightly more elongate than *L. sulcata* s.s. This is well shown in our figure which closely resembles the type. Williamson's specimen of 1858 has a more produced apex with long neck and everted lip preserved. Brady's specimens appear to represent other varieties of *L. sulcata*, near var. *torquiformis*. Boltovskoy's figures show a different species, altogether. A long, narrow form more than twice as long as wide.

DISTRIBUTION. Williamson recorded this variety from Swansea, South Wales, and from a number of localities all round the British Isles. This distribution would appear to be confirmed by the frequent listing given for it by later authors. These, however, in the absence of figures, must be considered doubtful. As can be seen from the synonymy good figures for citations for the North Atlantic region are restricted to the type figure and Williamson's second reference.

*Lagena sulcata* (Walker & Jacob) var. *torquiformis* Haynes n. var.

(Pl. 12, fig. 14; Pl. 13, figs 9 and 12)

*Lagena sulcata* Wright, 1877 : 103, pl. 4, fig. 10; Balkwill & Wright, 1885 : 338, pl. 14, figs 1, 2; Cushman, 1923 : 57, pl. 11, fig. 1 (not Walker & Jacob).

DIAGNOSIS. A variety of *Lagena sulcata* with up to four costae continued from the body chamber and spirally wound about the neck.

DESCRIPTION. (Holotype.) Test ovate with greatest width below the midpoint, round in section; with 23 longitudinal, blade-like costae, sharp edged towards the base but with smooth, flattened edge over the equator and towards the summit, some commencing up to one-third the distance from the base, some finishing below the summit, some at the base of the neck and four spirally wound about the neck where they are again sharp edged; neck cylindrical, narrow; aperture narrow and circular with lip formed by the looped back ends of the costae; wall minutely tuberculate, radial and finely perforate.

DIMENSIONS. Length 0·34 mm (neck 0·15 mm), breadth 0·24 mm.

MATERIAL. Twelve specimens.

VARIATION. From three to six costae may occur on the neck and there is variation in the development of costae on the chamber, odd ones being restricted to the ambitus. The base is denticulate in many specimens.

DEPOSITORY. B.M.(N.H.) Slide 1970 : 11 : 26 : 152-154 (paratypes). Stub 1970 : 11 : 26 : 642 (holotype).

PROVENANCE. Described specimen Holocene, Scrobicularia Clays, Borth.

REMARKS. This variety of *L. sulcata* appears to differ from *L. sulcata* var. *spirata* Bandy and from the M. Eocene of Alabama in a number of features. Bandy's holotype (kindly loaned by Alan Horowitz of Indiana University) is a spherical form with produced apex passing into a stout tapering neck. The costae are rounded, apparently broadest at midpoint and two continue onto the neck. Bandy's figure which is very good shows how the specimen appears sulcate rather than costate. It probably represents a Palaeogene species group, unrelated to *L. sulcata* but similarly developing spiral neck ornament.

It is interesting that the first illustration of this elegant foraminifer was by Balkwill and Wright from the Irish Sea, as *L. sulcata*. It was their figure that was repeated by Cushman (1923) and cited by Bandy in his synonymy (1949). Bandy also included one of the Pacific specimens of *L. sulcata* Brady (1884) pl. 57, fig. 23, in his variety. This may represent the same variety as ours.

DISTRIBUTION. This variety is probably listed as *L. sulcata* in the literature so its distribution remains to be worked out, firm identification being restricted to the Irish Sea and Cardigan Bay.

DERIVATION OF NAME. Refers to the similarity of the neck ornament to the spiral gold torques which are some of the most striking artifacts found in Celtic burial hoards.

*Lagena* species A

(Pl. 12, figs 3, 4)

DESCRIPTION. Test pear-shaped with rounded base and tapering summit, greatest width towards the base, round in section; with fine, longitudinal striae on the lower third of the test, apparently not reaching the base; neck wide, tapering, broken off.

DIMENSIONS. Length 0.20 mm, breadth 0.11 mm.

MATERIAL. One specimen only.

DEPOSITORY. B.M.(N.H.) 1970 : 11 : 26 : 637.

PROVENANCE. Described specimen, CB 528.

REMARKS. This specimen resembles *L. laevis* but is more pear-shaped with wider neck and is faintly striate towards the base.

Family **POLYMORPHINIDAE** d'Orbigny, 1839Genus **FISSURINA** Reuss, 1850*Fissurina elliptica* (Cushman)

(Pl. 14, fig. 5; Text-fig. 19)

*Lagena orbignyana* (Seguenza) var. *elliptica* Cushman, 1923 : 42, pl. 6, figs 10-12

DIAGNOSIS. An elongate, three keeled species of *Fissurina* with elliptical central part and produced, narrow, only slightly everted aperture.

DESCRIPTION. Test unilocular, subglobular with rounded base and produced rather narrow aperture, slightly compressed body chamber, strongly compressed at the aperture, greatest width below midpoint; wall radial, lamellar and densely perforated with fine pores; aperture truncating the produced apical end, an elongate slit with rounded lip, slightly everted but not at the sides, with long flaring ento-



0.0                    0.1 mm.

FIG. 19. *Fissurina elliptica*, apertural view.

solenian tube; thin, sharp marginal keel plus two subsidiary ones on each side with rounded ridges defining the body chamber; the edges of the subsidiary keels continue as costae on the apertural neck and there is also a central bar joining the rounded ridge to the lip, the hollows between filled with fine tubercles.

DIMENSIONS. Length approx. 0.25 mm, width 0.13 mm.

MATERIAL. Eleven specimens recovered.

DEPOSITORY. B.M.(N.H.) Slide 1970 : II : 26 : 155-156. Stub 1970 : II : 26 : 616.

PROVENANCE. Specimen described Holocene, Scrobicularia Clays, Borth.

REMARKS. This beautiful little species resembles nothing so much as an ornamented hand mirror from a vanity case. Our specimens although smaller are otherwise close to those figured by Cushman and it is probable that other specimens from around the British Isles referred by authors to *Lagena orbigniana* belong to this species; i.e. those figured by Balkwill & Millett (1884) and Mills (1900). Williamson (1858) included in *Entosolenia marginata* forms closer to *F. orbigniana* s.s. (figs 19, 20) rounder and more flattened with less developed subsidiary keels, everted aperture and small peduncle.

DISTRIBUTION. This form was first described from 382 fathoms in the Caribbean.

### *Fissurina lucida* (Williamson)

(Pl. 14, figs 1, 2; Text-fig. 20, nos 3, 4)

*Entosolenia marginata* (Montagu) var. *lucida* Williamson, 1848 : 17, pl. 2, fig. 17; ? Williamson, 1858 : 10, pl. 1, figs 22, 23.

*Entosolenia lucida* (Williamson) Cushman & Cole, 1930 : 98, pl. 13, figs 11, 12; Cushman, 1948 : 63, pl. 7, fig. 2.

*Lagena lucida* (Williamson) Reuss, 1862 : 324, pl. 2, figs 25, 26; Heron-Allen & Earland, 1911 : 318, pl. 10, fig. 16.

*Fissurina lucida* (Williamson) Bandy, 1950 : 274, pl. 41, figs 12a, b; Loeblich & Tappan, 1953 : 76, pl. 14, fig. 4; Haake, 1962 : 38, pl. 2, figs 11-12; Feyling-Hanssen, 1964 : 315, pl. 15, fig. 21.

DIAGNOSIS. A compressed, elongate-ovate species of *Fissurina* with horseshoe-shaped opaque areas on each side, and rounded margin.

DESCRIPTION. (Text-fig. nos 3, 4.) Test unilocular, elongate-ovate with produced apertural end and slightly pedunculate base, greatest width just below mid-point, compressed and half as wide as long in side view, margin rounded; aperture long and narrow between slight lips passing into a long entosolenian tube; wall radial lamellar, transparent with minutely and densely perforate areas making an opaque horseshoe-shaped pattern on either side.

DIMENSIONS. Length 0.28 mm, width 0.20 mm, width in side view 0.14 mm.

MATERIAL. More than 25 specimens.

VARIATION. Some specimens show rather more compressed tests than those illustrated and the slight peduncle is not always present. On the other hand the shape in side view remains rather constant in our material.

DEPOSITORY. B.M.(N.H.) Slide 1970 : II : 26 : 157, 158. Stub 1970 : II : 26 : 614.

PROVENANCE. Specimens described and illustrated from the Holocene, Scrobicularia clays at Borth, immediately below the Fossil Forest.

REMARKS. Some difficulty has been caused in the interpretation of this species because the illustrations in Williamson's Monograph of 1858 show specimens different in a number of respects from the type described in 1848. In particular fig. 22 of 1858 shows a pear-shaped form with rather flat base and fig. 23 an elongate form with marked spine. These figures were repeated by Cushman in 1923 but we believe they should be left out of the synonymy. Specimens described by Balkwill & Millett (1884) from Galway resemble fig. 22. Williamson mentions a 'carina' in his description which appears to refer to the clear peripheral band. As shown by our stereoscanner photo (Pl. 14, fig. 1) this can resemble a keel. The margin is in fact rounded. It is of interest that Heron-Allen and Earland illustrated a double specimen joined base to mouth which they described as 'due to budding'. It is possible that the slight peduncle in many specimens indicates this former attachment.

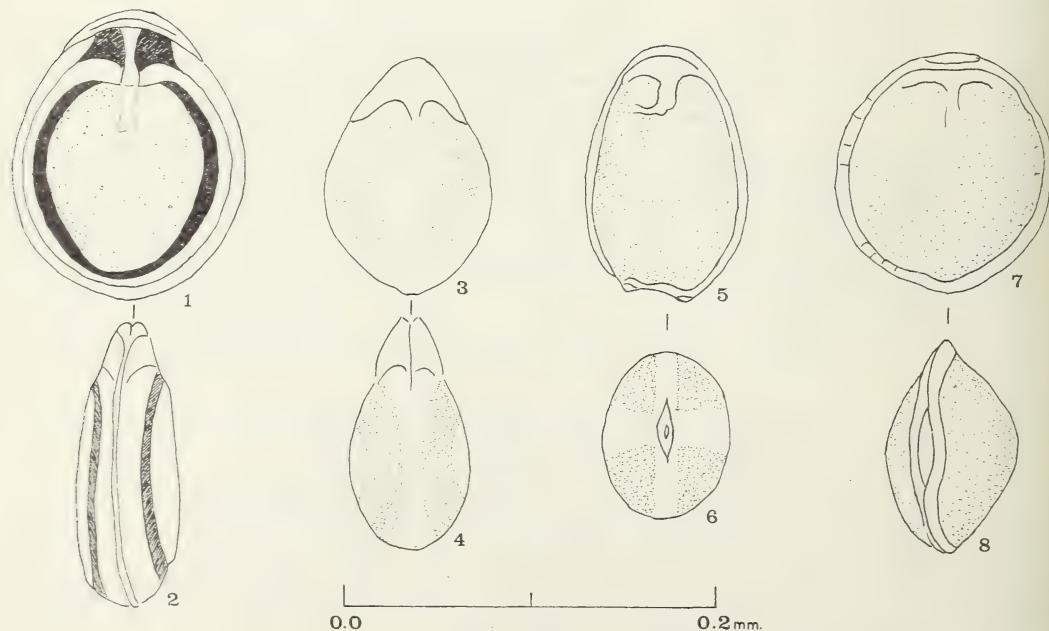


FIG. 20. 1, 2. *Fissurina* species A. 1, side view; 2, peripheral view. 3, 4. *Fissurina lucida*. 3, side view; 4, peripheral view  $\times \frac{1}{2}$  given scale. 5, 6. *Fissurina* species B. 5, side view; 6, apertural view. 7, 8. *Fissurina marginata*. 7, side view; 8, apertural view.

DISTRIBUTION. This species was originally recorded from all round the British Isles from the Shetlands, the Irish Sea, North Sea and English Channel. Later records confirm this distribution. Other records include:

North Atlantic: Arctic (Cushman, 1948; Loeblich & Tappan, 1953); Bay of Fundy (Harrington, 1956).

South Atlantic: off Argentina (Boltovskoy, 1955, 1957, 1961); Falklands (Heron-Allen & Earland, 1932).

Antarctic: (Pearcey, 1914; Wiesner, 1931; Chapman & Parr, 1937).

Mediterranean: Bay of Naples (Buchner, 1940).

Pacific: Coast of N. America (Cockbain, 1962; Cushman, 1941; Cushman & Todd, 1947a; Detling, 1958; Harman, 1964; Watkins, 1961; Zalesney, 1959); N. Zealand (Hulme, 1964; Vella, 1957).

These records suggest a cool temperate to cold water concentration.

### *Fissurina marginata* (Walker & Boys)

(Text-fig. 20, nos 7, 8)

*Serpula (Lagena) marginata* Walker & Boys, 1784 : 3, tab. 1, fig. 7.

*Vermiculum marginatum* Montagu, 1803 : 524.

*Lagena marginata* Walker, Brown, 1844 : 3, pl. 56, figs 30, 31 (1st edit. 1827 : pl. 1, figs 30, 31) figures after Walker & Boys.

*Lagena sulcata* Walker & Jacob var. (*Entosolenia*) *marginata* (Montagu) Parker & Jones, 1865 : 355, pl. 13, figs 42, 43 only.

*Entosolenia marginata* (Walker) Williamson, 1858 : 9, pl. 1, fig. 21 only; Cushman, 1948 : 65, pl. 7, fig. 7 (ascribed with ? to Montagu).

*Fissurina marginata* (Montagu) Loeblich & Tappan, 1953 : 77, pl. 14, figs 6-9; Voorthuysen, 1960 : 248, pl. 10, fig. 19; Feyling-Hanssen, 1964 : 315, pl. 15, fig. 22 (ascribed to Walker & Boys).

DIAGNOSIS. A smooth, compressed round to ovate species of *Fissurina* with narrow marginal keel and slightly to moderately protruding aperture.

DESCRIPTION. Test unilocular, rounded ovate, widest just below midpoint, compressed, a little more than half as thick as wide, with rounded sides and narrow, translucent keel; aperture very slightly produced, a narrow slit at the apex with entosolenian tube (not clearly seen because brownish tectin lining still present); wall radial, densely and finely perforate, appearing opaque; apparently some scattered larger pores present particularly near the keel; surface smooth.

DIMENSIONS. Length 0.13 mm, width 0.11 mm, width in side view 0.07 mm.

MATERIAL. One specimen only.

VARIATION. Authors' figures indicate that the chief variation is in the amount of protrusion of the apertural end.

DEPOSITORY. B.M.(N.H.) Slide 1970 : 11 : 26 : 159.

PROVENANCE. Shore sand at Ynyslas, Borth, CB 153.

**REMARKS.** This species was first described by Walker and Boys, but has been ascribed to Montagu by many workers on the grounds that the original name was not properly binomial. However, if we take the reference to *Lagena*, in brackets, as indicating subgeneric status this objection disappears. That this was the intention of Walker and Boys is made manifest by no less an authority than Williamson (1848), 'The earliest notice of any forms of Lagenae which has come to my observation is in the "Testacea Minuta Rariora" of Mr Walker, published in 1784. He describes a number of British species which he arranged amongst the Serpulae, distinguishing them, however, by the subgeneric name of *Lagena*.' Incidentally, we have followed a similar course in regard to *Lagena sulcata*.

Further difficulty arises from the diverse interpretations put upon the type figures which as Cushman (1923) noted, 'show a more or less compressed pyriform test gradually tapering from the somewhat curved apertural end, with a very broad rounded basal portion, and instead of having a thin broad keel, have a rounded narrow marginal carina'. Early workers, such as Williamson, included many keeled forms under this species, more closely allied to *F. elliptica*. As the types are lost it seems best to follow the interpretation of Cushman and also Loeblich and Tappan which would include Williamson's figure 21. However, difficulty remains because figure 6c of Loeblich and Tappan apparently shows a rounded form without a keel, on the face of it nearer to *F. laevigata* (Reuss). It is also true that the keel of our specimen which appears rounded in reflected light appears thin and sharp by transmitted light in xylene. Care has to be taken not to confuse the poreless peripheral band in *F. lucida* and *F. species B* with a rounded keel when observing the specimens in side view.

**DISTRIBUTION.** Originally described from Reculver, Kent, near the Straits of Dover, this species seems to have a wide distribution in the North Atlantic area and Arctic.

### *Fissurina* species A

(Pl. 14, figs 3, 4; Text-fig. 20, nos 1, 2)

**DESCRIPTION.** (Text-fig. nos 1, 2.) Test unilocular, ovate with slightly produced neck, widest at midpoint, compressed with flattened sides, widest towards the base in side view; wall radial with finely and densely perforate patch on each side; aperture a long narrow slit with slightly everted lips the edges continuing into the thin marginal keel, with elongate, flaring entosolenian tube; additional rounded ridge on each side just within the periphery; wall opaque near the keel and the secondary ridges with a clear, non-perforate area surrounding the perforated patch and on the apertural neck.

**DIMENSIONS.** Length 0·16 mm. Width 0·13 mm, thickness—width in peripheral view—0·06 mm.

**MATERIAL.** Two specimens.

**VARIATION.** The specimen illustrated by stereoscanner is more elongate than the specimen described.

DEPOSITORY. B.M.(N.H.) Slides 1970 : II : 26 : 160, 1970 : II : 26 : 161, 162.  
Stub 1970 : II : 26 : 615.

PROVENANCE. Both specimens from Brit. Mus. Core 16.

REMARKS. The secondary keels are difficult to discern by light microscope and it is not quite certain if they exactly define the oval perforated area.

This species comes close to *F. contusa* Parr but is finely perforated rather than pitted on the sides.

***Fissurina* species B**

(Text-fig. 20, nos 5, 6)

DESCRIPTION. Test unilocular, elongate-ovate, widest near the base and tapering to the apertural end, slightly compressed, base truncate with two short spines; wall radial with fine perforations making a horseshoe pattern on either side, the clear area on the middle of each side widening downwards and extending to just below mid-point, periphery also non-perforate the clear band giving the appearance of a keel; aperture an elongate slit with rounded lips and irregular, bent back entosolenian tube.

DIMENSIONS. Length 0·14 mm, width 0·08 mm, thickness—width in peripheral view—0·07 mm.

MATERIAL. Three specimens.

VARIATION. One specimen has a slightly more pronounced aperture than the one described.

DEPOSITORY. B.M.(N.H.) Slide 1970 : II : 26 : 163, 164.

PROVENANCE. All specimens from the Low Marsh, Clettwr Transect, Dovey.

REMARKS. This species resembles *F. cucurbitasema* Loeblich & Tappan but differs in its truncate, bispinose base and peculiar distribution of pores. It is close to *Fissurina cucurbitasema bispinata* Ujiié, but is more elongate.

Genus ***GLOBULINA*** d'Orbigny, 1839

***Globulina* cf. *inaequalis*** Reuss, 1850

(Pl. 15, fig. 11; Text-fig. 21, nos 14, 15)

DESCRIPTION. Test subglobular, elongate, pointed at the apex, compressed; chambers arranged in a guttuline-triloculine spiral, number uncertain, but probably about seven, embracing so that only three or four can be seen from each side; sutures flush, hardly discernible; wall radial, minutely perforate; aperture a terminal rematophore with about 12 radiating grooves; slight ornament of discontinuous longitudinal costae just discernible.

DIMENSIONS. Length 0·52 mm, maximum width 0·41 mm, thickness 0·31 mm.

MATERIAL. Eight specimens, mostly juvenile.

VARIATION. Apart from variation in size due to growth there are slight differences in the amount of compression and in the acuteness of the apex. The slight ornament noted on the specimen described is not seen on the smaller specimens recovered so it may be a feature of growth also.

DEPOSITORY. B.M.(N.H.) Slide 1970 : 11 : 26 : 171. Stub 1970 : 11 : 26 : 621.

PROVENANCE. Specimen described, CB 330, Tremadoc Bay. Specimen photographed, Brit. Mus. Core 16.

REMARKS. The closely embracing chambers in this species, with flush sutures, give a smooth surface that appears featureless in stereoscanner photos. However, a good shot of the aperture was obtained. It proves to be a trematophore with 11 radiating grooves and a single, off centre, terminal orifice (Pl. 15, fig. 11).

Our specimens resemble *G. inaequalis* Reuss in their compression but are less produced apically than the types. They are near to the specimens included by Feyling-Hanssen (1964) in Reuss' species, but the presence of slight ornament in the well grown specimen described shows a tendency towards the costation seen in *G. myristiformis* (Williamson), though Williamson's species, like *G. gibba* d'Orbigny, is round in section.

Genus ***GUTTULINA*** d'Orbigny, 1839

***Guttulina* (? *Laryngosigma*) *harrisi* Haynes n. sp.**

(Text-fig. 21, nos 1-5)

*Guttulina lactea* part Cushman & Ozawa, 1930 : 43, pl. 10, figs 2-4 (not 1) (not Walker & Jacob).

DIAGNOSIS. An elongate-ovate species of '*Guttulina*' widest at midpoint and tapering to both ends. The chambers are subglobose and elongate, becoming shorter in the last part, arranged in a flattened, guttuline to sigmoid-biserial, anticlockwise spiral.

DESCRIPTION. Holotype. (Text-fig. nos 1, 2.) Test subglobular, elongate-ovate, about twice as long as wide, widest at midpoint and tapering to both ends, flattened oval in section, outline semi-lobate; apparently, nine chambers arranged in an anticlockwise spiral, flattened guttuline to begin with then becoming sigmoid-biserial in the last part, elongate, subglobose, increasing gradually in size as added, tending to reach back to the base but final chamber shorter; sutures distinct, impressed at an angle of about 70° to the horizontal; wall radial, vitreous, very finely perforate, smooth; aperture radiate with entosolenian tube.

DIMENSIONS. Length 0.80 mm, maximum diameter 0.36 mm.

MATERIAL. Twenty-five well preserved specimens.

VARIATION. The material includes juveniles (Text-fig. no. 5) that could be confused with *L. lactea* but the chambers are more globose and less embracing. Some specimens show more definite biserial arrangement in the last part (Text-fig.

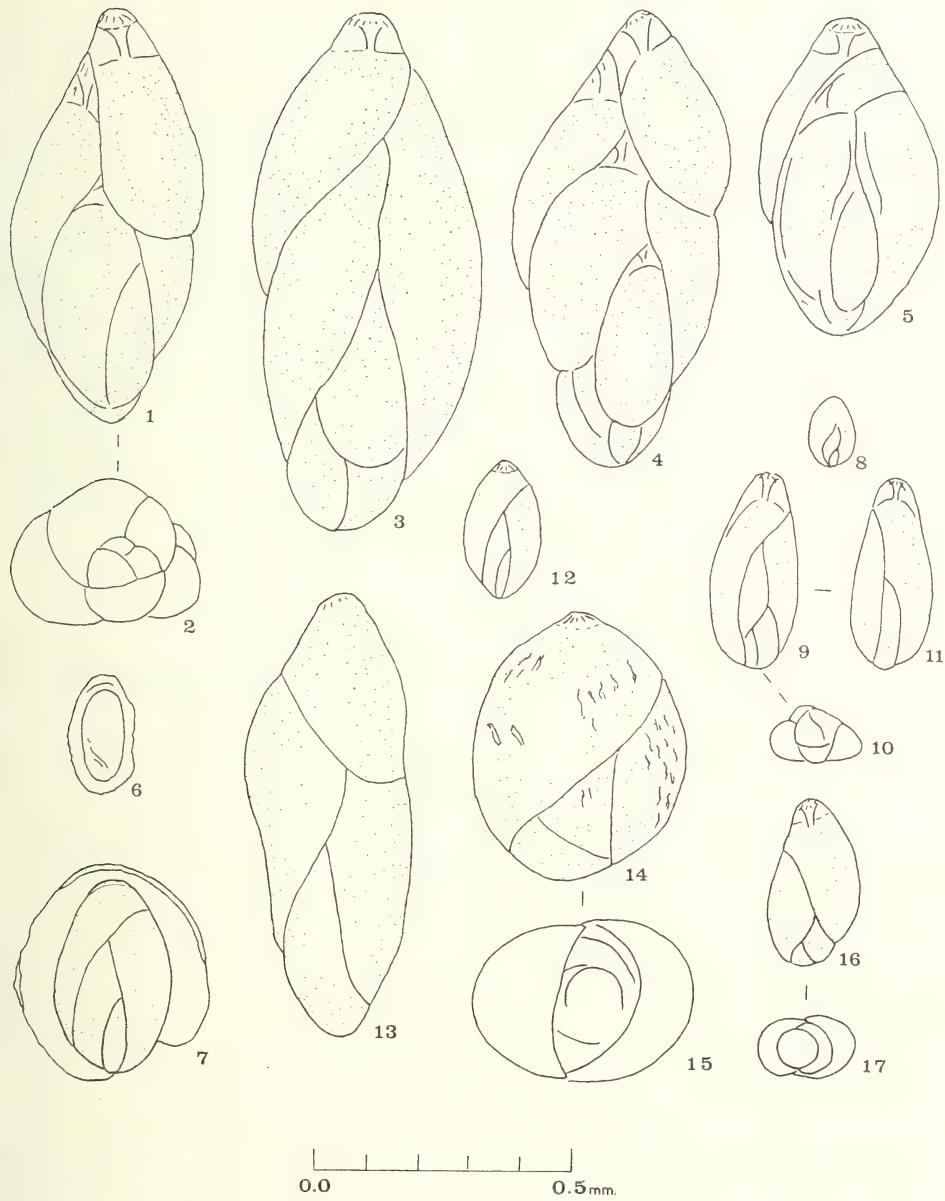


FIG. 21. 1-5. *Guttulina* (?*Laryngosigma*) *harrisi* n. sp. 1, side view of holotype; 2, basal view; 3-5, paratypes. 6, 7. *Laryngosigma lactea* var. *concava*. 6, small specimen with septa resorbed; 7, large specimen with septa visible. 8-12. *Laryngosigma lactea*. 8, type figure of Walker & Jacob (not to scale); 9, side view of specimen described (somewhat elongate variety); 10, basal view; 11, other side; 12, small oval specimen. 13. *Pseudopolymorphina suboblonga*, side view. 14, 15. *Globulina* cf. *aequalis*. 14, side view; 15, basal view. 16, 17. *Laryngosigma hyalascidia*. 16, side view; 17, basal view.

no. 4) here almost the entire adult part is biserial-sigmoid and contrasts with the specimen shown in Text-fig. no. 3 which shows less accelerated development. Specimens up to 1·10 mm in length occur.

DEPOSITORY. B.M.(N.H.) Slides 1970 : II : 26 : 165 (holotype), 1970 : II : 26 : 166-170 (paratypes).

PROVENANCE. Goldseeker haul 11059, North Sea, 58° North/1° West.

REMARKS. This species is difficult to place generically because it shows a flattened guttuline initial part while the adult part is sigmoid-biserial, as in *Sigmomorphina*. As a further complication the aperture has a striking entosolenian tube as in *Laryngosigma*. As we are still somewhat doubtful about the precise taxonomic significance of the internal tube we prefer to leave the generic status open for the time being and not to introduce a new name.

Cushman and Ozawa figured a number of specimens of this species from off Bantry Bay, S.W. Ireland and referred it to *Guttulina lactea* (W. & J.). In our view the type figure of Walker and Jacob shows a specimen with smoothly embracing chambers increasing faster in size as added and closely allied to *Laryngosigma williamsoni* (Terquem) = *Polymorphina oblonga* (Will.). The specimens of Cushman and Ozawa therefore require a new name and we have taken the opportunity of describing the species on the basis of specimens from the Harris collection of Goldseeker material —also referred to *G. lactea*. The species has been named in honour of Dr Harris whose work on the Scottish Recent Foraminifera, although unpublished, has been most valuable to us in the preparation of this monograph.

As pointed out by Cushman and Ozawa the more biserial specimens show an approach to *Sigmomorphina undulosa* (Terquem) and may have given rise to it.

DISTRIBUTION. This species occurs widely around the British Isles. It occurs in Goldseeker material from the Scottish Shelf, the Moray Firth and in the North Sea where, according to Dr Harris it reaches 6% of the total population at some stations.

### Genus *LARYNGOSIGMA* Loeblich & Tappan, 1953

#### *Laryngosigma hyalascidia* Loeblich & Tappan

(Text-fig. 21, nos 16, 17)

*Laryngosigma hyalascidia* Loeblich & Tappan, 1953 : 83, pl. 15, figs 6-8; Lutze, 1965 : 94, pl. 15, fig. 37; pl. 13, figs 10-12.

DIAGNOSIS. An elongate-ovate, subglobose species of *Laryngosigma* usually slightly irregular with the aperture turned to one side.

DESCRIPTION. Test subglobose, elongate-ovate, slightly compressed, with rounded base, maximum diameter near midpoint, outline entire; four chambers arranged in a biserial (?) flattened sigmoid) series, gradually increasing in size as added, becoming only slightly removed from the base with the last chamber reaching back

about three-quarters of the length; suture distinct, only slightly impressed, inclined at about  $55^{\circ}$  to the horizontal; wall radial, transparent, very finely perforate; aperture radiate with entosolenian tube.

**DIMENSIONS.** Length 0·33 mm, diameter 0·12 mm.

**MATERIAL.** Two specimens, both apparently juvenile.

**DEPOSITORY.** B.M.(N.H.) Slide 1970 : II : 26 : 172, 173.

**PROVENANCE.** Specimen described, Holocene, Grey Silty Sands, D21, Borth. Borehole 3.

**REMARKS.** Our specimens although small with only three and four chambers developed fit well into the series illustrated by Loeblich and Tappan, resembling those at the lower end of the size range, near 0·31 mm length. They are also very near to the specimens illustrated by Lutze.

**DISTRIBUTION.** Originally described from the Arctic this species has also been recovered from the Baltic.

***Laryngosigma lactea* (Walker & Jacob)**  
(Text-fig. 21, nos 8-12)

*Serpula lactea* Walker & Jacob, 1798 : 634, pl. 14, fig. 4.

*Vermiculum lacteum* (Walker & Jacob) Montagu, 1803 : 524.

*Biloculinia lactea* (Walker & Jacob) Brown, 1844 : 2, pl. 56, fig. 28 (1st edit. 1827, as *Miliola lactea*, pl. 1, fig. 23).

*Polymorphina lactea* (Walker & Jacob) Williamson, 1858 : 70, pl. 6, fig. 147, ? figs 153, 154; Brady, Parker & Jones, 1870 : 213, pl. 39, figs 1a, b; Terquem, 1875 : 441, pl. 5, fig. 12; 1876 : 79, pl. 10, figs 19, 20; Cushman, 1923 : 146, pl. 39, fig. 9 only (after Williamson).

*Guttulina lactea* (Walker & Jacob) Cushman & Ozawa, 1930 : 43, pl. 10, fig. 1 only, not 2-4 (figure after Walker & Jacob).

**DIAGNOSIS.** A compressed, egg-shaped to elongate-ovate species of *Laryngosigma* with chambers tending to reach back to the base. The sutures are often slightly sigmoid.

**DESCRIPTION.** (Text-fig. nos 9-II.) Test compressed, elongate-ovate with rounded base and slightly produced apex; six elongate chambers arranged in a flattened guttuline to sigmoid biserial series, gradually increasing in size as added, reaching back almost to the base; sutures distinct, very slightly impressed, slightly sigmoid, inclined at about  $70^{\circ}$  to the horizontal; wall radial and minutely perforate; aperture radiate with entosolenian tube; smooth and vitreous.

**DIMENSIONS.** Length 0·38 mm, maximum diameter 0·17 mm.

**MATERIAL.** Two specimens.

**DEPOSITORY.** B.M.(N.H.) Slide 1970 : II : 26 : 174, 1970 : II : 26 : 175 (elongate variety). Stub 1970 : II : 26 : 623.

**PROVENANCE.** Specimen described, Brit. Mus. Core 14.

**REMARKS.** This species has been widely misinterpreted, much of the confusion

being caused by the wide latitude given for the species by Williamson and Brady, Parker and Jones. Most of the specimens figured by Williamson belong to other species, possibly even fig. 147 which was accepted by Cushman (1923). We restrict the specific name to compressed, oval to elongate-ovate forms with the last two chambers making up most of the test, as in the type figure (copy Text-fig. no. 12). This species is in series with *L. williamsoni* (Terquem) which is distinguished by its oblong shape in side view and almost vertical septal sutures. The specimens figured by Cushman & Ozawa (1930) from S.W. of Ireland, figs 2-4, and by Harris (1958), are different and are included here in *Guttulina* (? *Laryngosigma*) *harrisii* n. species.

*Sigmomorphina semitecta* (Reuss) var. *terquemiana* (Fornasini) is probably synonymous with *L. lactea*.

DISTRIBUTION. The species was originally described from Sandwich (English Channel) and also by Brown from the coast of Devonshire. It also occurs on the channel coast of France and around the Scillies (Atkinson, 1970).

### *Laryngosigma lactea* var. *concava* (Williamson)

(Text-fig. 21, nos 6, 7)

*Polymorphina lactea* var. *concava* Williamson, 1858 : 72, pl. 6, figs 151, 152.

*Polymorphnia concava* (Williamson) Brady, Parker & Jones, 1870 : 236, pl. 40, figs 22a, b; Jones, 1896 : 264, pl. 5, fig. 22; Heron-Allen & Earland, 1909 : 431, pl. 17, fig. 6.

*Guttulina lactea* (Walker & Jacob) var. *earlandi* Cushman & Ozawa, 1930 : 45, pl. 10, fig. 5 (after Heron-Allen & Earland).

*Sigmomorphina concava* (Williamson) Cushman & Ozawa, 1930 : 139, pl. 38, figs 5-7.

DIAGNOSIS. An attached variety of *Laryngosigma lactea* with spreading peripheral flange.

DESCRIPTION. (Text-fig. no. 7.) Test attached, concavo-convex with spreading peripheral flange apparently formed by resorption of the fixed side; outline of the original chambers visible on the convex side showing the former egg shape and four elongate chambers with flattened guttuline to sigmoid biserial arrangement; former terminal aperture still visible and sutures distinct but internal septa largely dissolved away; smooth.

DIMENSIONS. Diameter 0.40 mm. Length of specimen before attachment 0.37 mm.

MATERIAL. Six specimens attached to sand grains.

VARIATION. There is variation in size down to specimens only 0.22 mm in maximum diameter and also every gradation to forms with internal septa entirely dissolved away and sutures no longer visible (Text-fig. no. 6).

DEPOSITORY. B.M.(N.H.) Slide 1970 : 11 : 26 : 176-177. Stub 1970 : 11 : 26 : 624.

PROVENANCE. Specimen described, CB 356. Other specimen figured, CB 477.

REMARKS. There seems little doubt that this variety represents a growth form

of *L. lactea*, possibly the modification of the test to act as a brood chamber. We certainly see no grounds for placing it in a separate subfamily, under *Webbinella*.

As a result of their conception of *L. lactea* (discussed above) Cushman and Ozawa transferred this variety to *Sigmorphina* and coined a new name for the specimen of Jones from the Coralline Crag. We believe these specimens are both variety *concava*.

Genus ***OOLINA*** d'Orbigny, 1839

***Oolina borealis*** Loeblich & Tappan

(Pl. 14, fig. 6)

*Entosolenia costata* Williamson, 1858 : 9, pl. 1, fig. 18.

*Lagena costata* (Williamson) Wright, 1877 : 103, pl. 4, figs 11, 12 and 13; Balkwill & Wright, 1885 : 338, pl. 14, figs 3-5; Cushman, 1923 : 12, pl. 1, fig. 16; pl. 2, figs 1, 2 (not pl. 3, fig. 8); 1944 : 21, pl. 3, fig. 4.

*Oolina costata* (Williamson) Parker, 1952a : 409, pl. 4, figs 20, 21; Loeblich & Tappan, 1953 : 68, pl. 13, figs 4-6.

*Oolina borealis* Loeblich & Tappan, 1954 : 384 (new name).

*Oolina patannae* Haman, 1966b : 68, pl. 7, figs 12, 13, 14.

DIAGNOSIS. An *Oolina* with broad longitudinal grooves which tend to be restricted to the lower two-thirds of the test.

DESCRIPTION. Test ovate with produced apertural end, round in section; with 22 broad grooves originating near the base and extending two-thirds of the way towards the apex, dividing the lower part of the test into flat ribs of about equal width; summit smooth with produced aperture bearing a rounded lip, with narrow internal tube; wall apparently radial and densely perforated with minute pores.

DIMENSIONS. Length 0.37 mm, breadth 0.28 mm.

VARIATION. Specimens with narrow ribs occur and Loeblich and Tappan illustrate a double specimen in which the terminal form has ribs reaching to the aperture, as in the type figure of Williamson. Some specimens have as few as 13 ribs and are more slender.

MATERIAL. Two specimens only.

DEPOSITORY. B.M.(N.H.) Slide 1970 : 11 : 26 : 178. Stub 1970 : 11 : 26 : 674.

PROVENANCE. Illustrated specimen, CB 316.

REMARKS. The type specimen is lost so it seems best to follow the interpretation of the figure made by Balkwill and Wright and followed consistently by Loeblich and Tappan.

Loeblich and Tappan describe radiate apertures in their population but this is not seen in our specimen which also differs in possessing a round lip. However, the illustrations of Balkwill and Wright do show a specimen with rounded lip as well as horizontal grooves which possibly mark the former attachment of another chamber. Variation in aperture form may therefore be connected with the occurrence of the bilocular 'freaks' of Loeblich and Tappan.

DISTRIBUTION. This species was originally described from Skye and records appear to be restricted to the North Atlantic, particularly west of Great Britain: Irish Sea (Balkwill & Wright, 1885); West of Scotland (Heron-Allen & Earland, 1916a); West of Ireland (Heron-Allen & Earland, 1913b; Wright, 1891, 1902); Faroes (Haman, 1966); Scillies (Atkinson, 1970).

As well as the Arctic records of Loeblich & Tappan (1953) it has also been recorded off New England by Cushman (1944) and Parker (1952a).

*Oolina heronalleni* Haynes n. sp.

(Pl. 14, fig. 7)

*Lagena costata* part Heron-Allen & Earland, 1916a : 243, pl. 41, figs 17, 18; part Cushman, 1923 : 12, pl. 3, fig. 8, after Heron-Allen & Earland (not Williamson).

DIAGNOSIS. An ovate *Oolina* with up to 20 strong costae, broad truncate neck and tendency to a pointed base.

DESCRIPTION. (Holotype.) Test ovate with bluntly pointed base and truncate summit, greatest width at midpoint, round in section; with about 20 longitudinal costae running from the base to just below the neck, tending to be slightly irregular towards the base; aperture narrow with internal tube and wide, truncate neck with rounded rim; wall radial and minutely perforate (there are a number of larger, scattered, irregular holes possibly bored by fungi).

DIMENSIONS. Length 0.20 mm, breadth 0.15 mm.

DEPOSITORY. B.M.(N.H.) Slide 1970 : 11 : 26 : 179-180 (paratypes). Stub 1970 : 11 : 26 : 668 (holotype).

PROVENANCE. Described specimen, Brit. Mus. Core 14.

MATERIAL. Three specimens. Two additional specimens in the Heron-Allen and Earland Runa Collection in the British Museum. Slide 1955 : 10 : 24 : 40-41.

VARIATION. There is variation in the number of costae developed, approximately 18-21, and in the regularity of their development towards the base (see figures of Heron-Allen & Earland).

REMARKS. As was so often their practise in their papers Heron-Allen and Earland illustrated their remarks on *Lagena costata* (= *O. borealis*) from the West of Scotland with a figure of an unusual specimen, a form in which 'the aperture is broad, furnished with a thickened lip and, but slightly, produced, contrasting with the short but stoutly built produced neck of the type'. Both Harris and later Adams in their unpublished theses interpreted their specimens of *Oolina costata* (*borealis*) on the basis of this figure. As stated under *O. borealis* we are now following the conception of *O. costata* (Williamson) developed by Balkwill and Wright and Loeblich and Tappan to cover specimens with deep grooves rather than costae, smooth summits and produced necks. This means that a new name is required for the specimens first discovered by Heron-Allen and Earland.

DISTRIBUTION. First described from a number of stations off the West of Scotland.

DERIVATION OF NAME. In honour of E. Heron-Allen, doyen of British Recent microscopists in the early twentieth century.

***Oolina hexagona* (Williamson)**

(Pl. 14, figs 12, 13; Pl. 15, figs 3 and 6)

*Entosolenia squamosa* (Montagu) var. *y hexagona* Williamson, 1848 : 20, pl. 2, fig. 23; Williamson, 1858 : 13, pl. 1, fig. 32.

*Entosolenia globosa* var. *squamosa* (Montagu) Parker & Jones, 1857 : 278, pl. 11, fig. 25.

*Lagena sulcata* Walker & Jacob var. (*Entosolenia*) *squamosa* Montagu, sp. Parker & Jones, 1865 : 354, pl. 13, figs 40, 41; pl. 16, figs 11a, b.

*Lagena hexagona* (Williamson) Brady, 1884 : 472, pl. 58, figs 32, 33; Goës, 1894 : 79, pl. 13, fig. 746; Cushman, 1923 : 24, pl. 4, fig. 6; 1949 : 22, pl. 4, fig. 7.

*Oolina hexagona* (Williamson) Voorthuysen, 1950 : 56, pl. 1, fig. 12; Loeblich & Tappan, 1953 : 69, pl. 14, figs 1, 2; Voorthuysen, 1960 : 246, pl. 10, fig. 14; Haake, 1962 : 35, pl. 2, fig. 5; Feyling-Hanssen, 1964 : 311, pl. 15, fig. 4.

*Lagena favosa* Reuss, 1863 : 334, pl. 5, figs 72, 73.

DIAGNOSIS. An *Oolina* with a raised network of ridges dividing the outer surface of the test into an irregular display of hexagonal depressions; 7–10 between summit and base.

DESCRIPTION. (Pl. 14, fig. 12; Pl. 15, figs 3 and 6.) Test ovate with produced apertural end, round in cross section; with a strongly raised network of ridges dividing the surface into an irregular, fishing net pattern of hexagonal depressions; about eight hexagons between the base and the aperture, minutely tuberculate in detail; aperture round, with narrow lip at the end of a short, smooth neck, with narrow internal tube; wall radial hyaline and minutely perforate, including the raised ridges; pores irregular in shape and distribution.

DIMENSIONS. Length 0·24 mm, breadth 0·16 mm. Hexagons approx. 30 microns in maximum diameter.

MATERIAL. Twelve specimens.

VARIATION. There is variation in appearance caused by differences in elevation and regularity of the hexagonal meshwork. Specimens with irregular outline also occur (Pl. 14, fig. 13).

DEPOSITORY. B.M.(N.H.) Slide 1970 : II : 26 : 181–183. Stubs 1970 : II : 26 : 669, 1970 : II : 26 : 753.

PROVENANCE. Described specimen, Holocene Scrobicularia Clays, Borth.

DISTRIBUTION. This species, originally described from near the Shetlands, occurs commonly at all depths on the continental shelf around the British Isles: Irish Sea (Bruce *et al.*, 1963; Burgess, 1891; Chaffer, 1894; Gough, 1906; Pearcey, 1891; Robertson, 1883; Wright, 1907); West of Scotland (Burgess, 1889; Heron-

Allen & Earland, 1916a; Robertson, 1877, 1892); West of Ireland (Heron-Allen & Earland, 1913b; Wright, 1895, 1900); Celtic Sea and English Channel (Atkinson, 1970; Heron-Allen & Earland, 1916b, 1930; Le Calvez, 1958; Murray, 1965a; Worth, 1904); North Sea (Haake, 1962; Heron-Allen & Earland, 1913c; Robertson & Brady, 1876).

The species also occurs in deep water, at 1000 fathoms off S.W. Ireland (Wright, 1889) and in the warm and cold areas of the Faroe Channel (Pearcey, 1890). It also occurs in the cold waters of high latitudes around Spitzbergen (Goës, 1894), Iceland (Norvang, 1945), Arctic Basin (Green, 1960; Loeblich & Tappan, 1953) as well as in the Eastern Atlantic.

South Atlantic and Antarctic records include (Boltovskoy, 1959, 1961; Chapman & Parr, 1937; Heron-Allen & Earland, 1932; Earland, 1934, 1936).

Mediterranean: (Buchner, 1940; Cita & Chierici, 1962; Norin, 1958; Ruscelli, 1949); North Pacific: (Asano, 1960; Cushman, 1913).

South Pacific and Australasia: (Hulme, 1964; Kindle, 1931; Sidebottom, 1912; Vella, 1957).

This species is therefore cosmopolitan but with an apparent preference for cooler waters, though tropical references include Brady (1884) and Le Calvez (1963).

### *Oolina laevigata* d'Orbigny

(Pl. 14, fig. 11)

*Oolina laevigata* d'Orbigny, 1839c : 19, pl. 5, fig. 3.

DIAGNOSIS. A smooth *Oolina* shaped like a tear drop and possessing a large glassy trematophore with radiating slits.

DESCRIPTION. Test globular with produced apertural end, round in section; aperture large and composed of a circular, glassy (possibly non-perforate) trematophore with eight radiate grooves; wall apparently radial, smooth and presumably, minutely perforate; faint trace of entosolenian tube.

DIMENSIONS. Length 0·23 mm, breadth 0·19 mm.

MATERIAL. Three specimens.

DEPOSITORY. B.M.(N.H.) Slide 1970 : 11 : 26 : 184. Stub 1970 : 11 : 26 : 670.

PROVENANCE. Described specimen, Station V, Clettwr Transect, Dovey Marshes.

REMARKS. Confusion of this species with *O. globosa* (Montagu) which has a small round aperture may account for the lack of records in the British Isles area.

DISTRIBUTION. This species was described by d'Orbigny from the Falkland Islands and other South Atlantic records are by Heron-Allen & Earland (1932) and Earland (1934). A listing by Atkinson (1970) for the Scillies and our records, for three stations, show that it also occurs rarely in high northern latitudes.

*Oolina lineata* (Williamson)

(Pl. 14, figs 8-10)

*Entosolenia lineata* Williamson, 1848 : 18, pl. 2, fig. 18; Cushman, 1949 : 35, pl. 7, fig. 1.*Entosolenia globosa* var. *lineata* Williamson, 1858 : 9, pl. 1, fig. 17.*Lagena lineata* (Williamson) Balkwill & Wright, 1885 : 336, pl. 14, figs 13-16; Cushman, 1923 : 31, pl. 5, fig. 10; pl. 6, figs 5-8.*Oolinea lineata* (Williamson) Loeblich & Tappan, 1953 : 70, pl. 13, figs 11-13; Voorthuysen, 1960 : 247, pl. 10, fig. 15; Haake, 1962 : 36, pl. 2, fig. 6.*Lagena caudata* Balkwill & Millett, 1884 : 78, pl. 1, fig. 9 (not d'Orbigny).

**DIAGNOSIS.** An *Oolina* with fine, longitudinal striae and slightly produced, truncate apertural end.

**DESCRIPTION.** (Pl. 14, figs 9, 10.) Test elongate-ovate with slightly produced, truncate apertural end, round in cross section, base rounded with broken remnant of a hollow spine; with delicate, close set longitudinal striae which although not continuous are interleaved to completely cover the surface; aperture of irregular radiating grooves set in a depressed hollow, with long internal tube; wall radial hyaline and minutely perforate; base near spine minutely tuberculate.

**DIMENSIONS.** Length (excluding spine) 0.28 mm, breadth 0.18 mm. Diameter of pores less than half one micron.

**MATERIAL.** Four specimens.

**VARIATION.** The basal spine may be absent and the shape varies from globular to elongate-ovate, Pl. 14, fig. 8.

**DEPOSITORY.** B.M.(N.H.) Slide 1970 : II : 26 : 185-186. Stubs 1970 : II : 26 : 667, 1970 : II : 26 : 671.

**PROVENANCE.** Described specimen, CB 493.

**REMARKS.** Williamson mentions that a produced, tubular neck may be present and Balkwill and Wright illustrate such a specimen from Lambay Deep in the Irish Sea. Possibly the 'neck' in this case represents the internal, entosolenian, tube of a broken, originally double chambered specimen. It is interesting that in the specimen we describe the basal spine is hollow, Pl. 14, fig. 9. Balkwill and Wright illustrate both an irregular double specimen as well as five separate chambers springing from a common centre.

Some of the Recent specimens referred to *Oolina apiculata* Reuss, a Cretaceous species, may belong here, as for instance those illustrated by Brady (1884, pl. 56, figs 15, 16) from the Shetlands. If definitely smooth, such specimens should be referred to *Oolina caudigera* (Wiesner) as pointed out by Loeblich and Tappan in the case of *Entosolenia lineata* Cushman (1948).

**DISTRIBUTION.** This species is widespread around the British Isles as shown by the original list of Williamson and many records since, particularly on the western side: Irish Sea (Balkwill & Millett, 1884; Balkwill & Wright, 1885; Chaster, 1892; Gough, 1906); West of Scotland (Heron-Allen & Earland, 1916a; Pearcey, 1888); West of Ireland (Cushman, 1923; Heron-Allen & Earland, 1913b); English Channel (Clarke, 1906; Earland, 1905); North Sea (Haake, 1962; Voorthuysen, 1960).

Other records appear to be restricted to the Arctic (Loeblich & Tappan, 1953), the Pacific record of Brady (1884, pl. 57, fig. 13) almost certainly representing another species, with regular striae that do not reach the summit of the test.

### *Oolina squamosa* (Montagu)

(Pl. 14, fig. 14; Pl. 15, figs 4, 5)

- Vermiculum squamosum* Montagu, 1803 : 526, pl. 14, fig. 2.  
*Lagena squamosa* (Montagu) Brown, 1844 : 3, pl. 56, fig. 32; Balkwill & Wright, 1885 : 340, pl. 14, fig. 9; Goës, 1894 : 79, pl. 13, fig. 745; Mills, 1900 : 147, pl. 2, fig. 24; Cushman, 1923 : 51, pl. 10, figs 3, 4; 1949 : 21, pl. 4, fig. 12.  
*Entosolenia squamosa* (Montagu) Williamson, 1858 : 12, pl. 1, fig. 29.  
*Entosolenia squamosa* var. *catenulata* Williamson, 1848 : 19, pl. 2, fig. 20; 1858 : 13, pl. 1, fig. 31.  
*Entosolenia squamosa* var. *scalariformis* Williamson, 1848 : 20, pl. 2, figs 21, 22.  
*Oolina squamosa* (Montagu) Van Voorthuysen, 1951 : 24, pl. 1, fig. 12; ? Van Voorthuysen, 1960 : 247, pl. 10, fig. 17.  
*Oolina melo* d'Orbigny, 1839c : 20, pl. 5, fig. 9; Loeblich & Tappan, 1953 : 71, pl. 12, figs 8-15; Van Voorthuysen, 1960 : 247, pl. 10, fig. 16; Haake, 1962 : 37, pl. 2, fig. 7; Feyling-Hanssen, 1964 : 312, pl. 15, figs 6, 7.  
*Lagena catenulata* (Williamson) Cushman, 1923 : 9, pl. 1, fig. 11; 1944 : 21, pl. 3, fig. 9.  
*Lagena melo* (d'Orbigny) Cushman, 1949 : 21, pl. 4, fig. 6.  
*Entosolenia globosa* (Montagu) var. *catenulata* (Williamson) Parker & Jones, 1857 : 278, pl. 11, fig. 26.  
*Entosolenia hexagona* Williamson var. *scalariformis* (Williamson) Cushman, 1948 : 64, pl. 7, fig. 6.  
not *Oolina squamosa* Loeblich & Tappan, 1953 : 73, pl. 13, figs 9, 10 (= *Oolina montagui*).

DIAGNOSIS. An *Oolina* with interlocking raised riblets producing a fish scale or chain mail pattern of loops. These may be irregular or arranged in vertical rows with their ends joined to make raised longitudinal ridges; 8-22 rows developed with the ridges strongest in specimens with the fewest rows, the loops being weak in these forms and sometimes developed as straight bars.

DESCRIPTION. (Pl. 14, fig. 14; Pl. 15, figs 4 and 5.) Test ovate with slightly produced apertural end, round in section; with 18-20 rows of interlocking riblets, generally looped towards the aperture but occasionally developed as straight bars and sometimes irregular, about 12 loops in a longitudinal row becoming smaller towards the aperture, the joined ends in adjacent rows making weak longitudinal ridges; aperture round, with a lip that is connected with the riblets and of equal thickness, with internal tube; wall radial and lamellar, minutely perforate.

DIMENSIONS. Length 0.25 mm, breadth 0.18 mm. Loops reaching about 25 microns in maximum length.

MATERIAL. Twelve specimens.

VARIATION. There is apparently continuous variation from specimens with irregular loops through to specimens with as few as eight strong vertical costae with weak horizontal bars, *Entosolenia squamosa* var. *scalariformis* of Williamson.

DEPOSITORY. B.M.(N.H.) Slide 1970 : II : 26 : 187. Stub 1970 : II : 26 : 673.

PROVENANCE. Described specimen, CB 657.

REMARKS. As can be seen from the synonymy workers have attempted to distinguish between this species and *Oolina melo* of d'Orbigny, here considered to be merely a variety with straight bars instead of rounded loops.

Williamson considered Montagu's figure, showing a fish scale pattern, to be the result of observation out of focus 'through the imperfect instruments used in the time of Mr Walker'. However, as shown by Pl. 14, fig. 14 the stereo scanning microscope validates the type figure in this respect. The figures of Loeblich and Tappan show specimens with both scale-like loops and straight bars and a range of form that includes the varieties recognized by Williamson.

Specimens crushed and examined in polarized light show two sizes of pores which also perforate the ornament.

DISTRIBUTION. This species is widespread on the continental shelf around the British Isles: Irish Sea (Balkwill & Wright, 1884, 1885; Pearcey, 1891; Robertson, 1883; Siddall, 1878); West of Scotland (Heron-Allen & Earland, 1916a; Robertson, 1892); English Channel (Heron-Allen & Earland, 1916b, 1930; Murray, 1965a; Robertson, 1870); North Sea (Cushman, 1949; Haake, 1962; Mills, 1900; Risdal, 1963; Voorthuysen, 1960).

The species is also common in northern cold water areas: Arctic (Cushman, 1948; Goës, 1894; Leslie, 1963; Loeblich & Tappan, 1953; Norvang, 1945) as well as in the cool water areas of the South Atlantic (Boltovskoy, 1954, 1959, 1961, 1963; Heron-Allen & Earland, 1932; d'Orbigny, 1839c) and the Antarctic (Bandy & Echols, 1964; Parr, 1950).

Pacific records are fewer but include (Brady, 1884; Sidebottom, 1912; Uchio, 1962) and in Australasia (Chapman, 1941; Hulme, 1964)

A cosmopolitan distribution is therefore indicated with a preference for shallow water in high latitudes.

### *Oolina williamsoni* (Alcock)

(Pl. 14, figs 15-17; Pl. 15, figs 1, 2, 7)

*Entosolenia williamsoni* Alcock, 1865 : 193.

*Lagena williamsoni* (Alcock) Wright, 1877 : 104, pl. 4, fig. 14; Balkwill & Wright, 1885 : 339, pl. 14, figs 6-8; Cushman, 1923 : 61, pl. 11, figs 8, 9; 1949 : 22, pl. 4, fig. 11.

*Oolina williamsoni* (Alcock) Voorthuysen, 1951 : 24, pl. 1, fig. 14; 1960 : 247, pl. 10, fig. 18; Haake, 1962 : 37, pl. 2, fig. 8; Feyling-Hanssen, 1964 : 312, pl. 15, fig. 8.

*Lagena alcocki* White, 1956 : 246, pl. 27, fig. 7 (new name).

DIAGNOSIS. An *Oolina* with longitudinal grooves between strong ribs which coalesce to form a series of lozenge-shaped meshes at the apertural end.

DESCRIPTION. (Pl. 14, figs 15, 16.) Test ovate with produced apertural end, round in cross section; with 22 strong ribs which originate at the base and cross the equator to coalesce at the apertural end to make a marked collar of lozenge-shaped meshes; sides between the ribs deeply grooved and the ribs as well as the meshes

of the collar undercut; aperture short and nipple-shaped with thick, rounded lip and narrow internal tube; wall radial hyaline and densely perforated with minute pores.

DIMENSIONS. Length 0·31 mm, breadth 0·20 mm.

MATERIAL. More than 25 specimens.

VARIATION. The ribs vary in number from 14–25 and in strength of development, being markedly produced at the sides and overhanging in some specimens (Pl. 14, fig. 17). There may be up to four rings of meshes in the collar. There is also variation in the size of the apertural tube, as in the figured specimens where the largest specimen has the smallest aperture.

DEPOSITORY. B.M.(N.H.) Slide 1970 : 11 : 26 : 188. Stub 1970 : 11 : 26 : 675.

PROVENANCE. Specimen described and additional ones illustrated, CB 65.

REMARKS. Examined in plane polarized light the wall of this species was seen to consist of a number of lamellae, the outermost being the thinnest. The wall is densely and finely perforate but some of the pores do not completely penetrate through the lamellae to reach the outside. N.B. White's suggested new name is unnecessary as the species has already properly been transferred to *Oolina* so homonymy with *Lagena williamsoni* Harvey & Bailey does not arise; in any case Harvey and Bailey gave no figure or depository.

DISTRIBUTION. This species occurs commonly at shallow depths all round the British Isles, particularly on the western side: Irish Sea (Balkwill & Wright, 1885; Bruce *et al.*, 1963; Burgess, 1891; Gough, 1906; Pearcey, 1891); West of Scotland (Burgess, 1889; Heron-Allen & Earland, 1916a; Robertson, 1892); West of Ireland (Alcock, 1865; Balkwill & Millett, 1884; Heron-Allen & Earland, 1913b; Wright, 1895, 1900); Celtic Sea and English Channel (Atkinson, 1970; Halkyard, 1889; Heron-Allen & Earland, 1909, 1911, 1916b, 1930; Le Calvez, 1958; Murray, 1965a, 1970); North Sea (Cushman, 1949; Haake, 1962; Hedley & Underwood, 1957; Heron-Allen & Earland, 1913c; Pearcey, 1902).

The species has also been recovered in the cold waters of high latitudes near Spitzbergen (Goës, 1894) and from the South Atlantic (Heron-Allen & Earland, 1932). As yet there are no references from the eastern seaboard of North America and only scattered records from the Mediterranean (Buchner, 1940; Hofker, 1960) and the Pacific (Cushman, 1927, 1933). This seems to indicate a marked concentration in the Eastern Atlantic and a preference for cooler waters. It is the most abundant species of *Oolina* in Cardigan Bay.

#### Genus **PSEUDOPOLYMORPHINA** Cushman & Ozawa, 1928

##### *Pseudopolymorphina* cf. *novangliae* (Cushman) 1923

(Pl. 15, fig. 8; Pl. 16, figs 10, 17)

DESCRIPTION. Test elongate, broadest towards the obtusely pointed base, tapering to the slightly produced, twisted, apex, compressed oval in section; cham-

bers arranged in a quinqueloculine spiral at the beginning, last ones polymorphine, elongate and inflated, embracing, last two making up most of the test; sutures only slightly impressed, making an angle of about  $50^{\circ}$  to the horizontal; wall thick, radial and minutely perforate, glassy; aperture terminal, a large, round trematophore with 16 projecting bars meeting irregularly at the centre.

DIMENSIONS. Length 0.35 mm, width 0.17 mm, thickness 0.14 mm.

MATERIAL. Two specimens, one of them broken.

DEPOSITORY. B.M.(N.H.) Stub 1970 : 11 : 26 : 684.

PROVENANCE. Holocene, Boreal Sands, Borehole 2, Borth.

REMARKS. Our specimens resemble Cushman's N.W. Atlantic species but are much smaller and the complete one illustrated has a more produced apex than the types. Cushman (1944) described his species as the largest member of the family occurring off the New England coast, up to 2 mm length, so our specimens could be juveniles.

### *Pseudopolymorphina suboblonga* Cushman & Ozawa

(Text-fig. 21, no. 13)

*Pseudopolymorphina suboblonga* Cushman & Ozawa, 1930 : 91, pl. 23, figs 3a-c; Feyling-Hanssen, 1964 : 300, pl. 13, fig. 4.

DIAGNOSIS. An elongate, suboblong species of *Pseudopolymorphina* reaching its greatest breadth towards the apical end.

DESCRIPTION. Test elongate, suboblong, greatest width at last two chambers, tapering to the subrounded base, apex broadly acuminate, subcircular in transverse section; chambers arranged in a sinistral guttuline to roughly biserial spiral, elongate, increasing gradually in size as added and successively removed from the base, terminal chamber shorter; sutures only very slightly impressed; wall radial, finely and densely perforate; aperture terminal and compressed, oval trematophore with irregular radiating grooves.

DIMENSIONS. Length 0.86 mm, diameter 0.36 mm.

MATERIAL. One adult and what appears to be one juvenile.

DEPOSITORY. B.M.(N.H.) Stub 1970 : 11 : 26 : 622.

PROVENANCE. Specimen described Brit. Mus. Core 15. Juvenile, Holocene Grey Silty Sands, Borth.

REMARKS. The specimen described is just below the size range given for the types.

DISTRIBUTION. This species was originally described from the Upper Pliocene and Recent of Japan. It has been recorded from the Holocene of Norway by Feyling-Hanssen.

## Family TURRILINIDAE Cushman, 1927

Genus **BULIMINELLA** Cushman, 1911*Buliminella borealis* Haynes n. sp.

(Text-fig. 22, nos 1-3)

*Bulimina elegantissima* Williamson, 1858 : 64, pl. 5, figs 134, 135 (not d'Orbigny).*Buliminella elegantissima* Cushman, 1911 : 88; Hoglund, 1947 : 215, pl. 18, fig. 1; text-figs 196, 197; Cushman, 1944 : 27, pl. 3, figs 43, 44; 1949 : 30, pl. 4, figs 4, 5; Parker, 1952a : 416, pl. 5, figs 27, 28; Voorthuysen, 1960 : 250, pl. 11, fig. 10; Haake, 1962 : 34, pl. 2, figs 1, 2.

**DIAGNOSIS.** An elongate-ovate species of *Buliminella* in which the last whorl makes up most of the test and in which the apertural face of the last chamber is about two-thirds the total length.

**DESCRIPTION.** (Holotype. Text-fig. no. 1.) Test elongate-ovate, more than twice as long as broad, greatest width just below midpoint, base and apex rounded, spiral suture marked and slightly impressed; about 18 chambers arranged in a drawn out, sinistral, helicoid spiral with about 11 in the last whorl which makes up most of the test; sutures distinct, flush and sinuous, approaching vertical in the last part; wall radial, minutely perforate; aperture within an excavation at the distal end of the flattened, imperforate apertural face which makes a distinct angle to the rest of the test and extends for more than two-thirds its length.

**DIMENSIONS.** Length 0.25 mm, maximum width 0.10 mm.

**MATERIAL.** More than 25 specimens.

**VARIATION.** Most of the specimens recovered were small (Text-fig. nos 1-3) but some specimens occurred over 0.30 mm in length. As shown by our figures there is variation from an elongate-ovate shape to specimens with more pointed ends,

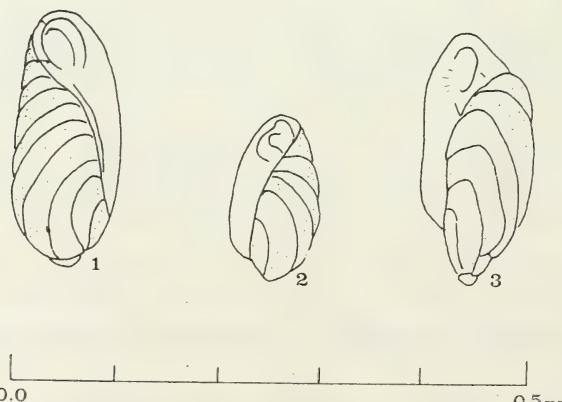


FIG. 22, 1-3. *Buliminella borealis*. 1, holotype, side and apertural view; 2, paratype, apertural view; 3, paratype, apertural view.

We do not have enough specimens to make a proper study of dimorphism but one figured with protruding proloculus (Text-fig. no. 3) comes near to the mean of 20 microns for the range of proloculus size given by Hoglund (1947). The number of chambers in the last whorl varies from 6 to 11. Coiling in both directions occurs.

DEPOSITORY. B.M.(N.H.) Slides 1970 : 11 : 26 : 189 (holotype), 1970 : 11 : 26 : 190-193 (paratypes). Stub 1970 : 11 : 26 : 550 (paratype).

PROVENANCE. Holotype, CB 549. Paratypes, Caernarvon Bay, CB 360 and CB 542. Stereoscanner photo, CB 360.

REMARKS. In 1947 Hoglund expressed doubt concerning the identity of specimens which he allowed with some hesitation, to pass under the designation of *Buliminella elegantissima*, a species first described from the west coast of South America by d'Orbigny (1839c). The type is apparently lost as it could not be found in d'Orbigny's Paris collections by Heron-Allen & Earland (1932), but the refiguring of the species by Hofker (1951a) and Loeblich & Tappan (1964a) with illustrations of specimens from off Brazil and Peru shows that d'Orbigny's type figure is remarkably accurate. The species is elongate and made up of about three whorls of chambers in a markedly drawn out spiral. The apertural face is a little less than half the total length with comma-shaped aperture and cornet-shaped, tooth plate with 'sawed' free end. Specimens from the North Atlantic first figured and put under this name by Williamson (1858) are different. Our specimens resemble Williamson's figure in that the last whorl makes up most of the test and in that they tend to be widest below midpoint and possess a flat apertural face about two-thirds the total length. The sutures are often markedly sinuous and the chambers extremely long. Like Hoglund we have found difficulty in making out the details of the aperture, 'sunk like a crater' near the apex and there is no sign of the neat, comma-shaped opening of d'Orbigny's species in our specimens. Elucidation of this structure will require exceptionally well preserved and clean specimens.

Workers in the N. Atlantic area appear to have consistently followed Williamson's lead in the interpretation of *B. elegantissima* and we have included references with good figures in our synonymy.

It is interesting that the figures given by Heron-Allen and Earland in their Falkland Island monograph seem to show yet another species, with shorter chambers and shorter, rounded, apertural face. They also show much larger, bulbous magalospheres, up to 60 microns in diameter. This is much larger than the range of 11-35 microns given by Hoglund for 100 specimens from Skagerak. In addition most specimens are widest at the apical end.

DISTRIBUTION. This species was recorded by Williamson from the Irish Sea, the Shetlands and the English Channel. Numerous subsequent references in lists suggest it is widespread all round the British Isles but these, in the absence of figures, must be treated with reserve.

North Sea records include: Skagerak (Hoglund, 1947); Dollart-Ems Estuary (Voorthuysen, 1960); Langeoog (Haake, 1962); Belgian Coast (Cushman, 1949).

Northwest Atlantic records include: Vineyard Sound, Mass. (Cushman, 1944); Long Island Sound and Buzzards Bay (Parker, 1952b).

Specimens collected by Mr K. H. James from Aransas Bay, Texas, match well with figures of d'Orbigny's species which indicates that references to *B. elegantissima* in the Gulf of Mexico are probably correct.

DERIVATION OF NAME. Refers to the range of the species and the probability that it is a northern form of *B. elegantissima*.

Family **BULIMINIDAE** Jones, 1875

Genus **BULIMINA** d'Orbigny, 1826

***Bulimina elongata*** d'Orbigny s.s.

(Pl. 10, figs 9, 11; Pl. 11, fig. 10; Text-fig. 24, nos 1-7; Text-fig. 23)

*Bulimina elongata* d'Orbigny, 1846 (not 1826) : 187, pl. 11, figs 19, 20; Cushman & Parker, 1937 : 49, pl. 7, figs 1-3; Marks, 1951 : 57, pl. 7, fig. 12; Colom, 1952 : 25, pl. 1, fig. 19.

*Bulimina elegans* Brady, 1884 : 398, pl. 50, figs 3 and 4 (not 1 and 2) (not d'Orbigny).

*Bulimina* aff. *aculeata* Parker, 1952b : 445, pl. 4, figs 7, 13 (not *B. aculeata* d'Orbigny).

DIAGNOSIS. A smooth, elongate *Bulimina* with up to five or six whorls, tapering from the initial end to reach its greatest width at the last whorl or becoming parallel sided in the last two whorls. Chambers becoming globular and as high as wide in the last part. Angle of taper measured to the last whorl typically between 30 and 40°.

DESCRIPTION. (Text-fig. nos 1 and 2) Test elongate, tapering to reach its greatest width in the last whorl which makes up about half the total length, apex pointed, spiral twisting more evident in the last part, lobate; 15 triserially arranged chambers after the proloculus, becoming as high as wide and globular in the last whorl, increasing about half as much again in size with each turn, but less in the last part; sutures distinct, markedly impressed in the last two whorls; wall radial and finely perforate; aperture elongate-ovate within a depression and extending from the basal suture to immediately below the apex, with a collar on one side (distal) which joins the flaring free border of a folded internal tongue.

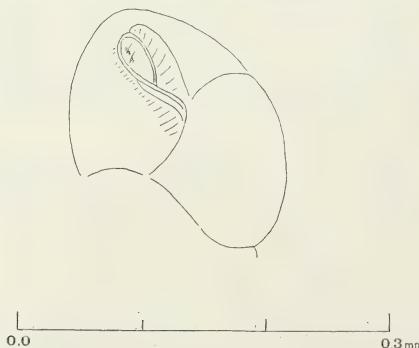


FIG. 23. *Bulimina elongata*, aperture and toothplate of specimen described.

DIMENSIONS. Length 0·46 mm, maximum width 0·20 mm. Approx. diameter of proloculus 35 microns. Angle of taper measured to last whorl 30°.

MATERIAL. More than 25 specimens.

VARIATION. Specimens occur with more parallel sided adult part than the tapering specimen described (Pl. 10, fig. 9 and Text-fig. no. 3). In these specimens the last whorls are more extended along the axis of growth, foreshadowing the bi-serial condition. In addition the axis of growth may be curved. There are also numerous specimens intermediate with *B. gibba* showing greater rate of chamber size increase and angle of taper from 40–50° (Pl. 10, fig. 11 and Text-fig. no. 4). One or two spines may occur at the base and on the first chambers, Text-fig. nos 2 and 3, intermediate with the variety distinguished as *subulata* (Cushman & Parker, 1937). Proloculus diameters measured in our population range from 20 to 40 microns. N.B. We also figure two doubtful specimens, Text-fig. no. 6 showing an individual with enlarged aperture and emarginate chamber borders and Text-fig. no. 7, an individual with expanded last whorl.

DEPOSITORY. B.M.(N.H.) Slides 1970 : 11 : 26 : 194–196, 1970 : 11 : 26 : 198–199 (aberrant). Stub 1970 : 11 : 26 : 544.

PROVENANCE. Described specimen, CB 551.

REMARKS. We have followed the example of Marks (1951) in taking d'Orbigny's description and figure of *B. elongata* in the Vienna Basin monograph as valid and as supplanting the listed reference to *Bulimina elongata* of 1826—a specimen not figured until 1902 by Fornasini and found to be arenaceous by Lys (Haynes, 1954).

Our slender, tapering specimen with pointed apex is very near to the specimen figured by Marks and the topotypes of Cushman and Parker which may be taken as the central type of the variable *B. elongata* group. These authors describe the species as finely perforate contrary to the impression given by d'Orbigny's figure. This is borne out by our photomicrographs which show very small round pores expanding at the exterior surface into pits less than half a micron in size. Many of the pits are joined in grooves which give the appearance of elongate pores (Pl. 11, fig. 10) especially where seen obliquely as at the top of the photo.

*B. elegans* of Brady (1884) from Porcupine Station 10, in part belongs here. The specimens in his figs 3 and 4 being close to our Text-fig. nos 1–4.

DISTRIBUTION. Listed references only must be treated with reserve but include numerous records from west of the British Isles: Irish Sea (Gough, 1904, 1906; Pearcey, 1891; Wright, 1907); West of Scotland (Heron-Allen & Earland, 1914a, 1916a); West of Ireland (Brady, 1884; Heron-Allen & Earland, 1913b); English Channel and Celtic Sea (Heron-Allen & Earland, 1916b, 1930; Le Calvez, 1958); Western Approaches (Murray, 1970).

Further North Atlantic records are: Bay of Biscay (Berthois & Le Calvez, 1959); Coast of Galicia (Colom, 1952); West Atlantic off N. England (Parker, 1952a).

South Atlantic: off Argentina (Boltovskoy, 1954, 1955, 1957, 1963); and Falklands (Earland, 1934).

Mediterranean: Adriatic (Chierici & Cita, 1962).

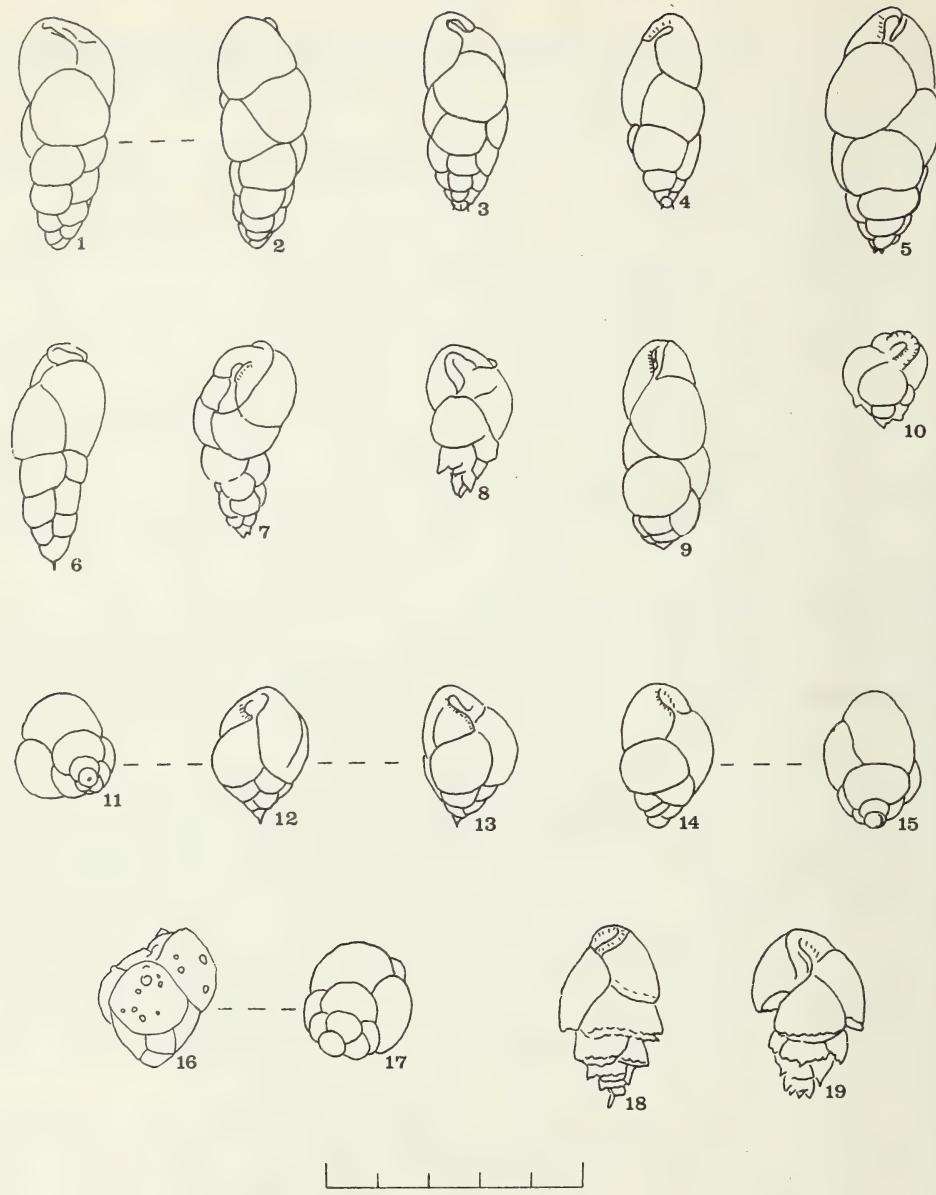


FIG. 24. 1-7. *Bulimina elongata*. 1, 2, apertural and rear view of described specimen; 3, 4, rather more parallel sided specimens with initial spines; 5, specimen intermediate with *B. gibba*; 6, aberrant specimen with enlarged aperture and slightly emarginate chambers; 7, aberrant specimen with expanded last whorl. 8. *Bulimina elongata* var. *subulata*, described specimen. 9. *Bulimina elongata* var. *lesleyae*. 10-17. *Bulimina gibba*. 10, spinose variety near to *B. gibba* var. *basispinosa*; 11-13, specimen described; 14, 15, specimen with protruding megalosphere; 16, 17, specimen with large megalosphere (broken and damaged by borings). 18, 19. *Bulimina marginata*. 18, specimen with initial spine; 19, specimen described.

North Pacific: Philippines and Japan (Cushman, 1911, 1921); California (Watkins, 1961).

Indian Ocean: Arabian Sea (Stubbings, 1939).

There is thus a concentration of records in cool, temperate waters in mid latitudes.

***Bulimina elongata* d'Orbigny var. *lesleyae* Atkinson**

(Pl. 10, fig. 6; Text-fig. 24, no. 9).

*Bulimina elongata* d'Orbigny subsp. *lesleyae* Atkinson, 1969 : 534, fig. 6, 2a, b.

*Bulimina elongata*, Brady, 1884 : 401, pl. 51, figs 1, 2 (not d'Orbigny).

DIAGNOSIS. A variety of *Bulimina elongata* with broadly rounded initial end and parallel or very gently tapering sides. Smooth or with one or two basal spines only.

DESCRIPTION (after Atkinson). Test free, over twice as long as broad, widest at the base of the final whorl, tapering rapidly from the penultimate whorl towards the rounded initial end which often has a short spine; beyond the base of the final whorl the test is either parallel sided or else it tapers very gently to the subrounded apertural end; test rounded in cross section. Chambers numerous, 9 to 15 in the adult, all visible externally, arranged in a regular triserial spine, increasing very rapidly in size at first, more constant in the last two whorls, slightly inflated later; last whorl constitutes at least half the test length. Sutures flush at first, more impressed later; aperture large, elongate, widely comma-shaped, extending from the basal suture well into the apertural face.

DIMENSIONS. Length 0·44 mm, width 0·20 mm.

MATERIAL. Fifteen specimens.

VARIATION. Our photomicrograph shows the smaller paratype (CB 561) which is essentially the same as the type with broad sunken aperture. We also illustrate the other paratype from CB 499 (Text-fig. no. 9) which tapers slightly towards the apertural end.

DEPOSITORY. B.M.(N.H.) Slides 1968 : 5 : 16 : 4 (holotype), 1970 : 11 : 26 : 200 (paratype). Stub 1970 : 11 : 26 : 548 (paratype).

PROVENANCE. Holotype, CB 488.

REMARKS. This variety has the same test shape as *B. elongata* var. *lapa* Cushman & Parker, but lacks the heavy ornament of rounded spines. The specimens of *Bulimina elongata* figured by Brady from the Porcupine Station appear to be this variety. In particular the specimen shown in his fig. 2 and said to be intermediate with *B. ovata* d'Orbigny is very close to the specimen shown in our Text-fig. no. 9.

DISTRIBUTION. Described from Cardigan Bay this variety has also been recorded in the North Atlantic (Brady, 1884).

*Bulimina elongata* d'Orbigny var. *subulata* Cushman & Parker

(Pl. 10, figs 10, 15; Text-fig. 24, no. 8)

*Bulimina elongata* d'Orbigny var. *subulata* Cushman & Parker, 1937 : 51, pl. 7, figs 6, 7; Marks, 1951 : 57, pl. 7, figs 13a, b.

*Bulimina aculeata* Cushman, 1944 : 28, pl. 3, fig. 47; Parker, 1952a : 415, pl. 5, figs 23-25 (not d'Orbigny).

*Bulimina Presli*, Reuss, var. *aculeata* Parker & Jones, 1865 : 373, pl. 17, figs 68, 69 (not pl. 15, fig. 11) (not *B. aculeata* d'Orbigny).

**DIAGNOSIS.** A variety of *Bulimina elongata* with a number of stout spines developed at random on the first few chambers.

**DESCRIPTION.** (Text-fig. no. 8.) Test with final chamber broken, elongate and tapering reaching its greatest width in the last whorl, lobate with slightly pointed apex to last chamber; chambers triserial, about 12 after the proloculus, increasing about half as much again in size with each whorl, globular; sutures distinct and impressed in the last part; wall radial, densely perforated with minute round pores, ornamented on early chambers with backward directed, stout spines; aperture (foramen) large within a depression, extending from the basal suture into the apertural face, with raised collar and internal tongue.

**DIMENSIONS.** Length 0.30 mm, maximum width 0.16 mm. Angle of taper about 40°.

**VARIATION.** This varietal group includes stoutly spinose forms with the shape of typical *B. elongata* and others that are intermediate with *B. gibba*. The distinction is necessarily arbitrary but specimens of *B. elongata* such as those figured (Text-fig. no. 3) with one or two small spines are excluded from the definition.

**MATERIAL.** Only about half a dozen specimens have so far been recovered with this varietal feature really well developed.

**DEPOSITORY.** B.M.(N.H.) Slide 1970 : 11 : 26 : 201. Stub 1970 : 11 : 26 : 545-546.

**PROVENANCE.** Described specimen, Holocene Scrobicularia Clays, Borth.

**REMARKS.** The types are from the Miocene of the Vienna Basin where, as in Cardigan Bay, they occur together with typical *B. elongata*. Our specimens closely resemble Cushman and Parker's figures which also show specimens with larger angle of taper. This variety has been recorded by some authors as *B. aculeata*. This name should be reserved for very spinose *B. marginata* which in our opinion should be excluded from the *B. elongata* plexus.

**DISTRIBUTION.** The range of this variety as here defined remains to be worked out. Many of the listed references to *B. aculeata* d'Orbigny from around the British Isles may belong to it. It is apparently common in the N. Eastern Atlantic off New England (Cushman, 1944) and Portsmouth, N. Hampshire (Parker, 1952a.) Some of the specimens referred to *B. elongata* var. *lapa* by Colom (1952) from the coast of Galicia may also belong here.

***Bulimina gibba*** Fornasini

(Pl. 10, fig. 14; Text-fig. 24, nos 10-17)

*Bulimina gibba* Fornasini, 1902 : 378, pl. 10, figs 32, ? fig. 34; Barker, 1960 : pl. 50, figs 1 and 2 (not 3 and 4) after Brady.

*Bulimina elegans* part Brady, 1884 : 398, pl. 50, figs 1 and 2 (not 3 and 4) (not d'Orbigny).

**DIAGNOSIS.** A stoutly inflated *Bulimina* with globular chambers tending to increase rapidly in size as added—rather more than half as much again with each turn—and little spiral twisting. Well grown specimens show an angle of taper between 45 and 55°, small, megalospheric specimens more than 60°. One or two basal spines may occur.

**DESCRIPTION.** (Text-fig. nos 11-13.) Test with last chamber broken off, globular with pointed initial end, widening rapidly to its maximum width at the last whorl which makes up more than half the test, more than half as wide as long, last chamber slightly pointed above the aperture; originally, ten, dextral, triserial chambers following the proloculus, almost doubling in size with each turn, globular with little spiral twisting; sutures impressed; wall radial, minutely perforate; aperture extending in a loop shape from the basal suture into the apertural face, in a broad depression with marked collar on one side joining an internal trough-like tongue which tapers to the foramen; basal spine and additional spine on one of the early chambers.

**DIMENSIONS.** Length 0·26 mm, maximum width 0·19 mm. Proloculus diameter approx. 30 microns. Angle of taper about 55°.

**MATERIAL.** More than 25 specimens.

**VARIATION.** There is gradation to *B. elongata* through intermediate forms with angle of taper less than 45° (these forms are included with that species). Authors' figures show what is probably the microspheric generation with larger, more elongate test (angle of taper 55° in the type figure) and apparently up to seven or eight whorls. Small megalospheric individuals may be difficult to distinguish from young *B. elongata* but show greater rate of size increase and protruding megalospheres from approx. 30-50 microns in diameter. Some of our specimens show a number of spines, Text-fig. no. 10, and thus gradation to *B. gibba* var. *basispinosa* (Tedeschi & Zanmatti)—originally described as a variety of *B. aculeata* d'Orbigny.

**DEPOSITORY.** B.M.(N.H.) Slides 1970 : 11 : 26 : 202-205, 1970 : 11 : 26 : 197 (intermediate with *B. elongata*). Stub 1970 : 11 : 26 : 547.

**PROVENANCE.** Specimen described, CB 739.

**REMARKS.** We have interpreted Fornasini's figure of a typical microspheric specimen, fig. 32, as the type for our population despite the apparently emarginate penultimate whorl and overhanging early whorls (which, however, could be spinose) because Fornasini clearly distinguished this from his var. *marginata*. This agrees with the view of Cushman & Parker in their study of recent Buliminids (1940) who at that time included *B. gibba* with *B. baccata* Fornasini and stated that the group was marked by almost the entire absence of marginal overhangs. Brady's fig. 2 is

like Fornasini's figure in its general shape and was included by them in *B. gibba* when they reverted to this name for the group (U.S.G.S. Prof. Paper 210-D, 1947) see Barker (1960).

DISTRIBUTION. This species was first described from the Adriatic and it has also been recovered from cores in the Western Mediterranean by Todd (1958) and in the E. Mediterranean by Parker (1958) and from the Gulf of Naples (Hofker, 1960).

Other records include: N. Atlantic (Brady, 1884); S. Atlantic (Boltovskoy, 1954, 1957, 1959, 1961); and Antarctic (McKnight, 1962; Bandy & Echols, 1964). This seems to indicate a cool temperate distribution.

### *Bulimina marginata* d'Orbigny

(Pl. 10, fig. 18; Text-fig. 24, nos 18, 19)

*Bulimina marginata* d'Orbigny, 1826 : 269, pl. 12, figs 10-12; Brady, 1884 : 405, pl. 51, figs 3-5; Goës, 1894 : 46, pl. 9, figs 439-444; Cushman, 1922 : 91, pl. 21, figs 4, 5; 1944 : 27, pl. 3, figs 45, 46; Hoglund, 1947 : 227, pl. 20, figs 1, 2; pl. 22, fig. 1; text-figs 205-218; Parker, 1952a : 415, pl. 5, fig. 26; Colom, 1952 : 24, pl. 1, figs 1-6; Feyling-Hanssen, 1964 : 303, pl. 14, figs 2-5.

*Bulimina pupoides* var. *marginata* Williamson, 1858 : 62, pl. 5, figs 126, 127.

*Bulimina Presli*, Reuss, var. *marginata* d'Orbigny, Parker & Jones, 1865 : 372, pl. 15, fig. 10; pl. 17, fig. 70.

DIAGNOSIS. An elongate-ovate *Bulimina* tending to reach its greatest width in the last whorl with undercut, spinose chamber margins. Angle of taper measured to the last whorl typically between 45 and 55°.

DESCRIPTION. (Text-fig. no. 19.) Test elongate-ovate, tapering to reach its greatest width at the last whorl which makes up about half the length, apex broadly rounded; about 12 triserially arranged chambers after the proloculus, wider than high and globular with horizontally undercut dorsal margins, doubling in size with each turn; sutures distinct and markedly impressed in the last part; wall radial and finely perforate; aperture elongate-ovate within a depression and extending from the basal suture to immediately below the apex, with a collar on one side (distal) which joins the flaring free border of a folded internal tongue; dorsal margins of the chambers with a fringe of small spines.

DIMENSIONS. Length 0.33 mm, maximum width 0.22 mm. Angle of taper measured to last whorl 55°.

MATERIAL. About 20 specimens.

VARIATION. More slender specimens occur and one specimen with angle of taper about 37°. However, the angle of taper is nearer 50° in most cases. Specimens also occur with an initial spine (Text-fig. no. 18). The material was insufficient for proper investigation of dimorphism.

DEPOSITORY. B.M.(N.H.) Stubs 1970 : 11 : 26 : 549, 1970 : 11 : 26 : 757.

PROVENANCE. Specimen described, CB 559; additional figured specimen, CB 555; specimen illustrated by stereoscanner photomicrograph, CB 15.

REMARKS. Our specimens closely resemble d'Orbigny's holotype, both in possessing horizontally undercut chambers and tuberculate to spinose margins. Some specimens possess an initial spine but we have not recovered the heavily spinose forms which according to Hoglund (1947) show gradation to *B. aculeata* d'Orbigny. In its angle of taper (that of the holotype is 50°) *B. marginata* resembles *B. gibba* rather than *B. elongata*.

DISTRIBUTION. The holotype was described from the Adriatic and there are numerous additional records. British Isles area: Irish Sea (Bruce *et al.*, 1963; Burgess, 1891; Heron-Allen & Earland, 1915; Pearcey, 1891; Siddall, 1876; Gough, 1906; Worth, 1902); West of Scotland and Shetlands (Heron-Allen & Earland, 1914a, 1916a; Pearcey, 1881; Robertson, 1877, 1892, 1901; Waller, 1868); West of Ireland (Brady, 1884; Heron-Allen & Earland, 1913b; Wright, 1895, 1900); Celtic Sea (Le Calvez, 1958); Western Approaches (Murray, 1970); English Channel (Heron-Allen & Earland, 1911, 1916b, 1930; Worth, 1902); North Sea (Heron-Allen, 1913c; Hoglund, 1947; Norvang, 1941; Pearcey, 1902; Robertson & Brady, 1876).

Further North Atlantic records are: off Nova Scotia (Barbieri & Medioli, 1969); Gulf and River St Lawrence (Dawson, 1870); W. Atlantic off New England (Cushman, 1921, 1944; Parker, 1948); Iceland (Norvang, 1945); Arctic (Cushman, 1944, 1948; Goës, 1894); coast of Galicia (Colom, 1952).

Bay of Biscay (Berthois & Le Calvez, 1959).

Gulf of Mexico (Van Andel & Postma, 1954; Drooger & Kaasschieter, 1958; Parker, 1954; Phleger, 1960a; Segura, 1963).

South Atlantic: off Argentina (Boltovskoy, 1954, 1955, 1957, 1959, 1961, 1963; Boltovskoy & Boltovskoy, 1968) and Brazil (Closs & Barberena, 1962); Falklands (Earland, 1934); Ivory Coast (Le Calvez, 1963); S. Africa (Albani, 1965).

Mediterranean (Jones & Parker, 1860; Chierici, Busi, Cita, 1962; Brady, 1884; Ruscelli, 1949; Norin, 1958; Parker, 1958; Reiss, Klug & Merling, 1961).

North Pacific: Malaysia (Millett, 1900); Philippines (Cushman, 1911, 1921); off China (Polski, 1959; Walker, 1960); California (Cushman & McCulloch, 1948; Bandy, 1951); Japan (Nagahama, 1951; Asano, 1960).

South Pacific: New Zealand (Hulme, 1964); Australia (Sidebottom, 1918).

Indian Ocean: Gulf of Suez (Said, 1949); West coast India (Bhatia, 1956).

This argues that the species has a cosmopolitan distribution but is possibly more abundant in deeper, cooler waters in mid latitudes.

### Genus *STAINFORTHIA* Hofker, 1956

*Stainforthia concava* (Hoglund) var. *loeblichii* (Feyling-Hanssen)

(Pl. 5, fig. 10)

*Virgulina loeblichii* Feyling-Hanssen, 1954 : 191, pl. 1, figs 14-18; text-fig. 3; 1964 : 308, pl. 14, figs 12-14.

DIAGNOSIS. A variety of *Stainforthia concava* without stout initial spine or spines.

**DESCRIPTION.** Test slightly damaged near the aperture; elongate and slender with the last three chambers making up about half the total length, round in section with the greatest width above midpoint, three times as long as wide; about 10 chambers, triserially arranged to begin with then passing into a drawn out dextral, biserial spiral, gradually increasing in size as added, not markedly embracing, longer than wide and pointed towards the apex; sutures impressed, wall thin, minutely perforate; aperture broken but a large, broad opening with a portion of the narrow lip remaining, joining the basal suture and upright in the apertural face, extending almost to the pointed apex.

**DIMENSIONS.** Length 0·44 mm, maximum width 0·13 mm. Angle of taper approx. 25°.

**MATERIAL.** One specimen only.

**DEPOSITORY.** B.M.(N.H.) Stub 1970 : 11 - 26 : 739.

**PROVENANCE.** CB 493.

**REMARKS.** Our specimen shows slightly less inflated chambers in the adult part than the specimens figured as *V. loeblichi* by Feyling-Hanssen and appears more slender but other features are the same, including the lack of the initial spine so characteristic of *Stainforthia concava*. In 1964, Feyling-Hanssen suggested the possibility that this species was a subspecies or form of Hoglund's and this view is followed here. In the original diagnosis, *Virgulina complanata* sensu Parker (1952a) and *Bulimina exilis* sensu Loeblich & Tappan (1953) were included as synonyms of *V. loeblichi*. However, the specimens figured by these authors are clearly spined and should probably be transferred to *Stainforthia concava* s.s. though on the whole they seem to exhibit a faster rate of chamber size increase and greater angle of taper.

Although he found all species of *Virgulina* in his material optically radial Feyling-Hanssen (1964) favoured retention of the name *Virgulina* rather than use of *Stainforthia*. However, Loeblich & Tappan (1961) have shown that *Virgulina* must be suppressed and have placed granular forms of 'Virgulina' in *Fursenkoina*. Radial species must, therefore, be placed in *Stainforthia*. Even if wall structure is not considered a good basis for generic classification *Stainforthia*, 1956 still has priority over *Fursenkoina*, 1961.

**DISTRIBUTION.** This variety was described from the Late Quaternary of Oslofjord and as a 'primary diagnostic' form in zones B and C.

### '*Stainforthia*' *fusiformis* (Williamson)

(Pl. 5, figs 7, 8)

*Bulimina pupoides* var. *fusiformis* Williamson, 1858 : 63, figs 129, 130.

*Bulimina fusiformis* (Williamson) Brady, 1887 : 897.

'*Bulimina*' *fusiformis* (Williamson) Hoglund, 1947 : 232, pl. 20, fig. 3; text-figs 219-233.

*Virgulina fusiformis* (Williamson) Parker, 1952a : 417, pl. 6, figs 3-6; 1952b : 449, pl. 4, fig. 10; Van Voorthuysen, 1960 : 250, pl. 11, fig. 13; Feyling-Hanssen, 1964 : 308, pl. 14, figs 15-18; Hansen, 1965 : 330, fig. 5 no. 4.

*Fursenkoina fusiformis* (Williamson) Murray, 1965a : 503 (list), pl. 1, pair o

*Virgulinella fusiformis* (Williamson) Atkinson, 1970 : 395 (list).

DIAGNOSIS. A globular, fusiform species of *Stainforthia* with the last three chambers making up the greater part of the test. Last chamber in the adult smaller than the penultimate with terminal aperture possessing marked collar and internal tongue.

DESCRIPTION. Test elongate fusiform with produced apex, round in section, inflated and lobate, greatest width above midpoint; chambers arranged in a sinistral, biserial series, increasing gradually and moderately in size as added but last one reduced, globular and higher than wide, about 11 in all; sutures impressed; wall thin, glassy, optically radial, minutely perforated with pores less than 1 micron in diameter (final chamber); aperture terminal, bordered by a denticulate collar on one side which passes down into a folded internal tongue.

DIMENSIONS. Length 0.28 mm, maximum width 0.10 mm. Angle of taper about 40°. Proloculus diameter about 15 microns.

MATERIAL. About 20 specimens.

DEPOSITORY. B.M.(N.H.) Slide 1970 : 11 : 26 : 206, 207. Stub 1970 : 11 : 26 : 738.

PROVENANCE. Specimen described, Station VII, Clettwr Transect, Dovey Marshes.

REMARKS. The interesting ontogenetic development of this species with the aperture becoming terminal with the addition of the final chamber has been discussed and illustrated by Hoglund (1947). The aperture in the juvenile resembles that of *Virgulina concava* (genoholotype of *Stainforthia*) and joins the basal suture while its adult condition resembles that of advanced species of *Globobulimina*, a group showing parallel development. The wall in Williamson's species proves to be optically radial, as in *Stainforthia concava*, which supports the idea that it is closely related or belongs to the same genus (rather than to '*Furstenkoina*'). Further work on the group is required in order to find out if the details of aperture development can be made the basis of generic or subgeneric distinction from *Stainforthia*.

DISTRIBUTION. This species was described by Williamson from Skye (as abundant) and also from Arran, W. Scotland, Boston, Lincolnshire and also Exmouth, English Channel. This wide distribution about the British Isles appears to be confirmed by later listings, as for instance those for Dogs Bay and S.W. Ireland (Wright, 1891, 1900); North Sea (Heron-Allen & Earland, 1913c); Cornwall (Heron-Allen & Earland, 1916b); English Channel, Plymouth (Murray, 1965a); Christchurch (Murray, 1968); West of Scotland (Heron-Allen & Earland, 1916a). However, as this form has undoubtedly been confused with other members of the '*Virgulina*' group these will not be given in full.

Good figured references for N.W. Europe include: Dollart-Ems Estuary (Voort-huyzen, 1960); Gullmar Fjord and Skagerak (Hoglund, 1947); Baltic, Oresund (Hansen, 1965); Holocene of Oslofjord (Feyling-Hanssen, 1964).

Records for the N.W. Atlantic include: Long Island Sound and Buzzards Bay (Parker, 1952b); off Portsmouth, New Hampshire and off Greenland (Parker, 1952a).

This suggests a temperate to cold water distribution.

*Stainforthia* species A

(Pl. 5, fig. 9; Pl. 8, fig. 4)

**DESCRIPTION.** Test elongate, slender, gradually increasing in width towards the rounded apex, three times as long as wide, slightly compressed in section, periphery lobate; chambers about 14 arranged in a drawn out dextral, triserial to biserial series, gradually increasing in size; elongate-ovate; subglobular; sutures depressed; wall thin, translucent with scattered pores about  $1\frac{1}{2}$  microns in diameter with numerous finer ones between; aperture comma-shaped, countersunk, extending upright into the apertural face from the basal suture with a denticulate collar that passes down into a folded tongue.

**DIMENSIONS.** Length 0.57 mm, maximum width 0.18 mm.

**MATERIAL.** Three specimens, two broken.

**DEPOSITORY.** B.M.(N.H.) Stub 1970 : 11 : 26 : 740.

**PROVENANCE.** Specimen described, CB 416.

**REMARKS.** Our specimens resemble specimens placed under *Virgulina schrieberiana* by Parker & Jones (1865) and Cushman (1922) but it is unlikely that these recent forms are conspecific with Czjzek's Tertiary species. *Virgulina schreibersiana* sensu Feyling-Hanssen (1964) is less evenly tapering.

## Family UVIGERINIDAE Haeckel, 1894

Genus **TRIFARINA** Cushman, 1923*Trifarina angulosa* (Williamson)

(Pl. 10, figs 12, 13, 16, 17; Pl. 11, fig. 11)

*Uvigerina angulosa* Williamson, 1858 : 67, pl. 5, fig. 140; Goës, 1894 : 51, pl. 9, figs 502-509; Cushman, 1923 : 170, pl. 41, figs 17-20.

*Uvigerina pygmaea* d'Orbigny, var. *angulosa* (Williamson) Parker & Jones, 1865 : 364, pl. 13, fig. 58; pl. 17, figs 66a, b.

*Angulogerina angulosa* (Williamson) Cushman, 1927 : 69; 1944 : 30, pl. 4, fig. 9; Hoglund, 1947 : 283, pl. 23, fig. 8, text-figs 305-308; Cushman, 1948 : 66, pl. 7, figs 8a, b; ? 1949 : 35, pl. 6, figs 9, 10; Hofker, 1951a : 193, figs 123, 124; Haake, 1962 : 38, pl. 2, fig. 16; Feyling-Hanssen, 1964 : 317, pl. 16, figs 1-3.

*Trifarina angulosa* (Williamson) Loeblich & Tappan, 1964a : C571, fig. 450, 1-3.

**DIAGNOSIS.** An elongate, trigonal *Trifarina* with up to about 10 longitudinal costae on each face and stronger ones at the corners forming carinae.

**DESCRIPTION.** (Pl. 10, figs 16, 17.) Test elongate, fusiform with pointed apertural end, twice as long as broad, widest at midpoint, trigonal in section; chambers apparently about 12 in number arranged in about four triserial whorls with the last

whorl making up just over half the total length and tending towards uniserial growth, inflated with distinct, impressed sutures but triangular in section; outer wall ornamented with discontinuous longitudinal costae that continue over the sutures in many cases and are strongly developed at the edges of the chambers to form carinae, in part overlapping on adjacent chambers to give a double keel; aperture terminal, at the end of a short, slightly produced neck, compressed oval, in line with one of the trifaces of the test, with internal, perforate plate and discontinuous, horseshoe-shaped everted lip; wall radial (sections show it to be composite lamellar with subcircular pores).

DIMENSIONS. Length 0·31 mm, breadth 0·28 mm.

MATERIAL. More than 20 specimens. This species occurs as a dead form in most parts of Cardigan Bay but specimens are generally small, less than 0·30 mm in length and usually broken and opaque making it difficult to make out the details of the test.

VARIATION. As shown by our illustrations specimens occur with costae reduced to the carinae at the edges of the test (Pl. 10, fig. 12) and others that are rounder in section with stronger more equally developed costae (Pl. 10, fig. 13). There are thus varieties within the *T. angulosa* group which show a tendency to develop characters more fully expressed in the Pacific and Arctic species *T. fluens* (Todd) and *T. carinata* (Cushman).

DEPOSITORY. B.M.(N.H.) Slide 1970 : II : 26 : 211. Stubs 1970 : II : 26 : 522-524.

PROVENANCE. The specimen described and the specimen with some affinity to *T. fluens*, CB 419. Other specimen figured with some affinity to *T. carinata*, Holocene Scrobicularia Clays, Borth.

REMARKS. Although smaller, with less whorls and with more costae developed on the faces of the test our figured specimen compares reasonably well with the paratype from the Williamson collection figured by Loeblich and Tappan.

Hoglund followed Cushman (1923) in quoting a size range of up to 1 mm for this species. In fact his four figures of specimens from the North Sea show lengths between 0·30-0·40 mm and are thus near to ours and the paratype, 0·52 mm. This fits in with Hofker's observation that his specimens from the West of Ireland (Heron-Allen Collection) show a length up to 0·32 mm. Cushman's observation was made at a time when specimens from the Pacific were included in this species. As pointed out by Hofker these forms are not only larger than *T. angulosa* but have different tooth plates, without a wing-like free border and belong to another species. Incidentally, Hofker did not observe apertural lips in his Irish population. As our figure shows a narrow, everted lip like the paratype, this probably indicates that his specimens, like many of ours, were damaged.

DISTRIBUTION. Williamson originally recorded this species from all round the British Isles and later records show that it is widespread in the N. Atlantic and Arctic. Records from warmer waters and the Pacific appear to refer to other species.

Family **BOLIVINITIDAE** Cushman, 1927Genus **BOLIVINA** d'Orbigny, 1839*Bolivina (Brizalina) britannica* Macfadyen

(Text-fig. 25, nos 1, 2)

*Textularia variabilis* Williamson var. *laevigata* Williamson, 1858 : 77, pl. 6, fig. 168 (not *T. laevigata* d'Orbigny).

*Bolivina laevigata* (Williamson) Brady, 1887 : 900; Heron-Allen & Earland, 1911 : 316, pl. 10, figs 8, 9; Cushman, 1922 : 36, pl. 4, fig. 2 (copy of Williamson's figure); 1937b : 159, pl. 16, figs 1-5.

*Bolivina britannica* Macfadyen, 1942 : 143 (new name for *B. laevigata*).

**DIAGNOSIS.** A compressed, finely perforate *Bolivina* with rounded periphery and up to six or seven pairs of square to oblong chambers; tending to become rather irregular in shape with marked collar or protruding tooth in the aperture.

**DESCRIPTION.** (Text-fig. nos 1, 2.) Test compressed, wedge-shaped, greatest width at last chambers which are slightly irregular; periphery rounded; five and a half pairs of chambers slowly increasing in size, slightly higher than wide and not much overlapping; sutures slightly impressed and only slightly oblique to the horizontal at the base of the chambers; wall smooth and finely perforate; aperture oval, in median line with marked collar or protruding tooth.

**DIMENSIONS.** Length 0.34 mm, maximum width 0.15 mm. Proloculus diameter approx. 42 microns. Angle of taper 35°.

**MATERIAL.** One specimen only.

**VARIATION.** Authors' figures appear to show one generation, with proloculus diameters varying between 30-55 microns. Cushman's specimens obtained from Earland and taken off the Faroes and S.W. Ireland show from 5-7 pairs of chambers and some irregularity of growth. One specimen becomes irregular and parallel sided, another shows spiral twisting.

**DEPOSITORY.** B.M.(N.H.) Slide 1970 : 11 : 26 : 212

**PROVENANCE.** Described specimen, Clettwr Transect, Dovey Marshes.

**REMARKS.** Our specimen resembles figs 2 and 5 of the series illustrated by Cushman and is near to the type figure which has five pairs of chambers. The distinct tooth or protruding tooth is unusual for *Bolivina* and as Cushman noted needs further study when more material becomes available. The projecting point on the last chamber of the type figure is presumably this feature.

**DISTRIBUTION.** Macfadyen's new name is very apposite considering the distribution of this form. It was described by Williamson from the Shetlands and Arran, Scotland and from Boston, Lincs. Heron-Allen and Earland's material was from the North Sea and the material studied by Cushman from off the western coasts of Great Britain and from the Faroes.

It is also listed from all round the British Isles from the Recent as well as the Pleistocene but these records must be considered doubtful because of the possibility

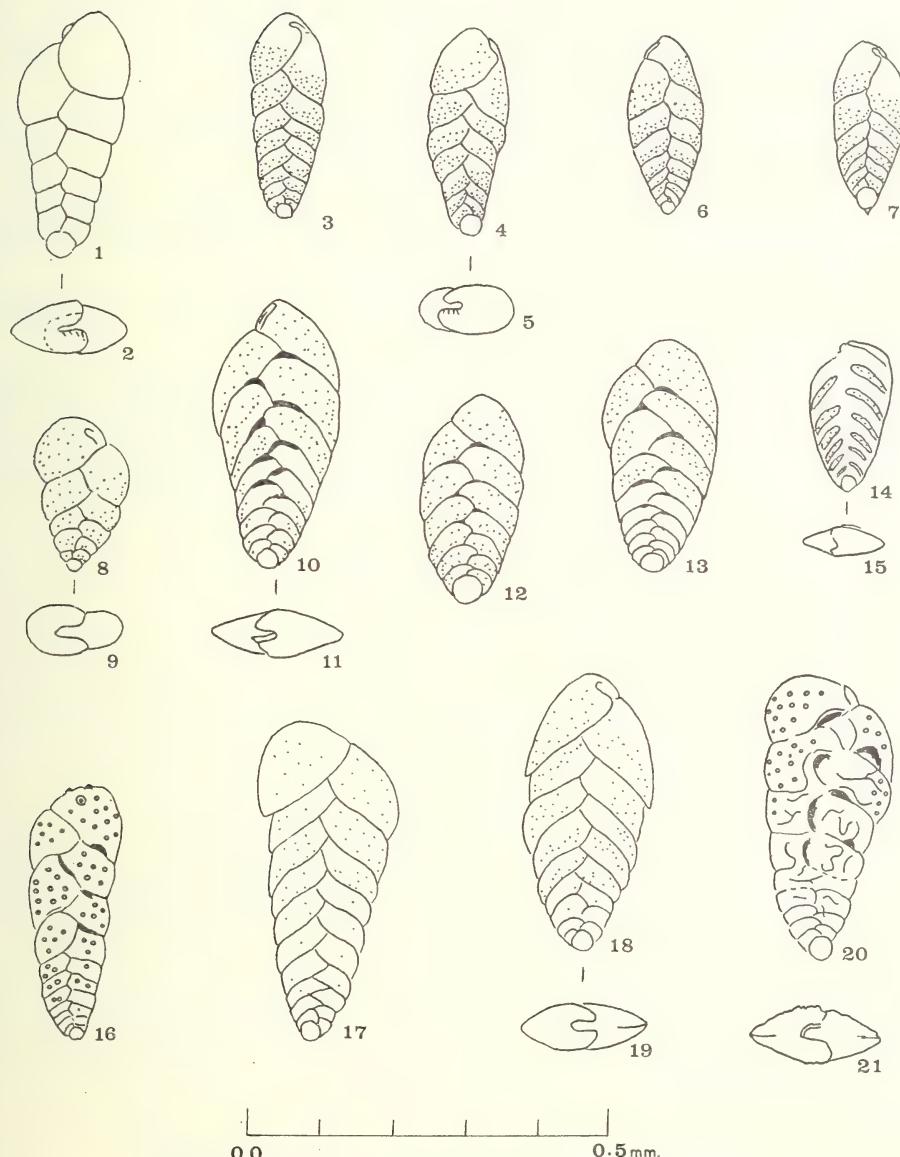


FIG. 25. 1, 2. *B. britannica*. 1, lateral view; 2, apertural view. 3-5. *B. pseudopunctata*. 4, 5, described specimen. 6, 7. *B. cf. vadescens*. 6, oval form; 7, with spine. 8, 9. *B. inflata*. 10-13. *B. spathulata*. 10, 11, described specimen. 14-15. *B. ordinaria*. 16. *B. variabilis*, showing excavations and pustular pores. 17. *B. cf. minima*. 18, 19. *B. minima*. 18, lateral view; 19, apertural view. 20, 21. *B. pseudoplicata*. 20, lateral view; 21, apertural view.

of confusion with other species, such as with *B. textilaroides* Reuss, as pointed out by Heron-Allen and Earland.

This species has also been recorded in the South Atlantic, Golfo San Jorge, Argentina (Boltovskoy, 1954).

### *Bolivina (Brizalina) inflata* Heron-Allen & Earland

(Text-fig. 25, nos 8, 9)

*Bolivina inflata* Heron-Allen & Earland, 1913b : 68, pl. 4, figs 16–19; Cushman, 1922 : 35, pl. 9, figs 1–4 (after Heron-Allen & Earland); 1937b : 166, pl. 18, fig. 16 (after Heron-Allen & Earland) ? Todd & Bronnimann, 1957 : 33, pl. 8, figs 32–34.

DIAGNOSIS. A smooth, inflated *Bolivina* with globular chambers and angle of taper up to about 50°.

DESCRIPTION. (Text-fig. nos 8, 9.) Test wedge-shaped, reaching its greatest width at the last pair of chambers, slightly compressed with rounded, lobate periphery; five pairs of chambers increasing fairly rapidly in size, slightly wider than high and globular; sutures impressed, slightly curved and oblique at about 25° to the horizontal; wall smooth, coarsely perforate; aperture elongate-ovate and pointed in the median line.

DIMENSIONS. Length 0.21 mm, maximum width 0.13 mm. Proloculus diameter approx. 15 microns. Angle of taper about 35°.

MATERIAL. Two specimens.

VARIATION. Our specimens are small but the type figures show up to seven pairs of chambers in 0.25 mm length.

DEPOSITORY. B.M.(N.H.) Slide 1970 : 11 : 26 : 213–214.

PROVENANCE. Described specimen, CB 647.

REMARKS. With its coarsely punctate, globular chambers and rather elongate aperture the described specimen is close to the types examined in the British Museum. The specimens described by Todd and Bronnimann from the Gulf of Paria are similar in chamber shape and taper but differ in possessing a broad, quadrate aperture.

DISTRIBUTION. This species was described as common in the type area of Clare Island, west of Ireland and was also recorded by the authors from West of Scotland and in the English Channel (1916b). Apart from the reference by Todd and Bronnimann we have found no records for the West Atlantic.

### *Bolivina (Brizalina) minima* Phleger & Parker

(Text-fig. 25, nos 18, 19)

*Bolivina minima* Phleger & Parker, 1951 : 14, pl. 6, figs 22, 25; pl. 7, figs 1, 2.

DIAGNOSIS. A compressed, elongate-ovate *Bolivina* with acute periphery. The chambers are wider than high and in the last part of the test tend to be produced at the basal margin into down curving points.

**DESCRIPTION.** (Text-fig. nos 18, 19.) Test elongate-ovate and compressed, widening quite rapidly from the subround initial end to reach maximum width at approximately midpoint; periphery acute, becoming serrate; eight pairs of biserial chambers gradually increasing in size, the last three pairs making up rather more than half the test, twice as wide as high, the last pair with downward pointing projections at the base; sutures distinct, flush, oblique at about  $40^{\circ}$  to the horizontal, wall smooth, coarsely and irregularly perforate, sometimes only at the top of each chamber, in the initial part sometimes only at the base; aperture oval, basal and in the median line with conspicuous internal tongue.

**DIMENSIONS.** Length 0.37 mm, maximum width 0.17 mm. Proloculus diameter approx. 28 microns. Angle of taper about  $40^{\circ}$ .

**MATERIAL.** Two specimens only.

**VARIATION.** Phleger and Parker's type material includes both megalospheric individuals similar to the specimen described and more elongate microspheric individuals with up to 11 pairs of chambers. The specimen illustrated as *B. cf. minima*, Text-fig. no. 17, resembles the microspheric generation although evenly and coarsely perforated and rather less compressed, length 0.44 mm, proloculus diameter 21 microns.

**DEPOSITORY.** B.M.(N.H.) Slide 1970 : 11 : 26 : 215. 1970 : 11 : 26 : 216 (*B. cf. minima*).

**PROVENANCE.** Described specimen Clettwr Transect, Dovey Marshes. Additional specimen, CB 416.

**REMARKS.** Our specimen appears to fall within the range of variation of Phleger and Parker's species. As they point out, this species differs from *B. barbata* (= *B. superba* as interpreted here) in its discrete chamber ends and lack of peripheral keel. *B. gramen* (d'Orbigny) in the sense of Hoglund, 1947, and Heron-Allen & Earland, 1913b, possibly = *B. pygmaea* Brady, has much more inflated, globose chambers with discrete points on nearly all of them. *B. difformis* (Williamson) has a much more flaring wedge shape and is more compressed, again with discrete points on nearly all chambers.

**DISTRIBUTION.** Described from bottom samples below 70 metres in the N.W. Gulf of Mexico, with greatest frequencies between about 150 and 250 metres.

### *Bolivina (Brizalina) ordinaria* Phleger & Parker

(Text-fig. 25, nos 14, 15)

*Bolivina ordinaria* Phleger & Parker, 1952 : 14 (new name for *B. simplex*); Phleger, 1960b : 73, pl. 3, fig. 4.

*Bolivina simplex* Phleger & Parker, 1951 : 14, pl. 7, figs 4-6.

**DIAGNOSIS.** A compressed, arrow-shaped *Bolivina* with pointed apertural end and opaque wall near the sutures which are limbate and markedly oblique.

DESCRIPTION. (Text-fig. nos 14, 15.) Test with last pairs of chambers broken; compressed with acute periphery, entire; seven pairs of chambers gradually increasing in size, much wider than high; sutures limbate, particularly towards the centre line, markedly curved and swept back at about  $40^\circ$  to the horizontal; wall coarsely perforate, thickened and opaque near the sutures where it appears white.

DIMENSIONS. Length 0.21 mm, maximum width 0.11 mm. Average angle of taper about  $30^\circ$ .

MATERIAL. A few broken specimens.

DEPOSITORY. B.M.(N.H.) Slide 1970 : 11 : 26 : 217. Stub 1970 : 11 : 26 : 746.

PROVENANCE. Described specimen, Holocene, Scrobicularia Clays, Ynyslas, Borth.

REMARKS. Our specimens, such as the one described, although broken show very well the characteristic opaque areas typical of this species, and fall within the size range. The chamber wall, in contrast to the thickened sutures, is very thin and this may explain why our specimens are broken. The wall is radial lamellar and densely perforated by small subcircular pores.

DISTRIBUTION. Described from the N.W. Gulf of Mexico where it was found characteristic of depths greater than 200 metres and to constitute 10% of the fauna, occasionally 20% in deeper water—down to 1000 metres.

### *Bolivina pseudoplicata* Heron-Allen & Earland

(Text-fig. 25, nos 20, 21; Pl. 10, fig. 3; Pl. 11, fig. 7)

*Bolivina pseudoplicata* Heron-Allen & Earland, 1930 : 81, pl. 3, figs 36–40; Cushman, 1937b : 166, pl. 19, figs 12–20; 1944 : 29, pl. 4, figs 7, 8; Hoglund, 1947 : 263, pl. 24, fig. 2; pl. 32, figs 8–11, text-fig. 287; Cushman, 1949 : 31, pl. 6, figs 11, 12; Voorthuysen, 1951 : 24, pl. 1, fig. 28; Parker, 1952a : 414, pl. 5, fig. 17; 1952b : 444, pl. 4, fig. 11; Voorthuysen, 1960 : 249, pl. 11, fig. 9; Todd & Low, 1961 : 16, pl. 1, fig. 19; Haake, 1962 : 39, pl. 2, fig. 19; Sliter, 1970 : 160, pl. 3, figs 1–6, pl. 8, figs 12–13.

*Bolivina plicata* Brady, 1870 : 302, pl. 12, figs 7a, b; Goës, 1894 : 51, pl. 9, figs 487–488 (not d'Orbigny).

DIAGNOSIS. A compressed, wedge-shaped *Bolivina* with subacute to subrounded periphery and pronounced sutural excavations bordered by irregular raised processes which tend to form a double, parallel row down the test and pass laterally into reticulations.

DESCRIPTION. (Text-fig. nos 20, 21.) Test wedge-shaped and compressed with the greatest width at the last two pairs of chambers, slightly less than half as wide as long, periphery subangular to acute in the last part, lobate; nine pairs of chambers, slowly increasing in size, slightly wider than high; sutures impressed, slightly oblique, at about  $20^\circ$  to the horizontal, excavated in the centre line and occasionally along the base of each chamber, the excavations bordered by raised processes which tend

to join up in parallel rows and zig-zag down the test and pass into a mesh of raised reticulation towards the periphery; wall coarsely perforate; aperture subquadrangular with prominent internal tongue.

DIMENSIONS. Length 0·39 mm, maximum width 0·17 mm. Proloculus diameter approx. 31 microns. Angle of taper approx. 30°.

MATERIAL. More than 25 specimens.

VARIATION. The type figures and the additional illustrations of Cushman show that generally this species is small, less than 0·40 mm in length with six to eight pairs of chambers and according to Hoglund, proloculus diameters range between 10 and 27 microns. The development of plications is variable but there is a tendency towards the development of a double row of ridges. Most of our specimens fall within this range but some such as the one described develop nine pairs of chambers and show slightly larger proloculus diameters. There is also variation in the form of the periphery, it is usually subangular but may be more acute.

DEPOSITORY. B.M.(N.H.) Slide 1970 : II : 26 : 233. Stubs 1970 : II : 26 : 533, 1970 : II : 26 : 747, 1970 : II : 26 : 760.

PROVENANCE. Described specimen, CB 515.

REMARKS. This species was first figured by Brady as *B. plicata* and his illustration shows the characteristic double row of plications which were taken by Heron-Allen and Earland to indicate a specific difference from d'Orbigny's Pacific species. When Cushman re-illustrated the species he removed the specimens recorded by Heron-Allen and Earland in the S. Atlantic from the synonymy and also distinguished his Miocene species *B. plicatella* from it on the basis of differences in the pattern of pits. It is interesting in the light of this that although it has been recorded quite often from off the N.E. coast of the U.S.A. none of the figures show such strong plication as the European material.

Thin sections show that the wall is radial, lamellar and very densely perforated by minute, irregularly-shaped, subcircular pores, with a few elongate, indented composite large, perforations. The areas of dense reticulation are much less perforated and as mentioned by Hoglund and shown by our photograph, Pl. II, fig. 7, the pores may be restricted to the centre of the hollows.

DISTRIBUTION. The types are from the Plymouth area of the English Channel. If, as Heron-Allen and Earland suggested, all British and European references to *B. plicata* are transferred to this species, a wide geographical range is indicated in the N.E. Atlantic and the Mediterranean, but with a concentration round the British Isles, particularly around Ireland. Unfortunately, these listed records must be treated with reserve as there is the possibility that authors have confused this species with *B. variabilis*, which also has excavated sutures. The same applies to the numerous Pleistocene records in the Irish Sea area.

If the South Atlantic records are excluded, following Cushman, its distribution elsewhere seems to be confined to the N.W. Atlantic with more doubtful citations for the Caribbean (Todd & Bronnimann, 1957; Ayala-Castanares, 1963). It has been recorded from off California by Sliter (1970).

*Bolivina (Brizalina) pseudopunctata* Hoglund

(Pl. 10, fig. 4; Pl. 11, figs 4-6; Text-fig. 25; nos 3-5)

*Bolivina pseudopunctata* Hoglund, 1947 : 273, pl. 24, fig. 5; pl. 32, figs 23, 24; text-figs 280, 281, 287; Parker, 1952a : 414, pl. 5, figs 20, 21; Loeblich & Tappan, 1953 : 111, pl. 20, figs 13, 14; Feyling-Hanssen, 1964 : 319, pl. 16, fig. 7.

*Bolivina punctata* Goës (part) 1894 : 49, pl. 9, figs 478, 480 not 475-477; Mills, 1900 : 145, pl. 10, fig. 10 (not d'Orbigny).

**DIAGNOSIS.** A slender, elongate *Bolivina* with rounded periphery and chambers which tend to become higher than wide and truncated by the aperture to produce a terminal point. The pores tend to be restricted to the base of each chamber, particularly in early chambers.

**DESCRIPTION.** (Text-fig. nos 4,5.) Test slender, elongate, reaching its greatest width at the last three chambers, periphery rounded; with six and a half pairs of chambers, gradually increasing in size and becoming slightly higher than wide, truncated by the aperture; sutures oblique at about  $45^{\circ}$  to the horizontal, slightly impressed and making a smooth curve between the last chambers; wall smooth and pores very fine, about 1 micron in diameter, and restricted to the base and periphery of the chambers; aperture oval, in the median line with internal tongue and raised collar on the free margin.

**DIMENSIONS.** Length 0.27 mm, maximum width 0.11 mm. Proloculus diameter approx. 27 microns. Angle of taper about  $25^{\circ}$ .

**MATERIAL.** Five specimens only.

**VARIATION.** Authors' figures show variation from very slender, parallel sided specimens to wider forms such as the one we describe. The test may also show spiral twisting. Up to nine pairs of chambers may be developed in the megalospheric generation, up to 11 pairs in the microspheric. What may be the microspheric generation is illustrated in Pl. 10, fig. 4 and Pl. 11, figs 4-6. This specimen has 10 pairs of chambers and more slender shape. A basal spine may occur.

**DEPOSITORY.** B.M.(N.H.) Slide 1970 : 11 : 26 : 218-220. Stub 1970 : 11 : 26 : 534.

**PROVENANCE.** Described specimen, CB 493. Additional figured specimen, CB 646.

**REMARKS.** The type figure shows a spirally twisted test, about 0.40 mm long with eight pairs of chambers, the last ones being high and pointed. Our specimens are smaller with fewer pairs of chambers and the last chambers are not so high; otherwise, they appear to agree well with Hoglund's concept of the species. Our described specimen resembles the slightly wider specimens figured by Parker which also show the characteristic curved sutures very well. The proloculus diameter in our specimen coincides with the peak of the frequency curve, 27-28 microns, determined by Hoglund. Only one microspheric individual has previously been found, by Hoglund, in Goës' material from Jutland Bank, with proloculus diameter of 10 microns and eleven and a half pairs of chambers.

This species differs from *B. punctata* d'Orbigny in its rounded periphery. *B. cf. vadescens* sensu Hoglund is more ovate with acute periphery in the initial part and larger pores.

DISTRIBUTION. The records suggest an Arctic and cool temperate distribution for this species. The types are from the Gullmar Fjord and Goës recovered specimens from off Bergen and Spitzbergen. Further cold water records are those of Loeblich and Tappan and Parker, as well as Feyling-Hanssen, Late Glacial. It has also been figured by Hedley & Underwood (1957) from the Kent coast and also by Murray (1965a) from Plymouth.

This species has undoubtedly been recorded as *B. punctata* from many stations around the British Isles and in the Pleistocene. Unfortunately, the likelihood of confusion with other species such as *B. cf. vadescens* means that list references only, are of little value.

### *Bolivina (Brizalina) spathulata* (Williamson)

(Text-fig. 25, nos 10-13)

*Textularia variabilis* Williamson, var. *spathulata* Williamson, 1858 : 76, pl. 6, figs 164, 165.

*Bolivina spathulata* (Williamson) Macfadyen, 1930 : 57, pl. 4, figs 20a, b; Cushman, 1937b : 162, pl. 15, figs 20-24; Hoglund, 1947 : 271, pl. 24, fig. 7; pl. 32, figs 21, 22; text-figs 286, 287; Colom, 1952 : 31, pl. 2, figs 8, 9; Feyling-Hanssen, 1964 : 321, pl. 16, fig. 10.

*Bolivina dilatata* Brady, 1884 : 418, pl. 52, figs 20, 21; Goës, 1894 : 50, pl. 9, figs 482-483; Mills, 1900 : 145, pl. 10, fig. 12 (not Reuss).

*Brizalina spathulata* (Williamson) Hedley, Hurdle & Burdett, 1965 : 21, pl. 6, fig. 23; text-figs 6A-G.

DIAGNOSIS. A compressed, wedge-shaped *Bolivina* with chambers much wider than high and curved, backswept sutures. The aperture tends to truncate the summit of the chamber making a terminal point which is marked on the sutures by thickening.

DESCRIPTION. (Text-fig. nos 10, 11.) Test wedge-shaped with subrounded initial end and rounded distal end truncated by the aperture to produce a terminal point; maximum width at last three chambers, half as wide as long, very much compressed with entire, acute periphery; nine pairs of chambers biserially arranged, gradually increasing in size (except that a slowing down in the rate after the fourth pair and acceleration at the sixth produces the effect of a waist); sutures curved, at 35-45° to the horizontal, thickened at the junctions in the centre line; wall smooth, coarsely and irregularly perforate with a tendency for concentration of the pores at the periphery; aperture basal and narrow in the median line, extending to the summit of the chamber, with lip and internal tongue.

DIMENSIONS. Length 0.37 mm, width 0.18 mm. Proloculus diameter approx. 24 microns. Angle of taper about 40°.

MATERIAL. More than 25 specimens.

VARIATION. Previous authors have described microspheric forms which show up to 16 pairs of chambers and pointed initial ends. Our material appears to

represent the megalospheric generation with up to nine pairs of chambers; specimens with very large proloculi such as the one illustrated in Text-fig. no. 12, 39 microns, tend to show less than seven. The pores seem to be uniformly coarse, about 2 microns diameter, but variable in distribution, the later chambers being perforated all over in many cases. Acceleration of growth after the first few chambers, producing the effect of a waist, is common. Specimens may show a definite keel and heavy limbation of the sutures.

DEPOSITORY. B.M.(N.H.) Slide 1970 : 11 : 26 : 221-230. Stub 1970 : 11 : 26 : 748.

PROVENANCE. Described and figured specimens, CB 493.

REMARKS. Williamson's type figure appears to represent the microspheric generation with pointed initial end and about 14 pairs of chambers increasing gradually in size to give a much compressed wedge-shaped test. The species was beautifully and accurately refigured by Cushman on the basis of material given to him by Earland from Porcupine Station 7 and from S.W. of Ireland. Our specimens closely resemble his figures of the megalospheric generation which show very well the dark, clear areas at the junctions of the sutures, but with more developed keels than in ours. As pointed out by Hoglund the thickness in Cushman's specimens, as well as in the specimens from the Gullmar Fjord, is half to one-third the width. Our specimens agree with those of Cushman in this respect also. This thickness is much greater than in the type figure which is much more compressed. This problem has been investigated by Hedley *et al.* who examined Williamson's syntypes but found none were as flat as that shown in the type figure. As all the later figured references to *B. spathulata* are similar in this regard, including Macfadyen's specimens it seems best to regard the original drawing as exaggerating this feature. As Hedley *et al.* have shown in their figures of six of the syntypes, there is considerable variation in shape, three show waisting and all appear to have keels, in one case extending onto the apertural face. There is considerable range of proloculus size and our figured specimens most resemble their figures F and G. None of our specimens show the limbation shown by C and D which led them to include their heavily ornamented New Zealand specimens in this species, previously *B. numerosa* of Vella.

This species has been extensively referred to as *B. dilatata* Reuss which, however, differs in its straight sutures. Where figures are given such as by Brady (1884) these may safely be put in synonymy but in most cases this name is listed only.

DISTRIBUTION. Williamson described this species from the S.W. coast of England at Torquay, from Arran and the Shetlands and from Boston, Lincolnshire. Its occurrence, particularly off western coasts is confirmed by later records for Porcupine Station 7 by Brady and Cushman; for Plymouth and Christchurch by Murray (1965a, 1968) and the Celtic Sea by Le Calvez (1958), as well as the Scillies (Atkinson, 1970). It is one of the most common species of *Bolivina* in Cardigan Bay and this makes it probable that most records of *B. dilatata* from the Irish Sea and from western coasts of Great Britain do belong to this species. Further Atlantic records are: Bay of Biscay (Caralp, Lamy & Pujos, 1970; Berthois & Le Calvez, 1959);

Coast of Galicia (Colom, 1952); Gulf of Paria (Todd & Bronnimann, 1957); San Blas Bay, Argentina (Boltovskoy, 1954); Ivory Coast (Le Calvez, 1963).

Mediterranean records are from the Adriatic (Chierici, Busi & Cita, 1962; Cita & Chierici, 1962) and there are also scattered records in the Pacific: China Seas (Polski, 1959; Waller, 1960) and New Zealand (Hulme, 1964; Hedley *et al.*, 1965). These records indicate a temperate to subtropical distribution with no records as yet for the Arctic.

### *Bolivina (Brizalina) striatula* Cushman

(Pl. 10, figs 1 : 1; Pl. 11, fig. 1)

*Bolivina striatula* Cushman, 1922 : 27, pl. 3, fig. 10; 1937b : 154, pl. 18, figs 30, 31; 1944 : 29 pl. 4, figs 4, 5; Colom, 1952 : 32, pl. 2, figs 1-5; Sliter, 1970 : 170, pl. 7, fig. 6; pl. 8, fig. 19.

**DIAGNOSIS.** An elongate, compressed *Bolivina* with sides tending to become parallel. Periphery rounded in the initial part becoming acute in the later part. Pores very fine and evenly distributed, except in the last few chambers where they become restricted to the lower part of each one. Lower half of the test strongly ornamented with parallel costae.

**DESCRIPTION.** (Pl. 10, figs 1 : 1.) Test complete but with small, round borings in the later chambers which could be mistaken for pores; elongate and compressed, gradually widening from the rounded initial part and tending to become parallel sided in the last part, three times as long as wide and greatest width above mid-point; periphery rounded in initial part and becoming more acute in the later part; about eight pairs of chambers, wider than high, the last three pairs making up about half of the test; sutures limbate, horizontal in the initial part, gradually changing to an angle of about 40° to the horizontal in the later part, impressed between last three chambers; aperture an elongate slit in the median line; wall radial and finely perforate (pores less than 1 micron in diameter and 5 microns apart) except in upper portions of the later chambers; last five chambers smooth, previous ones strongly ornamented with about 20 parallel costae commencing at the base.

**DIMENSIONS.** Length 0.37 mm, width 0.13 mm. Angle of taper about 25°.

**MATERIAL.** Three specimens only, two broken. A thorough investigation of apertures, tooth plates and chamber number could therefore not be made.

**VARIATION.** Specimens with up to 12 pairs of chambers have been illustrated.

**DEPOSITORY.** B.M.(N.H.) Slide 1970 : 11 : 26 : 231-232. Stub 1970 : 11 : 26 : 530.

**PROVENANCE.** Illustrated specimen, CB 528.

**REMARKS.** The details of ornament and perforation cannot be made out in Cushman's type figure but in his 1937b monograph the diagnostic features are clearly shown. This species is easily confused with *B. subaenariensis* which can, however, be distinguished by its two prominent axial costae, flanked by a few

shorter ones, its more flaring shape and its peripheral keel. The specimens recorded by Hoglund (1947) as *B. cf. striatula* appear to be very close to our specimens.

DISTRIBUTION. This species was first described from the Tortugas, off Florida, and Cushman later reported it from further north, off the New England coast as well as in material from Porcupine Station 7, west of the British Isles. British records include: Kent coast (Hedley & Underwood, 1957); Plymouth (Murray, 1965a); Western Approaches (Murray, 1970). As it has also been reported from the coast of Galicia by Colom it is apparently widespread in the North Atlantic. Boltovskoy also records it from the Golfo San Jorge, Argentina (1954) and from the littoral of Puerto Deseado (Boltovskoy & Lena, 1966). A Pacific record is given by Sliter (1970).

### *Bolivina (Brizalina) superba* Emiliani

(Pl. 10, figs 5 : 5; Pl. 11, figs 2, 3)

*Bolivina superba* Emiliani, 1949 : 6, pl. 1, figs 1a, b.

*Bolivina beyrichi* Heron-Allen & Earland, 1916a : 239, pl. 41, fig. 15; Cushman, 1923 : 30, pl. 9, fig. 6 (not Reuss).

*Bolivina alata* Cushman, 1937b : 106, pl. 13, figs 4, 5, 6, 9, 10, 11 not 3, 7, 8 (not *Vulvulina alata* Sequenza).

*Bolivina barbata* Phleger & Parker, 1951 : 13, pl. 6, figs 12, 13; Todd & Bronnimann, 1957 : 33, pl. 8, fig. 25.

*Bolivina difformis* Colom, 1952 : 32, pl. 2, figs 6, 7 (not Williamson).

DIAGNOSIS. A compressed, wedge-shaped *Bolivina* with peripheral keel broken into downward projecting points at the base of the later chambers. In the last part the height of the chambers tends to become equal to the width.

DESCRIPTION. (Pl. 10, figs 5 : 5.) Test complete but with a small hole in the penultimate pair of chambers; much compressed and gradually widening from the initial end to give a wedge-shape; periphery with continuous narrow keel which is broken into points at the base of the last five chambers; about eight pairs of biserial chambers gradually increasing in size and tending to become as high as wide, the last five chambers making up half the length of the test; sutures impressed and strongly curved but much less oblique to the horizontal plane between the later chambers; wall smooth, very sparsely perforated in the initial part, the pores being approx. 1.5 microns in diameter and restricted to the peripheral edge of the chamber while in later chambers they extend across the top of each chamber as well as more sparsely across the base, leaving an irregular imperforate area in the middle; aperture a narrow slit, basal in the median line with the lip on one side formed by the continuation of the keel. N.B. There are a number of small round borings slightly larger than the pores, particularly in the initial part.

DIMENSIONS. Length 0.39 mm, maximum width 0.18 mm. Angle of taper about 40°.

MATERIAL. One specimen only.

VARIATION. Authors' figures show specimens with up to 12 pairs of chambers,

barbs on nearly all chambers and perforations restricted to the top or becoming developed all over the chambers in the final pairs. Some specimens appear to be narrower with slower rate of chamber size increase.

DEPOSITORY. B.M.(N.H.) Stub 1970 : 11 : 26 : 537.

PROVENANCE. Described specimen, Clettwr Transect, Dovey Marshes.

REMARKS. Although only one specimen has been recovered and it is relatively small with the characteristic barbs not fully developed it corresponds well with the group included by Emiliani in *B. superba* from the Calabrian of Italy. As Emiliani has shown, this species has been much confused in the past, Eastern Atlantic representatives being referred by Heron-Allen and Earland to *B. beyrichi*, an Oligocene species, and by Cushman to *B. alata*, a narrow Calabrian species with oblique sutures. The Pacific specimens cited as *B. alata* by Brady (1884) and Cushman (1937) may not be *B. superba* as they show much more developed keels and tendency to uniserial growth. However, the specimens described as *B. barbata* by Phleger and Parker do appear to belong here. The figured paratype, in particular, appears close to our specimen. On the other hand, the figured holotype is a narrower form nearer to the specimen described by Heron-Allen and Earland. There is little doubt that *Bolivina difformis* in the sense of Colom also really belongs here because Williamson's species has characteristically a much more rapidly expanding wedge shape with discrete, pointed chamber ends and is without peripheral keel.

DISTRIBUTION. The types are from the Pleistocene of Italy and the species is widespread at the present day in the N. Atlantic, occurring off the Scottish and Irish coasts (Heron-Allen & Earland, 1916a; Cushman, 1937b); off the coast of Galicia and from the Canaries (Colom, 1952; Brady, 1884). In the Gulf of Mexico (Phleger & Parker, 1951) and from the Gulf of Paria (Todd & Bronnimann, 1957). Pleistocene records of *B. beyrichi* by Wright from the Isle of Man (1902b) and Ulster (1901) possibly refer to this species also.

***Bolivina (Brizalina) cf. vadescens*** Cushman sensu Hoglund

(Pl. 10, fig. 7; Pl. 11, fig. 9; Text-fig. 25, nos 6, 7; Text-fig. 26)

*Bolivina cf. vadescens* Cushman, Hoglund, 1947 : 265, pl. 24, fig. 6; pl. 32, figs 12, 13; text-fig 279.

DESCRIPTION. (Pl. 10, fig. 7; Pl. 11, fig. 9.) Test elongate, ovate and compressed; periphery entire and acute, becoming subrounded in last part, about eight pairs of chambers, final pair not much wider than high—earlier ones overlapping and appearing wider, the last five chambers making up half the total length, arranged in a biserial series with well marked interlocking lobes in the centre line; sutures impressed and sigmoid, at an angle of about  $30^{\circ}$  to the axis in the last part; aperture oval, in the median line, with rounded rim on the free border and straight internal tongue; wall smooth, conspicuously perforate in the lower half of each chamber with round pores about 2.5 microns in diameter. N.B. The test also shows some small round borings of slightly larger size, i.e. in the last chamber.

DIMENSIONS. Length 0·41 mm, width 0·16 mm. Angle of taper about 30°.

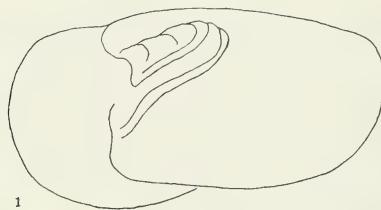
MATERIAL. Four specimens only.

VARIATION. Two smaller specimens with seven pairs of chambers are also illustrated both showing the characteristic elongate-ovate shape and proloculus diameters of 17 microns and 28 microns respectively, Text-fig. 25, nos 6, 7, the latter showing a slightly larger last pair of chambers and what may be a broken initial spine.

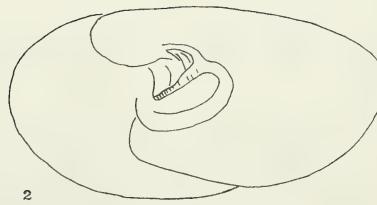
DEPOSITORY. B.M.(N.H.) Slide 1970 : 11 : 26 : 234-236. Stub 1970 : 11 : 26 : 532, 538, 539.

PROVENANCE. Specimen described, CB 502. The other specimens figured, Text-fig. 6, CB 646; Text-fig. 7, Aberystwyth harbour.

REMARKS. Our specimens are very close to *B. cf. vadescens* of Hoglund in size, chamber shape and proloculus size. This form resembles *B. pseudopunctata* in possessing chambers perforated mainly in the lower half but the pores are twice as large. The test is also more ovate in shape with acute periphery except in the last chambers. As pointed out by Hoglund, this form resembles *B. vadescens* in



1



2



FIG. 26. 1. *B. variabilis*, apertural view showing rim on free border and tongue.  
2. *B. cf. vadescens*, apertural view showing rim on free border and tongue.

its sigmoid sutures but is much smaller. In addition *B. vadescens* was described by both Cushman and later Hofker (1951a) as distinctly rounded, presumably throughout.

**DISTRIBUTION.** Hoglund's specimens are from the Gullmar Fjord and Skagerak with maximum abundance between 100–200 metres.

### *Bolivina variabilis* (Williamson)

(Pl. 10, fig. 8; Pl. 11, fig. 8; Text-fig. 25, no. 16)

*Textularia variabilis* Williamson, typica Williamson, 1858 : 76, pl. 6, figs 162, 163.

*Bolivina variabilis* (Williamson) Chaster, 1892 : 59; Cushman, 1922 : 49, pl. 4, figs 3a, b; 1937b : 158, pl. 16, figs 6, 12–14; 1949 : 32, pl. 6, figs 13–16; Voorthuysen, 1960 : 249, pl. 11, fig. 8; Sliter, 1970 : 166, pl. 5, fig. 4; pl. 6, figs 1–3; pl. 8, figs 15, 16.

**DIAGNOSIS.** An elongate, compressed *Bolivina* with chambers tending to become equal in length and height. Sutures deeply excavated, especially in the centre line where there is a tendency towards the development of lobes and re-entrants. Pores coarsely and evenly developed, sometimes within hexagonal pits.

**DESCRIPTION.** (Pl. 10, fig. 8; Pl. 11, fig. 8.) Test apparently complete but with small round borings of larger size than the natural perforation; elongate and compressed, gradually widening from the initial end to give a wedge shape; periphery rounded; about eight pairs of chambers, wider than high in the initial part but becoming equidimensional above the midpoint, the last two pairs making up half the length of the test; sutures impressed and inclined at about 20–30° to the horizontal with lobes and re-entrants in the centre line between the last three pairs of chambers; aperture large and subtriangular, in the median line, occupying two-thirds of the basal suture with rounded rim on the sinuous free border and straight tongue; wall conspicuously perforate with round pores about 1–2 microns in diameter, evenly distributed; the wall between the pores tends to be raised giving the appearance of hexagonal pits, particularly in the chambers towards midpoint, exaggerating the actual size of the pores.

**DIAMETER.** Length 0·35 mm, maximum width 0·17 mm. Angle of taper about 35°.

**MATERIAL.** Five specimens only, three broken.

**VARIATION.** A specimen with 10 pairs of chambers and rather more parallel sided last part is also illustrated, Text-fig. no. 16. There are also pustular openings in the last chamber.

**DEPOSITORY.** B.M.(N.H.) Slide 1970 : 11 : 26 : 237. Stub 1970 : 11 : 26 : 531.

**PROVENANCE.** Described specimen, CB 498. Specimen illustrated in Text-fig. no. 16, CB 416.

**REMARKS.** Stereoscanner photomicrographs confirm the excellent description of Williamson which emphasized the characteristic chamber shape, perforation and suture line of this species. Cushman in 1937b illustrated specimens sent to

him by Earland which show a variable shape in the last part from parallel sided to irregular, apparently with a tendency to a uniserial final chamber. As these specimens also show a narrower aperture they may not belong to the same species.

Our specimens closely resemble Williamson's type figure with fewer chambers developed.

DISTRIBUTION. This species was recorded from all round the British Isles by Williamson as well as from the Mediterranean. It is also recorded from the Belgian coast and the Dollart-Ems Estuary as well as from the New England coast. Bol'tovskoy (1954) records it from off Argentina and Sliter (1970) from the Eastern Pacific margin. This suggests a cool temperate distribution.

### Family SPIRILLINIDAE Reuss, 1862

#### Genus **PATELLINA** Williamson, 1858

##### **Patellina corrugata** Williamson

(Pl. 16, figs 7-9; Pl. 15, fig. 12)

*Patellina corrugata* Williamson, 1858 : 46, pl. 3, figs 86-89; Parker & Jones, 1865 : 398, pl. 15, figs 29a-c; Heron-Allen & Earland, 1913b : 109, pl. 9, fig. 11; Hofker, 1922 : 134, fig. 13; Cushman, 1930 : 15, pl. 3, figs 5a-c; 1931 : 11, pl. 2, figs 6, 7; 1944 : 30, pl. 4, fig. 14; 1948 : 68, pl. 7, fig. 11; 1949 : 41, pl. 7, figs 17, 18; Parker, 1952a : 420, pl. 6, figs 16, 17; Loeblich & Tappan, 1953 : 114, pl. 21, figs 4, 5; Phleger, Parker & Peirson, 1953 : 39, pl. 8, fig. 14; Haake, 1962 : 43, pl. 3, fig. 9; Feyling-Hanssen, 1964 : 335, pl. 18, fig. 9; Loeblich & Tappan, 1964a : C603, fig. 477, 6 and 7.

*Arpatellum dunst-corrugatum* (Williamson) Rhumbler, 1913 : 437, figs 134a-c, fig. 136; pl. 5, figs 5-7; pl. 7, figs 11-15.

*Discobolivina corrugata* (Williamson) Hofker, 1951b : 358.

DIAGNOSIS. A species of *Patellina* with up to about six whorls, the adult chambers divided into 20 or more radially elongate chamberlets. Angle of taper of the test about 110°.

DESCRIPTION. (Pl. 16, figs 7, 8, account of ventral side based on a separate specimen, Pl. 16, fig. 9.) Test concavo-convex, oval in outline with the evolute dorsal side making a straight sided cone, ventral side involute and depressed, periphery entire, sharply angular; chambers arranged in a dextral trochospire, all visible on the dorsal side, the first two whorls following the proloculus non septate, in turn followed by three whorls of biserial, elongate-crescentic chambers, increasing moderately in size as added, partially divided by septulae into narrow, slightly irregular chamberlets which open into the chamber interior, about 18 in the last chamber; sutures on dorsal side distinct, slightly impressed; last two chambers only, visible on the ventral side; wall thin, translucent with frosted appearance caused by secondary thickening on the dorsal side; densely perforated on the dorsal side with pores about a micron in diameter set in shallow pits, radial; aperture a ventral umbilical opening partly covered by an anchor-shaped lobe extending from the distal end of the last chamber, secondary apertures, three or four microns in diameter, in pits in the apertural face and similar, smaller openings irregularly developed

around the periphery in the ventral walls of the chamberlets; umbilical lobe of previous chamber partly visible but previous apertural opening secondarily covered in.

DIMENSIONS. Maximum diameter 0·32 mm, height of spire 0·08 mm. Angle of taper approx. 110°.

MATERIAL. More than 25 specimens but many with the apex damaged.

VARIATION. Specimens up to a maximum diameter of 0·41 mm occur. Damage to the initial part in most cases prevents assessment of dimorphism.

DEPOSITORY. B.M.(N.H.) Slide 1970 : 11 : 26 : 238-240. Stub 1970 : 11 : 26 : 678, 679.

PROVENANCE. Both specimens figured, CB 25.

REMARKS. Our specimens are very close to the types in number of chambers and chamberlets and in the height and angle of the spire. The stereoscanner photos clearly show the character of the ventral side which is difficult to make out under the light microscope, the test being so clear and transparent that surface details tend to be confused with internal ones. These show that the 'scroll-like median septum' of Loeblich & Tappan (1964a) is an appearance caused by superimposition of the umbilical lobes of successive chambers and that the aperture is actually umbilical. The non septate character of the early whorls emphasized in Williamson's description is clearly shown also (Pl. 16, fig. 8).

DISTRIBUTION. The species was originally described from a number of localities around the British Isles including the Western Isles, Arran, Skye and the Shetlands, Fowey, Cornwall and Brixham, Devon, as well as Boston in the Fens. Later British records confirm this distribution showing a concentration on west coasts: West of Ireland (Heron-Allen & Earland, 1913b); Irish Sea, Belfast Lough (Gough, 1906); Lambay (Wright, 1907); Isle of Man (Bruce *et al.*, 1963; Heron-Allen & Earland, 1915); Mersey (Burgess, 1891); Dee (Siddall, 1876); Southport (Chaster, 1892); West of Scotland, Shetlands (Waller, 1868); Oban (Burgess, 1889); Clyde (Robertson, 1877); Faroe Channel (Pearcey, 1890); Ardnamurchan and Mull (Heron-Allen & Earland, 1916a); Skye, Portree (Robertson, 1892); English Channel, Western Approaches (Murray, 1970); Scillies (Atkinson, 1970; Jones & Parker, 1876); Land's End (Le Calvez, 1958); Plymouth (Heron-Allen & Earland, 1930; Murray, 1965a; Worth, 1904); Selsey (Heron-Allen & Earland, 1909, 1911); Jersey (Halkyard, 1889); North Sea (Heron-Allen & Earland, 1913c); Kent coast (Hedley & Underwood, 1957); Forth (Pearcey, 1902).

Other N.W. European records: N. France, Dunkirk (Terquem, 1875); Belgian coast (Cushman, 1949); Germany, Langeoog (Haake, 1962); Holocene Oslofjord (Feyling-Hanssen, 1964).

Other N. Atlantic records: Arctic (Cushman, 1948; Goës, 1894; Parker & Jones' 1865; Loeblich & Tappan, 1953; Vilks, 1969); St Lawrence (Dawson, 1870); New England (Cushman, 1944; Parker, 1952a).

Most of the above records appear to be well founded but the cosmopolitan distribution indicated by Pacific, Australasian, Antarctic and Indian Ocean citations is possibly in error due to confusion with *P. advena* and *P. antarctica*.

Genus ***SPIRILLINA*** Ehrenberg, 1843***Spirillina perforata*** (Schultze)

(Pl. 16, figs 1, 2; Pl. 15, fig. 9)

*Cornuspinia perforata* Schultze, 1854 : 41, pl. 2, fig. 22.*Spirillina perforata* (Schultze) Williamson, 1858 : 92, pl. 7, fig. 202; Terquem, 1875 : 425, pl. 1, fig. 5; Cushman, 1931 : 5, pl. 1, figs 6, 7; Voorthuysen, 1960 : 250, pl. 11, fig. 15.

**DIAGNOSIS.** A compressed, coarsely perforate species of *Spirillina* with up to about six flattened, partially embracing whorls.

**DESCRIPTION.** (Pl. 16, figs 1, 2; Pl. 15, fig. 9.) Test with last chamber broken and holed; planispiral and compressed with flattened sides, bi-umbilicate, periphery rounded; subglobular proloculus followed by an undivided second chamber, wound in about six partially embracing whorls, only very gradually increasing in size as added; wall calcareous, perforated with irregular, oval to subquadangular pores up to 3 microns maximum diameter; aperture broken off.

**DIMENSIONS.** Maximum diameter 0·46 mm, thickness 0·06 mm.

**MATERIAL.** Two specimens only.

**DEPOSITORY.** B.M.(N.H.) Stub 1970 : 11 : 26 : 718.

**PROVENANCE.** Low Marsh, Clettwr Transect, Dovey Estuary.

**REMARKS.** Our specimens are close to those figured by previous authors and show the characteristic flattened whorls and dense, coarse, perforation of the species.

**DISTRIBUTION.** This species was described from off Mozambique. Records for N.W. Europe include: British coasts (Williamson, 1858—where, however, it is confused with *S. vivipara*); Dunkirk, N. France (Terquem, 1875); Belgian coast (Cushman, 1931); Dollart-Ems Estuary, Netherlands (Voorthuysen, 1960).

It is also recorded from the West Indies by Cushman (1931). This suggests a cosmopolitan distribution.

***Spirillina* species A**

(Pl. 16, figs 5, 6; Pl. 15, fig. 10)

**DESCRIPTION.** Test broken and holed; planispiral and biconcave with flattened periphery and twin keels; subglobular proloculus succeeded by about four undivided whorls, increasing very slowly in diameter as added; spiral suture distinct, immediately outside the raised ridge formed by the keels; wall calcareous, opaque, granular in appearance probably due to the thickness and coarse perforation; three rows of pores in deep pits visible on each side of the second chamber with a further row of smaller irregular ones in a discontinuous groove adjacent to the keel; numerous irregularly distributed pores at the periphery; aperture broken off.

**DIMENSIONS.** Maximum diameter 0·36 mm, thickness 0·06 mm.

**MATERIAL.** One specimen only.

DEPOSITORY. B.M.(N.H.) Stub 1970 - II : 26 : 716.

PROVENANCE. Brit. Mus. Core 16.

REMARKS. This species resembles *S. limbata* Brady in general shape but differs in its elaborate, pitted perforations. *S. limbata* var. *bipunctata* Cushman, an Oligocene species, has two rows of perforations on one side only, a single row in the juvenile part.

Genus **TURRISPIRILLINA** Cushman, 1927

***Turrispirillina*** species A

(Pl. 16, figs 3, 4)

DESCRIPTION. Test trochoid in the initial part, planispiral in the adult, concavo-convex; subglobular proloculus followed by an undivided, partially overlapping, flattened second chamber, first two whorls trochoid, last three planispiral, very gradually increasing in size as added; spiral suture ragged; periphery pinched off into an acute keel (with a marked groove) with strong nodes in the final whorl; wall calcareous, smooth, semitransparent, apparently granular, possibly due to thickness; aperture broken off.

DIMENSIONS. Maximum diameter 0.25 mm, height 0.06 mm.

MATERIAL. One specimen only.

DEPOSITORY. B.M.(N.H.) Stub 1970 : II : 26 : 717.

PROVENANCE. Brit. Mus. Core 16.

REMARKS. No other species quite like this one has been noted despite a thorough combing through the literature.

Family **DISCORBIDAE** Ehrenberg, 1838

Genus **CANCRIS** Montfort, 1808

***Cancris oblongus*** (Williamson)

(Pl. 20, fig. 13; Pl. 23, figs 5, 6; Text-fig. 27, nos 1-3)

*Rotalina oblonga* Williamson, 1858 : 51, pl. 4, figs 98-100.

*Cancris oblongus* (Williamson) Cushman & Todd, 1942 : 80, pl. 20, figs 2-5; Le Calvez, 1958 : 184, pl. 3, figs 42, 43; Hofker, 1969 : 94, fig. 265.

*Pulvinulina auricula* Goës, 1894 : 98, pl. 16, fig. 809 (not 810); Flint, 1899 : 329, pl. 73, fig. 2 (not Fichtel & Moll).

*Cancris auricula* Cushman, 1931 : 72, pl. 15, fig. 1 (not Fichtel & Moll).

DIAGNOSIS. A large, compressed, elongate to oblong species of *Cancris* with flattened dorsal side and up to seven or eight elongate chambers visible on the ventral side. The sutures become incised near the prominent umbilical flap and thickened with secondary calcite at the edges.

DESCRIPTION. (Text-fig. nos 1-3.) Test compressed and elongate to oblong in

shape, ventral side raised and umbilicate, dorsal side flattened, lobate in last part with slight keel commencing on the penultimate chamber and continuing almost to the base of the apertural face; 12 chambers arranged in a low, dextral trochoid spiral, 6 : 5—, following the proloculus, rapidly increasing in height, oblong—arcuate on dorsal, wedge-shaped on the ventral with apertural face markedly oblique to the periphery; final chamber with large irregular basal flap covering the umbilicus, sutures slightly impressed becoming incised and thickened at the sides with secondary calcite in the umbilicus, radial on the ventral side, markedly curved on the dorsal side; wall radial and densely perforated with pores approximately a micron in size, apart from an oval area in the apertural face which includes the umbilical flap; aperture a low slit at the basal suture on the ventral side extending beneath the umbilical flap.

**DIMENSIONS.** Maximum diameter 0·8 mm, height 0·32 mm. Approx. diameter of proloculus 25 microns.

**MATERIAL.** Three specimens only.

**VARIATION.** The material is insufficient for proper study of variation and dimorphism. This species is better developed outside Cardigan Bay in St Georges Channel. Juveniles show fewer chambers on the ventral side.

**DEPOSITORY.** B.M.(N.H.) Slide 1970 : II : 26 : 246, 247. Stub 1970 : II : 26 : 551.

**PROVENANCE.** Described specimen, CB 573.

**REMARKS.** Our specimens come close to the type figure of Williamson in their compression, in the character of the umbilical region and in the restriction of the

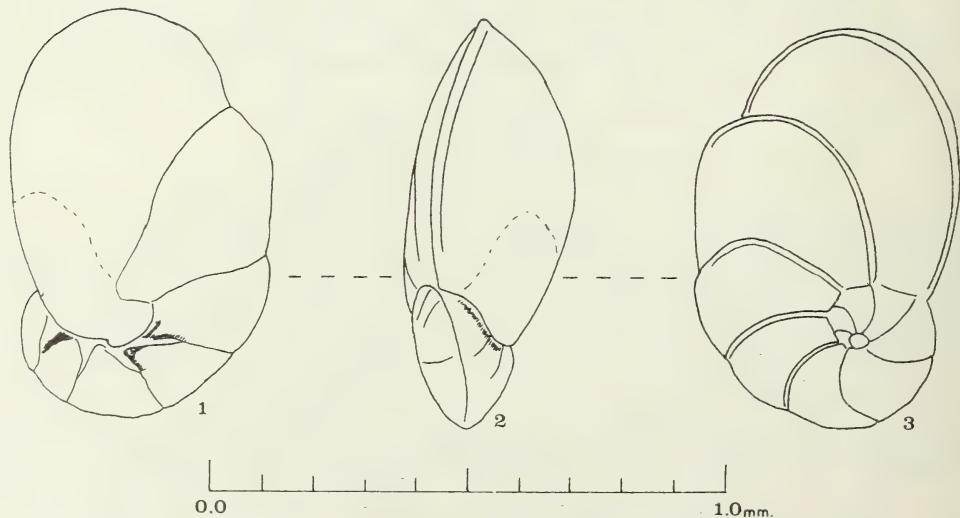


FIG. 27. 1-3. *Cancris oblongus*, specimen described. 1, ventral view; 2, side view; 3, dorsal view.

keel to the last one or two chambers although they are slightly less elongate. This species, as shown by Cushman & Todd (1942) and Le Calvez (1958) is distinguished from *C. auriculus* by its more elongate and compressed test and narrower chambers as well as by the pronounced incision of the sutures in the umbilical area; *C. oblongus* also appears to be more flattened on the dorsal side and to possess a larger umbilical lobe.

A specimen referred to this species by Brady (1884) from off S. Africa differs in its wider chambers and in lacking the characteristic umbilical features.

**DISTRIBUTION.** This species was first described from British waters with Skye as the chief locality. Williamson's records, apart from one at Boston, Lincs., show a marked concentration off western coasts. This is apparently borne out by numerous subsequent listings of *C. auriculus* which may well refer to *C. oblongus*. However, in the absence of figures these records must be treated with reserve as Le Calvez (1958) also records *C. auriculus* s.s. from the Celtic Sea.

Other records in the N. Atlantic area include: Bay of Biscay (Caralp, Lamy & Pujos, 1970); Tamar Estuary (Murray, 1965a); North Sea and Arctic (Goës, 1894); Baltimore, S.W. Ireland and off Florida (Cushman & Todd, 1942); Celtic Sea (Le Calvez, 1958); Western Approaches (Le Calvez & Boillot, 1967); Gulf of Mexico (Phleger & Parker, 1951).

Mediterranean records are: Western (Todd, 1958); Eastern (Parker, 1958).

#### Genus *DISCORBIS* Lamarck, 1804

##### *Discorbis (Glabratella) wrightii* (Brady)

(Pl. 16, figs 12–16; Pl. 19, fig. 5; Pl. 30, figs 4, 5; Text-fig. 30, nos 10–15)

*Discorbina wrightii* Brady, 1881 : 413, pl. 21, figs 6a–c (= *Discorbina parisiensis* sensu Wright, 1877 : 105, pl. 4, figs 2a–c, not fig. 1); Halkyard, 1889 : 70, pl. 2, fig. 9; Heron-Allen & Earland, 1913b : 131, pl. 12, fig. 4.

*Eponides wrightii* (Brady) Cushman, 1931 : 56, pl. 11, figs 7, 8 (figs after Brady and Heron-Allen & Earland).

*Rosalini wrightii* (Brady) Cooper, 1964 : 102, pl. 6, figs 13–15.

*Discorbina baccata* Heron-Allen & Earland, 1913b : 124, pl. 12, figs 1–3.

*Discorbis baccata* (Heron-Allen & Earland) Cushman, 1931 : 15, pl. 3, figs 1a–c (figs after Heron-Allen & Earland); 1949 : 45, pl. 8, fig. 7.

**DIAGNOSIS.** A plano-convex to biconvex species of *Discorbis (Glabratella)* with eight or nine chambers at the periphery, large, composite countersunk, umbilical boss and coarse perforations on the dorsal side.

**DESCRIPTION.** (Text-fig. nos 13–15.) Test biconvex with raised, conical evolute, dorsal side and flattened, involute, ventral side, periphery subangular and becoming subrounded in the last part, entire becoming semi-lobate at the last three chambers; 18 chambers seen on the dorsal side (in xylene), in a sinistral trochospire of 5 : 7 : 6—, chambers following the proloculus, increasing very gradually and somewhat irregularly in size, trapezoid, becoming longer than high and arcuate in the third

whorl; spiral and septal sutures flush and thickened (less so between last two chambers), septal sutures moderately backward curving; nine chambers visible on the ventral side, the last three becoming elongate with rounded umbilical lobes, the final one showing both distal and proximal re-entrants; sutures sinuous, becoming fissured towards the umbilicus which is filled with a large, flat, countersunk, vesicular boss, mainly of rounded masses of calcite but with some blade-like outgrowths extending onto the chambers; wall very thick (thinner in last three chambers) lamellar, apparently radial, coarsely perforate with elongate pores on the thickened, glassy dorsal side, finely perforate on the ventral side and dorsal pores giving the appearance of a milled edge in the early part; aperture apparently at the ventral basal suture opening into the umbilicus beneath the lobe; ventral surface covered with rows of fine beads radiating from the umbilicus, producing a striking, frosted, appearance.

DIMENSIONS. Maximum diameter 0·39 mm, maximum height 0·20 mm. Diameter of proloculus (very approximately) 20 microns.

MATERIAL. More than 25 specimens, smaller than the specimen described with broken last chambers (as in the holotype), generally rough and eroded, some golden brown in colour.

VARIATION. Most of the specimens recovered are less than 0·3 mm in diameter and show eight chambers at the periphery which is more or less entire. Both plano-convex and more biconvex specimens occur (Text-fig. nos 10-12; Pl. 16, fig. 13). There is also variation in the size of the umbilical boss. The stereoscaner photos also show the details of perforation. There are very small scattered pores less than  $\frac{1}{2}$  micron in size on the ventral side, coarser pores up to 2 microns in size on the dorsal side (Pl. 16, figs 13, 14). All the specimens appear to be sinistral. As can be seen in Pl. 16, fig. 12, erosion of the lamellar thickening on the dorsal side, sometimes gives the effect of a sharp periphery or keel.

DEPOSITORY. B.M.(N.H.) Slide 1970 : 11 : 26 : 248-252. Section 1970 : 11 : 26 : 477. Stubs 1970 : 11 : 26 : 586, 587, 1970 : 11 : 26 : 750, 751.

PROVENANCE. Specimen described, CB 491. Specimen shown in Text-fig. nos 10-12, Clettwr VII, Dovey Marshes. Other specimens illustrated by stereoscaner photos, CB 11.

REMARKS. Our specimens, although smaller than the types with less than three whorls of chambers developed, otherwise show all the characteristic features exhibited by the excellent specimens from Belfast Lough in the Brady Collection and the Norman Collection at the British Museum. In particular they show the details of ventral ornament well shown in Wright's figure and cited by Brady in his diagnosis. There is little doubt that Cushman (1931) was correct in his surmise that *Discorbina baccata* of Heron-Allen and Earland is synonymous. This is borne out by an examination of their Clare Island types though unfortunately one specimen is decomposing and the details of the others are obscure. Although the figure given by these authors appears to show coarse perforations on the ventral side their description makes it clear that it is beaded. Other details are the same as

in *D. wrightii*. As noted by Heron-Allen and Earland the surface tends to be rough and eroded. So much so that at first we were tempted to believe our specimens derived.

This species has been referred successively to *Discorbina*, *Eponides* and *Discorbis* because of the difficulty of observing the true nature and position of the aperture in the generally broken specimens. In the complete specimen we describe the aperture is apparently umbilical, beneath a lobe and there are definite proximal re-entrants, 'secondary apertures' of authors. The vesicular, umbilical boss also extends over the chambers like the cover plate in typical *Discorbis*. Loeblich & Tappan (1964a) have removed discorbids with radial ornament on the ventral side and plastogamic reproduction (noted in this species by Heron-Allen & Earland in 1913b) to the Glabratellidae. This seems to us too drastic a move but we retain *Glabratella* as a subgeneric designation.

Specimens referred to *Eponides wrightii* by Parker (1952a, 1952b) and Cushman (1944, 1948) appear to be a different species with fewer chambers. *Discorbis baccata* sensu Cushman (1948) may be the same as these.

DISTRIBUTION. This species was first described from Novaya Zemlya Island, Arctic and from Belfast Lough. As *Discorbina baccata* it was described from Western Ireland, Llanfihangel-y-Traethau on Cardigan Bay and from Swanage in Dorset. Further records were given by Heron-Allen & Earland for Cornwall (1916b), the West of Scotland (1916a) and Plymouth (1930) and by Halkyard for Jersey (1889).

#### Genus ***DISCORBINELLA*** Cushman & Martin, 1935

*Discorbinella* species A. aff. *bertheloti* d'Orbigny, 1839b

(Text-fig. 29, nos 1-5)

DIAGNOSIS. A compressed, plano-convex species of *Discorbinella*, slightly involute on the dorsal side but all whorls visible with depressed spiral suture. Ventral side with about seven chambers visible, triangular lobes and flat umbilical boss. Aperture basal and just extending over the periphery beneath a lip. Sutures limbate, periphery acute to sub-carinate. Densely perforate with medium sized pores, less on ventral side, especially towards the lobes.

DESCRIPTION. (Text-fig. nos 1-3.) Test with slightly damaged, pushed-in last chamber; compressed, plano-convex with raised, slightly involute dorsal side in which the first whorl is depressed below the level of those succeeding it and flat slightly uncoiling ventral side, periphery subcarinate; 17 chambers arranged in a very low, sinistral trochospire, 6 : 7 : 4—, following the proloculus, trebling in size with each volution and becoming much higher than long, eight chambers visible at the periphery on the ventral side with triangular umbilical lobes; umbilicus with flat boss, the later lobes drawing away from it to produce a wide pseudumbilicus; dorsal spiral and septal sutures limbate and impressed (showing as dark lines on the golden brown test), septal sutures gently curved back, ventral septal sutures limbate, and gently curved to almost straight, continuing into the thickened keel, fissured

towards the umbilicus and knotted behind the lobes of the last four chambers; wall apparently lamellar, densely perforated with medium sized pores, less on the ventral side especially towards the lobes, aperture along the basal suture of the last chamber on the ventral side, just extending over the periphery beneath a lip, freely connecting with the open pseudumbilicus and the knotted sutural slits of previous chambers.

**DIMENSIONS.** Maximum diameter 0·71 mm, maximum height 0·16 mm. Approx. diameter of proloculus 25 microns.

**MATERIAL.** Eight specimens.

**VARIATION.** Only the specimen described is well grown. All the other specimens are small, less than 0·40 mm in diameter and develop less than two whorls of chambers. In some cases the chambers are high in the second whorl in others they are more arcuate. The test is generally brown in colour, especially the first whorl as seen from the dorsal side.

**DEPOSITORY.** B.M.(N.H.) Slide 1970 : 11 : 26 : 253-255.

**PROVENANCE.** Specimen described, CB. Pool A, Monks Cave, Cards.

**REMARKS.** Our specimens are less wafer thin and carinate than the specimen shown in d'Orbigny's figure of the genotype, *D. bertheloti*, and differ in their greater tendency towards uncoiling with the dorsal side being only slightly involute. The ventral side in our specimens is also different being plane with limbate sutures and flat umbilical boss. It is interesting that d'Orbigny does mention a 'disque omnilical' in his description, but no boss is shown in his figure or in the specimen of Flint refigured by Loeblich & Tappan as part of their generic diagnosis (1964a). Our specimens also appear to be more distinctly perforate on both sides. *D. berthelotiana* of Parker & Jones (1865) described from the 'marginal plateau' off Ireland with limbate sutures and 'granule' replacing the umbilical flap may be near to our specimens.

### Genus *ROSALINA* d'Orbigny, 1826

#### *Rosalina anomala* Terquem

(Pl. 17, figs 1-3; Pl. 19, fig. 2; Pl. 30, figs 1, 2; Text-fig. 28, nos 1-7)

*Rosalina anomala* Terquem, 1875 : 438, pl. 5, fig. 1.

*Rosalina globularis* Voorhuisen, 1958 : 33, pl. 24, fig. 16; Haake, 1962 : 43, pl. 3, figs 10-11 (not d'Orbigny).

*Discorbina globularis* Goës, 1894 : 94, pl. 15, figs 793a, b (not d'Orbigny).

*Discorbina globularis* var. *vesicularis* sub. var. *globularis* Parker & Jones, 1865 : 386, pl. 14, figs 20-23 (not Lamarck, not d'Orbigny).

*Discorbis globularis* Cushman, 1931 : 22, pl. 4, figs 9a-c; 1948 : 68, pl. 7, fig. 12 (not d'Orbigny).

*Discorbis globularis* (d'Orbigny) var. *anglica* Cushman, 1931 : 23, pl. 4, figs 10a-c.

*Rosalina globularis* d'Orbigny var. *anglica* Heron-Allen & Earland, Le Calvez & Boillot, 1967 : 397 (list), pl. 1, figs 7, 8 (wrongly ascribed).

*Rotalina concamerata* part Williamson, 1858 : 52, pl. 4, figs 104, 105 only (not Montagu).

*Discopulvinulina globularis* Hofker, 1951a : 457, text-fig. 311 (not d'Orbigny).

**DIAGNOSIS.** A species of *Rosalina* with coarse pores up to 8 microns in diameter

on the dorsal side and glassy, poreless ventral side with 5–6 chambers visible. The chambers develop beak-like lobes in the ventral umbilicus.

**DESCRIPTION.** (Text-fig. nos 1–3.) Test concavo-convex with raised evolute, dorsal side and concave, involute, ventral side, periphery entire, irregular in outline, subangular, dorsal side flattened in the centre giving a bun-shape; 17 chambers arranged in a low sinistral trochospire, 6 : 5 : 5—, following the proloculus as seen on the dorsal side, doubling in size with each volution and becoming arcuate and longer than high in the third whorl, six chambers visible on the ventral side with pointed, beak-like lobes projecting into the open umbilicus (final lobe chipped), septal sutures swept back, making an even curve with the periphery between the last two chambers; dorsal spiral and septal sutures limbate and slightly impressed, sutures on ventral side deeply impressed and fissured towards the umbilicus, gently backward curving with re-entrants behind the lobes; wall apparently weakly radial, lamellar, tending to peel off on the generally poreless ventral side making thinner, more glassy patches, surface on dorsal side smooth with coarse, well-spaced round pores, up to 8 microns in diameter (in ventral view the appearance of a milled edge is given by those near the periphery); aperture along the basal suture of the last chamber extending from the periphery to the umbilical lobe beneath a slight, arched lip, freely connecting with the open umbilicus and the knotted, sutural slits of previous chambers.

**DIMENSIONS.** Maximum diameter 0·43 mm, maximum height 0·17 mm. Diameter of proloculus approx. 10 microns.

**MATERIAL.** More than 25 specimens. Generally small and current worn. For this reason and because it is necessary to establish the identity of specimens such as those of Cushman hitherto referred to *D. globularis* in the N. Atlantic region abundant material has been examined from Dogs Bay, Galway and Mannin Bay, Connemara. The description is of a specimen from Connemara. However, two well grown specimens from Cardigan Bay are illustrated in the stereoscanner photographs.

**VARIATION.** Examination of material from Connemara, more than 100 specimens shows that there is a range of proloculus size from about 10 microns to 30 microns. Specimens with small proloculus tend to develop up to three whorls and 16 to 18 chambers, specimens with large proloculus tend to develop 2–2½ whorls and from 12–15 chambers, Text-fig. nos 4, 5. The Cardigan Bay specimens fall within this range. As is to be expected in an attached form there is diversity in outline and in the height of the spire, some specimens being more conical, Text-fig. nos 4, 5, with more acute periphery. This conical, well grown megalospheric individual also shows very long, low chambers in the final whorl.

**DEPOSITORY.** B.M.(N.H.) Slide 1970 : II : 26 : 256–259. Section 1970 : II : 26 : 478. Stub 1970 : II : 26 : 574, 576, 577.

**PROVENANCE.** Specimen described and additional specimens in text-fig. from beach sand, Mannin Bay, Connemara. Specimens by stereoscanner photos, CB 542.

**REMARKS.** In their redescription of *Rosalina*, Loeblich & Tappan (1964a) have shown that the genotype, *R. globularis* d'Orb. is finely punctate on both sides—as

is, indeed, suggested by the original figure of d'Orbigny. This means that specimens such as *Discorbis globularis* sensu Cushman (1931) from Dogs Bay, described in the Atlantic Monograph require another name. The first available appears to be *R. anomala*. This species of Terquem appears to have been largely ignored in the literature owing to the wide degree of latitude given to the interpretation of *R. globularis*, but his type figures appear to show the essential features of size, shape, chamber number and perforation shared by populations in Cardigan Bay and off the west coast of Ireland. The irregularity shown by the specimen can easily be matched in our material. *Discorbis globularis* var. *anglica* Cushman, from a Gold-seeker sample in the Moray Firth, almost certainly belongs here also as it was found by Harris (1958) as a commonly occurring irregular form in normal populations of '*Discorbis globularis*' around the Scottish coast. It can be noted here that the first good illustration of the coarse, dorsal pores in this species were given by Williamson (1858) who considered it the juvenile of *Rotalina concamerata*.

It is possible that *Discorbis floridana* Cushman is a closely related species though smaller with less developed umbilical area. Most of the specimens referred to *Discorbis globularis* in the British Museum collections, such as those of Brady from the Wansbeck, Northumbria and Marazion, Cornwall and those of Norman from the Shetlands and Valentia, Ireland belong here.

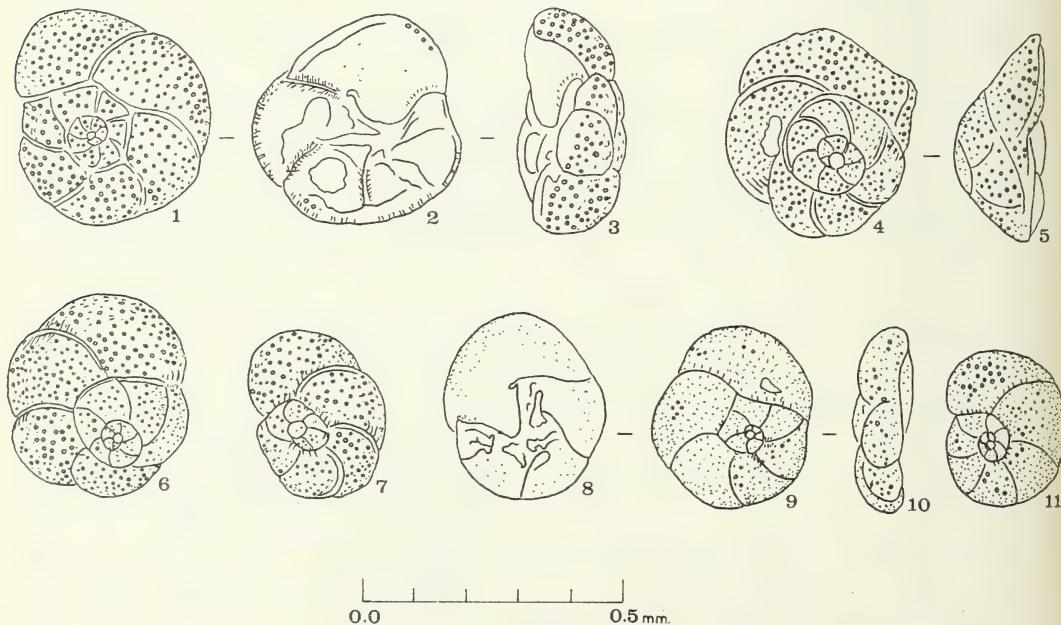


FIG. 28. 1-7. *Rosalina anomala*. 1, dorsal view showing coarse pores; 2, ventral view showing peeling areas; 3, side view showing subangular periphery; 4, 5, dorsal view and peripheral view of conical specimen with acute periphery; 6, conical specimen, mishapen and sloping to one side; 7, small irregular specimen (with large proloculus). 8-11. *Rosalina* cf. *bradyi*. 8, ventral view showing hammer-shaped lobes; 9, dorsal view showing medium sized pores; 10, peripheral view; 11, dorsal view of small specimen.

Due to the coarse perforation the dorsal side has the appearance of frosted glass. These pores are evenly distributed and vary from 2–8 microns in diameter and from 8–18 microns apart with growth. Some are apparently plugged and show finer perforations within, i.e. 'deutero pores'. The initial whorls are brownish in colour in many specimens.

**DISTRIBUTION.** This species was first described from shore sands at Dunkirk in the English Channel and it is also recorded from the North Sea (Goës, 1894; Haake, 1962; Harris, 1958) and from the 'English coasts' by Hofker (1951a). It was also described from Dogs Bay, Ireland by Cushman (1931).

Other records are from the Arctic (Cushman, 1948) and for Davis' Strait (Parker & Jones, 1865).

### *Rosalina cf. bradyi* (Cushman) 1915

(Pl. 17, figs 4, 5; Pl. 19, figs 1, 3, 6; Text-fig. 28, nos 8–11)

**DESCRIPTION.** (Text-fig. nos 8–10.) Test concavo-convex with raised evolute dorsal side and concave, involute, ventral side; periphery slightly lobate, subangular, dorsal side flattened with early whorls depressed; 13 chambers arranged in a low dextral, trochospire, 5 : 6 : 2—, following the proloculus, as seen from the dorsal side, trebling in size with each volution and becoming arcuate and longer than high in the third whorl, five chambers seen on the ventral side with marked umbilical lobes projecting into the open umbilicus, early lobes raised, thickened and hammer-shaped, final lobe triangular; both septal and spiral sutures limbate and depressed on dorsal side, septal sutures curved backwards on the dorsal side, radial to sigmoid and deeply excavated on the ventral side, with re-entrants behind the lobes; wall apparently radial, lamellar with very fine scattered pores on the ventral side, rough on dorsal side and densely perforated with irregular pores up to 5 or 6 microns in diameter; aperture along the basal suture of the last chamber, extending from the periphery to the umbilical lobe and freely connecting with the open umbilicus.

**DIMENSIONS.** Maximum diameter 0·36 mm, maximum height 0·11 mm. Approx. diameter of proloculus 15 microns.

**MATERIAL.** Six specimens only.

**VARIATION.** Two specimens are illustrated by stereoscanner photos, two others by camera lucida drawings. The proloculus size is fairly constant near 15 microns and five or six chambers are shown at the periphery. The photograph of the single, large specimen recovered (diameter approx. 0·60 mm) shows that the chambers tend to become long and low in well grown individuals and the dorsal side is higher and less flattened. The photographs also show the rough surface and irregular pores on the dorsal side, many with plugs, also finely perforated. In two specimens the coarser pores on the dorsal side seen through the test give the appearance of a milled edge to the periphery. The development of thickening on the umbilical lobes is variable and in one specimen it takes the form of minute beading. All the specimens are golden brown in colour, seen from the dorsal side.

DEPOSITORY. B.M.(N.H.) Slide 1970 : II : 26 : 270-272. Stub 1970 : II : 26 : 575, 578.

PROVENANCE. Specimen described, Dovey Estuary, Station 20.

REMARKS. Our specimens bear some resemblance to *Rosalina bradyi* Cushman, especially to the specimen figured by Brady as *Discorbina globularis* (1884, pl. 86, fig. 8, not fig. 13) and included by Cushman in his synonymy, but differ in having depressed rather than raised spiral and septal sutures on the dorsal side.

In his type description Cushman mentions a 'peculiar bifid indentation extending inward from the peripheral region', this is not apparent on the type specimen from Japan and appears to refer to the sutural re-entrant on the last chamber of Brady's specimen from Hong Kong. Hedley *et al.* (1967) have re-examined Brady's material from Hong Kong and figured a number of smaller but 'identical' specimens from New Zealand. These show an extensive development of shelly patches on the borders of the ventral umbilicus with branched fissures extending into the chambers. None of them show the more regular, sharply recurved, hammer shaped umbilical lobes of our specimens. It is likely that our material represents a new species but it is insufficient for a proper diagnosis.

### *Rosalina irregularis* (Rhumbler)

(Pl. 30, figs 9, 10; Text-fig. 29, nos 6-16)

*Discorbina irregularis* Rhumbler, 1906 : 70, pl. 5, figs 57, 58; Heron-Allen & Earland, 1913b : 120, pl. 10, figs 2-4.

*Discorbina mediterranensis* Heron-Allen & Earland, 1913b : 118, pl. 9, figs 12-14; pl. 10, fig. 1 (not d'Orbigny).

*Discorbis mediterranensis* Cushman, 1931 : 24, pl. 5, figs 2a-c (after Heron-Allen & Earland). *Rosalina irregularis* (Rhumbler) Hedley *et al.*, 1967 : 45, pl. 11, figs 3A, B.

? *Discorbina orbicularis* Balkwill & Wright, 1885 : 349, pl. 13, figs 31-33 (not *Rosalina orbicularis* Terquem).

DIAGNOSIS. A conical or concavo-convex species of *Rosalina* like *R. globularis* in the initial portion but becoming spreading with irregular, long and low, arcuate chambers. Periphery subrounded to acute.

DESCRIPTION. (Text-fig. nos 14-16.) Test slightly damaged, conical with almost flat ventral surface, periphery subacute; 23 chambers arranged in a sinistral trochospire, 6 : 6 : 6 : 5, in each whorl following the proloculus, as seen from dorsal side, becoming longer than high and arcuate in the third whorl, then irregular, last chamber making up almost half the circumference, septal and spiral sutures limbate and depressed; five irregularly overlapping chambers seen on the ventral side with broad lobes projecting into the umbilicus, sutures distinct, slightly impressed, irregular; wall apparently optically granular and lamellar, densely perforated with medium sized pores, less on ventral side, especially towards the lobes where there are a few scattered, larger pores; aperture at basal suture of the last

chamber on the ventral side, freely communicating beneath the umbilical lobe with the open, irregular umbilicus, probably slightly damaged when detatched.

**DIMENSIONS.** Maximum diameter 0·63 mm, maximum height 0·20 mm. Approx. diameter of proloculus 15 microns.

**MATERIAL.** Seven specimens, five of them well grown, all from the same locality.

**VARIATION.** As is to be expected in an irregularly spreading fixed form there is considerable individual variation, especially in profile. This is well shown in the text figures. There appear to be two proloculus size groups. One group, including the specimen described, with initial chamber about 15 microns or slightly less in diameter, Text-fig. nos 6, 10, and another represented by Text-fig. no. 12 with initial chamber about 25 microns. The microspheric group develop up to four whorls of chambers which become longer than high in the third whorl. The specimen with larger proloculus shows three whorls with chambers tending to become longer than high by the end of the second whorl.

**DEPOSITORY.** B.M.(N.H.) Slide 1970 : II : 26 : 273-277. Section 1970 : II : 26 : 479.

**PROVENANCE.** All specimens from *Corallina*, Pool A, Monk's Cave.

**REMARKS.** This species was described by Rhumbler from Chatham Island in the Pacific. Topotypes have been studied by Hedley *et al.* (1967) and found to be identical with New Zealand intertidal material. Our specimens, though slightly less irregular, compare with their figures. There seems little doubt that the specimens described by Heron-Allen and Earland as *Discorbina irregularis* and *D. mediterranensis* from Clare Island, are shape variations and that both belong here. *Rosalina mediterranensis* d'Orbigny is undescribed but the type figure of Fornasini (1906) shows a globular form with rounded periphery. *D. orbicularis* of Balkwill and Wright from the coast near Dublin may belong here also (see under *R. neapolitana*).

**DISTRIBUTION.** An attached intertidal species known from the S.W. Pacific and the coasts of Ireland.

### *Rosalina milletii* (Wright)

(Pl. 17, figs 11, 12; Pl. 30, fig. 6; Text-fig. 31, nos 5-7)

*Discorbina milletii* Wright, 1911 : 13, pl. 2, figs 14-17; Heron-Allen & Earland, 1913b : 121, pl. 10, figs 5-7.

*Discorbis milletii* (Wright) Cushman, 1931 : 24, pl. 5, figs 3, 4 (3 after Wright).

*Rosalina milletii* (Wright) Voorthuysen, 1958 : 33, pl. 24, figs 17a-c; 1960 : 251, pl. 11, figs 18a-c; Haake, 1962 : 43, pl. 3, figs 12, 13.

*Discorbis orbicularis* (Terquem) var. *selseyensis* (Heron-Allen & Earland) Cushman, 1949 : 43, pl. 8, figs 3a-c (? = *Discorbina rosacea* d'Orbigny var. *selseyense* Heron-Allen & Earland).

*Glabratella milletti* (Wright) Le Calvez & Boillot, 1967 : 394 (list).

**DIAGNOSIS.** A finely perforate, scale-like, keeled species of *Rosalina* with fine striae and beads radiating from the umbilicus on the ventral side, rugose on the dorsal side. Four to five chambers visible on the ventral side.

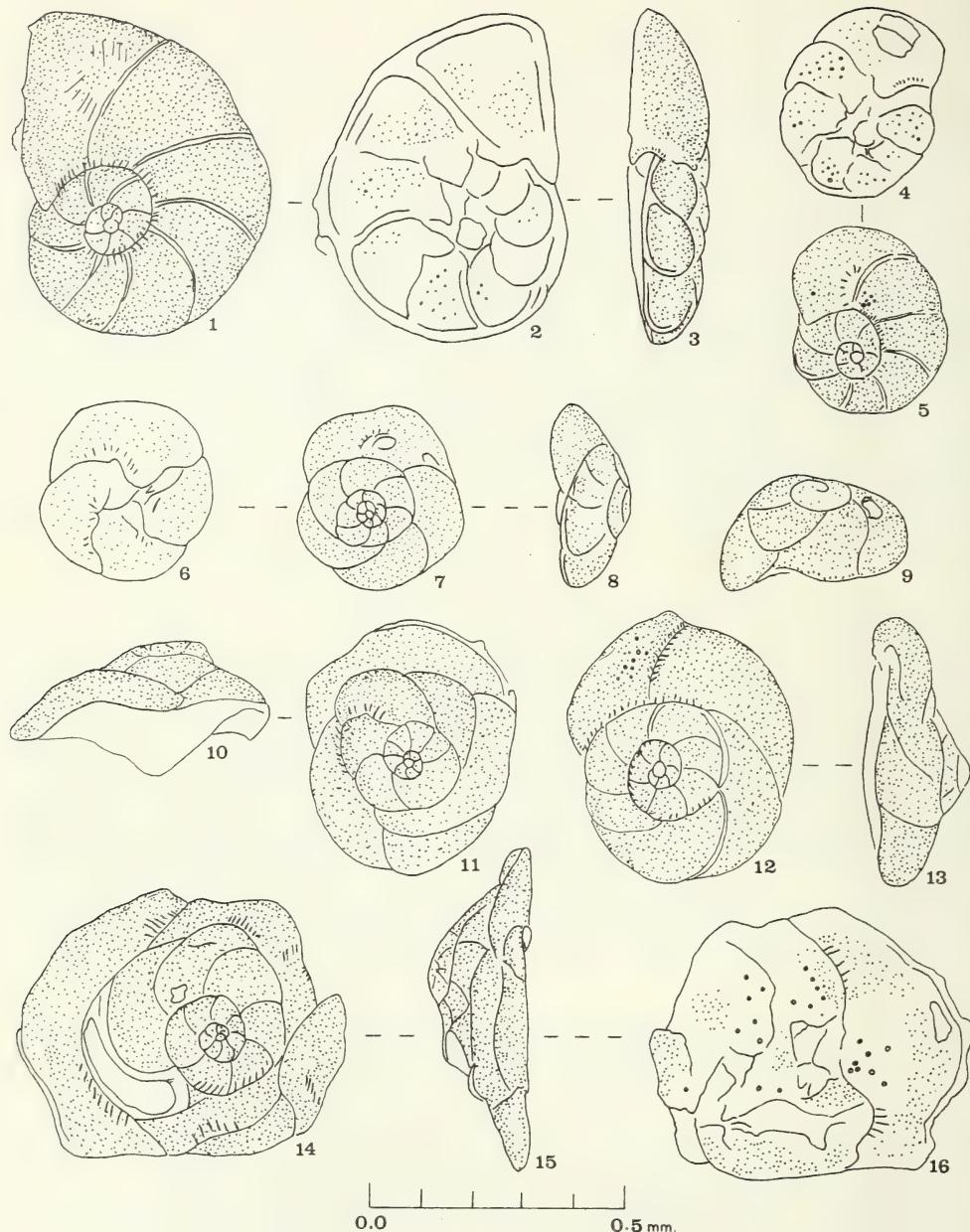


FIG. 29. 1-5. *Discorbinella* sp. A. 1, dorsal view; 2, ventral view; 3, side view; 4, ventral view of juvenile; 5, dorsal view. 6-16. *Rosalina irregularis*. 6, ventral view of juvenile; 7, dorsal view; 8, side view; 9, irregular specimen with rounded dorsal side; 10, side view of irregular conical specimen with acute periphery; 11, dorsal view, showing small proloculus; 12, dorsal view of specimen with rounded periphery and large proloculus; 13, side view; 14, dorsal view of well grown specimen described; 15, side view showing flat base; 16, ventral view.

**DESCRIPTION.** (Text-fig. nos 5-7.) Test damaged with holed penultimate chamber, concavo-convex and scale-like with low conical, evolute dorsal side and concave, depressed, involute ventral side, periphery with narrow keel, entire, slightly irregular; 13 chambers visible on the dorsal side, 5 : 5 : 3—, following the proloculus, becoming longer than high in the second whorl, becoming twice as long with each volution but not increasing much in height, spiral and septal sutures flush, slightly thickened, septal sutures markedly backwards curving; five chambers visible on the ventral side with rounded umbilical lobes, sutures markedly backwards curving, impressed towards the umbilicus; wall lamellar, apparently minutely perforate on both sides; aperture obscured, presumably at ventral basal suture opening beneath the umbilical lobe into the umbilicus; ornament of striae and small raised beads radiating from the umbilicus on the ventral side, dorsal side rugose.

**DIMENSIONS.** Maximum diameter 0.32 mm, maximum height 0.09 mm. Approx. diameter of proloculus 20 microns

**MATERIAL** Four specimens only.

**VARIATION.** Authors' figures appear to show from four to five chambers and the curvature of the ventral septal sutures becoming less with growth. The rugosity of the dorsal side, so well developed in our specimens, may also be a variable feature as authors such as Cushman (1931) described this species as very close to *R. williamsoni* on this side; on the other hand this feature may have been overlooked. The ornament is well shown in Pl. 17, figs 11, 12 also the minute pores about 1 micron in size.

**DEPOSITORY.** B.M.(N.H.) Slide 1970 : 11 : 26 : 278. Section 1970 : 26 : 480. Stub 1970 : 11 : 26 : 588, 589.

**PROVENANCE.** Specimen described, CB 417. Specimens illustrated by stereoscanner photos, Station 20, Dovey Marshes.

**REMARKS.** The original figures of Wright are somewhat diagrammatic and include a ventral view, fig. 17 which shows four equal sized chambers (preceding the last one) with straight sutures at right angles to each other. On the other hand, fig. 16 shows a specimen with curved sutures, though apparently not all the chambers are drawn in. Our material is not extensive but the ventral septal sutures are least curved in a specimen showing only 4½ chambers at the periphery. The specimen described closely resembles that illustrated by Heron-Allen and Earland from Clare Island with five chambers visible on the ventral side and curved sutures in the early part.

*Discorbis orbicularis* var. *selseyense* sensu Cushman appears to belong here as pointed out by Voorthuysen (1960) but the original figures of *Discorbina rosacea* var. *selseyense* of Heron-Allen and Earland appear to be different with the last two chambers making up most of the test. Differences from *R. williamsoni* include slightly faster rate of chamber size increase and less limbation of the sutures as well as ornament.

The removal of this species to *Glabratella* is not considered justified merely on the basis of the ornament. As it is close to *R. williamsoni* it is retained under *Rosalina*.

DISTRIBUTION. This species was originally described by Wright from off the west coast of Ireland and from the Irish Sea off Antrim and off Dublin. A general distribution along the western seaboard is confirmed by later records of Heron-Allen & Earland: Clare Island, West of Scotland and Cornwall (1913b, 1916a, 1916b); Western Approaches (Le Calvez & Boillot, 1967; Murray, 1970).

North Sea records include: Langeoog (Haake, 1962), Dollart-Ems Estuary (Voorthuysen, 1960).

### *Rosalina (Neoconorbina) neapolitana* (Hofker)

(Pl. 17, figs 16-18; Text-fig. 30, nos 1-3)

*Neoconorbina neapolitana* Hofker, 1951a : 438, text-figs 300, 301.

*Discorbina orbicularis* Balkwill & Millett, 1884 : 23, pl. 4, fig. 13; ? Balkwill & Wright, 1885 : 349, pl. 13, figs 31-33 (not *Rosalina orbicularis* Terquem).

DIAGNOSIS. A low conical species of *Rosalina* with acute periphery and chambers becoming long, low and arcuate and reduced to three at the periphery. The umbilical lobes are pulled over to the distal side of each chamber and there are coarse pores on each side; the dorsal pores tending to be arranged in rows.

DESCRIPTION. (Text-fig. nos 1-3.) Test concavo-convex and low conical with rounded summit, dorsal side evolute and ventral side involute with early part slightly exposed in the open umbilicus, periphery acute, entire; 14 chambers arranged in a low, sinistral trochospire, as seen from dorsal side, 5 : 6 : 3—, following the proloculus, doubling in size with each volution and becoming longer than high in the second whorl and finally extremely long and arcuate, septal and spiral sutures slightly impressed, septal sutures markedly backward curving; four chambers visible on ventral side with rounded umbilical lobes, the final lobe is seen to be pulled over towards the distal end of the last chamber so that the distal knot is seen as a crease running in line with the very straight basal suture, sutures distinct becoming impressed and slightly fissured towards the umbilical lobes, markedly backwards curving; wall lamellar, distinctly perforate with large and small pores on each side, the large pores tending to be in lines parallel with the periphery on the dorsal side; aperture at the ventral basal suture freely communicating with the umbilicus below the umbilical lobe.

DIMENSIONS. Maximum diameter 0.25 mm, maximum height 0.08 mm. Approx. diameter of proloculus 20 microns.

MATERIAL. Four specimens only.

VARIATION. The specimens range from 0.25 to 0.45 mm in diameter and from rather flattened bun-shaped (Pl. 16, fig. 18) to low-conical as in the specimen described. The largest specimen (Pl. 16, fig. 16) shows a well developed, rather more subangular final umbilical lobe. The proloculus diameter in the specimen described appears to be near to that shown in Hofker's figure 300c.

DEPOSITORY. B.M.(N.H.) Slide 1970 : II : 26 : 279. Stub 1970 : II : 26 : 579, 580, 585.

PROVENANCE. Specimen described Clettwr VII, Dovey Marshes. Large specimen, CB 390. Other specimen illustrated, CB 25.

REMARKS. Our specimens agree with those of Hofker in their distinctive perforation, in the character of the umbilical lobes and in having acute margins rather than true keels. On the basis of the figures it seems probable that the specimens referred by Balkwill and Millett to *D. orbicularis* belong here. The specimens of Balkwill and Wright which show even, medium sized perforation and sharper periphery are more like *R. irregularis*. This species was placed in *Neoconorbina* by Hofker. However, as the ventral sutures are slightly fissured towards the umbilical lobes there is a difference only of degree with typical *Rosalina*. On the other hand, the species also shows the markedly elongate chambers of *R. terquemi* (genoholotype) and distinctive perforation. The name *Neoconorbina* is therefore retained as a subgeneric distinction.

DISTRIBUTION. The species was described from the Bay of Naples. The only other good record appears to be that of Balkwill and Millett from Galway, W. Ireland.

### *Rosalina praegeri* (Heron-Allen & Earland)

(Pl. 17, figs 6–9; Pl. 19, fig. 4; Pl. 30, fig. 3; Text-fig. 30, nos 4–9)

*Discorbina praegeri* Heron-Allen & Earland, 1913b : 122, pl. 10, figs 8–10.

*Discorbis* (?) *praegeri* (Heron-Allen & Earland) Cushman, 1931 : 30, pl. 6, figs 4a–c (figures after Heron-Allen & Earland).

*Gavelinopsis praegeri* (Heron-Allen & Earland) Hofker, 1951a : 486, text-figs 332–334; Loeblich & Tappan, 1964a : C578, text-fig. 456, 4; Murray, 1970 : 484 (list), pl. 2, figs 17, 18.

DIAGNOSIS. A biconvex or plano-convex species of *Rosalina* generally with prominent umbilical boss, five to eight chambers visible on the ventral side and with imperforate umbilical ends to the chambers.

DESCRIPTION. (Text-fig. nos 7–9.) Test plano-convex with conical, evolute dorsal side, outline indented at spiral suture, flat to slightly concave, involute ventral side, periphery acute, subcarinate, lobate in last part; 19 chambers seen on dorsal side, 6 : 6 : 6—, following the proloculus, becoming longer than high and arcuate in the second whorl, doubling in length with each volution but not increasing much in height, spiral and septal sutures thickened, septal sutures markedly swept back and continuing into a keel, spiral suture becoming impressed at last whorl;  $5\frac{1}{2}$  chambers visible on the ventral side with subangular lobes towards the umbilicus which is filled with a flat boss, each lobe with proximal re-entrant, sutures gently curved, impressed and becoming fissured towards the umbilicus; wall lamellar, with fine pores restricted to the central and distal portions of the chambers on both sides; aperture at the ventral, basal suture beneath a lip, communicating with the

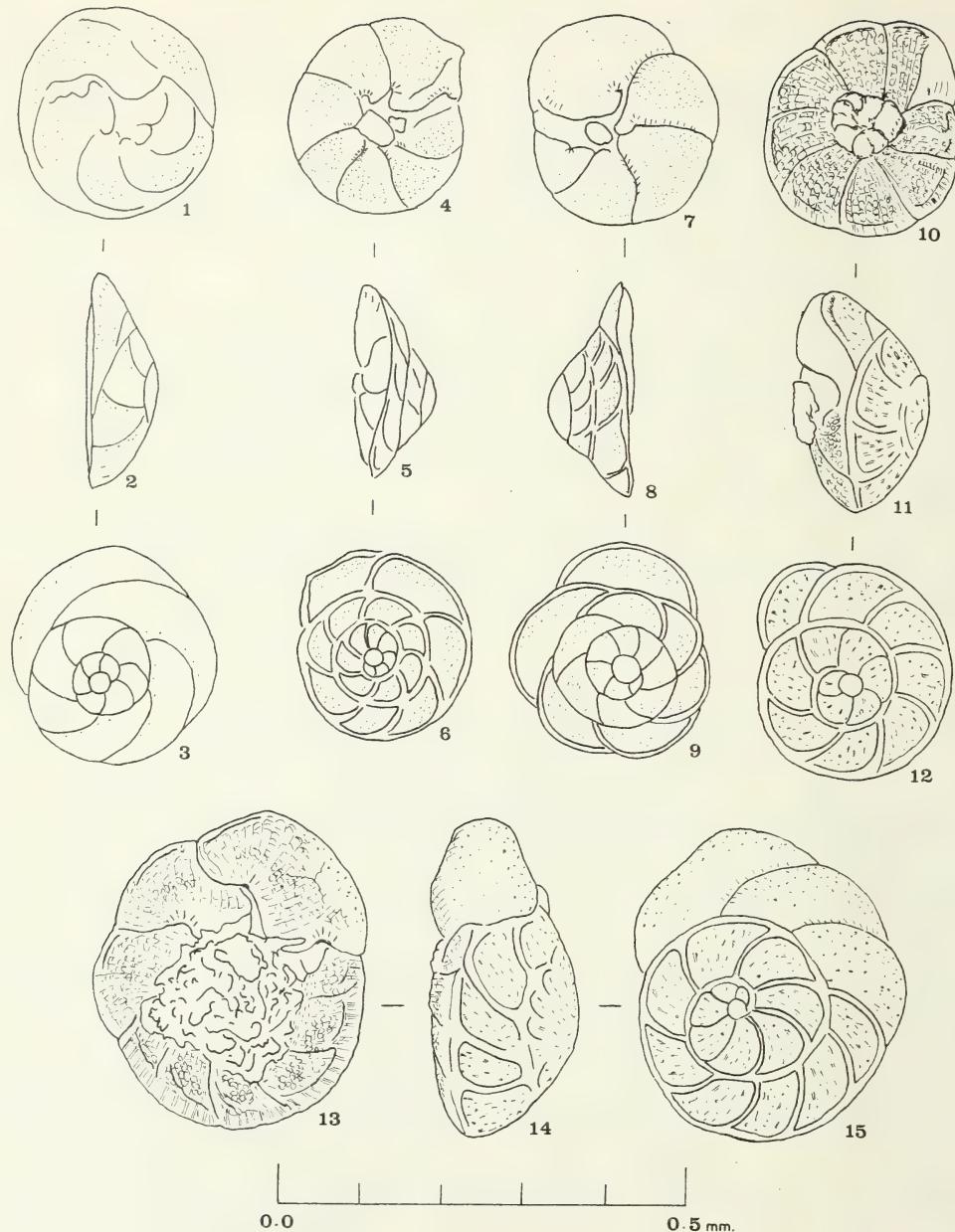


FIG. 30. 1-3. *Rosalina neapolitana*. 1, ventral view; 2, side view; 3, dorsal view. Note chains of larger pores on dorsal side. 4-9. *Rosalina praegeri*. 4, ventral view of specimen with small proloculus; 5, side view; 6, dorsal view, note lack of perforation at umbilical lobes and proximal part of chambers; 7, ventral view of specimen described; 8, side view; 9, dorsal view. 10-15. *Discorbis (Glabratella) wrightii*. 10, ventral view of small specimen typical of material with broken last chamber; 11, side view; 12, dorsal view, note elongate pores in glassy secondary calcite; 13, ventral view of large specimen described; 14, side view; 15, dorsal view.

umbilical region beneath the lobe; thick deposits of clear calcite coat the centre of the dorsal side.

**DIMENSIONS.** Maximum diameter 0·26 mm, maximum height 0·11 mm. Approx. diameter of proloculus 30 microns.

**MATERIAL.** Fourteen specimens only, most of them damaged.

**VARIATION.** The specimens figured show the extremes of proloculus size measured, 15 and 30 microns. The specimen with small proloculus has 6 : 7 : 7 chambers in each of three whorls following the proloculus and is almost biconvex, in contrast to the plano-convex specimen described with larger proloculus which has  $5\frac{1}{2}$  chambers at the periphery and is plano-convex. One specimen with small proloculus has eight chambers at the periphery, the same as the specimen described by Loeblich and Tappan from Ireland. Two specimens are without umbilical boss (Pl. 17, fig. 7). Both dextral and sinistral specimens occur.

**DEPOSITORY.** B.M.(N.H.) Slide 1970 : 11 : 26 : 280-284. Section 1970 : 11 : 26 : 481. Stub 1970 : 11 : 26 : 583, 584.

**PROVENANCE.** Specimen described and all specimens figured, CB 15.

**REMARKS.** Heron-Allen and Earland distinguished their species from *R. williamsoni* on the basis of the prominent umbilical boss. As this may be absent (while a small one is often present in *R. williamsoni*) diagnosis is more surely based upon the character of the larger, less divided umbilical lobes and the coarser, more restricted perforation. The range of proloculus size and growth rate are also different and the glassy, thickened dorsal side and impressed spiral suture very characteristic. The details of the umbilicus are not well shown in the type figure, the final chamber very possibly being broken.

Hofker erected the genus *Gavelinopsis* for this species and this was followed by Loeblich and Tappan who distinguish it from *Discorbis* on the basis of its umbilical plug. However, as we have shown, specimens without plugs can occur and as can be seen in Pl. 17, fig. 7 have umbilical flaps or lobes with knotch behind like typical *Rosalina*. We therefore include the species in that genus taking the peculiar perforation to be a specific feature.

The sutural slits and knotch in *Rosalina* have been considered as 'relict apertures' but this seems to beg the phylogenetic question. They are in no sense previous apertures left uncovered when a new chamber is added, as is well shown in Pl. 19, fig. 4, the knotch behind the lobe of the final chamber appears to be a primary feature connected with a morphological development which allows communication between the aperture and the deeply grooved suture via the covered umbilical region.

*Gavelinopsis praegeri* sensu Hofker from the Pacific was considered by him to be a geographical race as all the proloculus size groups described are represented by biconvex individuals. Probably they should be considered a distinct subspecies.

**DISTRIBUTION.** This species was described from the west coast of Ireland and also from 'Goldseeker' dredgings around the Scottish coasts. Other records are doubtful and as noted, Pacific records may indicate a separate subspecies.

*Rosalina williamsoni* (Chapman & Parr)

(Pl. 17, figs 13-15; Text-fig. 31, nos 1-4)

*Rotalina nitida* Williamson, 1858 : 54, pl. 4, figs 106-108; Terquem, 1875 : 430, pl. 2, fig. 9  
(homonym of *Rotalina nitida* Reuss).

*Rotalia nitida* (Williamson) Brady, 1864 : 474.

*Discorbina nitida* (Williamson) Wright, 1889 : 449; ? Heron-Allen & Earland, 1916a : 269,  
pl. 42, figs 26-28.

*Discorbis nitida* (Williamson) Cushman, 1931 : 26, pl. 6, figs 1a-c; 1949 : 41, pl. 8, figs 1a-c.

*Discorbis williamsoni* n. name Chapman & Parr, 1932 : 226, pl. 21, fig. 25.

*Rosalina williamsoni* (Chapman & Parr) Voorthuysen, 1958 : 34, pl. 24, fig. 1; 1960 : 252,  
pl. 11, fig. 19; Haake, 1962 : 43, pl. 4, figs 1, 2.

Not *Neoconorbina nitida* Hofker, 1951a : 433, text-fig. 297.

**DIAGNOSIS.** A finely perforate, scale-like, keeled species of *Rosalina* with five or six chambers visible on the ventral side. The umbilical lobes are small and irregular with fine creases diverging from the proximal re-entrant. One or two small bosses usually present.

**DESCRIPTION.** (Text-fig. nos 1-3.) Test with last chamber broken away and penultimate one damaged, concavo-convex with low conical, evolute dorsal side and involute ventral side, periphery sharply keeled, slightly lobate; 18 chambers (originally) seen from the dorsal side, arranged in a low, sinistral trochospire, 5 : 6 : 6 : 1—, following the proloculus, becoming longer than high in the second whorl and finally arcuate, not increasing much in height, septal and spiral sutures broadly limbate, flush, septal sutures markedly backwards curving; six chambers visible on the ventral side with small, slightly thickened, irregular umbilical lobes, these showing small creases diverging from the proximal re-entrants, small umbilical boss present, sutures sinuous, radial to slightly backwards curving at an angle of from 70 to 80° to each other, becoming impressed and fissured towards the lobes; wall very thin and translucent, lamellar, densely and finely perforate on both sides; aperture obscured (normally at basal suture and communicating with the umbilicus beneath the lobe).

**DIMENSIONS.** Maximum diameter 0·40 mm, maximum height 0·11 mm. Approx. diameter of proloculus 35 microns.

**MATERIAL.** More than 25 specimens but most tending to be broken.

**VARIATION.** Large specimens tend to become irregularly lobate (Pl. 17, fig. 13) and the umbilical lobes vary from irregularly rounded to pointed, in some cases they are raised and embossed. Specimens up to 0·47 mm diameter occur. Most specimens show a proloculus diameter near 35 microns with chambering as described but specimens showing larger diameters also occur. In Text-fig. no. 4 we illustrate a specimen with nine chambers arranged in whorls of 5 : 4—, following a proloculus of approx. 60 microns, maximum diameter of test 0·42 mm. This form is also lower on the dorsal side. It is noteworthy that Terquem's excellent figures clearly show these two proloculus size groups.

**DEPOSITORY.** B.M.(N.H.) Slide 1970 : 11 : 26 : 285-286. Stub 1970 : 11 : 26 : 581, 582. *Rosalina* species A Slide 1970 : 11 : 26 : 287-288. Stub 1970 : 11 : 26 590.

PROVENANCE. Specimens described, CB 7. Additional specimen with large megalosphere, CB 308. Specimens in stereoscanner photo, CB 428.

REMARKS. Our specimens come close to the original description and figures of Williamson which are very good and agree with them in the distinctive characters of the umbilicus and the markedly limbate dorsal sutures which continue into the peripheral keel.

The pores are too fine to be individually seen at ordinary powers of the light microscope and are apparently somewhat less than 1 micron in diameter.

Although widely listed from around the British coasts this species has not often been figured. The illustrations of Heron-Allen & Earland from the West of Scotland (1916a) seem to show two other species. We have three specimens similar to the one illustrated in ventral view in their fig. 30, with lobulate periphery and large, narrow umbilical lobes with curved proximal re-entrants (Pl. 17, fig. 10, as *Rosalina* sp. A).

Williamson's species has suffered no less than five generic name changes in its history as well as renaming by Chapman and Parr to avoid homonymy with *Rotalina nitida* Reuss, 1844. We follow Voorthuysen in placing this species in *Rosalina* as the aperture appears to freely communicate beneath the umbilical lobe with the essentially open umbilicus. Although there is a small umbilical boss this cannot be considered analogous to the cover plate developed in typical *Discorbis*. Further, we consider it is unnecessary to employ the generic name *Neoconorbina* as done by Hofker because the ventral sutures are fissured at their umbilical ends and in

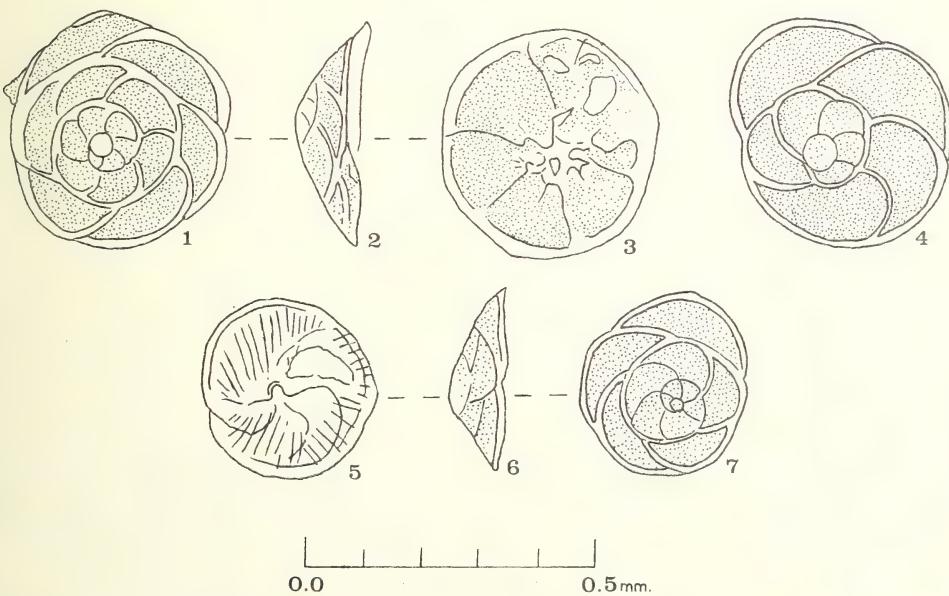


FIG. 31. 1-4. *Rosalina williamsoni*. 1, dorsal view specimen described; 2, side view; 3, ventral view; 4, dorsal view of specimen with large proloculus. 5-7. *Rosalina milletti*. 5, ventral view; 6, side view; 7, dorsal view.

this respect differ only in degree from typical *Rosalina* (see Pl. 17, fig. 13). Incidentally Hofker's specimens are from the Eocene and differ in perforation and umbilical characters from *R. williamsoni*.

DISTRIBUTION. Williamson originally recorded this species from all round the British Isles and this appears to be confirmed by later records. Unfortunately, Heron-Allen and Earland attempted to distinguish *R. praegeri* from *R. williamsoni* on the presence of an umbilical plug. In fact both are umbonate and must be presumed confused in both the earlier and the later 20th Century lists. These records will therefore not be given in detail:

North Sea records include: Langeoog (Haake, 1962); Belgium (Cushman, 1931, 1949); Netherlands (Voorthuysen, 1960).

North Atlantic: Faroes (Cushman, 1931); Galicia (Colom, 1952); Gulf of Mexico (Shifflet, 1961).

South Atlantic: Orinoco-Trinidad Shelf (Drooger & Kaasschieter, 1958); littoral S. Brazil (Closs & Barberena, 1962); off Argentina (Boltovskoy, 1959).

Mediterranean: Marseilles coast (Blanc-Vernet, 1958); East Mediterranean (Parker, 1958; Said & Kamel, 1957).

This would appear to indicate a wide distribution in the littoral zone and shallow water areas of the Atlantic and Mediterranean oceans.

### Family ASTERIGERINIDAE d'Orbigny, 1839

#### Genus *ASTERIGERINATA* Bermudez, 1949

##### *Asterigerinata mamilla* (Williamson)

(Pl. 18, figs 1-4; Pl. 19, figs 7, 9; Text-fig. 32, nos 1-5)

*Rotalina mamilla* Williamson, 1858 : 54, pl. 4, figs 109-111.

*Discorbina mamilla* (Williamson) Heron-Allen & Earland, 1913b : 123, pl. 11, figs 4-6.

*Discorbis mamilla* (Williamson) Cushman, 1931 : 23, pl. 5, figs 1a-c; Voorthuysen, 1951 : 24, pl. 2, fig. 5; Phleger, Parker & Peirson, 1953 : 39, pl. 8, figs 18, 23, 24.

*Asterigerinata mamilla* (Williamson) Hofker, 1951a : 472, text-figs 322-326.

*Heminwayina mamilla* (Williamson) Troelsen, 1954 : 466 (*Heminwayina*=*Eoeponidella*).

*Rosalina mamilla* (Williamson) Voorthuysen, 1960 : 251, pl. 11, figs 17a-c.

*Gavelinopsis mamilla* (Williamson) Le Calvez & Boillot, 1967 : 394 (list).

*Discorbina rosacea* H. B. Brady, 1864 : 194; 1887 : 918; Goës, 1894 : 94, pl. 15, fig. 792; Heron-Allen & Earland, 1913b : 124, pl. 11, figs 7-9 (not d'Orbigny).

*Discorbis?* *rosacea* Cushman, 1949 : 44, pl. 8, figs 6a-c (not d'Orbigny).

*Discorbis planorbis* Heron-Allen & Earland, 1913b : 124, pl. 11, figs 10-12 (not d'Orbigny).

DIAGNOSIS. A robust though small plano or concavo-convex species of *Asterigerinata* with high dorsal side, becoming acute to subcarinate in the adult. There are chains of large tubular pores near the edges of the chambers on the dorsal side and at the proximal edge of the supplementary chambers on the ventral side.

DESCRIPTION. (Text-fig. nos 1-3.) Test with one chamber broken; plano-convex with high, rounded, evolute dorsal side and slightly concave, involute ventral side, periphery acute, subcarinate, entire, becoming slightly lobate; 12 chambers

seen on the dorsal side, arranged in a high (slightly irregular) sinistral trochospire  $5:4:3$ —, following the proloculus, doubling in size with each of the first two whorls, less in the third whorl and becoming longer than high and crescentic in the second whorl; dorsal sutures limbate, flush, markedly backwards curving, last whorl slightly imbricate; five ( $4\frac{1}{2}$ ) chambers only, visible on the ventral side alternating towards the umbilicus with subtriangular supplementary chamberlets giving a stellate appearance; ventral sutures irregularly curved, flush but impressed between supplementary chambers; wall thick, glassy, radial lamellar, very finely perforate with pores less than  $\frac{1}{2}$  micron in size and with coarse, tubular pores about 5 microns in diameter near the periphery of the chambers on the dorsal side and at the proximal edge of the supplementary chamberlets; aperture a high arch with a narrow lip at the basal suture of the last chamber, opening into the umbilicus; the lip passes proximally into the plate which cuts off the chamberlet from the primary chamber; irregular umbilical boss present on ventral side; minute tubercles about 1 micron in diameter scattered over the dorsal side.

**DIMENSIONS.** Maximum diameter 0.25 mm, height 0.15 mm. Approx. diameter or proloculus 22 microns.

**MATERIAL.** More than 25 specimens.

**VARIATION.** There is considerable variation in the height of the dorsal side and extreme examples have a beehive shape. The periphery varies from subround to

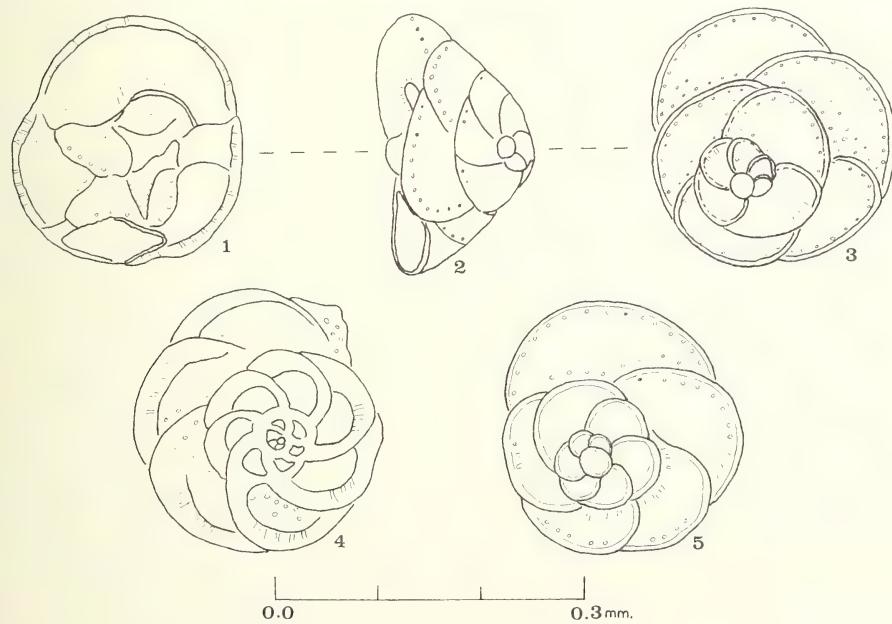


FIG. 32. 1–5. *Asterigerinata mamilla*. 1, ventral view; 2, side view; 3, dorsal view of specimen described; 4, microspheric specimen in xylene by transmitted light, wall thickness exaggerated; 5, megalospheric specimen.

subcarinate (Pl. 18, figs 3, 4) and this is largely, though not entirely, connected with growth. In well grown specimens the coarse pores (which appear tubular due to the thickness of the wall) are developed all over the dorsal chamber surface. The development of the umbilical boss is also variable.

Hofker (1951a) has studied proloculus size groups in a population from the Bay of Naples in the Mediterranean and found evidence for trimorphism. The population from Cardigan Bay shows strikingly similar size groups and 25 specimens studied showed the following tendency for chamber number to decrease with proloculus size:

1. Proloculus diameters 20–30 microns, chambers about 10 or 11 in all, 4–5 visible ventrally.
2. Proloculus diameters about 15 microns, chambers about 13 in all, 4–5 visible ventrally.
3. Proloculus diameters less than 10 microns, chambers about 18 in all, 5–6 visible ventrally.

The first two groups presumably represent the megalospheric generation, the third the microspheric generation. Most specimens belong to group 1, microspheric specimens being rare, two only. In all cases rather less chambers are developed compared with the Bay of Naples population.

DEPOSITORY. B.M.(N.H.) Slide 1970 : II : 26 : 289–296. Stubs 1970 : II : 26 : 525, 526, 1970 : II : 26 : 608, 609, 1970 : II : 26 : 752.

PROVENANCE. Specimen described and also specimen illustrated in Text-fig. no. 5, Dovey Estuary, CB 156. Specimens illustrated Text-fig. no. 4 and by stereoscanner, CB 8.

REMARKS. As is shown by the tangled synonymy previous workers have found this species difficult to classify. In part this is because the original figures of Williamson do not show the supplementary chamberlets although they show the other characteristic features very well, including the coarse pores, 'the marginal row of white foramina'. This led to confusion with *Discorbina rosacea* which on the basis of d'Orbigny's model is a species without chamberlets and with distinct umbilical boss. This means that the attempt of Heron-Allen and Earland to divide the Clare Island population of *A. mamilla* into three species, including *D. rosacea* and *D. planorbis* on the basis of differences in test height is invalid. As shown above these variations are considered infraspecific as is the tendency to develop a keel.

The presence of supplementary chamberlets excludes this species from *Discorbis* and *Rosalina* and we follow Hofker in placing it in *Asterigerinata*. However, some doubt remains because the high arched aperture opening into the umbilicus and the rounded periphery in the young specimens indicate a relationship with *Eoeponiella*; possibly that genus is a Cretaceous-Palaeogene fore-runner of *Asterigerinata*.

DISTRIBUTION. This species was originally described from the western coasts of Great Britain from the Shetlands to Bantry Bay and the Western Approaches of the English Channel. Later records confirm this distribution: Connemara (Alcock, 1865); off Jura and Ardnamurchan and in Loch Sunart, West of Scotland (Heron-Allen & Earland, 1916a); Isle of Man (Heron-Allen & Earland, 1915; Bruce

*et al.*, 1963); Mersey (Burgess, 1891); Scillies (Atkinson, 1970); Plymouth (Heron-Allen & Earland, 1930; Murray, 1965a); Clare Island (Heron-Allen & Earland, 1933b); off Cork (Cushman, 1931); off Northumberland and Durham (Brady, 1867); Western Approaches (Le Calvez & Boillot, 1967; Murray, 1970).

Other N.W. European records are: off Finistère (Dupeuble, 1963); Celtic Sea (Le Calvez, 1958); Dollart-Ems Estuary and Wadden Sea (Voorthuysen, 1960, 1958); Belgian coast (Cushman, 1949); North Atlantic Cores (Parker *et al.*, 1953).

Mediterranean records are: Gulf of Naples (Hofker, 1951a); Western Mediterranean (Todd, 1958); Aegean (Parker, 1958); Tyrrhenian Sea (Norin, 1958); off Marseilles (Blanc-Vernet, 1958); Eastern Mediterranean (Parker, 1958).

There is thus a marked concentration of records in the Mediterranean—Lusitanian province. It is also recorded dead from the Rio de La Plata (Boltovskoy, 1958).

### Family SIPHONINIDAE Cushman, 1927

#### Genus *SIPHONINA* Reuss, 1850

##### *Siphonina georgiana* Haynes n. sp.

(Pl. 20, figs 15, 16; Pl. 23, fig. 9; Pl. 33, fig. 10)

*Siphonina tubulosa* Heron-Allen & Earland, 1930 : 188, pl. 4, figs 62–64 (not Cushman).

*Siphonina reticulata?* Cushman, 1931 : 68, pl. 14, figs 1a–c; 1949 : 48, pl. 9, figs 5a–c (not Czjzek).

**DIAGNOSIS.** A biconvex, smooth species of *Siphonina* with relatively narrow, fimbriate keel and short apertural neck.

**DESCRIPTION.** Holotype (Pl. 20, fig. 16; Pl. 23, fig. 9; Pl. 33, fig. 10.) Test biconvex, with ventral side slightly more raised than the dorsal side, oval to almost circular in side view, entire, slightly compressed with narrow, fimbriate keel; about two and a half whorls of chambers visible on the evolute dorsal side arranged in a trochoid spiral, much longer than high and gradually increasing in size, five visible on the involute ventral side; sutures on dorsal side indistinct, flush, strongly backwards curving, subradial on the ventral side; wall radial with coarse, round pores along the septal sutures, double rows on the ventral side, smooth; aperture sub-round with short neck and frilled, everted lip, with an internal plate that partially closes the apertural opening on the ventral side and turns in to join the previous foramen, bearing a narrow lip on its free border.

**DIMENSIONS.** Maximum diameter 0·37 mm, height 0·17 mm.

**MATERIAL.** Four specimens. Three additional specimens in the Plymouth collection of Heron-Allen and Earland, 1955 : 10 : 25 : 99 : 200.

**VARIATION.** The paratypes are more equally biconvex than the type but consistently show five chambers on the ventral side. The dorsal side of a small paratype, 0·23 mm maximum diameter, is illustrated (Pl. 20, fig. 15). The largest paratype measures 0·35 mm maximum diameter.

DEPOSITORY. B.M.(N.H.) Slide 1970 : II : 26 : 287-288 (paratypes). Stub 1970 : II : 26 : 714 (holotype), 1970 : II : 26 : 715 (paratype).

PROVENANCE. Holotype, Brit. Mus. Core 16. Small paratype on stub, Brit. Mus. Core 13. Large paratype in slide, CB 503; small paratype in slide, off the Breaches, north of Wicklow Head.

REMARKS. In 1931 Cushman referred a specimen of *Siphonina* from the Belgian coast with question to *S. reticulata* although noting that it did not entirely fit with Czjzek's Miocene species. Similar specimens were illustrated as *S. tubulosa* from Plymouth by Heron-Allen & Earland in 1930 and again as *S. reticulata?* by Cushman from the Belgian coast in 1949. Our specimens are identical with these (Cushman's specimens being somewhat larger, 0.50 mm maximum diameter) and although they are few in number we feel justified in proposing a new name to cover them and the material from the English Channel.

*S. georgiana* differs from *S. reticulata* in its smooth rather than spinose surface and in its less developed keel. It similarly differs from *S. bradyana*, the Caribbean species, in its less developed keel and fewer rows of pores; the apertural neck is also better developed. *S. tubulosa* Cushman has very well developed tubules extending from the margin.

DERIVATION OF NAME. Refers to provenance on the edge of St Georges Channel.

DISTRIBUTION. This species was reported as occasional all round the south and west coasts of Britain by Heron-Allen & Earland (1930). Other records are: off Jersey (Halkyard, 1889); Belgian coast (Cushman, 1931, 1949).

Chaster's record of *S. reticulata* from Southport, North Irish Sea (1892) probably does not belong here as the figure shows a form nearer *S. tubulosa*, as noted by Heron-Allen and Earland.

### Family EPONIDIDAE Hofker, 1951

#### Genus EPONIDES Montfort, 1808

##### *Eponides repandus concameratus* (Montagu)

(Pl. 18, figs 10-12; Text-fig. 33, nos 1-3)

*Serpula concamerata* Montagu, 1808 : 160 (fide Williamson).

*Rotalina concamerata* (Montagu) Williamson, 1858 : 52, pl. 4, figs 101-103 only, not 104, 105.

*Pulvinulina concamerata* (Montagu) Cushman, 1915 : 52, pl. 25, fig. 1.

*Pulvinulina repanda* Carpenter, Parker & Jones, 1862 : 311 (new name for Williamson's specimens, not Fichtel & Moll).

*Pulvinulina repanda* var. *concamerata* (Montagu) Brady, 1884 : 685, pl. 104, figs 19a-c.

*Eponides repanda* var. *concamerata* (Williamson) Cushman, 1931 : 51, pl. 11, figs 4a-c (after Williamson).

*Rosalina isabelleana* Le Calvez & Boillot, 1967 : 397 (list), pl. 1, figs 1, 2 (not d'Orbigny).

DIAGNOSIS. A heavily ornamented subspecies of *Eponides repandus* with six to seven chambers visible on the ventral side.

**DESCRIPTION.** (Text-fig. nos 1-3.) Test large and robust, biconvex with raised, rounded, evolute dorsal side and rather flattened, involute, ventral side with deep pseudumbilicus, periphery with thick, blunt keel, entire to semilobate; approx. three whorls of chambers arranged in a low, sinistral trochospire, last two whorls visible on the dorsal side, the chambers gradually increasing in size and long and low, lunate in shape, septa swept back, limbate and raised; six chambers visible on the ventral side, septa limbate, flush, sutures radial to sinuous, incised (along distal edge of each septum); wall thick, radial and lamellar, finely perforate; aperture a low, arched opening along the basal suture of the last chamber towards the periphery, connecting with the pseudumbilicus by a long slit, with a prominent lip; dorsal chamber surfaces covered with small tubercles (occasional ones near periphery on the ventral side), the first whorl and proloculus being hidden by secondary calcite.

**DIMENSIONS.** Maximum diameter 1.20 mm, height approx. 0.72 mm.

**MATERIAL.** Rare in Cardigan Bay but common below 20 fathoms in St Georges Channel. More than 25 specimens but most are current worn with broken last chamber.

**VARIATION.** The material is not sufficiently well preserved for study of dimorphism and this aspect must await further collection. Our specimens consistently show the characteristic heavy ornament on the dorsal side with tubercles also present near the periphery on the ventral side. The pseudumbilicus is a feature of well grown specimens, formed as the later chambers draw away from the centre.

**DEPOSITORY.** B.M.(N.H.) Slide 1970 : II : 26 : 297-299. Stub 1970 : II : 26 : 613.

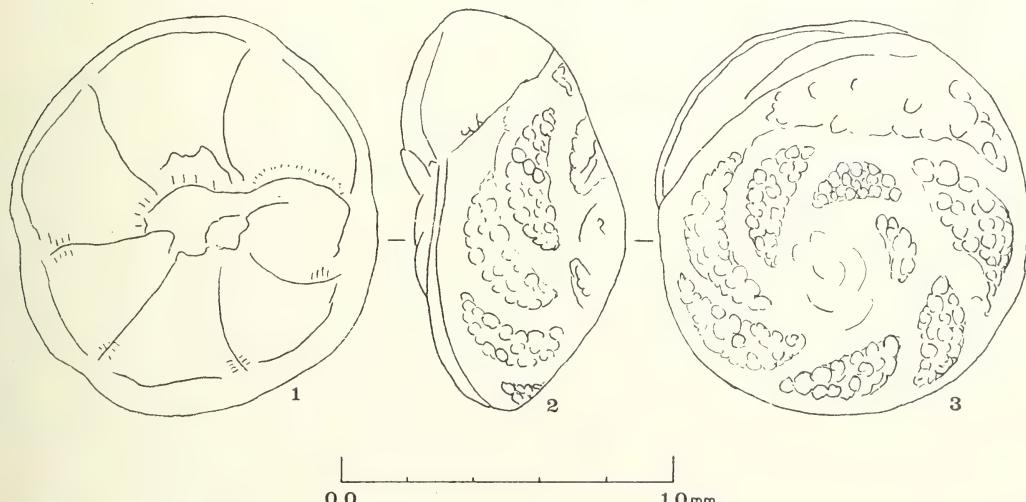


FIG. 33, 1-3. *Eponides repandus* concameratus. 1, ventral view; 2, side view; 3, dorsal view, showing heavy ornament.

PROVENANCE. Specimen described, St Georges Channel, CB 585. Specimens illustrated by stereoscanner, Brit. Mus. Core 16.

REMARKS. This form was first described but not figured by Montagu, the first illustrations being given by Williamson. Williamson, however, included *Rosalina globularis* = *R. anomala* in his conception of the species so the figures apply only in part. Cushman (1931) ascribed the name to Williamson rather than Montagu and this was followed by Barker (1960) on the ground that Montagu did not figure his *Serpula concamerata* and its identity is problematical. Contrariwise it can be maintained that as Montagu's name is accompanied by a valid indication and as Williamson clearly put his material in synonymy with Montagu's species the name must be ascribed to Montagu. Under the Rules of Nomenclature we cannot have it both ways. If we want the advantage of following Williamson's usage we must accept his view that Montagu's material was the same. If we argue that it was different then a new name has to be found for Williamson's material (as in the parallel case of *Elphidium williamsoni*). The type description, despite some difficulties, can be taken to apply to Williamson's figures, as well as ours. For instance, there is a tendency for the chambers, 'concamerations', to be of unequal size with the penultimate one often smaller than the antepenultimate. Further, we have taken this form live from hydroids in St Georges Channel which resembles its 'natural habit' according to Montagu, 'fixed on Sertulariae'.

The question now arises of the relationship of this form to *Eponides repandus* (Fichtel & Moll) as redefined on the basis of a neotype from the Bay of Naples by Loeblich & Tappan (1962). This neotype is much closer to Williamson's form than the specimens traditionally placed in *E. repandus* by authors following Brady (1884)—actually *Poroeponides*. However, the British material can be distinguished as including larger specimens with more chambers in the 'last whorl' (indicating a slower rate of chamber size increase) and heavier ornament. Incidentally, Todd (1965) figures an eight chambered form from the tropical Pacific but this is also distinguished by a ventral boss.

Le Calvez & Boillot (1967) refer specimens identical to ours from the Western English Channel to *Rosalina isabelleana* d'Orbigny. D'Orbigny's species was first described from the Falklands (1839c) and the type figures and description indicate a lobate, thin keeled form with conspicuous perforation and umbilical ornament. Confusion has probably arisen because Heron-Allen & Earland (1932) refigured d'Orbigny's species on the basis of specimens close to *E. repandus concameratus* because they supposed d'Orbigny's figures 'extremely unsatisfactory'. This was a dangerous assumption to make without re-examination of the type material especially as our experience is that d'Orbigny's figures (like Williamson's) are generally accurate.

DISTRIBUTION. Williamson's material was from the Irish Sea, including Whitesands Bay, Pembrokeshire, Belfast Bay and the Hebrides and Shetlands. It was also described from Scarborough on the east coast. This distribution with concentration on the western side of the British Isles is confirmed by later records: Clare Island (Heron-Allen & Earland, 1913b); Connemara (Alcock, 1865); Porcupine Station AA, off Scotland (Brady, 1884); West of Scotland (Heron-Allen & Earland,

1916a); Mersey (Burgess, 1891); English Channel, Western Approaches (Le Calvez & Boillot, 1967); Finistère (? Dupeuble, 1963); Channel Islands (Halkyard, 1889); Bay of Biscay (Caralp, Lamy & Pujos, 1970).

Norvang (1945) recorded it off Iceland and emphasized its Boreal and Lusitanian range.

Family **CIBICIDIDAE** Cushman, 1927

Genus **CIBICIDES** de Montfort, 1808

*Cibicides fletcheri* Galloway & Wissler

(Text-fig. 35 nos 1-3)

*Cibicides fletcheri* Galloway & Wissler, 1927 : 64, pl. 10, figs 8a-c; Adams & Frampton, 1965 : 58, pl. 5, fig. 11; Haman, 1966b : 69, pl. 7, figs 22, 23.

**DIAGNOSIS.** A plano-convex, coarsely perforate *Cibicides* with marked boss in the ventral umbilicus, sharp periphery, limbate sutures and up to about 10 chambers visible at the periphery.

**DESCRIPTION.** Test with last chamber broken, plano-convex, with raised ventral side bearing a marked umbilical boss and flat dorsal side, periphery acute and entire becoming slightly lobate at the last few chambers; about two whorls of chambers arranged in a low sinistral, trochospire, ten visible at the periphery, slowly increasing in size; sutures strongly limbate, slightly curved on the ventral side, markedly swept back on the dorsal side; wall apparently granular, coarsely perforate; aperture periphero-dorsal beneath a lip, apertural face imperforate and making an obtuse angle with the ventral side of the chamber, centre of dorsal side obscured by slight thickening.

**DIMENSIONS.** Maximum diameter 0.31 mm, maximum height 0.14 mm.

**MATERIAL.** More than 25 specimens, most with broken last chamber or chambers.

**VARIATION.** Smaller specimens show only seven or eight chambers at the periphery. The umbilical boss varies in size and increase in the amount of thickening on the dorsal side gives a gradation to *C. fletcheri* var. *sachalinica*.

**DEPOSITORY.** B.M.(N.H.) Slide 1970 : 11 : 26 : 300. Stub 1970 : 11 : 26 : 562, 563.

**PROVENANCE.** Described specimen, Low Marsh, Clettwr Transect, Dovey Marshes.

**REMARKS.** Our specimens come near to those illustrated by Galloway and Wissler although smaller, with fewer chambers developed, though often with larger umbilical boss and more limbate sutures. This species appears to be closely related to *C. lobatulus* from which it differs in its umbilical boss, slower rate of chamber size increase, with ten rather than eight in the second whorl, and coarser pores in equivalent sized chambers. The wall observed in crushed specimens is apparently optically granular (but see remarks on *C. lobatulus*).

**DISTRIBUTION.** The type specimens were described from the Pleistocene of California and it has also been described from the Pliocene of Russia (Vasilenko, 1954). Recent records are as follows: Pacific, California coast (Butcher, 1951; Bandy, 1953; Walton, 1955).

North Atlantic, Iceland (Adams & Frampton, 1965); fjord in the Faroe Islands (Haman, 1966b).

South Atlantic, Argentina coast (Boltovskoy, 1954, 1957). This would seem to indicate a cool temperate to cold water distribution.

*Cibicides fletcheri* var. *sachalinica* Vasilenko

(Pl. 21, figs 1, 2; Text-fig. 34, nos 1-3)

*Cibicides (Cibicidoides) fletcheri* Galloway & Wissler var. *sachalinica* Vasilenko, 1954 : 185, pl. 33, figs 2a-c.

? *Planorbulina akneriana* Goës, 1894 : 89, pl. 15, figs 778, 779.

DIAGNOSIS. A variety of *Cibicides fletcheri* with flat umbilical boss on the dorsal side.

DESCRIPTION. (Text-fig. nos 1-3.) Test with last chamber broken, with raised, rather rounded ventral side and flattened dorsal side, entire, becoming slightly lobate at the last two chambers; chambers arranged in a low dextral trochospire, 10 visible on the dorsal side which is partially involute, increasing slowly in size and higher than long, 10 visible on the involute ventral side, also slowly increasing in size and again higher than long; septal sutures limbate and strongly thickened, gently curved on both sides and meeting in a large central boss on the ventral side; dorsal umbilicus filled with an equally large but flat boss defined by a deeply excavated spiral suture; wall apparently coarsely perforate on both sides.

DIMENSIONS. Maximum diameter 0.24 mm, ventral boss slightly larger than one third the total diameter; height 0.10 mm.

MATERIAL. About 20 specimens in many cases with the last chamber broken, all small.

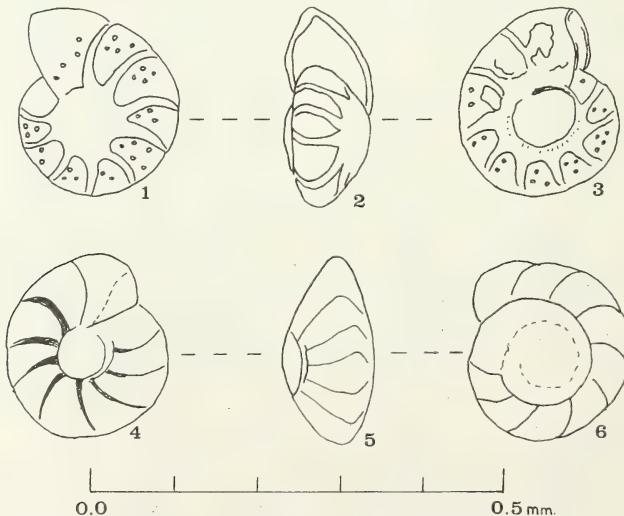


FIG. 34. 1-3. *Cibicides fletcheri* var. *sachalinica*. 1, ventral view; 2, side view; 3, dorsal view. 4-6. *Cibicides* sp. 4, ventral view; 5, side view; 6, dorsal view.

VARIATION. Specimens with flat dorsal side and angular periphery occur as well as some that are slightly raised like the one described with more rounded periphery. Most commonly nine chambers can be counted on the ventral side. A specimen which is damaged by boring is also figured (Pl. 21, figs 1, 2) which as well as a discrete, dorsal plug has excavated septal sutures and well developed lobes. Wall in crushed specimens apparently granular.

DEPOSITORY. B.M.(N.H.) Slides 1970 : II : 26 : 301, 1970 : II : 26 : 302, 303. Stub 1970 : II : 26 : 565, 566.

PROVENANCE. Described specimen Holocene, Scrobicularia Clays, Borth. Other specimens illustrated CB 21, 28 and 57.

REMARKS. Our specimens resemble *C. fletcheri* var. *sachalinica* in size and shape but differ in developing up to 10 chambers in the 'last whorl', bigger plugs and coarse perforation on the ventral side.

At Station CB 28 two specimens were recovered with similar plugs and limbate sutures to *C. fletcheri* on the ventral side but with the dorsal sides slightly raised and evolute with thick, glassy secondary calcite rather than plugs. One of these specimens is illustrated for comparison as *Cibicides* species, (Text-fig. nos 4-6). The perforation is apparently finer in these forms and they also have a resinous brown coloration which may be indicative of reworking.

DISTRIBUTION. Vasilenko described his variety of *C. fletcheri* from the Upper Pliocene of the U.S.S.R. It has not hitherto been recorded in the Atlantic but specimens recorded by Goës (1894) as *Planorbolina akneriana* may belong to the same group.

### *Cibicides lobatulus* (Walker & Jacob)

(Pl. 20, figs 1, 2; Pl. 21, figs 3, 5, 6; Pl. 33, figs 1-7; Text-fig. 35, nos 4-10)

*Nautilus lobatulus* Walker & Jacob, 1798 : 642, pl. 14, fig. 36.

*Truncatulina tuberculata* = *Truncatulina lobatula* (Walker & Jacob) d'Orbigny, 1826 : 279, no. 1, mod. 37.

*Truncatulina lobatula* (Walker & Jacob) d'Orbigny, 1839b : 134, pl. 2, figs 22-24; (as '*lobata*'); 1846 : 168, pl. 9, figs 18-23; Parker & Jones, 1857 : 293, pl. 10, figs 17-21; Williamson, 1858 : 59, pl. 5, figs 121-123; Terquem, 1875 : 434, pl. 4, figs 2a-c (ascribed to d'Orbigny); Brady (part), 1884 : 660, pl. 92, figs 1a-c only; Mills, 1900 : 150, pl. 11, fig. 38.

*Cibicides lobatulus* (Walker & Jacob) Cushman, 1927a : 93, pl. 20, fig. 4; 1931 : 118, pl. 21, figs 3a-c; 1944 : 36, pl. 4, figs 27, 28; ? 1948 : 79, pl. 8, figs 14a-c; 1949 : 51, pl. 10, fig. 6; Parker, 1952b : 446, pl. 5, figs 11a, b; Colom, 1952 : 39, pl. 3, figs 23-25; Todd & Low, 1961 : 21, pl. 2, fig. 20; Dupeuble, 1962<sup>1</sup> : 197, pl. 1, figs 1, 4; Haake, 1962 : 44, pl. 4, figs 7-9; Feyling-Hanssen, 1964 : 339, pl. 19, figs 1-3; Lutze, 1965 : 105, pl. 15, fig. 38; Adams & Frampton, 1965 : 58, pl. 5, fig. 10; Haman, 1966b : 69, pl. 7, figs 24-26; Murray, 1970 : 484, pl. 2, figs 13, 14.

*Planorbolina farcta* Fichtel & Moll sp. var. (*Truncatulina*) *lobatula* (Walker & Jacob) Parker & Jones, 1865 : 381, pl. 14, figs 3-6; pl. 16, figs 18-20.

*Planorbolina lobatula* (Walker & Jacob) Goës, 1894 : 88, pl. 15, fig. 774.

*Lobatula vulgaris* Fleming, 1828 : 232.

*Heterolepa lobatula* (Walker & Jacob) Gonzalez-Donoso, 1969 : 6, pl. 2, fig. 1.

DIAGNOSIS. A plano-convex, attached species of *Cibicides* with about eight

<sup>1</sup> See addendum.

chambers in the second whorl and distinct perforations on both sides. Ventral sutures swept back and impressed, meeting in a shallow umbilicus. The chambers increase markedly with each whorl to slightly more than double their size as seen in dorsal view and tend to become arcuate and lobate. A slight keel may be developed.

DESCRIPTION. (Text-fig. nos 4-6.) Test plano-convex with flat, dorsal attachment side and moderately raised ventral side, periphery acute, becoming slightly lobate at the last three chambers, ventral side with shallow umbilicus; about two whorls of chambers arranged in a low, dextral trochospire, eight visible at the periphery and in ventral view, slightly more than doubling in size in the 'last whorl' as seen on the dorsal side and becoming arcuate and longer than high; sutures on the ventral side impressed and swept back in an even curve, meeting in a shallow umbilicus, sutures on dorsal side limbate and becoming markedly curved back between the last few chambers, thickened spiral septum also prominent; wall bilamellar, weakly radial and densely perforated with pores up to 5 microns in diameter (see below); aperture periphero-dorsal beneath a lip extending back along the spiral suture.

DIMENSIONS. Maximum diameter 0.33 mm, height 0.13 mm. Proloculus and initial chambers not clearly seen.

MATERIAL. More than 25 specimens. Abundant but mostly rather small and often with broken last chambers.

VARIATION. Most specimens recovered come near to the specimen described in their size but larger specimens occur some reaching more than 1.0 mm in maximum diameter. These tend to have six or seven chambers visible in the 'last whorl' and are more lobate, more distinctly perforated on the ventral side and flatter (Text-fig. nos 9, 10). Many of them show irregular coiling. Some specimens are rather higher on the ventral side and the last chamber may overlap the umbilicus. We illustrate a form with ventral umbo and nine chambers visible that seems to be intermediate with *C. fletcheri* (Text-fig. nos 7, 8).

DEPOSITORY. B.M.(N.H.) Slide 1970 : II : 26 : 334-343. Section 1970 : II : 26 : 484-490. Stub 1970 : II : 26 : 559-561.

PROVENANCE. Specimen described, CB 534.

REMARKS. Many authors such as McLean (1956), Hulme (1964) and Nyholm (1961) have lumped this species with others, such as *C. refulgens* Montfort. McLean went so far as to say 'unfortunately, so many different forms have been ascribed to Walker and Jacob's species that assigning the name "lobatulus" to a *Cibicides* is tantamount to giving the form a status more truthfully described by the term "incertae sedis"'. The species should probably be suspended as being of no taxonomic value—it was badly figured and inadequately described in the first place'. However, we regard these views as extreme and on our part we find *C. lobatulus* an abundant and easily distinguishable species in Cardigan Bay, closely comparable with populations occurring elsewhere off British coasts, both off Ireland and Scotland, and consistently identified by previous authors.

The specimen described comes very close to that figured by Williamson especially in the shape and regular increase in size of the chambers and in the appearance of the ventral sutures. As he noted, the shell is often glassy in the young state tending to become opaque in the adult. Larger specimens from Cardigan Bay come nearer to the type figures of Walker and Jacob which show a lobate form with six chambers on the ventral side with rather irregular increase in growth. We show a very similar individual with identical aperture on the dorsal side and which also has an incipient keel, a feature also mentioned by Williamson. The test is distinctly perforated on both sides with round to irregular pores, up to 5 microns in diameter on the dorsal side, cylindrical, often plugged and sometimes linking up in lines or clusters giving a frosted appearance to the test (Pl. 21, fig. 6). The pores are irregular in size and density and as shown in Text-fig. no. 10, where the dorsal side becomes thickened in large specimens considerable areas become poreless. The pores are equally dense on the ventral side but smaller, up to about 2 microns in diameter (Pl. 21, fig. 3). They are also funnel-shaped, widening to the exterior. It is possible that it is for this reason that younger tests appear more glassy on this side.

Thin sections (Pl. 33, figs 1-7) of specimens from Cardigan Bay, Connemara and Moss Head, Scotland reveal that the chamber walls are weakly, optically radial and possess an inner lining separated from an outer lamella by a dark, probably organic, intervening layer; though in some cases and particularly towards the final chamber the dark layer cannot be readily distinguished from the outer layer (Pl. 33, figs 2-4) which probably explains why the wall appears optically granular in a simple crush (Adams, 1963). Hofker described this wall structure as trilamellar, believing the dark layer to be granular (1967) but it is more likely that it represents the original tectin layer. In this case the test can still be considered essentially bilamellar in the sense of Reiss (1959) and Hansen, Reiss & Schneidermann (1969).

This structure is much the same as that shown by typical *C. refulgens* Montfort from Moss Head, Pl. 32, figs 6-9. The chief difference is that in *Cibicides lobatulus* the outer lamellae do not fully invest previous chambers in the adult part, the spiral cord remaining thin. In many cases the lamellae simply wedge out or merely abut previous chambers. This is consistent with the more spreading growth and ventrally umbilicate form in this species.

The idea that the details of wall structure are specific only in this group is supported by the structure of the closely related, possibly ancestral, Paleocene species *C. cassivellauni* Haynes which is bilamellar but optically granular (Pl. 33, fig. 9). This is a plano-convex species which can be placed with *Cibicidoides* only on the basis of its granular wall. Conversely *C. pseudoungerianus* (Cushman), otherwise near *Cibicidoides* with coarse pores and raised dorsal side, is radial (Pl. 33, fig. 8, see also Wood & Haynes, 1957). This strongly indicates the possibility of progressive changes in wall structure at the specific level, as suggested by Haynes (1956) and Hofker (1967). N.B. According to Gonzalez-Donoso (1969) *C. lobatulus* is 'pseudotrilamellaire' and the dark layer is interpreted as the original primary outer wall. It is supposed that this layer is covered by an extension of the inner lining (analogous to a 'septal flap') when a further chamber is added. For this

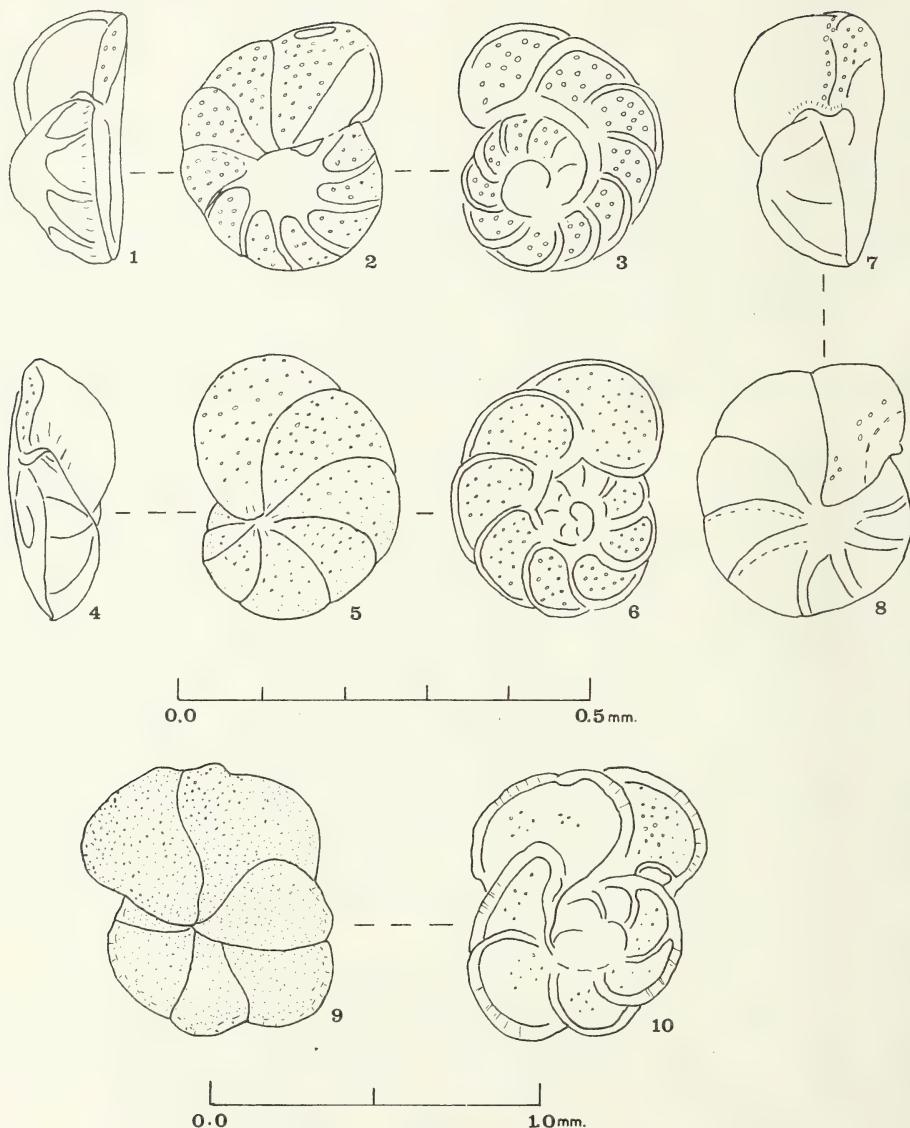


FIG. 35. 1-3. *Cibicides fletcheri*, Dovey. 1, side view; 2, ventral view; 3, dorsal view. 4-6. *Cibicides lobatulus*, CB 534. 4, side view; 5, ventral view; 6, dorsal view. 7, 8. *Cibicides lobatulus*, specimen intermediate with *C. fletcheri*, side and ventral views. 9, 10. Large specimen of *C. lobatulus* with lobate periphery, incipient keel and strongly punctate ventral side and glassy, imperforate areas on the dorsal side.

reason the species was transferred to *Heterolepa*. We do not follow this interpretation which may have arisen because of the difficulty of distinguishing the dark zone consistently from the outer layer. In any case, even if the differences between *C. lobatulus* and *C. refulgens* were considered generic the name *Truncatulina* d'Orbigny, 1826 takes precedence over *Heterolepa* Franzenau, 1884, *T. lobatula* being the geno-holotype.

Thin sections of the other species studied have also been put on file: 1970 : 11 : 26 : 491 (*C. pseudoungerianus*), 1970 : 11 : 26 : 492 (*C. cassivellauni*).

DISTRIBUTION. This species has been described from every latitude in both hemispheres but many of the records are suspect. For instance Brady (1884) gives an excellent illustration of the species from Vigo Harbour, Spain which was later used by Cushman (1927) to illustrate his conception of *Cibicides*. However, the other figures given by Brady, of specimens from the Pacific, are different. Also many of the British listed records may possibly include *C. fletcheri*. For this reason we restrict ourselves to well founded, illustrated, records for the North Atlantic.

*C. lobatulus* was originally described from Whitstable, Kent, S.E. England and as shown by Williamson 'abounds on all parts of the coast of Great Britain and Ireland . . . the dead shells . . . of common occurrence amongst the shelly shore sand' More particularly it occurs, 'lurking amongst the roots of Laminariae or . . . clustering round the large corallines, which it often does in vast numbers'. It occurs widely as a dead form in the Western Approaches (Le Calvez & Boillot, 1967; Murray, 1970).

Other records for the North Sea area are: coast of Norway (Parker & Jones, 1857; Goës, 1894; Feyling-Hanssen, 1964); Langeoog (Haake, 1962); Ostsee (Lutze, 1965); Belgian coast (Cushman, 1949).

North Atlantic: Eastern plateau, Hunde Islands and Baffin Bay—common to 78 fathoms, absent from abyssal depths (Parker & Jones, 1865); Greenland (Goës, 1894); Arctic including Iceland and Hudson Bay (Cushman, 1948); New England (Cushman, 1944; Parker, 1952a; Todd & Low, 1961); coast of Spain (Colom, 1952).

These records indicate a generally shallow water distribution where shelter can be found in weeds; apparently the species does not occur living under estuarine conditions.

### Family PLANORBULINIDAE Schwager, 1877

#### Genus *PLANORBULINA* d'Orbigny, 1826

##### *Planorbulina distoma* Terquem

(Pl. 20, figs 10–12; Pl. 21, figs 4, 7, 8; Text-fig. 36, nos 1, 2)

*Planorbulina distoma* Terquem, 1876 : 73; 1877 : 164, pl. 8, fig. 11 (duplicate of deuxième fascicule).

*Planorbulina vulgaris* Williamson, 1858 : 57, pl. 5, figs 119, 120 (not d'Orbigny).

*Planorbulina mediterranensis* Brady, 1884 : 656, pl. 92, figs 2, 3; Goës, 1894 : 91, pl. 15, fig. 786; Mills, 1900 : 149, pl. 11, fig. 37; Cushman, 1931 : 129, pl. 24, fig. 5 only; 1949 : 52, pl. 10, fig. 9 (not d'Orbigny).

DIAGNOSIS. A species of *Planorbulina* with relatively high, subinvolute ventral

side and subangular periphery. The initial part is like *Cibicides* for about two whorls and is followed by about six irregular whorls of chambers finally arranged in alternating rings (megalospheric form). The chambers tend to be almost square at first in dorsal view, up to three times as long as high later.

**DESCRIPTION.** (Pl. 20, fig. 11, account of pores and apertures on the dorsal side based on additional specimen Pl. 20, fig. 12.) Test presumed originally attached, plano-convex with raised, partially involute ventral side and flat, evolute, dorsal side, roughly pentagonal in outline, periphery semi-lobate, subangular; all the chambers visible on the dorsal side commencing with 14 arranged in a low, trochoid spiral of about  $2\frac{1}{2}$  whorls, these being followed by about 30 chambers arranged in rings, the rings at first irregular but finally of regular alternations of five chambers each, chambers increasing slowly but irregularly in size, becoming longer than high and slightly overlapping, septa limbate but flush; alternating rings of chambers of the last part clearly seen in ventral view, inflated and overlapping with impressed sutures, some with irregular, flap-like extensions along the sutures between previous chambers; wall radial, composite lamellar, densely perforated by pores between 1-2 microns in diameter and widening to the surface on the ventral side, up to 4 microns in diameter with interleaved sieve plates on the dorsal side (there is a tendency for the distance between the pores to be about double their diameter); aperture multiple, small openings about 15 microns in diameter, with lips, each chamber with two at the periphery and two at the dorsal basal suture, lips tending to become tubular extensions, apertures also developed on the flaps along the sutures on the ventral side.

**DIMENSIONS.** Maximum diameter 0.66 mm.

**MATERIAL.** More than 25 specimens.

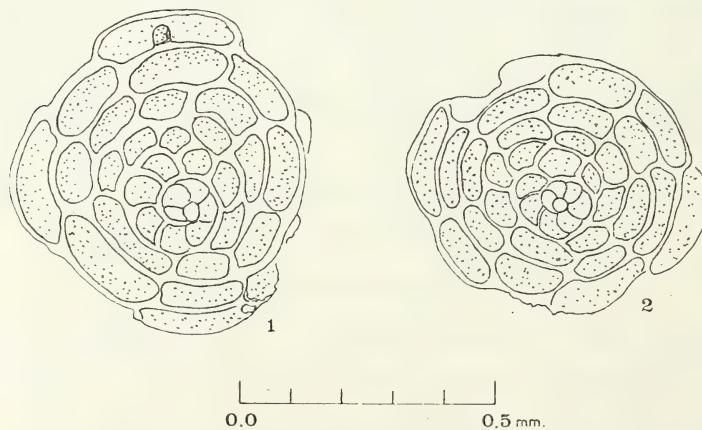


FIG. 36, 1, 2. *Planorbulina distoma*, dorsal views of dextral, megalospheric specimens showing initial trochospiral part, drawn in xylene, thus wall thickness and chamber rounding exaggerated. Dorsal, sutural apertures seen when specimens dry, also small umbilical boss and dorsal aperture in spiral part of no. 1.

VARIATION. As shown by the text figures the chambers are irregular in arrangement and shape immediately following the trochoid initial part but are consistently longer than high in the later part. The outline tends to pass from trigonal through quadrangular-pentagonal to subcircular with growth. Proloculus diameters measured between 20 and 30 microns.

DEPOSITORY. B.M.(N.H.) Slide 1970 : II : 26 : 344-347. Stub 1970 : II : 26 : 558.

PROVENANCE. Specimens described, CB 480. Additional specimens figured Text-fig. 1, CB 15, fig. 2 from off Helmsdale, Scotland.

REMARKS. Specimens hitherto identified as *Planorbulina mediterranensis* from around the British Isles show consistent differences from that species. D'Orbigny's original figures and model show a large, much depressed form with marked ventral umbilicus and with chambers tending to remain higher than long, particularly on the ventral side. Recent illustrations of material from the Spanish Mediterranean coast by Schnitker (1969) confirm these original illustrations, particularly in regard to the wafer thin, subcarinate test, the ventral umbilicus and the high ventral chambers. Although the dorsal views show more elongate chambers than the originals another detail is added in that the sutures are shown to be markedly raised. The specimens in our material show only a slight ventral umbilicus as the chambers are more inflated on that side with the periphery subangular rather than acute. The chambers as seen from the dorsal side become longer than high much more quickly and the septa although limbate are flush, not raised. The chambers in the final rings as seen from the ventral side are markedly elongate.

Fortunately there is a name available for the N.W. European species in *P. distoma* as Terquem's illustration gives the ventral view of a quadrangular specimen very near to forms occurring in our material.

As far as we can ascertain peripheral apertures are absent from the intial *Cibicides*-like portion. So in this respect this species resembles *P. mediterranensis*. It therefore differs from Schnitker's N. Carolina shelf species '*P. mediterranensis*' = *Planorbulina polystoma*, in this regard as well as in its subangular rather than rounded periphery; the ventral pores also continue right up to the edge. The initial part although *Cibicides*-like is brownish in colour and there seems little danger of confusing juveniles with well developed specimens of *C. lobatulus*.

DISTRIBUTION. This species was first described from shore sands at Dunkirk. Material in the British Museum collections originally referred to *P. mediterranensis* but which belongs here includes specimens from the English Channel, Salcombe, Devon (Brady Coll.); Skye (Parker & Jones Coll.); North Sea, Budle Bay, River Blyth and Montrose Basin; S.W. Ireland, Valentia (Norman Coll.). If we accept Williamson's citation of *P. vulgaris* then there are records for all round the British Isles from the Shetlands to Eddystone Lighthouse.

Other N.W. European records include: Belgian coast (Cushman, 1931); Scandinavia (Goës, 1894); N. Atlantic, Porcupine Station 23, N.W. of Ireland (Brady, 1884); Western Approaches (Le Calvez & Boillot, 1967; Murray, 1970).

Material in British Museum collections from the Mediterranean includes both *P.*

*mediterranensis*, Crete (Parker & Jones Coll.); Sardinia (Brady Coll.) and specimens intermediate with *P. distoma*, Leghorn (Parker & Jones Coll.); Delos (Heron-Allen & Earland Coll.). Similar intermediate forms occur with *P. mediterranensis* in the West Indies (Parker & Jones Coll.). It thus seems probable that the two species form a morphological continuum; with *P. distoma* s.s. typical of high latitudes.

Specimens referred to *P. mediterranensis* in the Parker & Jones collections from the Indian Ocean and Pacific (Melbourne) are different from *P. mediterranensis* s.s. and show a 'Caribeanella' initial stage followed by rings of small round, inflated chambers.

### ***Planorbulina* species A**

(Pl. 5, fig. 14; Pl. 21, fig. 9)

**DESCRIPTION.** Test probably originally fixed, apparently largely undamaged; irregular in outline; about 10 globular chambers visible showing no definite arrangement and apparently not increasing rapidly in size as added; sutures distinct and impressed; apertures two in number at base of the last formed chamber, at either side, round with slight lip and denticulate margin within; wall radial with coarse pores set in deep pits, the pores with interior plates; margins of the pits smooth and raised giving a reticulate appearance to the surface.

**DIMENSIONS.** Maximum diameter about 0·30 mm.

**MATERIAL.** Six specimens.

**DEPOSITORY.** B.M.(N.H.) Stub 1970 : 11 : 26 : 517.

**PROVENANCE.** Described specimen, Brit. Mus. Core 14.

**REMARKS.** The twin apertures at the base of the last chamber and the coarse pores (about 6 microns in diameter) show the close relationship of this form to *P. distoma*. A further difference in addition to the irregular arrangement and globular shape of the chambers is in the well developed character of the pits, only slightly shown on the dorsal side of *P. distoma*. The pores are also larger.

### Family **GLOBIGERINIDAE** Carpenter, Parker & Jones, 1862

#### Genus **BIORBULINA** Blow, 1956

##### ***Biorbulina bilobata* (d'Orbigny)**

(Pl. 20, fig. 5)

*Globigerina bilobata* d'Orbigny, 1846 : 164, pl. 9, figs 11–14.

*Orbulina bilobata* (d'Orbigny) Brönniman, 1951 : 135, text-fig. 3, nos. 1, 2, 9, 10, 17, 19; text-fig. 4, nos 5, 6, 17, 18; Colom, 1952 : 43, pl. 8, figs 20, 21.

*Biorbulina bilobata* (d'Orbigny) Blow, 1956 : 69, text-fig. 2, no. 16.

**DIAGNOSIS.** A species of *Biorbulina* with two sub-equal chambers visible and scattered multiple apertures.

**DESCRIPTION.** Test globose; two subequal, globular chambers visible; suture impressed; wall pitted and coarsely perforate; aperture apparently multiple, scattered.

DIMENSIONS. Length 0·42 mm, width 0·30 mm.

MATERIAL. One specimen only.

DEPOSITORY. B.M.(N.H.) Stub 1970 : II : 26 : 745.

PROVENANCE. Holocene, Scrobicularia Clays, Borth.

REMARKS. This genus has been lumped with *Orbulina* by Loeblich & Tappan (1964a) but according to Blow has evolved independently. We have insufficient material to enter usefully into the debate but our specimen comes close to authors' figures.

DISTRIBUTION. Records are insufficient for this to be worked out.

Genus ***GLOBOQUADRINA*** Finlay, 1947

***Globoquadrina hexagona*** (Natland)

(Pl. 20, figs 7-9; Pl. 21, fig. 12; Text-fig. 37, nos 1-5)

*Globigerina hexagona* Natland, 1938 : 149, pl. 7, fig. 1; Phleger, Parker & Peirson, 1953 : 12 pl. 1, figs 13, 14.

*Globoquadrina hexagona* (Natland) Parker, 1962 : 244, pl. 8, figs 5-12.

DIAGNOSIS. A species of *Globoquadrina* with from  $4\frac{1}{2}$  to 6 chambers visible on the ventral side, rapid rate of chamber size increase, radial ventral sutures and large polygonal to hexagonal pits.

DESCRIPTION. (Text-fig. nos 1-3.) Test globular and with irregular and slightly depressed lobate outline; low trochospiral and evolute on the dorsal side with the early whorls slightly depressed below the level of the later ones, ventral side involute and raised with small umbilicus; about two whorls of chambers arranged in a dextral spiral, increasing rapidly in size, wider and thicker than high, the last two making up more than half the test; sutures markedly impressed, radial on the ventral side, slightly curved back on the dorsal; wall radial and coarsely perforate, pores countersunk in large hexagonal pits, corners of the hexagons sometimes developed as tubercles, especially on the ventral side; aperture umbilical to slightly extra-umbilical, arcuate (best seen in side view) with marked lip.

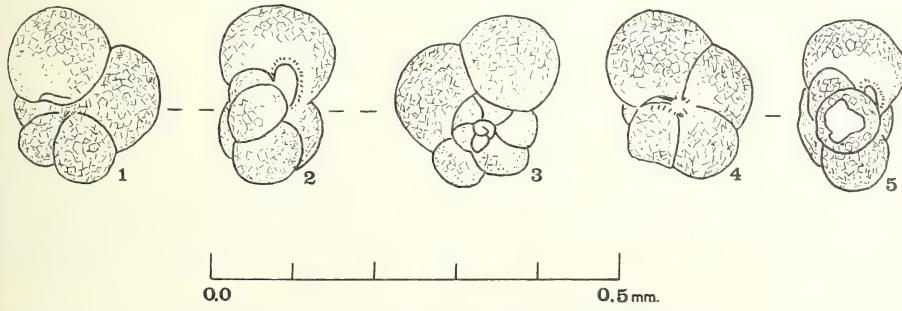


FIG. 37, 1-5. *Globoquadrina hexagona*. 1-3, specimen described. 1, ventral view; 2, side view; 3, dorsal view; 4, 5, additional four chambered specimen, ventral view and side view.

DIMENSIONS. Maximum diameter 0·21 mm, height in side view 0·13 mm.

MATERIAL. Four specimens, one broken and one with only a trace of the last chamber left.

VARIATION. The material is insufficient for detailed analysis but there are slight variations in rate of chamber size increase and in the size of the hexagonal pits (Pl. 20, fig. 7 as compared with fig. 9).

DEPOSITORY. B.M.(N.H.) Slide 1970 : II : 26 : 348, 349. Stub 1970 : II : 26 : 617, 618.

PROVENANCE. Specimen described and others illustrated (Text-fig. nos 4, 5 and Pl. 20, fig. 9.) Sample D22, Borehole 3, Borth at 95' in Holocene (Boreal) sands. Specimen illustrated Pl. 20, figs 7, 8, CB 362, Tremadoc Bay.

REMARKS. We have identified our specimens as *G. hexagona* following the broad interpretation of the species made by Parker (1962) to cover a series of variants from the South Pacific. These range from rather loosely coiled, flat forms with six chambers at the periphery and large umbilicus with marked teeth through five chambered forms, like the holotype (though smaller) to more globular, close coiled forms with more rapid rate of chamber size increase and small umbilicus, like ours. It is noteworthy that the only published record for the N. Atlantic (Phleger, Parker & Peirson, 1953) is of the same variant which may, therefore, constitute a geographical subspecies in this area. However, confirmation of this idea requires more material (preferably living). As three of our specimens are from a borehole it is possible that the species only occurs as a derived form in Cardigan Bay.

As shown by the stereoscanner photo of one specimen in dorsal view (Pl. 21, fig. 12) the pores are irregular, up to 2 microns diameter in deep hexagonal pits up to 8 microns in diameter.

DISTRIBUTION. The species was originally described from 884 metres off Long Beach, California. Other Pacific records are: mid Pacific sea mounts (Hamilton, 1953); Equator and north to lat. 54° (Bradshaw, 1959); Gulf of California (Bandy, 1961); South Pacific north of lat. 45° (Parker, 1962). The only other record is for the N. Atlantic, as noted above, from lat. 0° to 20° North, 'with one or two rare occurrences further north'. According to Bé (1967, 1969), the species is restricted to the Indo-Pacific, this underlines the idea that the N. Atlantic variety is distinct.

### Genus *GLOBOROTALIA* Cushman, 1927

#### *Globorotalia inflata* (d'Orbigny)

(Pl. 20, figs 3, 4; Pl. 21, figs 10, 11)

*Globigerina inflata* d'Orbigny, 1839b : 134, pl. 2, figs 7-9; Goës, 1894 : 84, pl. 14, figs 763-765; Flint, 1899 : 322, pl. 69, fig. 3; Cushman, 1931 : 12, pl. 3, figs 1-3; Wiseman & Ovey, 1950 : 66, pl. 2, figs 5a-c; Colom, 1952 : 42, pl. 8, figs 37-41; Phleger, Parker & Peirson, 1953 : 13, pl. 1, figs 15, 16.

*Globorotalia inflata* (d'Orbigny) Parker, 1967 : 179, pl. 29, figs 1, 3.

*Globigerina bulloides* var. *inflata* (d'Orbigny) Parker & Jones, 1865 : 367, pl. 16, figs 16, 17.

DIAGNOSIS. A species of *Globorotalia* with rounded periphery, high arcuate

aperture and three to four chambers only, visible on the high, commonly tuberculate ventral side. The dorsal side may be almost flat.

DESCRIPTION. (Pl. 20, fig. 3.) Test with holed final chamber; globular and biconvex with slightly raised, evolute dorsal side and strongly raised, rounded, involute ventral side, moderately lobate; apparently about 14 chambers arranged in a low sinistral trochospire of about  $2\frac{1}{2}$  whorls, longer than high, increasing moderately in size as added; septal and spiral sutures impressed, radial on the ventral side, radial to slightly curved on the dorsal; wall radial lamellar and densely perforated with pores up to 3 microns in diameter in shallow pits; aperture extraumbilical, large, a high arched opening with thick, rounded lip, reaching to the periphery; umbilicus closed; ventral side and apertural face densely tuberculate, dorsal side slightly so.

DIMENSIONS. Maximum diameter 0·34 mm.

MATERIAL. Two specimens only.

VARIATION. The other specimen recovered is larger, 0·40 mm, and shows only three chambers on the ventral side. This specimen is heavily tuberculate. According to Parker (1962) the wall is of variable thickness and smooth or rough in Pacific forms and the overall shape varies from biconvex to plano-convex with more angular periphery. The species is generally left coiling (Bé, 1967).

DEPOSITORY. B.M.(N.H.) Stub 1970 : 11 : 26 : 619.

PROVENANCE. Both specimens from Holocene, Scrobicularia Clays, Borth.

REMARKS. We have departed from our rule (excluding citations without adequate description from the synonymy) in order to include some entries with good figures and excellent distribution data. Doubtful records such as that of Balkwill & Millett (1884) are excluded.

DISTRIBUTION. This species, originally described from the Canary Islands, was considered cosmopolitan by Brady (1884) and he considered that it ranged from latitude  $53^{\circ}$  South to  $82^{\circ}$  North. Parker & Jones (1865) found it abundant and large in the N. Atlantic and the more detailed records of Phleger, Parker & Peirson (1953) show that it constitutes 5% of the fauna at lat.  $60^{\circ}$ N. increasing to 54% southwest of the British Isles. The range of high frequency was found to be from  $50^{\circ}$ N. to  $20^{\circ}$ N. with the highest frequencies north of lat.  $35^{\circ}$ N. This is also shown by the detailed maps of Bé & Hamlin (1967) and the records of Caralp, Lamy & Pujos (1970) who found it made up 30% of the fauna on the continental plateau, Bay of Biscay.

In the South Atlantic (Bé, 1969) the species makes up 70% of the total population in spring in transitional waters between the subtropical and subantarctic regions. In contrast Bé found it most abundant in the Pacific in subantarctic waters. Other Pacific records are Bradshaw (1959) who found it in the N. Pacific, north of lat.  $25^{\circ}$ N. and Parker (1960, 1962) who found it at all latitudes south of  $5^{\circ}$ S. but only scattered north of  $25^{\circ}$ S.

As noted by Wiseman & Ovey (1950) and Bé (1967) these records confirm a general cold temperate distribution, with greatest abundance in waters from  $13^{\circ}$ - $17^{\circ}$ C. (Bé & Hamlin, 1967).

Genus ***ORBULINA*** d'Orbigny, 1839***Orbulina universa*** d'Orbigny

(Pl. 20, fig. 6)

*Orbulina universa* d'Orbigny, 1839a : 3, pl. 1, fig. 1; 1839b : 122, pl. 1, fig. 1; Williamson, 1858 : 2, pl. 1, fig. 4; Carpenter, Parker & Jones, 1862 : 176, pl. 12, fig. 8; Parker & Jones, 1865 : 364, pl. 16, figs 13, 14; Flint, 1899 : 323, pl. 69, fig. 1; Cushman, 1924 : 28, pl. 5, figs 2-9 (not 3, 8); Wiseman & Ovey, 1950 : 67, pl. 3, fig. 6; Phleger, Parker & Peirson, 1953 : 17, pl. 2, fig. 8; Blow, 1956 : 66, text-fig. 2, nos 8, 9; Bé & Hamlin, 1967 : 102, text-fig. 26; Bé, 1967 : sheet 108, fig. 3.

**DIAGNOSIS.** A species of *Orbulina* in which the final chamber completely encloses the trochospiral juvenile.

**DESCRIPTION.** Test spherical with final chamber broken open to reveal the low trochospiral juvenile within; early chambers globular, increasing slowly in size, sutures deeply impressed, about eight in number with prominent spine bases; penultimate chamber globular, possibly not quite enveloping the previously formed test, with a large aperture (? apertures or signs of resorption); final chamber completely enveloping; wall thick, radial, coarsely perforated, tectin lining of final chamber clearly visible; aperture multiple of small, scattered round openings.

**DIMENSIONS.** Diameter of final chamber 0·37 mm.

**MATERIAL.** One specimen only.

**DEPOSITORY.** B.M.(N.H.) Stub 1970 : 11 : 26 : 676.

**PROVENANCE.** Holocene, Scrobicularia Clays, Borth.

**REMARKS.** Our specimen shows a much more complete and apparently larger initial, trochospiral part than that normally found, see for instance the 'embryonic' chambers illustrated by Loeblich & Tappan (1964a); sufficient perhaps to cast doubt on its specific identity with *O. universa*. It is interesting also that the coarsely prismatic wall clearly arises from an inner tectin lining (seen folded back above the trochospiral part). No inner lamella of calcite can be seen.

**DISTRIBUTION.** The large number of records would indicate that this species is cosmopolitan but more than one species may be involved, as noted by Parker (1962). Detailed work by Bé and Hamlin in the N. Atlantic shows that it is widespread in tropical, subtropical and transitional waters with highest concentrations in the Gulf Stream and in the Eastern Atlantic off Spain and Morocco. Numbers diminish northwards and only a few occur near the British Isles.

Family ***ROTALIIDAE*** Ehrenberg, 1839Genus ***AMMONIA*** Brunnich, 1772***Ammonia aberdoveyensis*** Haynes n. sp.

(Pl. 18, fig. 15; Text-fig. 38, nos 1-7)

*Ammonia beccarii* var. *batavus* Adams & Haynes, 1965 : 30; Haynes & Dobson, 1969 : 244 (not Hofker).

**DIAGNOSIS.** A biconvex species of *Ammonia* with low conical dorsal side and rounded periphery, reaching 0·40 mm in average diameter in 2–3 whorls, with 8–9 chambers visible on the ventral side. The ends of the chambers are sharply pointed and minutely tuberculate and project into a large, open umbilicus.

**DESCRIPTION.** (Holotype, Text-fig. nos 1–3.) Test biconvex with evolute, low conical dorsal side and involute, moderately raised ventral side, slightly less than twice as wide as high, with rounded periphery and semi-lobate outline; chambers 29, slowly increasing in size as added and arranged in a low trochospire, 6 : 7 : 9 : 6—, in each whorl following the proloculus, becoming longer than high and lunate rather than square in the third whorl as seen in dorsal view; sutures flush in the initial part on the dorsal side, slightly impressed after chamber 20, deeply impressed on the ventral side and fissured towards the open umbilicus; eight chambers visible on the ventral side with pointed, minutely tuberculate umbilical ends; last chamber breached but showing part of original ventral, basal and umbilical aperture and areal foramen of previous apertural face with toothplate below; wall radial, lamellar and minutely perforate.

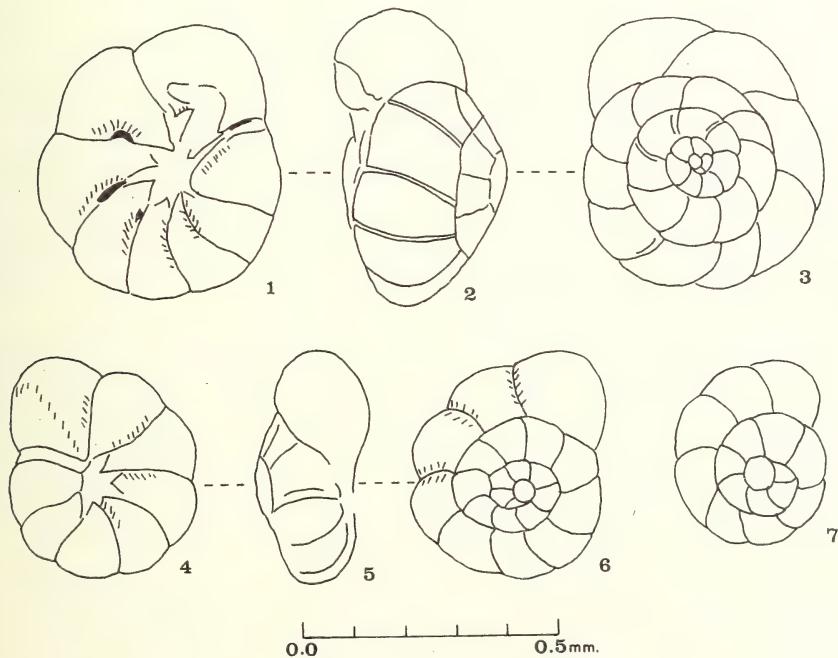


FIG. 38, 1–7. *Ammonia aberdoveyensis*. 1, ventral view of holotype; 2, side view; 3, dorsal view; 4–6, megalospheric specimen; 7, megalospheric specimen, November population, dorsal view. Holotype a microspheric form from May population.

DIMENSIONS. Diameter 0·56 mm, height 0·32 mm. Proloculus diameter approx. 20 microns.

MATERIAL. More than 25 specimens. One of the dominant living species on the Dovey Marshes.

VARIATION. This species shows much the same size range as *A. batavus* reaching an average diameter of 0·40 mm in 2–3 whorls (more than 100 specimens examined). Again there is a close relationship between proloculus size and total chamber number. Proloculus diameters range from 15–60 microns and there is a marked tendency for average chamber number to fall with increase in size, from 28 to 15 (Text-fig. nos 1–7). Text-fig. nos 4–6 show an intermediate form with proloculus diameter about 37 microns and 6 : 8 : 8, chambers in each whorl following the proloculus. It is interesting that specimens like this with a proloculus about 40 microns in diameter were dominant at Clettwr Station II in May, 1963, with specimens like the holotype subordinate. In November 1963, specimens with proloculus diameters near 60 microns were dominant (Text-fig. no. 7). This may indicate a tendency for A<sub>2</sub> forms to replace A<sub>1</sub> forms in the autumn. As yet we have no evidence of a definite microspheric generation. It is also interesting that the November population also shows a tendency to develop slightly more ornament on the umbilical ends of the chambers and one specimen was found with a small umbilical boss, see also Pl. 18, fig. 15, which shows a possible vestigial boss. This might indicate a response to late summer salinities.

DEPOSITORY. B.M.(N.H.) Slides 1970 : 11 : 26 : 350 (holotype), 1970 : 11 : 26 : 351–368 (paratypes). Stub 1970 : 11 : 26 : 520.

PROVENANCE. Holotype and illustrated specimens, Station II, Clettwr Transect, Dovey Marshes (pool in High Marsh Sward, see Haynes & Dobson, 1969).

REMARKS. As long ago as 1870, Brady drew attention to 'the brackish water modification of the type' of '*Rotalia beccarii*' occurring in the Bure and Tyne and in the Exe Estuary. His figure shows a specimen like ours with rounded periphery, open umbilicus and pointed umbilical ends to the chambers though the dorsal side is less raised. This may be the same as our species.

*A. aberdoveyensis* shows close similarities to both *A. batavus* and *A. tepida*. It has the same size range as *A. batavus* and shows similar proloculus size—chamber number relationships. It differs in its low conical, rather than flattened dorsal side, round periphery and lack of ventral ornament. It is similar to *A. tepida* in its raised, conical dorsal side and open ventral umbilicus but differs in growth rate, being larger in equivalent whorls with more chambers visible ventrally, 8–9 rather than 6–8, and in the pointed rather than rounded umbilical ends to the ventral chambers.

Some of the specimens referred to '*tepida*' in the cool temperate areas of the N. Atlantic region may be nearer to our species, as for instance, '*Streblus beccarii tepida*' of Todd & Low (1961).

DISTRIBUTION. This species occurs as a dominant member of the living community in the Dovey Estuary. Many of the records of '*Rotalia beccarii*' from estuaries around the British coast probably refer to this form.

*Ammonia batavus* (Hofker)

(Pl. 18, figs 5, 6, 14, 16; Text-fig. 39, nos 1-4)

*Streblus batavus* Hofker, 1951 : 498, 340, 341; Haake, 1962 : 52, pl. 6, figs 6-12.*Ammonia batavus* (Hofker) Feyling-Hanssen, 1964 : 349, pl. 21, figs 4-13.*Rotalina beccarii* Williamson, 1858 : 48, pl. 14, figs 90-92 (not *Nautilus beccarii* Linné).*Rotalia beccarii* part Parker, 1952b : 457, pl. 5, figs 5a, b; ? Cushman, 1949 : 47, pl. 9, fig. 4 (not Linné).? *Streblus beccarii* Todd & Low, 1961 : 18, pl. 2, figs 18, 19.*Ammonia beccarii* (Linné) var. *batavus* (Hofker) Murray, 1965a : 502 (list), pl. 1, figs 1, 1; 2, 2 (stereopairs).

**DIAGNOSIS.** A biconvex *Ammonia* generally flattened on the dorsal side with subangular to subround periphery, reaching 0.40 mm in average diameter in 2-3 whorls, with eight or nine chambers visible on the ventral side. A large plug (often divided) fills the ventral umbilicus and smaller granules line the deeply fissured septal sutures. The spiral suture is often raised on the dorsal side and divided in the last whorl with small openings at the junctions with the sutures.

**DESCRIPTION.** (Text-fig. nos 1-3.) Test with broken final chamber; biconvex, about twice as wide as high, with subangular periphery, ventral side involute and more strongly raised than the evolute, rather flattened dorsal side, outline weakly lobate; chambers 26 (including proloculus) slowly increasing in size as added and arranged in a very low trochoid spiral, 6 : 7 : 9 : 3—, in each whorl following the proloculus, becoming slightly longer than high in the third whorl as seen in dorsal view; dorsal side extremely smooth and sutures flush; nine chambers visible on the ventral side with thickened, angular umbilical ends, sutures straight, deeply incised towards the umbilicus and lined by small, clear calcite bosses; umbilicus large and filled by a single prominent plug; last chamber broken so the typical ventral, basal

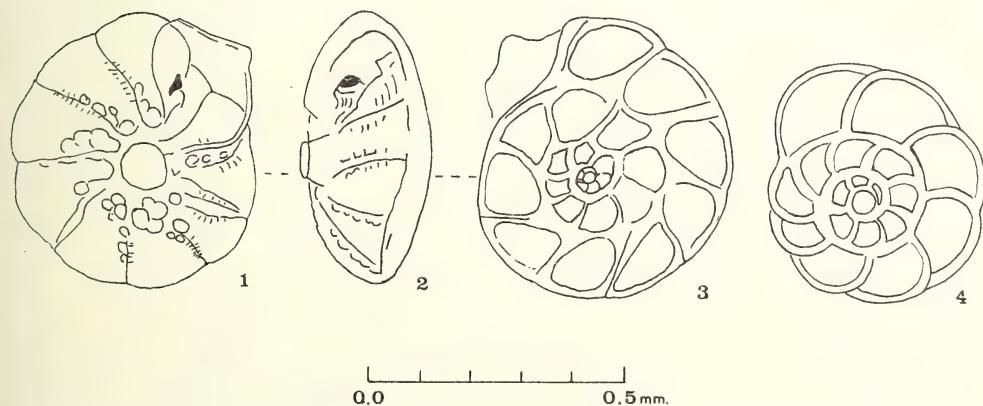


FIG. 39, 1-4. *Ammonia batavus*. 1-3, specimen described; 1, ventral view; 2, side view; 3, dorsal view; 4, additional megalospheric specimen, dorsal view.

and umbilical aperture is not seen but the areal foramen of the previous apertural face can be seen with a rudimentary toothplate just below it; wall radial and lamellar building up a thick spiral septum, finely perforate.

DIMENSIONS. Maximum diameter 0·56 mm, height 0·25 mm. Proloculus diameter approx. 20 microns.

MATERIAL. More than 25 specimens. This is the dominant species in Cardigan Bay in the dead populations but so far has not been found abundantly in the living state.

VARIATION. We have made a variation study of one hundred specimens. This confirms in general Hofker's observation that *A. batavus* represents a member of the *A. beccarii* plexus with distinctive shape, ornament and growth rate. In brief *A. batavus* is smaller, with less angular periphery in the adult, develops fewer chambers and has a range of proloculus sizes that is smaller and only just overlaps that of *A. beccarii*. Ventral ornament is also less developed.

Our measurements show that the proloculus diameter in the Cardigan Bay population ranges from just less than 10 microns up to 80 microns (compared to 4–54 microns in Hofker's North Sea population) and confirm his finding that the larger the diameter the lower the total number of chambers. Thus we found one specimen with a proloculus just below 10 microns in diameter to have 32 chambers while the specimen with a proloculus diameter of about 80 microns had 16. The text figures show the marked acceleration in growth that is connected with increase in prolocular size. Text-fig. no. 4 shows that a specimen with a proloculus diameter of about 40 microns reaches a test diameter of 0·40 mm in two whorls (16 chambers) whereas in the specimen described with proloculus of 20 microns diameter a test diameter of 0·40 mm is reached in  $2\frac{1}{2}$  whorls (20 chambers) and the first whorl is by comparison only half the size.

Hofker has suggested that his material reveals at least three proloculus size groups—microospheric or B forms averaging about 6 microns; megalospheric A1 forms, about 17 microns, and A2 forms about 50 microns. On this basis our figured specimens would represent the A1 and A2 forms. However, our material also shows specimens with much larger megalospheres so there may be a range of sizes without clear cut groups.

Our material also shows that considerable variation in ornament occurs. In many cases the umbilical plug is divided and the spiral septum may be raised on the dorsal side.

DEPOSITORY. B.M. (N.H.) Slide 1970 : II : 26 : 369–378, 1970 : II : 26 : 379–380, 1970 : II : 26 : 381. Stub 1970 : II : 26 : 514, 515, 519.

PROVENANCE. Described specimen (and other specimens used in variation study) Brit. Mus. Core 16, Cardigan Bay.

REMARKS. Both directions of coiling occur in our population (76% anti-clockwise) and it is interesting that this was noted by Walker & Boys (1784) in the very earliest days of scientific investigations into the foraminifera when they coined the sub-specific name '*perversus*' for left coiling specimens of what was probably *A. batavus*.

(*Nautilus beccarii perversus*). However, no ventral view was given by them, or later by Montagu (1803) or Brown (1844). In any case through long disuse the name should lapse as a *nomen oblitum*.

DISTRIBUTION. As this species has been confused with *A. beccarii* for a long period its distribution remains to be worked out. It is undoubtedly widely distributed around the coasts of the British Isles and in the North Sea. It has been well figured by Murray from Plymouth (1965a) and in addition Parker (1952) and Todd & Low (1961) figure specimens that may belong to it from the eastern seaboard of N. America.

### *Ammonia limnetes* (Todd & Bronniman)

(Pl. 18, figs 7-9; Pl. 19, fig. 8; Pl. 30, fig. 8; Text-fig. 40, nos 1-5)

*Streblus limnetes* Todd & Bronniman, 1957 : 38, pl. 10, figs 4a-c.

*Rotalia beccarii* (Linné) var. *sobrina* Parker, 1952b : 457, pl. 5, figs 7a, b (not Shupak).

'*Rotalia beccarii* (Linné) variant C, Parker, Phleger & Peirson, 1953 : 13, pl. 14, figs 29-30.

DIAGNOSIS. A thin walled, compressed *Ammonia* with flattened dorsal side and six to seven chambers visible on the ventral side with subangular to subround lobes filling the umbilicus.

DESCRIPTION. (Text-fig. nos 1-3.) Test with last chamber broken off; compressed with flattened, evolute dorsal side and slightly raised, involute ventral side, periphery rounded and only slightly lobate in outline; chambers 17, arranged in a very low trochospire and increasing slowly in size as added, 6 : 7 : 3—in each whorl following the proloculus, becoming longer than high and lunate in the second whorl as seen in dorsal view; sutures flush on the smooth dorsal side; six chambers visible in ventral view with subrounded lobes filling the umbilicus, sutures impressed and deeply fissured towards the umbilicus, excavated behind the prominent lobes; the last chamber is broken so the typical ventral, basal and umbilical aperture is not seen but the oval, areal foramen of the previous apertural face is revealed; wall radial,

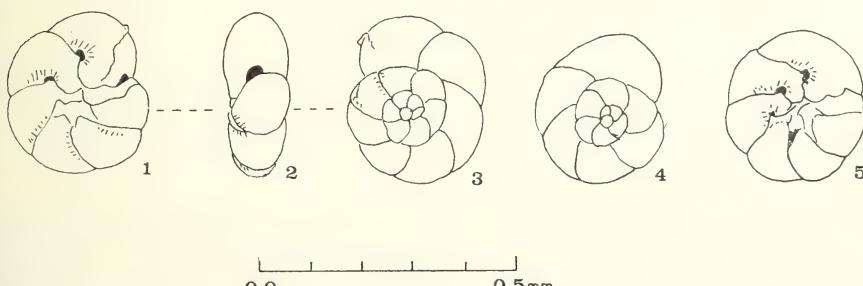


FIG. 40, 1-5. *Ammonia limnetes*. 1-3, specimen described; 1, ventral view; 2, side view; 3, dorsal view; 4, specimen with lower chambers coming in earlier, dorsal view; 5, ventral view of another specimen.

thin and finely perforated (sections show the wall is lamellar in this species).

DIMENSIONS. Diameter 0·32 mm, height 0·12 mm. Proloculus diameter approx. 20 microns.

MATERIAL. More than 20 specimens. Abundant in the Boreal sediments penetrated by the Borth Boreholes.

VARIATION. No proloculus size groups could be discerned in our specimens and those measured were all near 20 microns. Most of the specimens recovered show between 2–3 whorls and reach about 0·30 mm in total diameter. This is just below the lower end of the size range, 0·32 mm to 0·42 mm, reported by Todd and Bronnimann for their Trinidad population. Six or seven chambers are developed in the second whorl and six are generally visible externally. Some specimens such as those figured (Text-fig. nos 4, 5) show larger, lower chambers coming in earlier.

DEPOSITORY. B.M.(N.H.) Slide 1970 : II : 26 : 382–385, Section 1970 : II : 26 : 493. Stubs 1970 : II : 26 : 542, 543, 1970 : II : 26 : 759.

PROVENANCE. Illustrated specimens, Holocene, Borth Borehole 2, D7.

REMARKS. Our population although reaching smaller diameters is otherwise almost identical with that of Todd and Bronnimann. This is well shown by a comparison of the stereoscanner photomicrograph of one of our specimens (Pl. 18, figs 7, 8) with the type figures. It will be noted that in both cases the umbilical lobes appear pointed. Caution is necessary here because this appearance is exaggerated by the oblique angle at which the lobes are set in ventral view and by their overlap. Pl. 19, fig. 8 shows a close-up of the final lobe almost at right angles to the observer and it is seen to be subround rather than pointed (shaped like a finger nail) with a slight, tuberculate flange, arched along the basal suture to reveal the aperture. The close-up also shows that the sutural fissures are lined with tubercles as in other *Ammonia* species, though these are not apparent using the optical microscope.

This species is close to *A. tepida* but distinguished by its thin, translucent although brownish wall, flat dorsal side and accelerated growth rate with the chambers doubling in size with each whorl (as seen in dorsal view). The lobes also cover up the umbilicus to a greater extent. It is distinguished from *A. perlucida* by its less inflated chambers and again by its flattened dorsal side.

Todd and Bronnimann include '*Rotalia*' *beccarii* variety C. Parker, Phleger & Peirson from San Antonio Bay and Parker's *Rotalia beccarii* var. *sobrina* in their species although these authors did not give side views. These references are therefore included here fide Todd and Bronnimann.

DISTRIBUTION. This species was first described from Mangrove swamps in Trinidad and is a common Caribbean form as well as (apparently) penetrating as far north as New England along the coasts of N. America. In Cardigan Bay it is much more common in the Boreal than in the present-day sediments. It therefore has a similar distribution to *A. tepida*. It also occurs abundantly in the Holocene of the Somerset Levels.

*Ammonia tepida* (Cushman)

(Pl. 18, fig. 17; Pl. 30, fig. 7; Text-fig. 41, nos 1-7)

*Rotalia beccarii* (Linnaeus) var. *tepida* Cushman, 1926 : 79, pl. 1; 1931 : 61, pl. 13, figs 3a-c.*Rotalia beccarii* var. B, Parker, Phleger & Peirson, 1953 : 13, pl. 4, figs 25-28.*Streblus beccarii* var. *tepida* (Cushman) Bradshaw, 1957 : 1138-1147, text-fig. 1; Todd & Bronnimann, 1957 : 38, pl. 10, figs 5-11.*Streblus tepidus* (Cushman) Bandy, 1961 : 17, pl. 1, fig. 5.*Ammonia tepida* Brodniewicz, 1965 : 216, pl. 7, figs 3a-c.

**DIAGNOSIS.** A small *Ammonia*, generally less than 0.40 mm in diameter after three whorls, with rounded periphery and raised, low conical dorsal side. From six to eight chambers are visible on the ventral side with rounded umbilical lips. The umbilicus is open.

**DESCRIPTION.** (Text-fig. nos 5-7.) Test biconvex, twice as wide as high with the dorsal side most strongly raised and conical, periphery rounded and entire; chambers 22 (including proloculus) slowly increasing in size as added and arranged in a low, dextrally trochoid spiral, 6 : 7 : 8, in each whorl following the proloculus, tending to become longer and lower in the third whorl as seen in dorsal view; sutures swept back and flush on the dorsal side; eight chambers visible on the

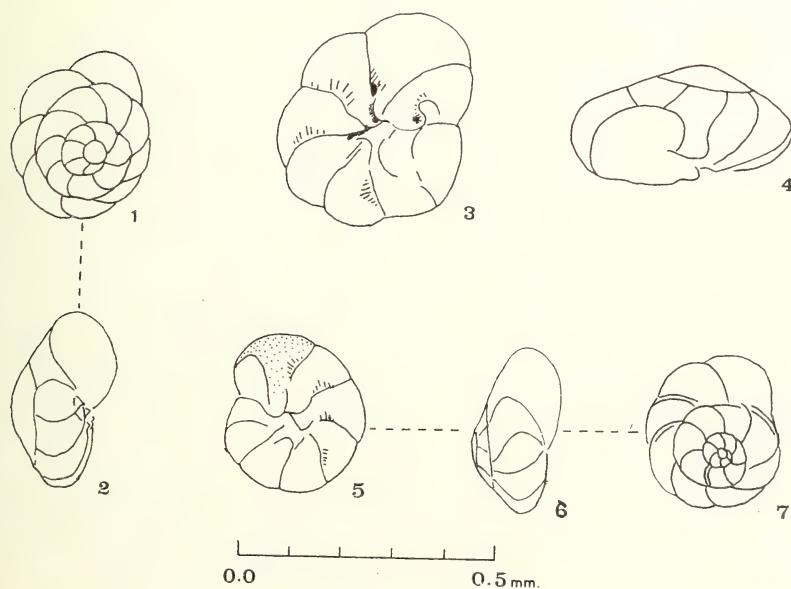


FIG. 41, 1-7. *Ammonia tepida*. 1, megalospheric specimen; 2, side view; 3, large specimen; 4, large specimen side view; 5-7, specimen described; 5, ventral view; 6, side view; 7, dorsal view.

ventral side with rounded umbilical lobes tending to cover the otherwise open umbilicus; sutures straight to gently curved, depressed and fissured towards the umbilicus and excavated behind each lobe; aperture ventral, basal and umbilical internal foramen areal, oval with small toothplate below it; wall radial, lamellar and finely perforate apart from apertural face and umbilical lobes; possibly minutely tuberculate in the umbilical region.

DIMENSIONS. Diameter 0·32 mm, height 0·17 mm. Proloculus diameter approx. 15 microns.

MATERIAL. More than 20 specimens. Very abundant in borehole material from Boreal sediments in the Dovey Estuary.

VARIATION. Specimens up to 0·40 mm in diameter occur (Text-fig. no. 3) but most specimens are nearer 0·30 mm. A range of proloculus sizes from 15–75 microns was noted and as in the case of *A. batavus* an increase in size of the proloculus is associated with a tendency to a decrease in total number of chambers, to 15 or less. Longer, lower, more lobate chambers also come in earlier (Text-fig. no. 1). However, no definite size groups could be distinguished.

As in other *Ammonia* species the umbilical area tends to be minutely tuberculate. This is not very apparent in the specimen fully described but is beautifully shown in the specimen illustrated by stereoscaner photomicrograph (Pl. 18, fig. 17).

DEPOSITORY. B.M.(N.H.) Slide 1970 : II : 26 : 386–392. Section 1970 : II : 26 : 494. Stub 1970 : II : 26 : 521.

PROVENANCE. Described and illustrated specimens, Holocene, Grey Silty Sands, Borehole 3, D8 (Boreal).

REMARKS. Our specimens seem to fit well into the present concept of the species held by the authors quoted but doubt remains because the original description was not well illustrated and included the phrase 'towards the umbilicus . . . the ends of the chambers extended to a point'. This would apply more to our species *A. aberdoveyensis* than to the group we are applying the name '*tepida*' which tends to have bluntly rounded umbilical lobes. However, these lobes overlap and do appear more pointed when half hidden and this is also the case with topotypes of Cushman's species in the British Museum. In addition our population is closely similar to that illustrated by Todd and Bronnimann and which like the types is from the Caribbean. The population discovered in San Antonia Bay by Parker, Phleger and Peirson and cultured by Bradshaw includes a majority of forms with six chambers visible ventrally and large megalospheres, again though, with large, rounded umbilical lobes.

There is also doubt concerning the relationship of *A. flevensis* Hofker to *A. tepida*. This species appears to be very close in general morphology but on the evidence of the photographs of Irena Brodniewicz (1965) has a different rate of chamber increase size with 'fine, sharp, prick-like spines' in the umbilical area.

DISTRIBUTION. This species was first described from Puerto Rico and is common in the Caribbean. It has been recorded from the Holocene of Poland by Brodniewicz and may have been widespread in northern latitudes in the Boreal.

Genus ***BUCCELLA*** Anderson, 1952***Buccella frigida*** (Cushman)

(Pl. 18, fig. 13; Text-fig. 42, nos 1-5)

*Pulvinulina frigida* Cushman, 1922 : 12 (co-types not figured).*Eponides frigida* Cushman, 1931 (part) : 45.*Buccella frigida* (Cushman) Anderson, 1952 : 144, figs 4a-c, 5, 6a-c; Loeblich & Tappan, 1953 : 115, pl. 22, figs 2, 3; Voorthuysen, 1958 : 32, pl. 24, figs 15a-c; Todd & Low, 1961 : 18, pl. 1, figs 24, 25; Haake, 1962 : 44, pl. 4, figs 3-6; Feyling-Hanssen, 1964 : 337, pl. 18, figs 15-18.*Buccella frigida* (Cushman) var. *calida* Cushman & Cole, 1930 : 98, pl. 13, figs 13a-c; Cushman, 1931 : 47, pl. 10, figs 3, 4; 1944 : 34, pl. 4, figs 19, 20; 1949 : 46, pl. 9, figs 1a-c; Parker, 1952b : 450, pl. 5, figs 3a, b.

**DIAGNOSIS.** A biconvex species of *Buccella* with broadly rounded periphery and generally with raised, rounded dorsal side. Most commonly in what is probably the megalospheric generation, there are 6 : 7 : 3 or 4—, chambers in each whorl following the proloculus.

**DESCRIPTION.** (Text-fig. nos 1-3.) Test biconvex with broad, shallow ventral umbilicus, flattened dorsal side and rounded periphery, apertural face oblique to the equatorial plane, semilobate; with ten chambers in a low, trochoid dextral spiral, 6 : 4—, following the proloculus, gradually but irregularly increasing in size and becoming longer than high and lunate in the second whorl, six visible on the ventral side; dorsal sutures distinct and slightly thickened, curving back to the periphery, slightly impressed in the last whorl, ventral sutures indistinct, radial, impressed; apertures not visible; wall finely perforate, ornamented on the ventral side with small granules that fill the umbilicus and sutural depressions and cover the lower part of the apertural face, coalescing at the centre to give the appearance of a small button-like plug.

**DIMENSIONS.** Maximum diameter 0.20 mm, height 0.10 mm. Proloculus diameter approx. 32 microns.

**MATERIAL.** Eight specimens examined.

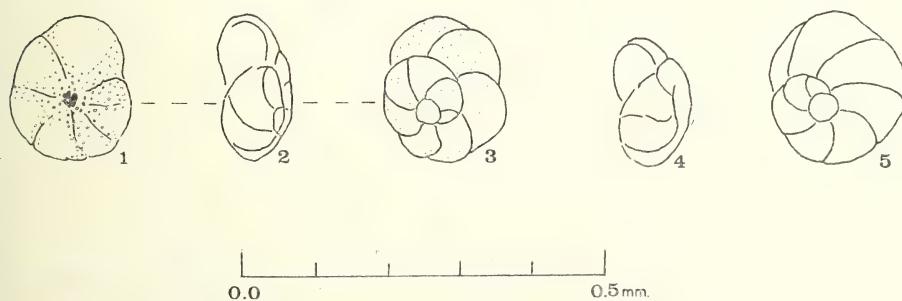


FIG. 42, 1-5. *Buccella frigida*. 1-3, specimen described; 1, ventral view; 2, side view; 3, dorsal view; 4, side view, additional specimen; 5, dorsal view of specimen with high chambers.

VARIATION. The specimens from Cardigan Bay are smaller than the types and appear to be juveniles with only one and a half whorls developed. There is variation in the height of the dorsal side, some specimens being bun-shaped (Text-fig. no. 4). Another specimen shows larger, higher chambers in the second whorl (Text-fig. no. 5). These variations are also shown in authors' figures and Loeblich and Tappan illustrate a specimen with a pointed or conoidal dorsal side.

DEPOSITORY. B.M.(N.H.) Slide 1970 : II : 26 : 241-245. Stub 1970 : II : 26 : 540, 541.

PROVENANCE. Figured specimens, Clettwr Transect, Station VII, Dovey Marshes.

REMARKS. We follow here the emended definition of the species made by Anderson based on a lectotype chosen from Cushman's co-types. Anderson's figures also include as hypotype the holotype of *Eponides frigidus* (Cushman) var. *calida* Cushman & Cole. This means that sharp keeled specimens such as those illustrated by Cushman, actually copies of figures of *Pulvinulina repanda* Fichtel & Moll var. *Karsteni* Reuss, Parker & Jones, 1865, must be given other names. Most references to *Eponides karsteni* probably indicate *B. inusitata* Anderson. Thin sections show that the test wall is built of radial laminated calcite perforated by small round pores a little less than a micron in diameter. The strong development of calcite granules on the ventral side is shown in Pl. 18, fig. 13 extending to the periphery below the apertural face.

DISTRIBUTION. The lectotype was recovered from 18·3 metres in a bay near Black Whale Harbour, Canadian Arctic. This cold water occurrence has been generally confirmed by later discoveries such as those of Loeblich & Tappan (1953) and Vilks (1969). It occurs widely in cool temperate waters of the Western Atlantic and sparingly near the British Isles: Plymouth (Murray, 1965a); Christchurch (Murray, 1968); Bay of Biscay (Caralp, Lamy & Pujos, 1970) and in the North Sea area (Haake, 1962). Pleistocene references are given by Feyling-Hanssen (1964) and Voorthuysen (1958). A record for the Pacific coast of Japan is given by Matoba (1970).

### Family CASSIDULINIDAE d'Orbigny, 1839

#### Genus *CASSIDULINA* d'Orbigny, 1826

##### *Cassidulina* cf. *reniforme* (Norvang)

(Text-fig. 43, nos 1-4)

*Cassidulina crassa* d'Orbigny var. *reniforme* Norvang, 1945 : 41, text-figs e-h; Cushman, 1948 : 75, pl. 8, figs 10a-c (figures after Norvang).

DESCRIPTION. (Text-fig. nos 1-3.) Test slightly compressed with broadly rounded periphery, reniform in outline; chambers arranged in a planispirally wound alternating, biserial series, three and a half pairs visible in the last whorl, the chambers extending over the umbilical region one side while extending one-third of the way to it on the other; sutures straight to slightly curved, flush; wall granular,

distinctly and densely perforate; aperture countersunk, a short, curved slit, oblique to the basal suture, joining it at the junction with the basal suture of the previous chamber, bearing a flat tooth on the proximal side.

**DIMENSIONS.** Maximum diameter 0.13 mm, height 0.6 mm.

**MATERIAL.** Twelve specimens only, most of them with the last chamber broken.

**VARIATION.** Specimens occur with four pairs of chambers visible and up to 0.22 mm in diameter.

**DEPOSITORY.** B.M.(N.H.) Slide 1970 : 11 : 26 : 393-397.

**PROVENANCE.** Described specimen Cardigan Bay, Brit. Mus. Core 14.

**REMARKS.** This is the only species of *Cassidulina* we have so far recovered in any numbers in Cardigan Bay. The specimens are extremely small (possibly juvenile) and the details of the test consequently rather difficult to make out. Although smaller, about half the size, they are very close to *Cassidulina crassa* var. *reniforme* Norvang in shape and chamber form. They differ in that the aperture appears to be oblique to the basal suture rather than developed along it as in Norvang's fig. h. In this regard our specimens more resemble *Islandiella islandica* (Norvang) but the tooth does not appear to protrude in our specimens and the wall is granular (two crushed specimens examined in polarized light).

Norvang referred his new variety to *Cassidulina crassa* d'Orbigny but this is untenable. The original description and the later redescription of Heron-Allen & Earland (1932) from d'Orbigny's collection in Paris and additional Falkland Islands material show that *C. crassa* is a large species, up to 1 mm diameter with five pairs of chambers and aperture almost at right angles to the basal suture. Apparently similar forms in the northern hemisphere were distinguished as *C. obtusa* by Williamson (1858) who, with his usual accuracy, figures the aperture as a long slit, parallel to the periphery, as in *C. laevigata*. There seems little doubt that many of the

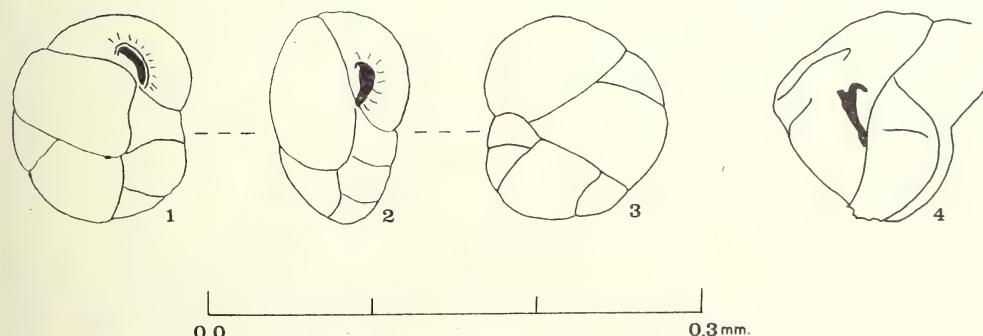


FIG. 43. 1-4. *Cassidulina* cf. *reniforme*. 1, side view showing aperture; 2, oblique peripheral view; 3, view of reverse side; 4, foramen of broken specimen, apparently with areal branching.

North Atlantic references to *C. crassa* such as those of Brady (1884), Goës (1894), Cushman (1922) and Norvang (1945) refer to *C. obtusa*. Similarly *C. laevigata* sensu Heron-Allen & Earland (1930) is *C. obtusa*. Norvang's variety differs from *C. obtusa* in its shape and in its flush sutures as well as in the form of the aperture and should probably be regarded as a distinct species. The specimens described as *Cassidulina laevigata* d'Orbigny var. *crassa* d'Orbigny by Parker & Jones (1865) may be the same as ours, as the figures show a short, oblique aperture and they remark significantly, 'on the eastern plateau of the North Atlantic it is very rare and very small'. However, it is possible their figures are of a broken specimen and show the foramen of the previous chamber rather than the aperture. The foramen may differ from the aperture, even, apparently, showing areal branching as in our Text-fig. no. 4. Care must, therefore, be taken with broken specimens, especially before we know anything of the ontogenetic development of the aperture in *Cassidulina* species.

#### Family NONIONIDAE Schultze, 1854

This family is interpreted in the wide sense to include both *Nonion* and *Elphidium*. Changes in wall structure are progressive and advanced forms tend to be optically radial. However, this feature cannot be used as the basis for subfamily division as in many cases it is demonstrably of specific importance only. Again, although Loeblich & Tappan (1964a) have recognized a number of genera in the *Elphidium* group we continue to interpret this genus in the wide sense of Wade (1957) and earlier workers. This is because we still do not know enough about the stratigraphical relations of the species to decide what characters are important at the generic level. Two of our species, *E. magellanicum* and *E. asterotuberculatum*, are apparently primitive in possessing open sutural canals or irregular canal openings only. These appear close to *Protelphidium* on the one hand and *Elphidiella* on the other. *E. cuvillieri*, *E. selseyense* and *E. waddensis* show coarse pores, irregular septal pits and bars and questionable retral processes. On this basis they could be grouped with *Cribrononion*. Except that some specimens of *E. selseyense* show areal apertures which alternatively suggest *Cribroelphidium*. *E. incertum* is finely perforate with incipient fossettes. The other species appear to fall into *Elphidium* s.s. but *E. exoticum* is optically granular, as is *E. incertum*.

Apparently, we are dealing with a plexus of species that has arisen from within the *Nonion* group, showing a general tendency towards development of radial walls and closed septal canals which then find an exit through regular fossettes with attendant enlargement of the septal flap and strengthening by septal bars. As evolution does not occur at a steady rate and we may be dealing with many lines we should not expect a particular species to be necessarily 'advanced' in all its characters. Thus, *E. exoticum* is optically granular but has regular fossettes and advanced retral processes that communicate to the exterior via the proximal end of the septal bar. We therefore feel it to be unwise to multiply the number of generic names at present.

Genus ***ELPHIDIUM*** Montfort, 1808***Elphidium asterotuberculatum*** (Voorthuysen)

(Pl. 22, fig. 7)

*Nonion depressulus* (Walker & Jacob) forma *asterotuberculata* var. Voorthuysen, 1958 : 28  
pl. 23, figs 3a, b; 1960 : 254, pl. 11, fig. 21; Haake, 1962 : 41, pl. 3, fig. 5; ? Feyling-Hanssen,  
1964 : 331, pl. 17, figs 13, 14.

*Cribrononion asklundii* Lutze, 1965 : 105, pl. 15, fig. 42 (not Brotzen).

**DIAGNOSIS.** A compressed species of *Elphidium* with high chambers and flat sides. The sutures are widely excavated but together with the umbilicus are closed by calcareous material giving a star-shaped figure. Septal canal openings small and irregular.

**DESCRIPTION.** Test with last chamber broken, compressed, circular in outline, periphery rounded, entire; chambers arranged in a planispiral, seven to eight visible, slowly increasing in size, higher than long and higher than wide in apertural view; sutures broadly excavated and widening to the umbilicus, filled with calcareous material and small tubercles; openings of septal canals small and irregular with no development of true fossettes and bars; wall apparently radial, minutely perforate; no aperture but foramina multiple and basal.

**DIMENSIONS.** Maximum diameter 0.20 mm, width approx. 0.05 mm.

**MATERIAL.** One specimen.

**DEPOSITORY.** B.M.(N.H.) Stub 1970 : 11 : 26 : 685.

**PROVENANCE.** Clettwr Transect, Dovey Marshes.

**REMARKS.** This species was first described as a variety of *N. depressulum* = *P. anglicum*. It differs from that species in its more flattened form, more excavated sutures and in its closed septal canals with irregular openings. The tubercles tend to be restricted to the sutures and umbilicus.

**DISTRIBUTION.** This species was described from the Eemian of the Netherlands but has also been recorded from the Recent at the following European localities: Netherlands, Dollart-Ems Estuary (Voorthuysen, 1960); Germany, Langeoog (Haake, 1962); Baltic, Ostsee (Lutze, 1965). Also from the Holocene of Oslofjord (Feyling-Hanssen, 1964). These last are more inflated than the types and resemble our material from the Holocene (Boreal) at Borth.

***Elphidium cuvillieri* Lévy**

(Pl. 24, figs 17, 18; Pl. 26, fig. 12)

*Elphidium cuvillieri* Lévy, 1966 : 5, pl. 1, fig. 6.

*Cribrononion cuvillieri* (Lévy) Lévy et al., 1969 : 93, pl. 1, figs 10a, b, 11.

**DIAGNOSIS.** A compressed species of *Elphidium* with conspicuous round to oval septal pits and umbilicus closed with a perforate, glassy plate formed by the fused ends of the chambers.

**DESCRIPTION.** Test compressed with slightly depressed, closed, umbilical areas, periphery rounded, entire to semi-lobate at the last few chambers; chambers arranged in an involute planispiral; ten visible on the exterior, gradually increasing in size, septal sutures not visible but marked by well developed round to oval septal pits marking the surface expression of the internal septal canals, up to seven on each chamber, septal bridges (? internal retral processes) becoming bar-like only on last two chambers; wall apparently radial, densely perforated with fine to medium sized pores up to 2 microns in diameter, these pores absent from the umbilical areas and the apertural face, umbilical plate with scattered septal pits (and possibly the openings of umbilical canals), up to 10 microns in size, aperture a series of irregular openings along the basal suture of the last chamber.

**DIMENSIONS.** Maximum diameter 0·47 mm, approx. width 0·15 mm.

**MATERIAL.** One specimen only.

**DEPOSITORY.** B.M.(N.H.) 1970 : 11 : 604.

**PROVENANCE.** Described specimen, CB 411.

**REMARKS.** Our specimen appears to be identical with the holotype in its pitted umbilical areas, in the size and distribution of the septal pits and in its perforation. This species can easily be overlooked because in certain lights the umbilical pits can appear to be umbilical bosses.

**DISTRIBUTION.** This species was described from Roussillon and from the shore sands of Dunkirk in France.

### *Elphidium exoticum* Haynes n. sp.

(Pl. 24, figs 8, 9; Pl. 26, figs 2, 3, 6, 8; Pl. 28, figs 1-4)

**DIAGNOSIS.** A compressed species of *Elphidium* with pearly, transparent granular wall and wide, flat umbilicus. Developing up to seven fingernail-shaped septal pits (fosslettes) on each side of the final chambers and bar-like septal bridges.

**DESCRIPTION.** (Holotype, Pl. 24, figs 8, 9; Pl. 26, figs 2, 3, 6, 8.) Test compressed, rather flattened with wide flat umbilicus depressed below the level of the chamber sides, periphery subrounded, semilobate and slightly irregular; chambers arranged in an involute planispiral, 11 visible externally, gradually increasing in size; sutures curved back to the periphery with well developed fingernail-shaped septal pits, narrow septal bars marking internal retral processes about one-quarter of the chambers in length, in some cases open proximally, especially on the last chamber; umbilicus filled with a flat plate formed by the fused ends of the earlier chambers, last five chambers with rounded, fissured, lobes drawn slightly away from the umbilicus; wall thin, granular, transparent with pearly lustre, densely perforate with fine pores less than  $\frac{1}{2}$  micron in diameter; aperture a series of small, round, hooded, openings at the basal suture of the last chamber; sharp spines line the septal pits and there are rather sparse tubercles at the base of the apertural face.

DIMENSIONS. Maximum diameter 0·38 mm, maximum width approx. 0·10 mm.

MATERIAL. More than 25 specimens.

VARIATION. Specimens develop 10 or 11 chambers in the second whorl and apparent variation in the material from 7 to 11 is largely due to differences in growth. In two specimens cut the following measurements were obtained:

Total diameter	Proloculus diameter	chambers in each whorl
0·29 mm	35 microns	7 : 11 : 1—,
0·26 mm	30 microns	7 : 10 : 1—,

Both specimens presumably belong to the megalospheric generation. The specimen described is larger than these, presumably with more than 2 whorls. Most specimens in the material appear to show less than two whorls. The paratypes show an average of nine chambers visible externally.

DEPOSITORY. B.M.(N.H.) Slide 1970 : 11 : 26 : 398–406 (paratypes). Sections, 1970 : 11 : 26 : 495, 1970 : 11 : 26 : 496, 1970 : 11 : 26 : 497 (paratypes). Stub 1970 : 11 : 26 : 596 (holotype).

PROVENANCE. Holotype CB 156, Dovey Marshes. Paratypes CB 411, Tremadoc Bay.

REMARKS. This species is distinguished from *E. discoidale* (d'Orbigny) by its flat, non-pitted umbilical areas, flat sides, fewer chambers and fewer pits, also by its pearly, minutely perforate wall. The wide, flat umbilicus also distinguishes this species from *E. poeyanum* (d'Orbigny) and *E. articulatum* (d'Orbigny).

The open retral processes are very distinctive in this species but they have been noted in *E. williamsoni* as well.

DERIVATION OF NAME. Refers to the fact that this species has a beautiful, optically granular, wall—one of only two amongst the *Elphidium* species recovered from Cardigan Bay.

### *Elphidium incertum* (Williamson)

(Pl. 22, fig. 6; Pl. 24, figs 14–16; Pl. 28, figs 8, 9)

*Polystomella umbilicatula* var. *incerta* Williamson, 1858 : 44, pl. 3, fig. 82a.

*Elphidium incertum* (Williamson) part Cushman, 1930 : 18, pl. 7, fig. 4a only (figure after Williamson); 1948 : 56, pl. 6, figs 7a, b; Brodniewicz, 1965 : 207, pl. 10, figs 9–11; text-figs 30, 31; Buzas, 1966 : 593, pl. 72, figs 1–6.

*Cribronion incertum* (Williamson) Lutze, 1965 : 103, pl. 21, figs 43, 44.

*Elphidium voorhuyseri* Haake, 1962 : 51, pl. 5, figs 6, 7.

*Elphidium varium* Buzas, 1965 : 21, pl. 2, fig. 7; pl. 3, figs 1, 2.

DIAGNOSIS. A thin walled, granular, compressed species of *Elphidium* with flat sides, prominent sutural slits and only partial development of septal bars. The septal openings tend to remain elongate in the line of the septa and there is little development of true fossettes until the last few adult chambers.

**DESCRIPTION.** (Pl. 24, figs 15, 16.) Test compressed with flat, slightly umbilicate sides, umbilicus closed by the fused ends of the chambers, later chambers withdrawing slightly from the centre producing a pseudumbilicus, periphery rounded and entire; chambers arranged in an involute planispire, 11 visible externally, slowly increasing in size; sutures swept back in an even curve to the periphery, deeply excavated with irregular development of bars, true fossettes and retral processes not developed until the last few chambers; wall thin, optically granular and densely perforated with pores less than 1 micron in diameter; aperture a series of irregular openings along the basal suture of the last chamber, partly hidden by tubercles which also line the excavated sutures.

**DIMENSIONS.** Maximum diameter 0.22 mm, maximum width 0.09 mm.

**MATERIAL.** Eleven specimens, most of them small.

**VARIATION.** The number of chambers visible externally ranges from eight in juveniles (Pl. 24, fig. 14) to 11 in well grown specimens. A thin section (Pl. 28, fig. 8) reveals a proloculus diameter of 20 microns and 7 : 9 : 9—, chambers in successive whorls.

**DEPOSITORY.** B.M.(N.H.) Slide 1970 : II : 26 : 407, 408. Section 1970 : II : 26 : 498. Stubs 1970 : II : 26 : 607, 1970 : II : 26 : 660.

**PROVENANCE.** Specimen described and additional specimen illustrated, Clettwr Transect, Dovey Marshes.

**REMARKS.** As noted by Loeblich & Tappan (1953) this characteristically thin walled, glassy species has been confused with a number of others in particular with the coarsely perforate, umbonate species, *E. clavatum* Cushman. The Williamson Collection in the British Museum includes seven specimens of *E. incertum* put on a separate slide as 'paralectotypes' by Loeblich and Tappan. One of these specimens was examined by Buzas (1966) and found to be optically granular. This character together with the sutural slits and depressed umbilicus without a boss led him to place his own species, *E. varium*, in synonymy with it. We have made a thin section of another 'paralectotype' and our observations confirm those of Buzas. It is probable, also, that *E. voorthuyseni* of Haake belongs here, as a topotype, kindly sent by Dr Haake, seems virtually indistinguishable.

Our specimens, like the types, are rather small. Buzas gives a mean diameter of 0.36 mm for his population but specimens over 0.50 mm occur. Large specimens also occur in the Baltic population very well figured by Brodniewicz. Two of her illustrations show sectioned specimens with proloculus diameters between 40-60 microns, possibly near the upper limit of the megalosphere size range.

**DISTRIBUTION.** Williamson found this species to be 'prevalent' only at Scarborough on the North Sea coast; it has also been figured by Murray (1968) from Christchurch.

Other records include: Baltic (Brodniewicz, 1965; Lutze, 1965) as well as a number in the N.W. Atlantic: Long Island Sound (Buzas, 1966); Hudson Bay (Cushman, 1948). These records indicate a temperate to cold water habitat. It occurs live on the Dovey Marshes.

***Elphidium macellum* (Fichtel & Moll)**

(Pl. 24, figs 1-3; Pl. 25, figs 1-5, 7, 8; Pl. 27, figs 4, 5)

*Nautilus macellus* Fichtel & Moll, 1798 : 66, var.  $\beta$ , pl. 10, figs h-k.*Elphidium macellum* (Fichtel & Moll) Montfort, 1808 : 15; Cushman & Leavitt, 1929 : 18, pl. 4, figs 1, 2; Cushman, 1939 : 51, pl. 14, figs 1-3; pl. 15, figs 9, 10; Feyling-Hanssen, 1964 : 347, pl. 20, fig. 16.*Polystomella macella* (Fichtel & Moll) var. *aculeata* Silvestri, 1901 : 45.*Elphidium macellum* (Fichtel & Moll) var. *aculeatum* (Silvestri) Cushman, 1949 : 27, pl. 5, fig. 10.*Elphidium crispum* (Linné) subsp. *spinosum* Atkinson, 1969 : 537, fig. 6, figs 4a, b.

**DIAGNOSIS.** A slightly keeled species of *Elphidium* with up to about 20 chambers visible and flat umbilical areas filled with the irregular, embossed ends of the chambers. Diameter usually less than 1 mm. Keel often spinose in the juvenile part.

**DESCRIPTION.** (Pl. 24, fig. 1; Pl. 25, figs 2-5, 7, 8.) Test compressed, lenticular, sub-carinate, entire becoming slightly lobate at the last few chambers; numerous chambers arranged in an involute planispiral, 17 visible at the exterior, increasing in size very slowly; sutures raised and strongly reflexed towards the periphery, with a row of narrow septal pits (fossettes) separated by bar-like septal bridges, representing retral processes almost equal in length to the chamber width, the pits which lead into the septal canals lined with spines, 14 pits on each side of the last chamber; less than 12 in early whorls; wall radial, very finely perforate, larger pores (small pits?) in umbilicus; aperture consisting of irregular openings along the base of the last chamber linking up with the pits of the first visible chamber below, apertural face concave in the median line with rounded tubercles; umbilicus filled with the rounded, irregular ends of the chambers, large perforations surrounded by spines between.

**DIMENSIONS.** Diameter 0.72 mm, width approx. 0.27 mm.

**MATERIAL.** More than 25 specimens, all growth stages.

**VARIATION.** Two specimens cut show proloculus diameters near 70 microns and are presumed megalospheric. One of these, illustrated Pl. 27, fig. 5, is about 0.7 mm in diameter and shows 9 : 18 : 5 —, chambers in each whorl following the proloculus, with twenty chambers visible at the periphery. The chambers gradually become higher. It is noteworthy that the second chamber is rounded as in *Nummulites*. These specimens are beautifully radial in wall structure.

Juveniles tend to bear spines at the periphery, usually as a continuation of the septal suture, in some cases double or treble (Pl. 24, figs 2, 3).

**DEPOSITORY.** B.M.(N.H.) Slides 1970 : 11 : 26 : 409-413, 1970 : 11 : 26 : 414 (juvenile). Stub 1970 : 11 : 26 : 593-595. Sections 1970 : 11 : 26 : 499, 1970 : 11 : 26 : 500.

**PROVENANCE.** Specimen described, CB 742. Specimens cut (Pl. 27, figs 4, 5), CB 37. Spinose juvenile, Holocene, Scrobicularia Clays, Borth.

**REMARKS.** As pointed out by Cushman & Leavitt (1929) the name of this species has often not been used in the original sense. Paucity of records around the British

coasts probably indicates confusion with *E. crispum* which is larger and has pitted umbilical bosses. *E. crispum* in the sense of Montagu (1808) and Brown (1827) probably belongs here.

Spinose forms of this species were originally recognized as var. *aculeatum* by Sylvestri (a homonym of *Polystomella aculeata* d'Orbigny). However, there is little doubt that spines tend to be developed as a juvenile feature and Adams (1963) was able to show that apparently unornamented forms sometimes revealed spinose early chambers in thin section. If a name is thought necessary then *spinosum* of Atkinson is available. *Elphidium macellum* sensu Heron-Allen & Earland (1909) does not belong here.

DISTRIBUTION. This species was first described from 'Zoophytic Concretions' in the Mediterranean and Cushman used material from Rimini and Sebenico on the Adriatic and from off the Island of Delos.

Other records are: Indian Ocean, beach sand, Karachi (Cushman, 1939); off South Africa (Brady, 1884); South Pacific, off Sydney (Brady, 1884); South Atlantic, Falklands (Brady, 1884; Boltovskoy, 1953, 1954, 1963).

This species was also found in the post glacial deposits of Norway by Feyling-Hanssen (1964).

### *Elphidium magellanicum* Heron-Allen & Earland

(Pl. 22, fig. 5; Pl. 24, figs 5, 6; Pl. 26, fig. 11; Pl. 28, figs 5-7)

*Elphidium (Polystomella) magellanicum* Heron-Allen & Earland, 1932 : 440, pl. 16, figs 26-28.  
*Elphidium magellanicum* (Heron-Allen & Earland) Cushman, 1939 : 62, pl. 17, figs 14, 15  
 (after Heron-Allen & Earland); Haake, 1962 : 48, pl. 5, fig. 8.

*Cibronion magellanicum* (Heron-Allen & Earland) Lévy *et al.*, 1969 : 94, pl. 1, figs 7a, b;  
 pl. 2, figs 3, 4.

DIAGNOSIS. A small, compressed species of *Elphidium* with lobate to pentagonal periphery and five or six chambers visible. The irregularly developed septal pits are almost hidden by tubercles.

DESCRIPTION. (Pl. 24, figs 5, 6; Pl. 26, fig. 11.) Test compressed with wide flat umbilicus on both sides, outline subpentagonal, periphery subrounded; five chambers visible, arranged in an involute planispiral, slowly increasing in size and last chamber irregularly subquadrate; irregularly developed septal pits at sutures which curve evenly back to the periphery, pits confined to chamber sides; wall radial, minutely perforate with pores less than 1 micron in diameter; aperture a series of irregular openings at the basal suture of the last chamber, hidden by small tubercles which also cover the umbilicus on each side and wide areas each side of the rows of pits.

DIMENSIONS. Maximum diameter 0.24 mm, maximum width approx. 0.08 mm.

MATERIAL. More than 25 specimens.

VARIATION. The chief variation is from specimens with rounded chambers and lobate periphery (Pl. 26, fig. 11) to forms more compressed and pentagonal in

outline like the specimen described. Two thin sections show specimens with proloculus about 40 microns, presumably megalospheric and 5 : 5, chambers in two whorls following the proloculus (Pl. 28, fig. 5). Some specimens show six chambers at the periphery.

DEPOSITORY. B.M.(N.H.) Slide 1970 : II : 26 : 415-418. Stub 1970 : II : 26 : 603. Sections 1970 : II : 26 : 502, 1970 : II : 26 : 503.

PROVENANCE. Station IV, Clettwr Transect, Dovey Marshes.

REMARKS. Our specimens come close to the types and similarly have the sutural depressions covered with 'snow-like' granules. The size range also seems to be the same, given as up to 0·35 mm diameter. There is no development of real septal bars and in this character the species comes near *Elphidiella*.

DISTRIBUTION. This species was first described from the Straits of Magellan and additional records for the South Atlantic are: San Blas Bay (Boltovskoy, 1954); Rio de la Plata (Boltovskoy, 1957) and Puerto Deseado, Patagonia (Boltovskoy, 1959).

British records include: Western Approaches (Murray, 1970); Plymouth (Murray, 1965); Christchurch (Murray, 1968).

Further records off N.W. Europe are given for Germany, Langeoog (Haake, 1962) and France, Dunkirk (Lévy *et al.*, 1969).

### *Elphidium margaritaceum* (Cushman)

(Pl. 24, figs 12, 13; Pl. 29, fig. 8)

*Elphidium advenum* (Cushman) var. *margaritaceum* Cushman, 1930 : 25, pl. 10, fig. 3; 1939 : 61, pl. 17, fig. 2; Parker, 1952a : 411, pl. 5, fig. 4; 1952b : 447, pl. 3, fig. 10.  
*Elphidium margaritaceum* (Cushman) Voorthuysen, 1958 : 32, pl. 23, fig. 13; Todd & Low, 1961 : 19, pl. 2, fig. 3; Haake, 1962 : 49, pl. 5, fig. 11.  
*Polystomella macella* Heron-Allen & Earland, 1909 : 696, pl. 21, figs 3a, b (not Fichtel & Moll).

DIAGNOSIS. A compressed species of *Elphidium* with acute periphery. About ten chambers visible, slowly increasing in size, raised and densely perforated and tuberculate having the appearance of frosted glass.

DESCRIPTION. (Pl. 24, figs 12, 13.) Test compressed, almost circular in outline, semi-lobate, periphery acute, shallow umbilicus on both sides; chambers arranged in an involute planispiral, nine visible, very slowly increasing in size; irregular septal pits well developed, the rows curved gently back to the periphery, up to eight on each side of the chambers, septal bridges bar-like and covered with tubercles, covering less than one-third of the chamber surface and depressed below the level of the rest of the chamber which is evenly raised; wall radial and densely perforated with pores which reach about 1 micron in diameter; aperture a row of irregular openings along the basal suture of the last chamber; small tubercles, about 3 microns in diameter cover most of the surface but are most densely developed in and around the septal pits and below the apertural face.

DIMENSIONS. Maximum diameter 0·41 mm, maximum width approx. 0·15 mm.

MATERIAL. More than 25 specimens.

VARIATION. Specimens have been found up to 0·5 mm in diameter, generally with nine or ten chambers visible. A thin section (Pl. 29, fig. 8) of one specimen reveals:

Prolocus diameter	Chambers in following whorls	Total/visible	Test diameter
approx. 30 microns	8 : 10 : 3—	22—9	0·48 mm

There is a tendency for an irregular increase in the size of the chambers in some specimens and occasionally some of the chambers are smaller than the ones preceding, altering the outline of the test.

DEPOSITORY. B.M.(N.H.) Stub 1970 : 11 : 26 : 602. Section 1970 : 11 : 26 : 501. Slide 1971 : 2 : 16 : 5-7.

PROVENANCE. Specimen described, CB 335.

REMARKS. This species was first described by Cushman as a variety of *E. advenum*. However, it differs in a number of features from that species. It has fewer chambers, lacks the prominent umbilical bosses and possesses characteristically frosted and raised chamber walls.

*Elphidium macellum* sensu Heron-Allen & Earland probably belongs here and possibly also *E. macellum* part of Cushman, 1949 : 27, pl. 5, figs 7a, b (not 8a, b).

DISTRIBUTION. The species was first described from beach sand at Rhode Island. Other references for the Western Atlantic include: New Hampshire (Parker, 1952a); Long Island—Buzzard's Bay area (Parker, 1952b); Martha's Vineyard, Massachusetts (Todd & Low, 1961).

Records for the North Sea area include: Germany, Langeoog (Haake, 1962). Voorthuysen's record is from the Eemian of the Netherlands (1958).

### *Elphidium selseyense* (Heron-Allen & Earland) sensu lato

(Pl. 22, figs 3, 4; Pl. 24, fig. 11; Pl. 26, figs 4, 5, 7, 9, 10; Pl. 29, figs 1-3)

*Polystomella striatopunctata* (Fichtel & Moll) var. *selseyensis* Heron-Allen & Earland, 1911 : 448.

Type description and figure 1909 : 695, pl. 21, figs 2a-c.

*Elphidium selseyense* (Heron-Allen & Earland) Cushman, 1939 : 59, pl. 16, figs 26-28 (figures after Heron-Allen & Earland); Parker, 1952b : 449, pl. 4, fig. 9; Voorthuysen, 1958 : 31, pl. 23, fig. 9; Haake, 1962 : 49, pl. 5, figs 12-15; pl. 6, figs 1-5.

DIAGNOSIS. A compressed species of *Elphidium* with irregular development of septal pits and variable development of granules along the sutures and in the umbilicus. The sutures are often deeply fissured and the periphery entire to lobate.

DESCRIPTION. (Pl. 22, fig. 4; Pl. 26, fig. 7.) Test compressed, periphery rounded, entire becoming semi-lobate at the last few chambers; chambers arranged in an involute planispiral, 11 visible at the exterior, very gradually increasing in size; septal sutures curved back, fissured with irregular development of septal pits, no regular development of septal bridges; wall radial and densely perforated with pores

about 1 micron in diameter; aperture a series of irregular openings along the basal suture of the last chamber; sutural fissures lined with small, irregular granules which also fill the umbilicus and extend along the base of the apertural face, umbilicus also occupied by the irregular lobate ends of the chambers.

**DIMENSIONS.** Maximum diameter 0·42 mm, approx. width 0·18 mm, widest at umbilicus.

**MATERIAL.** More than 25 specimens, all growth stages; this species being one of the dominants in Cardigan Bay.

**VARIATION.** Both entire and lobate forms occur with the tendency for the outline to become more lobate with growth. The specimen illustrated (Pl. 22, figs 1, 2; Pl. 26, figs 5, 10) may represent a distinct variety being inflated and lobate from early in growth, with wide depressed umbilicus filled with fine material, markedly fissured sutures, areal apertures and pores up to 3 microns in diameter. Specimens also occur with more marked umbilical bosses (Pl. 26, fig. 4) approaching *E. clavatum* but lacking the single, elevated, umbilical boss diagnostic of that species as emended by Loeblich and Tappan. In Pl. 22, fig. 3; Pl. 26, fig. 9 we illustrate a specimen with irregular almost bulla-like final chamber bearing areal apertures with protruding necks and large pores up to 2 microns in diameter. Some specimens show small, round bosses in the umbilical area and extending along the sutures; these approach *E. lidoense* Cushman.

Specimens develop up to three whorls, generally with 9–11 chambers visible on the exterior. Two thin sections (Pl. 29, figs 1, 2) show the following:

			visible	
	total diameter	chambers per whorl	externally	proloculus diameter
entire specimen	0·40 mm	7 : 8 : 2—,	9	35 microns
lobate specimen	0·43 mm	7 : 8 : 3—,	9	35 microns

The rate of chamber size increase in both cases is: to end of first whorl  $\times 2$ , to end of second whorl  $\times 1$ .

**DEPOSITORY.** B.M.(N.H.) Slides 1970 : II : 26 : 419, 420, 1970 : II : 26 : 421–423, 1970 : II : 26 : 424, 425 (lobate var.). Stub 1970 : II : 26 : 599–601, 605, 606. Sections 1970 : II : 26 : 504, 1970 : II : 26 : 505.

**PROVENANCE.** Described specimen, CB 62. Other specimens illustrated, CB 58. Lobate variety, Clettwr Transect, Dovey Marshes.

**REMARKS.** Our specimens closely resemble material placed by Heron-Allen and Earland in the 'Students Collection' in the British Museum and also material picked from Selsey shore sand which includes both entire and lobate specimens with both raised and sunken umbilical areas. What Heron-Allen and Earland referred to in their description as a vesicular extension of the final whorl into the umbilicus proves to be fine grained, granular calcite. The type figures show one specimen with nine chambers visible and one, more lobate, with 11 visible.

A similar range of form to that in our specimens was noted by Haake (1962) in material from N. Germany.

Lutze (1965) followed by Lévy *et al.* (1969) supposed *E. selseyense* to be a junior synonym of *E. excavatum* (Terquem) described from the shore sands of Dunkirk (1875). However, Terquem's type figure apparently shows a non-granulate form with excavated umbilicus. The specimen is lost but Lévy *et al.*, in their redescription of a topotype state that the umbilicus is without granules; this diagnosis excludes *E. selseyense*. On the other hand, intermediate forms which they describe between *E. excavatum* and *E. lidoense* presumably are *E. selseyense*.

As noted some of our specimens show the areal apertures of '*Criboelphidium*'.

DISTRIBUTION. This species was first described from the shore sands at Selsey Bill in the English Channel and is recorded by Murray from Plymouth (1965a) and from the Western Approaches (1970) and by Atkinson (1970) from the Scillies. Other records for N.W. Europe are: N. Germany, Langeoog (Haake, 1962); N. France, Dunkirk (? part *E. excavatum* Lévy *et al.*, 1969).

There is one record for the Western Atlantic (Parker, 1952b), other records may be included under *E. incertum* and *E. clavatum*.

### *Elphidium waddensis* (Voorthuysen)

(Pl. 24, figs 4, 10; Pl. 26, fig. 1; Pl. 28, figs 10, 11)

*Elphidium gunteri* Cole var. *waddensis* Voorthuysen, 1951 : 25, pl. 2, figs 16a, b.

*Elphidium gunteri* Tood & Low, 1961 : 19, pl. 2, fig. 10; Haake, 1962 : 48, pl. 5, figs 3, 4 (not *E. gunteri* Cole).

DIAGNOSIS. A coarsely perforate *Elphidium* with up to 14 rather narrow, depressed chambers and irregularly developed septal pits (fossettes).

DESCRIPTION. (Pl. 24, figs 4, 10.) Test semi-inflated with irregular outline, periphery rounded, semi-lobate; ten chambers visible arranged in a planispiral, increasing slowly in size, depressed; irregular development of square septal pits or fossettes at the sutures which in some cases appear simply irregularly incised, about four pits on each side, where developed, extending to the periphery, septal bars short; wall radial and coarsely perforate with both very fine and large pores up to 3 microns in diameter; aperture a series of irregular openings at the basal suture of the last chamber; apertural face only finely perforate with round tubercles at the base; rounded glassy beads in the umbilicus as well as tubercles which extend along the sutures and are particularly well developed below the apertural face.

DIMENSIONS. Maximum diameter 0.29 mm, maximum width approx. 0.11 mm.

MATERIAL. More than 25 specimens, most of them small, generally golden-brown in colour.

VARIATION. The chambers gradually increase in size and number per whorl. Externally visible chamber number varies from about nine in the smaller specimens to 14 in the largest noted, 0.35 mm in diameter. The chambers tend to become narrow and in some cases appear pressed back on each other giving an irregular outline. A thin section (Pl. 28, fig. 10) shows a large proloculus of approx. 70 microns diameter with 7 : 12 : 4—, chambers in the following whorls, 24 chambers in all.

DEPOSITORY. B.M.(N.H.) Slide 1970 : II : 26 : 436-430. Section 1970 : II : 26 : 506. Stubs 1970 : II : 26 : 598, 1970 : II : 26 : 758.

PROVENANCE. Specimen described, Clettwr Transect, Station II, Dovey Marshes.

REMARKS. This species was originally described as a variety of *E. gunteri* Cole known from the Pliocene of Florida. However, that species differs in being larger with much more regularly developed sutural pits and bars, up to 10 on each chamber side, it is also smoother. The specimens referred by Todd and Low and by Haake to Cole's species also appear to belong here. Our specimens are identical with topotypes of Voorthuysen's variety on file at the British Museum.

Dr John Murray (personal communication) has referred specimens similar to ours to *E. oceanensis* (d'Orbigny). However, the type figures given by Fornasini (1904) appear to show high rather than depressed chambers and a smooth periphery; other details are not made clear.

DISTRIBUTION. This species was described from the Holocene and Recent in the Wadden See off Groningen, Netherlands. Other records for N.W. Europe are: Germany, Langeoog (Haake, 1962); France, Dunkirk (Lévy *et al.*, 1969).

It is also described from the marshes of Martha's Vineyard, Massachusetts (Todd & Low, 1961). This resembles its distribution on the Dovey Marshes where it is a frequent living form, usually golden-brown in colour.

### *Elphidium williamsoni* Haynes n. sp.

(Pl. 24, fig. 7; Pl. 25, figs 6, 9; Pl. 27, figs 1-3)

*Polystomella umbilicatula* Williamson, 1858 : 42, pl. 3, figs 81, 82; Terquem, 1875 : 429, pl. 2 figs 3a, b (not *Nautilus umbilicatus* Walker & Jacob).

*Elphidium umbilicatum* (Williamson) Lévy *et al.*, 1969 : 96, pl. 1, figs 6a, b; pl. 2, figs 1, 2.

*Elphidium excavatum* Cushman, 1930 (part) : 21, pl. 8, figs 4-7 only; 1939 : 58, pl. 16, figs 10-12 only; 1949 : 28, pl. 6, figs 2a, b; Todd & Low, 1961 : 19, pl. 2, fig. 5; Haake, 1962 : 47, pl. 5, fig. 5; Feyling-Hanssen, 1964 : 344, pl. 20, figs 7, 8; Brodniewicz, 1965 : 214, pl. 8, fig. 5; pl. 11, fig. 4; Adams & Frampton, 1965 : 58, pl. 5, fig. 7; Murray, 1965a : 503 (list), pl. 1, fig. 6, 6 (stereopairs) (not Terquem).

*Cribrononion* cf. *alvarezianum* Lutze, 1965 : 101, pl. 15, fig. 46 (not *Polystomella alvareziana* d'Orbigny).

DIAGNOSIS. A rotund species of *Elphidium* with rounded periphery and slight, rather flat umbilicus on each side filled with the irregular ends of the chambers. Fossettes and septal bars well developed, reaching about eight or nine in number on each side and covering about half the chambers. Up to 14 chambers visible. Wall smooth with relatively sparse tubercles within the septal pits and at the base of the apertural face.

DESCRIPTION. (Holotype, Pl. 24, fig. 7; Pl. 25, figs 6, 9.) Test semi-inflated, slightly umbilicate with rounded periphery, entire becoming semi-lobate at the last few chambers—chambers arranged in an involute planispiral, 13 visible, slowly increasing in size with marked septal pits (fossettes) increasing from six to eight or nine on each side (ten on third chamber from the last), strong, narrow septal bars

almost equal in length to the rest of each chamber, in one case (on the last chamber) with a proximal opening, pits lozenge-shaped, tuberculate within; septal sutures flush—not visible; wall radial, finely perforate, pores rather less than 1 micron in diameter, tuberculate below the apertural face; aperture a series of irregular openings along the basal suture of the last chamber, linking with the pits of the first exposed chamber.

DIMENSIONS. Diameter 0·48 mm, width approx. 0·20 mm.

MATERIAL. More than 25 specimens. Very abundant in the marshes.

VARIATION. There is some variation in the degree of inflation and some specimens are slightly more subangular at the periphery. Variation of chamber number as seen externally is largely a function of growth, there being a gradual increase with each whorl. Thin sections show megalosphere sizes near 50 microns and the specimen illustrated (Pl. 27, fig. 1) has 7 : 9 : 7—, chambers in each whorl following the proloculus, with 11 visible at the periphery.

DEPOSITORY. B.M.(N.H.) Slide 1970 : 11 : 26 : 431, 432 (paratypes). Sections 1970 : 11 : 26 : 507, 1970 : 11 : 26 : 508 (paratypes). Stub 1970 : 11 : 26 : 597 (holotype).

PROVENANCE. Described specimen and specimens cut Clettwr Transect, Station II, Dovey Marshes.

REMARKS. This species was for a long while confused with *E. excavatum* Terquem. After study of topotype material, Lévy *et al.* have reverted to Terquem's original conception of that species and include *E. selseyense* within its limits. The inflated, many chambered, marsh and estuarine form widely referred by authors to *E. excavatum* is referred by them to *E. umbilicatum* = *Polystomella umbilicatula* (Williamson) not *Nonion umbilicatum* (Walker & Jacob). However, this contravenes article 49 of the International Committee on Zoological Nomenclature as Williamson clearly put his species in synonymy with that of Walker and Jacob. This species is therefore renamed *E. williamsoni*. *Cribrononion cf. alvarezianum* of Lutze also belongs here. See also under *E. selseyense*.

When living this species is usually found coloured green with contained algae.

DISTRIBUTION. This species is widespread around the British Isles (often erroneously recorded previously as *Polystomella striato-punctata* (Fichtel & Moll) particularly in the estuarine environment. Williamson mentions specimens obtained from the stomach of a shell drake shot in Belfast Bay, unmixed with any other foraminifera. He supposed this 'bonne bouche' to have been selected via an intermediate predator such as a mollusc but in fact this species can sometimes occur to the exclusion of other forms in the Dovey Estuary, also the haunt of shell duck.

Other records for N.W. Europe are: N. France, Dunkirk (Terquem, 1875; Lévy *et al.*, 1969); Belgium (Cushman, 1949); Germany, Langeoog (Haake, 1962); Ostsee (Lutze, 1965); Poland, Baltic (Brodniewicz, 1965); Holocene of Oslofjord (Feyling-Hanssen, 1964).

Records from the Western Atlantic include: Massachusetts, Martha's Vineyard (Todd & Low, 1961).

Confusion of this species with both *E. excavatum* and *E. selseyense* makes other records, especially those from farther afield doubtful.

Genus **NONION** Montfort, 1808

**Nonion depressulus** (Walker & Jacob)

(Pl. 22, figs 8-11; Pl. 29, fig. 9; Text-fig. 44, nos 1-3)

'*Nautilus spiralis utrinque subumbilicatus*' Walker & Boys, 1784 : 19, pl. 3, fig. 68.

*Nautilus depressulus* Walker & Jacob, 1798 : 641, pl. 14, fig. 33.

*Nonion depressulum* (Walker & Jacob) Cushman, 1930 : 3, pl. 1, fig. 3 only; Murray, 1965b : 148, pl. 25, figs 6, 7; pl. 26, figs 7, 8 (as *depressulus*).

*Nonion asterizans* Heron-Allen & Earland, 1913b : 143, pl. 13, figs 12, 13; Le Calvez, 1958 : 168, pl. 1, fig. 13 (not Fichtel & Moll).

**DIAGNOSIS.** A compressed species of *Nonion* with between 8 and 14 chambers visible at the periphery, but generally nine or ten. Chambers rather high and tending to uncoil slightly from the umbilicus which is filled with granules of calcite and an off centre, glassy boss (both sides). Sutures often hooked back towards the umbilicus, excavated with the granular umbilical material extending along them producing a star shape. Periphery subrounded.

**DESCRIPTION.** (Pl. 22, figs 10, 11.) Test compressed with flattened sides, slightly uncoiled, bi-umbilicate, periphery subrounded becoming semilobate at the last few chambers; chambers arranged in a planispiral, gradually increasing in size and becoming much higher than long, ten visible at the periphery with slight, umbilical lobes; sutures slightly curved back and almost radial towards the periphery, hooked back at the umbilicus, strongly incised; large umbilicus on either side with glassy boss and with granules of calcite which extend along the sutures; wall granular, finely perforate; aperture a row of small irregular holes between rough granules at the basal suture.

**DIMENSIONS.** Maximum diameter 0·24 mm, thickness 0·7 mm.

**MATERIAL.** More than 25 specimens, mostly small.

**VARIATION.** Specimens up to 0·40 mm, maximum diameter occur and show from 8 to 11 chambers at the periphery (Text-fig. nos 1-3). This variation is probably related to proloculus size.

**DEPOSITORY.** B.M.(N.H.) Slide 1970 : 11 : 26 : 443, 444. Section 1970 : 11 : 6 : 509. Stub 1970 : 11 : 26 : 658, 663, 664.

**PROVENANCE.** Specimen described, CB 463. Other specimens figured, nos 1, 2, CB 13, no. 3, CB 54. Specimens illustrated Pl. 22, figs 8-11, Station VII, Clettwr Transect, Dovey Marshes; specimens thin-sectioned from the same locality.

**REMARKS.** Dr F. T. Banner has pointed out to us that although Dr John Murray mended the diagnosis of this species on the basis of topotypes from Reculver each sands he did not erect a neotype. To avoid further confusion we now propose that his topotype, Reg. no. 1962.2.12.533, becomes the neoholotype.

This species has been widely confused with the common marsh form now referred

to *Protelphidium anglicum* and in marine waters has masqueraded under the name of its relative, *N. asterizans*, a larger form with angular periphery and higher chambers.

DISTRIBUTION. This species was described from the shore sands of Reculver, East Kent and has been recorded also from the West of Ireland, Clare Island (Heron-Allen & Earland, 1913b) and the Celtic Sea (Le Calvez, 1958). It is recorded by Murray from the Tamar Estuary (1965a), from Christchurch Harbour (1968) and from the Western Approaches (1970).

### *Nonion (Florilus) pauperatum* (Balkwill & Wright)

(Pl. 22, figs 13, 14; Pl. 23, fig. 4; Text-fig. 44, nos 4-7)

*Nonionina pauperata* Balkwill & Wright, 1885 : 353, pl. 13, figs 25, 26; Halkyard, 1889 : 71, pl. 2, fig. 13; Heron-Allen & Earland, 1911 : 342, pl. 11, figs 16, 17.

*Nonion pauperatum* (Balkwill & Wright) Cushman, 1930 : 13, pl. 5, figs 4, 5, 7 (after Balkwill & Wright, Halkyard and Heron-Allen & Earland); 1949 : 26, pl. 5, fig. 5; Haake, 1962 : 42, pl. 3, figs 6, 7.

DIAGNOSIS. An angular species of *Nonion (Florilus)* with eight or nine chambers visible and distinct, limbate sutures meeting in a large, flat boss (on each side).

DESCRIPTION. (Pl. 22, figs 13, 14.) Test compressed, tapering from the umbilici to the angular periphery, semi-lobate; chambers arranged in an involute planispiral, slowly increasing in size as added, becoming much higher than long, triangular in apertural view, nine visible at the periphery; sutures distinct, limbate, swept back,

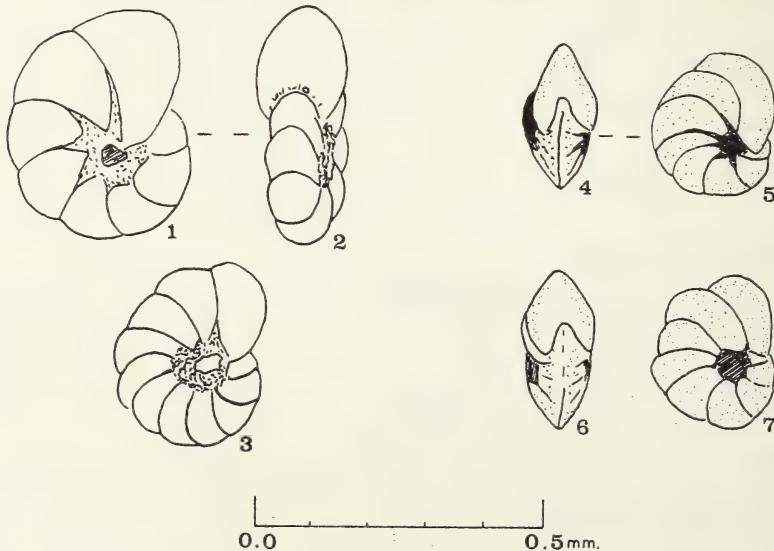


FIG. 44. 1-3. *Nonion depressulus*. 1, side view of eight chambered specimen, probably megalospheric; 2, apertural view; 3, side view of specimen with 11 chambers visible. 4-7. *Nonion pauperatum*. 4, apertural view of specimen with eight chambers visible externally; 5, side view; 6, apertural view of specimen with nine chambers visible; 7, side view.

meeting in a flat, glassy boss; wall granular, distinctly perforated with pores about  $\frac{1}{2}$  micron in size; aperture comprising two elongate, areal slits near the basal suture, one on each side, overlapping at the periphery; granules of calcite developed below the apertural face.

**DIMENSIONS.** Maximum diameter 0.30 mm, thickness 0.12 mm.

**MATERIAL.** Six specimens.

**VARIATION.** The specimens which apart from the one described are all less than 0.30 mm in diameter show irregular lobation of the outline (Text-fig. 44). The aperture is a variable basal to raised oblong opening at the periphery (areal when examined in detail).

**DEPOSITORY.** B.M.(N.H.) Slide 1970 : 11 : 26 : 445-449. Stub 1970 : 11 : 26 : 661.

**PROVENANCE.** Specimen described, CB 477. Other specimens illustrated figs 6, 7, CB 501, figs 4, 5, CB 542.

**REMARKS.** Viewed with the light microscope this small species appears to have a basal aperture extending up into the apertural face as an oblong arch. Before the details revealed by the stereoscan photo are seized on as being of generic significance more work must be done on allied *Nonion* (*Florilus*) species; many of which have similar arched apertures.

**DISTRIBUTION.** This species was first described from the Irish Sea and there are a number of records from west of the British Isles: Dublin coast (Balkwill & Wright, 1885); Southport, Lancs. (Chaster, 1892); West of Ireland, Dogs Bay (Wright, 1900); Clare Island (Heron-Allen & Earland, 1913b); West of Scotland (Heron-Allen & Earland, 1916a); English Channel, Selsey (Heron-Allen & Earland, 1911); Jersey (Halkyard, 1889).

It has been recorded from N. Germany, Langeoog by Haake (1962) and there is also an Eemian record for the Netherlands (Voorthuysen, 1958).

### Genus **NONIONELLA** Cushman, 1926

#### ***Nonionella auricula*** Heron-Allen & Earland

(Text-fig. 45, nos 1-3)

*Nonionella auricula* Heron-Allen & Earland, 1930 : 192, pl. 5, figs 68-70; Cushman, 1939 : 33, pl. 9, figs 7-9 (after Heron-Allen & Earland); Voorthuysen, 1960 : 254, pl. 11, fig. 22; Feyling-Hanssen, 1964 : 327, pl. 16 figs 21-23.

**DIAGNOSIS.** A minute, glassy, subglobose species of *Nonionella* with chambers becoming about twice as high as long. Last chambers not projecting much into the central umbilicus which is small and deep.

**DESCRIPTION.** Test compressed, subglobose, ear-shaped with semi-lobate, rounded periphery; 11 chambers following the proloculus, arranged in a low, sinistral

trochospire, 8 : 3—, gradually increasing in size as added, inflated, becoming twice as high as long, last one slightly projecting into the ventral umbilicus; sutures distinct, impressed, radial on the ventral side, slightly curved back on the dorsal side; wall translucent, distinctly perforate; aperture apparently ventral and basal; distinct ventral umbilicus.

**DIMENSIONS.** Maximum diameter 0.15 mm, width 0.10 mm, thickness 0.66 mm, proloculus diameter approx. 15 microns.

**MATERIAL.** One specimen only.

**DEPOSITORY.** B.M.(N.H.) Slide 1970 : 11 : 26 : 450.

**PROVENANCE.** Aberystwyth Harbour.

**REMARKS.** Our specimen is very close to the types in general morphology and in size. Heron-Allen and Earland give a range of 0.18–0.25 mm for the maximum diameter with up to 13 chambers developed. The specimens described by Voorthuysen and Feyling-Hanssen also come very close but specimens ascribed to this species from the Arctic (Loeblich & Tappan, 1953) and from off the N.E. seaboard of the United States, New England (Cushman, 1944; Parker, 1952a) are much larger and more compressed with entire periphery and higher chambers (see especially fig. 9 of Loeblich & Tappan). These last appear to be closer to the specimens we describe below as *Nonionella* species A.

**DISTRIBUTION.** This tiny, vitreous species was first described from the English Channel near Plymouth. It has also been found living off the N. Kent coast, Hedley & Underwood (1957) and is listed from the Scillies by Atkinson (1970). It has also been recorded from the Dollart-Ems Estuary (Voorthuysen, 1960) and from the Holocene of Oslofjord (Feyling-Hanssen, 1964).

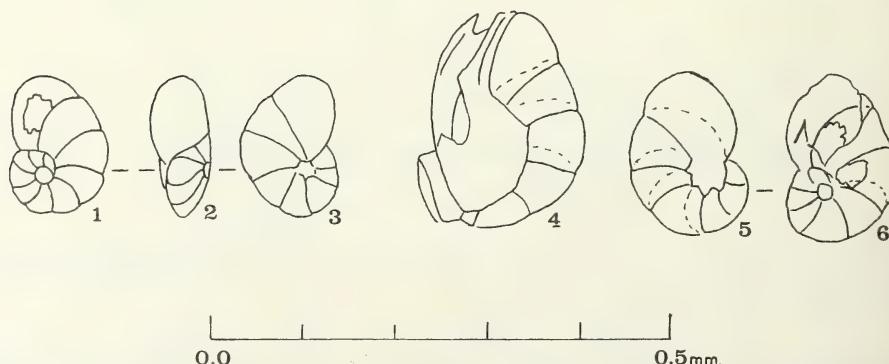


FIG. 45. 1–3. *Nonionella auricula*, specimen described. 1, dorsal view; 2, side view; 3, ventral view. 4. *Nonionella turgida*, specimen with large umbilical process. 5, 6. *Nonionella turgida* var. *digitata*. 5, ventral view; 6, dorsal view, specimen broken.

*Nonionella turgida* (Williamson)

(Pl. 22, fig. 12; Text-fig. 45, no. 4)

*Rotalina turgida* Williamson 1858 : 50, pl. 4, figs 95-97.*Nonionina asterizans* var. *turgida* (Williamson) Carpenter, Parker & Jones, 1862 : 311.*Polystomella crispa* sp., var. (*Nonionina*) *turgida* (Williamson) Parker & Jones, 1865 : 405, pl. 17, figs 57a-c.*Nonionina turgida* (Williamson) Brady, 1884 : 731, pl. 109, figs 17-19; Goës, 1894 : 105, pl. 17, fig. 832.*Nonionella turgida* (Williamson) Cushman, 1930 : 15, pl. 6, figs 1-4, 1 after Williamson and 2 after Brady; 1939 : 32, pl. 9, figs 2, 3; Feyling-Hanssen, 1964 : 328, pl. 17, figs 2-6.

**DIAGNOSIS.** (Pl. 22, fig. 12.) A compressed species of *Nonionella* with chambers increasing very rapidly in height and the final one extending in a broad lobe across the ventral umbilicus.

**DESCRIPTION.** Test compressed, ovate in outline with pointed apex, periphery rounded, entire; about 11 chambers in a low, sinistral trochospire, increasing rapidly in height, subglobose, last one extending in a broad lobe across the ventral umbilicus, nine visible on ventral side; sutures distinct, incised, radial; wall apparently granular, thin, densely but minutely perforate; aperture ventral and basal with a lip extending from the periphery into the umbilicus.

**DIMENSIONS.** Length 0.21 mm, width 0.13 mm, thickness about 0.10 mm.

**MATERIAL.** Three specimens.

**VARIATION.** As shown in Text-fig. 4 and by authors' figures there is considerable variation in the strength of development of the umbilical lobe.

**DEPOSITORY.** B.M.(N.H.) Slide 1970 : 11 : 26 : 451. Stub 1970 : 11 : 26 : 666.

**PROVENANCE.** Specimen described and illustrated by Stereoscanner photo, CB 562. Other specimen illustrated, CB 382.

**REMARKS.** Williamson's type figure clearly shows an inequilateral test with the last chamber developing an umbilical bulge on the ventral side. Our specimens although smaller and less developed show essentially the same features. Some difficulty has been introduced because Brady (fig. 17, 1884) included in his concept of the species an aequilateral specimen from the Porcupine Station 67, East of the Shetlands. This has been accepted by later workers possibly partly because the figure was copied and wrongly ascribed to Williamson by Cushman (1930) on his plate explanation, though not in the text. However, Cushman also figured another similar, specimen from S.W. of Ireland. These probably do not belong here.

**DISTRIBUTION.** This species was originally described as common off the Shetlands and Arran, West of Scotland and also rare at Whitehaven, Cumberland, N. Irish Sea. Subsequent records confirm this concentration off western coasts of the British Isles: Irish Sea (Balkwill & Wright, 1885); Dee (Siddall, 1876); Southport Chaster, 1892); West of Scotland, Shetlands (Waller, 1868); Faroe Channel (Pearcey, 1890); Inner Hebrides (Heron-Allen & Earland, 1914a, 1916a; Robertson, 1892); lyde (Robertson, 1877); West of Ireland (Wright, 1889); Dogs Bay (Wright, 1900);

Clare Island (Heron-Allen & Earland, 1913b); English Channel, Eddystone (Robertson, 1870); Cornwall (Heron-Allen & Earland, 1916b); Plymouth (Heron-Allen & Earland, 1930); Celtic Sea (Le Calvez, 1958); Western Approaches (Murray, 1970); North Sea, off Durham (Robertson & Brady, 1870); Forth (Pearcey, 1902).

Other N.W. European records are: Scandinavia (Goës, 1894; Kiaer, 1900); Holocene, Oslofjord (Feyling-Hanssen, 1964); Hardangerfjord (Holterdahl, 1965).

North Atlantic records are: Bay of Biscay (Berthois & Le Calvez, 1959); E. Atlantic (Brady, 1884); West Atlantic (Parker, 1948); Arctic (Cushman, 1948; Parker & Jones, 1865); Iceland (Norvang, 1945).

Caribbean records include: Gulf of Paria (Todd & Bronnimann, 1957).

South Atlantic: Falklands (Earland, 1934); off Brazil (Boltovskoy, 1959); off Argentina (Boltovskoy, 1961; Brady, 1884).

Mediterranean: Western (Todd, 1958); Tyrrhenian Sea (Norin, 1958); Eastern (Parker, 1958); Gulf of Naples (Hofker, 1960); Adriatic (Cita & Chierici, 1962); off Israel (Reiss, Klug & Merling, 1961).

Pacific: off California (Natland, 1933); off Japan (Brady, 1884); eight stations in the S. Pacific including off New Zealand (Brady, 1884); Malay Archipelago (Millett, 1898); Manukau Harbour, New Zealand (Hulme, 1964).

These records suggest in general a cool temperate distribution.

### *Nonionella turgida* (Williamson) var. *digitata* Norvang

(Text-fig. 45, nos 5 and 6)

*Nonionella turgida* var. *digitata* Norvang, 1945 : 29, text-fig. 4; Cushman, 1948 : 55, pl. 6, fig. 5 (after Norvang); Parker, 1952a : 413, pl. 5, figs 15, 16.

DIAGNOSIS. A variety of *Nonionella turgida* with digitate margin to the umbilical process.

DESCRIPTION. Test with last chamber broken and others holed, elongate-ovate with pointed apex, subglobose, periphery rounded; nine chambers following the proloculus in a low, dextral trochospire, becoming high but less than twice as high as long, gradually increasing in size as added, inflated, seven visible on the involute ventral side; sutures incised, radial on the ventral side, swept back on the dorsal side; wall apparently granular, thin, transparent, finely and densely perforated; last chamber extending over the ventral umbilicus with digitate margin, the finger-like processes extending along the line of the sutures.

DIMENSIONS. Maximum length 0.17 mm, width 0.10 mm.

MATERIAL. One specimen only.

DEPOSITORY. B.M.(N.H.) Slide 1970 : 11 : 26 : 452.

PROVENANCE. CB 646.

REMARKS. Our specimen appears to show the incipient development of the remarkable 'tubulose appendices' which in the type partially cover the earlier cham-

bers. A similar development occurs in *Elphidium selseyense* (Pl. 22, fig. 3) and is probably connected with a particular phase of ontogeny. It is reminiscent of the bulla in certain Globigerinidae.

DISTRIBUTION. This variety was described from Pistilfjörour, Iceland and has also been recorded from off the N.E. seaboard of N. America, Portsmouth, New Hampshire (Parke, 1952a).

### *Nonionella* (?*Nonionellina*) species A

(Pl. 22, figs 17, 18; Pl. 23, fig. 3; Text-fig. 46, nos 1-4)

DIAGNOSIS. A compressed species of *Nonionella* with chambers becoming more than three times as high as long; test apparently tending to become almost planispiral and aequilateral in the last part; ventral umbilicus tuberculate.

DESCRIPTION. (Pl. 22, figs 17, 18; Pl. 23, fig. 3.) Test compressed, ear-shaped with entire to slightly lobate, subround periphery; chambers arranged in a low, dextral trochospire, ten visible at the periphery with flattened sides, gradually increasing in size as added, last one more than three times as high as wide and projecting into the ventral umbilicus; sutures thickened and incised, swept back; wall thin, apparently granular, finely and densely perforate; aperture a series of small irregular openings at the ventral, basal suture of the last chamber surrounded by tubercles which fill the umbilicus and line the sutures.

DIMENSIONS. Maximum diameter approx. 0.50 mm, width 0.35 mm, thickness 0.15 mm.

MATERIAL. Four specimens.

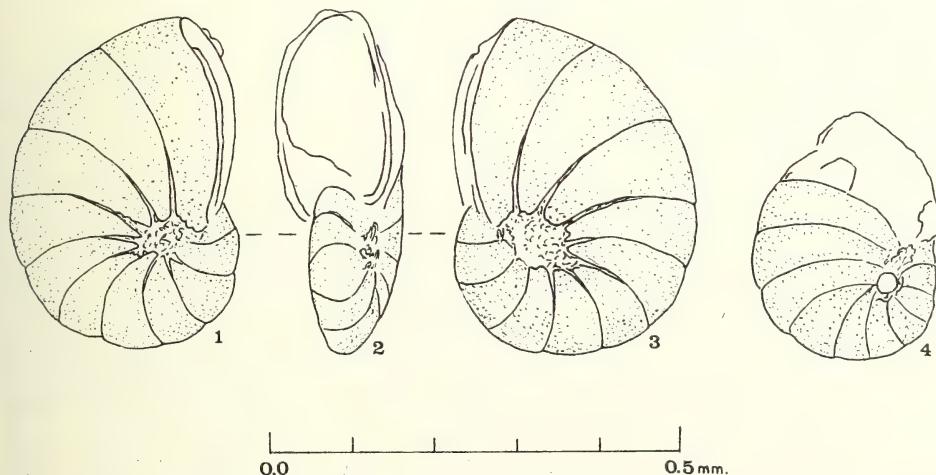


FIG. 46, 1-4. *Nonionella* species A. 1-3, specimen showing almost equal involution on both sides; 1, view of ventral side; 2, edge; 3, dorsal side; 4, additional specimen, side view.

VARIATION. The text figures show two of the other specimens recovered, both are broken but the more complete one, nos 1-3, shows the tendency for both sides to become involute and the test almost aequilateral with 11 chambers visible. The other specimen shows 12 chambers.

DEPOSITORY. B.M.(N.H.) Slide 1970 : 11 : 26 : 453, 454. Stub 1970 : 11 : 26 : 665.

PROVENANCE. Specimen described and illustrated by stereoscanner photos, CB 15. Other specimens, Text-fig. nos 1-3, CB 384; Text-fig. no. 4, CB 343.

REMARKS. This species has some resemblance to *Nonionella atlantica* Cushman but is more compressed and becomes more involute on the dorsal side. Some of the specimens referred to *N. auricula* from the Arctic and Western Atlantic may be the same (see for instance Loeblich & Tappan, 1953, fig. 9). *Nonionella* sp. A of Todd & Bronnimann (1957) from the Gulf of Paria, Trinidad is also very close.

### Genus ***PROTELPHIDIUM*** Haynes, 1956

#### ***Protelphidium anglicum*** Murray

(Pl. 22, figs 15, 16; Pl. 23, figs 1, 2; Pl. 27, figs 6-9)

*Protelphidium anglicum* Murray, 1965b : 149, pl. 25, figs 1-5, pl. 26, figs 1-6; 1968 : 94 (list), pl. 1, figs 11a, b.

*Nonionina crassula* Williamson, 1858 : 33, pl. 3, figs 70, 71, as *N. umbilicatula* on figure (not Walker & Jacob).

*Nonionina depressula* Brady, 1867 : 106 (not *Nautilus depressulus* Walker & Jacob).

*Nonion depressulus* Cushman, 1930 : 3, pl. 1, figs 3-6; Voorthuysen, 1958 : 28, pl. 23, fig. 2; Haake, 1962 : 40, pl. 3, figs 1, 2 (as *depressulum*).

*Protelphidium depressulum* Adams & Haynes, 1965 : 36 (list).

DIAGNOSIS. An inflated species of *Protelphidium* with apertural face not much higher than wide, entire periphery and eight or nine chambers visible externally. Sutures deeply excavated towards the umbilicus and lined with minute tubercles. Wall very thin and minutely perforate.

DESCRIPTION. (Pl. 22, figs 15, 16; Pl. 23, figs 1, 2.) Test moderately compressed with rounded periphery, circular in outline, becoming slightly uncoiled in the last part with small, deep, open umbilicus, periphery entire; chambers arranged in an involute planispiral, eight visible externally, gradually increasing in size as added; sutures gently curved back towards the periphery, deeply excavated towards the umbilicus, lined with minute tubercles, approx. 5 microns in length; wall thin, radial, densely and minutely perforated with pores less than 1 micron in diameter; aperture multiple, apparently a series of small openings along the basal suture of the last chamber, largely hidden by tubercles.

DIMENSIONS. Maximum diameter 0.36 mm, width 0.14 mm.

MATERIAL. More than 25 specimens. One of the most abundant species in the Dovey Estuary.

VARIATION. Specimens with nine or even ten chambers visible at the periphery occur and also specimens with the last chambers becoming lobate. Thin sections show that at least two proloculus sizes occur, Pl. 27, figs 6, 9, with chambers developed as follows:

Proloculus diameter	Chamber number in following whorls	Total number + proloculus	Total visible	Test diameter
approx. 10 microns	7 : 9 : 10 : 2—	29	9	0·45 mm
approx. 40 microns	6 : 8 : 5—	20	8	0·35 mm

Thus both microspheric and megalospheric forms appear to be present.

DEPOSITORY. B.M.(N.H.) Slide 1970 : 11 : 26 : 455-462. Sections 1970 : 11 : 26 : 510, 1970 : 11 : 26 : 511, 1970 : 11 : 26 : 512. Stub 1970 : 11 : 26 : 659.

PROVENANCE. Specimen described and specimens cut Station III, Clettwr Transect, Dovey Marshes.

REMARKS. As shown by Murray (1965b) this brackish water species has been confused with *Nonion depressulus*. It is distinguished from the neotype of that species by its radial wall structure, inflated, more depressed chambers and open umbilicus also by generally having eight or nine rather than 10 or 11 chambers visible externally.

Most references in the British literature to *N. depressulus* from brackish water habitats probably belong here, such as Brady (1867) who gives a record for the mouth of the Wansbeck on the N.E. coast. A figured reference which can be included with fair certainty in synonymy is Williamson's of *N. crassula*. The specimen figured by Brady (1884) from off Sydney, Australia, probably does not belong here.

DISTRIBUTION. The types are from Christchurch Harbour, Hampshire. Probably ubiquitous in brackish water habitats around the British Isles.

#### Family UNCERTAIN

Genus ***EPISTOMINELLA*** Husezima & Maruhasi, 1944

*Epistominella naraensis* (Kuwano)

(Pl. 20, fig. 14; Pl. 23, figs 7, 8; Test-fig. 47, nos 1-5)

*Pseudoparrella naraensis* Kuwano, 1950 : 317, text-figs 6a-c.

? *Epistominella sandiegoensis* Uchio, 1960 : 68, pl. 9, figs 6, 7.

*Pulvinulinella exigua* Hofker, 1951a : 322, text-figs 219-221 (not Brady).

DIAGNOSIS. A small, biconvex species of *Epistominella* with rounded periphery and six chambers in each whorl.

DESCRIPTION. (Text-fig. nos 1-4.) Test small, biconvex with rounded periphery and shallow ventral umbilicus, entire to slightly lobate; 18 chambers arranged in

a low, sinistral, trochospire, all visible on the dorsal side, 6 : 6 : 6, in each whorl following the proloculus, gradually increasing in size and becoming longer than high in the second whorl, six visible on the ventral side, umbilical extremities slightly overlapping; sutures slightly impressed, markedly backwards curving on the dorsal side, radial to slightly curved on the ventral side; wall thin, glassy, radial with fine perforations less than  $\frac{1}{2}$  micron in size, ventral umbilical area adjacent to internal tooth plates imperforate; aperture a curved slit almost parallel to the periphery, extending from the basal suture of the final chamber, curving slightly dorsally within a depression in the truncate, apertural face, with denticulate border, the proximal edge passing into a trough shaped internal tooth plate.

**DIMENSIONS.** Maximum diameter 0.13 mm, height 0.07 mm. Approx. diameter of the proloculus 7 microns.

**MATERIAL.** Six specimens only.

**VARIATION.** Some specimens are rather more lobate and in some cases the final chamber is more subangular at the periphery with subquadrate apertural face (Text-fig. no. 5). In our specimens the proloculus diameter varies between 6–8 microns, with up to 19 chambers developed, they thus come near to what Hofker described as the B form (microspheric generation) with proloculus of 6 microns diameter and up to 17 chambers developed.

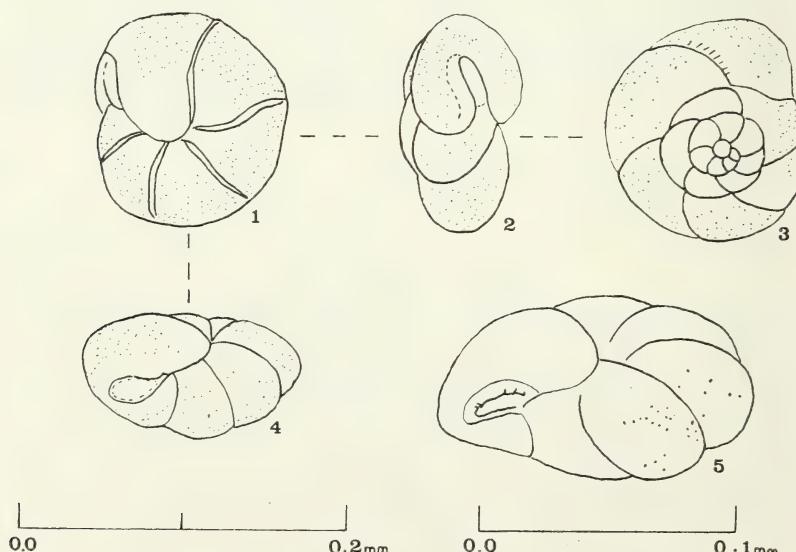


FIG. 47, 1–5. *Epistominella naraensis*. 1, ventral view; 2, side view; 3, dorsal view; 4, oblique side view of specimen described. N.B. Internal chamber walls seen through the thin glassy outer wall give appearance of double septa; 5, specimen with more angular periphery at last chamber, drawn from stereoscaner photo.

DEPOSITORY. B.M.(N.H.) Slide 1970 : 11 : 26 : 463, 464. Stub 1970 : 11 : 26 : 610-612.

PROVENANCE. Specimen described, CB 419. Other specimens shown in text-fig. and by stereoscan photos, Clettwr Transect, Dovey Marshes.

REMARKS. Our specimens closely resemble *E. naraensis* in chamber number and size, with diameters generally less than 0.2 mm. *Epistominella sandiegoensis* may be synonymous, as the dorsal and ventral views given are identical with *E. naraensis* and it is described as biconvex, although no side view is given. *E. vitrea* differs in being slightly larger with flattened ventral side.

The specimens described as *Pulvinulinella exigua* by Hofker also appear to belong here as the figures show identical chambering, distribution of pores and aperture shape; *Epistominella exigua* (Brady) has an acute periphery and must be ruled out.

DISTRIBUTION. The types are from the Pliocene of Honshu Island, Japan while Uchio's specimens are from 350 fathoms off San Diego, California. Hofker's material is also from the Indo-Pacific region and on the equator, though at great depth, 582 fathoms, bottom temperature 6.6°C. It is also recorded by Matoba (1970) from Matsushima Bay, N.E. Japan.

## VII. SUMMARY AND CONCLUSIONS

1. One hundred and sixty-five species are described belonging to 65 genera and 27 families. One genus is new, *Eggerelloides*, genoholotype *E. scabrum* (Williamson) and also the following 12 species:

- Ammobaculites balkwilli*
- Ammonia aberdoveyensis*
- Buliminella borealis*
- Elphidium exoticum*
- Elphidium williamsoni*
- Guttulina harrisi*
- Lagena doveyensis*
- Lagena hibernica*
- Lagena sulcata* var. *torquiformis*
- Oolina heronalleni*
- Siphonina georgiana*
- Spiroptalmidium acutimargo* var. *emaciatum*
- Technitella teivyense*

In addition a neotype has been selected and described for *Quinqueloculina bicornis* (Walker & Jacob) and a neotype for *Nonion depressulus* (Walker & Jacob) cited from the Murray Collection in the British Museum.

2. Revised identifications of species mentioned in our published lists, apart from simple generic shifts, are as follows:

<i>Ammobaculites agglutinans</i>	= <i>A. balkwilli</i> n. sp.
<i>Ammonia beccarii batavus</i> (estuary variety)	= <i>A. aberdoveyensis</i> n. sp.
<i>Buliminella elegantissima</i>	= <i>B. borealis</i> n. sp.
<i>Cyclogyra involvens</i>	= <i>C. selseyensis</i> (Heron-Allen & Earland)
<i>Discorbis baccata</i>	= <i>Discorbis wrightii</i> (Brady)
<i>Elphidium crispum</i>	= <i>E. macellum</i> (Fichtel & Moll)
<i>Elphidium discoidale</i>	= <i>E. exoticum</i> n. sp.
<i>Elphidium excavatum</i>	= <i>E. williamsoni</i> n. sp.
<i>Elphidium granosum</i>	= <i>E. waddensis</i> (Voorthuysen)
<i>Elphidium voorthuyseni</i>	= <i>E. incertum</i> (Williamson)
<i>Epistominella vitrea</i>	= <i>E. naraensis</i> (Kuwano)
<i>Fissurina orbignyana</i>	= <i>F. elliptica</i> (Cushman)
<i>Nonion asterizans</i>	= <i>Nonion depressulus</i> (Walker & Jacob)
<i>Nonionella atlantica</i>	= <i>N. species A</i>
<i>Oolina apiculata</i>	= <i>O. lineata</i> (Williamson)
<i>Planorbulina mediterranensis</i>	= <i>P. distoma</i> Terquem
<i>Protelphidium depressulum</i>	= <i>P. anglicum</i> Murray
<i>Protoschista findens</i>	= <i>Reophax moniliforme</i> Siddall
<i>Pyrgo williamsoni</i>	= <i>P. species A</i>
<i>Quinqueloculina agglutinata</i>	= <i>Q. aspera</i> d'Orbigny
<i>Quinqueloculina subarenaria</i>	= <i>Q. aspera</i> d'Orbigny
<i>Quinqueloculina</i> species 3	= <i>Q. lata</i> Terquem
<i>Spirillina vivipara</i>	= <i>S. perforata</i> (Schultze)

Species represented by single, imperfect specimens are not described. In addition all the species of *Lenticulina* and all species of *Cassidulina* except one are set aside until better material is obtained from deeper parts of the Irish Sea.

3. No attempt is made to arrange the species in groups above the family level.

4. Although the fundamental character of the wall is valuable in classification it cannot be applied rigidly. It seems unlikely that all the different wall structure groups arose separately from tectinous ancestors. In particular, optically granular structure is near to radial structure and one may derive from the other. For this reason, the attempt to hive off granular forms into the three super families Cassidulinacea, Anomalinacea and Nonionacea is abandoned.

5. The family Nonionidae is interpreted in the wide sense to include both *Nonion* and *Elphidium*. *Elphidium* is interpreted widely to include radial and granular species both with and without septal bridges and fossettes.

6. The family Discorbidae is interpreted in the wide sense and some recently suggested generic names, *Glabratella*, *Neoconorbina* and *Gavelinopsis*, are used only tentatively or abandoned. Much more needs to be known about wall structure and reproduction before further names are coined for the 'discorbids'.

## VIII. REFERENCES

- ACOSTA, J. T. 1940. Algunos Foraminiferos nuevas de las costas Cubanos. *Torreia* **5** : 3-6.
- ADAMS, T. D. 1963. *Holocene foraminifera from the Dovey Estuary and Cardigan Bay*. Unpublished Ph.D. thesis, Univ. Coll. of Wales.
- ADAMS, T. D. & FRAMPTON, J. 1965. A note on some recent foraminifera from North west Iceland. *Contr. Cushman Fdn. Foramin. Res.* **16** (2) : 55-59, pl. 5, 1 tf.
- ADAMS, T. D. & HAYNES, J. 1965. Foraminifera in Holocene marsh cycles at Borth, Cardiganshire (Wales). *Palaeontology* **8** : 27-38.
- ADAMS, T. D., HAYNES, J. R. & WALKER, C. T. 1965. Boron in Holocene illites of the Dovey Estuary, Wales and its relationship to palaeosalinity in cyclothsems. *Sedimentology* **4** : 189-195.
- ADEGOKE, O. S., DESSAUVAGIE, T. F. J. & YOLOYE, V. L. A. 1969. *Hemisphaerammina*-like egg capsules of *Neritina* (Gastropoda). *Microfauna* **15** (1) : 102-106, pl. 1, tfs 1-5.
- ALBANI, A. D. 1965. The foraminifera in a sample dredged from the vicinity of Salisbury Island, Durban Bay, South Africa. *Contr. Cushman Fdn. Foramin. Res.* **16** (2) : 60-66, 1 pl., 1 tf., 1 tab.
- 1968. Recent Foraminiferida from Port Hacking. *Contr. Cushman Fdn. Foramin. Res.* **19** (3) : 85-119, pls 7-10, tfs 1-11., tabs.
- ALCOCK, T. 1865. Notes on the natural history specimens lately received from Connemara. *Proc. lit. phil. Soc. Manchr.* **4** : 192-208.
- ANDEL, T. H. VAN & POSTMA, H. 1954. Recent Sediments of the Gulf of Paria. *Verh. K. ned. Akad. Wet.*, **1**, **20** : 1-245.
- ANDERSON, G. J. 1963. Distribution patterns of recent foraminifera of the Bering Sea. *Microfauna* **9** (3) : 305-317, 1 pl., 12 tfs, 1 tab.
- ANDERSON, H. V. 1952. *Buccella* a new genus of the rotalid foraminifera. *J. Wash. Acad. Sci.* **42** (5) : 143-151, tfs 1-13.
- 1953. Two new species of *Haplophragmoides* from the Louisiana Coast. *Contr. Cushman Fdn. Foramin. Res.* **4** (1) : 21-22, pl. 4.
- ARNAL, R. E. 1958. Rhizopoda from the Salton Sea, California. *Contr. Cushman Fdn. Foramin. Res.* **9** (2) : 36-45, pls 9-12, 1 tf.
- ASANO, K. 1960. The Foraminifera from the adjacent Seas of Japan. *Scient. Rep. Tōhoku Univ. Ser. 2, Spec. Vol.* **4** : 189-201.
- ATKINSON, K. 1967. *A study of the Foraminifera in the Trawling Grounds, Cardigan Bay*. Unpublished Ph.D. thesis, Univ. Coll. of Wales.
- 1968. The genus *Sigmoilopsis* Finlay 1947 from Cardigan Bay, Wales. *Contr. Cushman Fdn. Foramin. Res.* **19** (4) : 160-162, pl. 18.
- 1969. The association of living foraminifera with Algae from the littoral zone, south Cardigan Bay. *J. nat. Hist.* **3** : 517-542, tfs 1-6.
- 1970. The marine flora and fauna of the Isles of Scilly: Foraminifera. *J. nat. Hist.* **4** : 387-398.
- AVNIMELECH, M. 1952. Revision of the Tubular Monothalamia. *Contr. Cushman Fdn. Foramin. Res.* **3** : (2), 60-68 17 tfs.
- AYALA-CASTANARES, A. 1963. Sistematica y distribucion de los foraminiferos Recientes de la Laguna de Terminos, Campeche, Mexico. *Boll. Inst. de Geol. Univ. Mex.* **67** (3) : 1-130, 11 pls, 60 tfs.
- BALKWILL, F. P. & MILLETT, F. W. 1884. The foraminifera of Galway. *J. microsc. nat. Sci.* **3** (9) : 19-28; (10) : 78-90, pls 1-4.
- BALKWILL, F. P. & WRIGHT, J. 1882. Recent foraminifera of Dublin and Wicklow. *Proc. R. Ir. Acad. ser. 2, 3* : 545-550.
- 1885. Report on some Recent foraminifera found off the coast of Dublin in the Irish Sea. *Trans. R. Ir. Acad.* **28** (Sci.) : 317-372, pls 12-14.
- BANDY, O. L. 1949. Eocene and Oligocene foraminifera from Little Stave Creek, Clarke County, Alabama. *Bull. Am. Paleont.* **32** (131) : 5 : 211, pls 1-27, tfs 1, 2, 1 tab.

- BANDY, O. L. 1950. Some later Cenozoic foraminifera from Cape Blanco, Oregon. *J. Paleont.* **24** (3) : 269-281, pls 41, 42, 2 tfs.
- 1951. Upper Cretaceous foraminifera from the Carlsbad area, San Diego County, California. *J. Paleont.* **25** (4) : 488-513, pls 72-75, tfs 1, 2, tabs 1, 2.
- 1953. Ecology and palaeontology of some Californian foraminifera. Pt 1. The frequency distribution of Recent foraminifera off California. *J. Paleont.* **27** : 161-182, pls 21-25.
- 1961. Distribution of foraminifera, radiolaria and diatoms in sediment of the Gulf of California. *Micropaleontology* **7** (1) : 1-26, pls 1-5.
- 1963. Dominant paralic foraminifera of Southern California and the Gulf of California. *Contr. Cushman Fdn. Foramin. Res.* **14** (4) : 127-134.
- BANDY, O. L. & ECHOLS, R. J. 1964. Antarctic foraminiferal zonation—Biology of the Antarctic Seas, Milton O. Lee, Antarctic Research Series 1, *Am. Geophys. Un.* **1190** : 73-91, tfs 1-14.
- BARBIERI, F. & MEDIOLI, F. 1969. Distribution of foraminifera on the Scotian Shelf (Canada). *Riv. Ital. Paleont. Stratigr.* **75** (4) : 849-878, pls 62-68.
- BARKER, R. W. 1960. *Taxonomic notes on the species figured by H. B. Brady in his report on the Foraminifera dredged by H.M.S. Challenger during the years 1873-1876. Accompanied by a reproduction of Brady's Plates.* Soc. Econ. Paleontologists and Mineralogists, Tulsa, Okla. Sp. Pub. 9, 238 pps.
- BARNARD, T. 1959. Some arenaceous foraminifera from the Lias of England. *Contr. Cushman Fdn. Foramin. Res.* **10** (4) : 132-136, pl. 11.
- BARTENSTEIN, H. 1938. Foraminiferen der meerischen und brackishen Bejinke des Jade-Gebietes. *Senckenbergiana* **20** : 386-412.
- 1969. Das problem der gattungs und art-trennung bei Brackwasser-Foraminiferen am beispiel der weltweit verbreiteten *Jadammina polystoma* und ihrer verwandten. *Senckenberg. leth.* **50** (4) : 367-375.
- BARTENSTEIN, H. & BRAND, E. 1938. Die Foraminiferen Fauna des Jade-Gebiete. I. *Jadammina polystoma* n.g. n.sp. sus dem Jade-Gebiete (For.). *Senckenbergiana* **20** : 381-385.
- BARTLETT, G. A. 1964. A preliminary study of foraminifera distribution on the Atlantic Continental Shelf, Southeastern Nova Scotia. *Geol. Surv. Pap. Can.* **64-5** : 1-19, 2 tabs, fig.
- BÉ, A. W. H. 1967. Zoo plankton, Sheet 108. Foraminifera Families: Globigerinidae and Globorotaliidae. *Fich. Ident. Zooplankton*.
- 1969. Planktonic Foraminifera, from, 'Distribution of selected groups of Marine Invertebrates in waters South of 35°S. Lat.' *Antarctic Map Folio Ser.* **11** : 9-12.
- BÉ, A. W. H. & HAMLIN, W. H. 1967. Ecology of Recent planktonic foraminifera. Pt 3—Distribution in the North Atlantic during the summer of 1962. *Micropaleontology* **13** (1) : 87-106.
- BEHM, H. J. & GREKULINSKI, E. F. 1958. Ecology of Foraminifera in Main and Richmond Creeks, Staten Island, New York. *Proc. Staten Isl. Inst. Arts Sci.* **20** (2) : 53-66, 1 pl.
- BERMUDEZ, P. J. 1949. Tertiary smaller foraminifera of the Dominican Republic. *Spec. Publ. Cushman Lab.* **25** : 322 pps, 26 pls, 4 tabs, 6 tfs.
- BERTHELIN, G. 1878. Liste des foraminifères recueillis dans la baie de Bourgneuf et a Pornichet. *Soc. acad. Nantes ser.* **5**, 8 : 203-246.
- BERTHOIS, L. & LE CALVEZ, Y. 1959. Deuxième contribution a l'étude de la sédimentation dans le Golfe de Gascogne. *Revue Trav. Inst. Pêches marit.* **23** (3) : 323-376, 1 pl., 17 tfs.
- BHATIA, S. B. 1956. Recent foraminifera from the Shore Sands of Western India. *Contr. Cushman Fdn. Foramin. Res.* **7** (1) : 15-24, pls 1-5.
- BLANC-VERNET, L. 1958. Les milieux sédimentaires littoraux de la Provence occidentale (Côte rocheuse). Relations entre la microfauna et la granulométrie de sédiment. *Bull. Inst. océanogr. Monaco* **1112** : 1-45, 10 pls, 8 tfs.
- BLAINVILLE, H. M. DUCROTAY DE. 1825. *Manuel de malacologie et de conchyliologie.* 664 pps, 87 pls, F. G. Levraud, Paris.

- BLOW, W. H. 1956. Origin and Evolution of the foraminiferal genus *Orbulina* d'Orbigny. *Micropaleontology* **2** (1) : 57-70, 4 tfs.
- BOLTOVSKOY, E. 1954. Foraminiferos del Golfo San Jorge. *Revta Inst. nac. Invest. Cienc. nat. Mus. argent. Cienc. nat. Bernardino Rivadavia, Ciencias geologicas* **3** (3) : 79-228, pls 1-19.
- 1955. Recent Foraminifera from Shore Sands at Quequen, Province of Buenos Aires, and changes in the Foraminiferal fauna to the North and South. *Contr. Cushman Fdn. Foramin. Res.* **6** (1) : 39-42, pl. 7, 1 tf.
- 1957. Los foraminiferos del estuario del Rio de la Plata y su zona de Influencia. *Revta Inst. nac. Invest. Cienc. nat. Mus. argent. Cienc. nat. Bernardino Rivadavia* **6** (1) : 1-76, 11 pls, 1 tab.
- 1958. The foraminiferal fauna of the Rio de la Plata and its relation to the Caribbean area. *Contr. Cushman Fdn. Foramin. Res.* **9** (1) : 17-21, pl. 6, tfs 1, 2.
- 1959. Foraminiferos Recientes del de Brasil y sur relaciones con los de Argentina e India de Oeste. *Marina. B. Aires*, **N1005** : 1-122, 20 pls, 2 tabs, 1 map.
- 1961. Foraminiferos de la plataforma continental entre el calo Santo Tome y la embocadura de Rio de la Plata. *Revta. Mus. argent. Cienc. nat. Bernardino Rivadavia Inst. nac. Invest. Cienc. nat., Ciencias zoologicas* **4** (6) : 249-346, pls 1-12, 1 tf.
- 1963. The littoral foraminiferal biocenoses of Puerto Deseado (Patagonia, Argentina). *Contr. Cushman Fdn. Foramin. Res.* **14** (2) : 58-70, pls 6, 7.
- BOLTOVSKOY E. & BOLTOVSKOY A. 1968. Foraminiferos y Tecamebas de la parte inferior del Rio Quenquen Grande. *Revta Mus. argent. Cienc. nat. Bernardino Rivadavia Inst. nac. Invest. Cienc. nat., Hidrobiol.* **2** (4) : 127-164, pls 1-3.
- BOLTOVSKOY, E. & LENA, H. 1966. Unrecorded foraminifera from the littoral of Puerto Deseado. *Contr. Cushman Fdn. Foramin. Res.* **17** (4) : 144-149, pl. 13.
- BOWERBANK, J. S. 1862. On the anatomy and physiology of the Spongiidae; Part III. On the generic characters, the specific characters, and on the method of examination. *Phil. Trans. R. Soc.* **152** : 1087-1135, pls 72-74.
- BRADSHAW, J. S. 1957. Laboratory studies on the rate of growth of the foraminifera *Streblus beccarii* (Linné) var. *tepidia* (Cushman). *J. Paleont.* **31** (6) : 1138-1147, 5 tfs.
- 1959. Ecology of living planktonic foraminifera in the north and equatorial Pacific. *Contr. Cushman Fdn. Foramin. Res.* **10** (2) : 25-64, pls 6-8.
- BRADY, G. S. & ROBERTSON, D. 1876. Report on the dredging off the coast of Durham and North Yorkshire. *Rep. Br. Ass. Advmt. Sci.* **45** : 185-197.
- BRADY, H. B. 1864. Contributions to the knowledge of the foraminifera. On the Rhizopodal fauna of the Shetlands. *Trans. Linn. Soc. Lond.* **24** : 463-475, pl. 48.
- 1865. 'Foraminifera' in T. R. Jones: Microzoa of the Valley deposits of the Nar, Norfolk. *Geol. Mag.* **2** : 306-307.
- 1867. A catalogue of the Recent foraminifera of Northumberland and Durham. *Trans. nat. Hist. Soc. Northumb.* **1** : 83-107, pl. 12.
- 1870. 'Foraminifera' in G. S. Brady, D. Robertson and H. B. Brady: The Ostracoda and Foraminifera of tidal rivers. *Ann. Mag. nat. Hist. ser.* **4**, 6 : 273-306, pls 11 and 12.
- 1881. On some Arctic foraminifera from soundings obtained on the Austro-Hungarian North-Polar Expedition of 1872-1874. *Ann. Mag. nat. Hist. ser.* **5**, 8 : 393-418, pl. 21.
- 1882. Report on the Foraminifera. In: Tizard and Murray's Exploration of the Faroe Channel during the summer of 1880 in H.M.S. 'Knight Errant'. *Proc. R. Soc. Edinb.* **2** (III) : 708-717.
- 1884. Report on the Foraminifera dredged by H.M.S. 'Challenger' during the years 1873-1876. *Challenger Rep. Zool.* **9** : 814 pps, 115 pls, 2 maps, in 2 vols.
- 1887. A synopsis of the British Recent Foraminifera. *Jl. R. microsc. Soc.* **14** : 872-926.
- BRADY, H. B., PARKER, W. K. & JONES, T. R. 1870. A monograph of the genus *Polymorphina*. *Trans. Linn. Soc., Lond.* **27** : 197-253, pls 29-42.
- BRAGA, J. M. 1961. Foraminiferos da costa de Mocambique. *Pub. Inst. Zool. 'Dr. Augusto Nobre', Fac. de Ciênc. Porto. Portugal* **77** : 1-208, pls 1-21.

- BRODNIEWICZ, I. 1965. Recent and some Holocene foraminifera of the southern Baltic Sea. *Acta Palaeont. pol.* **10** (2) : 131-248, pls 1-11, tf 34.
- BRONNIMANN, P. 1951. The genus *Orbulina* d'Orbigny in the Oligo-Miocene of Trinidad, B.W.I. *Contr. Cushman Fdn. Foramin. Res.* **2** (4) : 131-138, tfs 1-5.
- BROWN, T. 1827. *Illustrations of the conchology of Great Britain and Ireland.* 1-4, 52 pls. W. H. & D. Lizan, Edinburgh.
- 1844. *Illustrations of the Recent conchology of Great Britain and Ireland, with the descriptions and localities of all the species.* 2nd Edit., London, 145 pps, 59 pls.
- BRUCE, J. R., COLMAN, J. S. & JONES, N. S. 1963. Marine fauna of the Isle of Man. *Lpool. Univ. Press* **36** : 1-307, 6 chts.
- BRÜNNICH, M. T. 1772. *M. T. Brünnich Zoologiae fundamenta.* 253 pps, Grunde i Dyreloeren (Hafniae et Lipsiae).
- BUCHNER, P. 1940. Die Lagenen des Golfes von Neapel und der marinens ablangerungen auf Ischia. *Nova Acta Leopoldina* **9** (62) : 363-560, 29 pls, 642 tfs.
- BURGESS, E. W. 1889. Foraminifera of Oban, Scotland. *Trans. Bgham nat. Hist. microsc. Soc. Midl. Nat.*, n.s. **12** : 77-81; 116-120; 130-133.
- 1891. Notes on some foraminifera from the river Mersey. *Trans. Lpool biol. Soc.* **5** : 73-80.
- BUTCHER, W. S. 1951. Foraminifera, Coronado Bank and Vicinity, California Univ. *Rep. Scripps Instn. Oceanogr., Geol.* **19** : 1-9, 6 tfs.
- BUZAS, M. A. 1965. The distribution and abundance of foraminifera in Long Island Sound. *Smithson. misc. Collns* **149** (1) : 1-88, pls 1-4.
- 1966. The discrimination of morphological groups of *Elphidium* (Foraminifer) in Long Island Sound through canonical analysis and invariant characters. *J. Paleont.* **40** (3) : 585-594, pls 71-72.
- CARALP, M., LAMY, A. & PUJOS, M. 1970. Contribution a la connaissance de la distribution bathymétrique des Foraminifères dans Le Golfe de Gascogne. *Revta esp. Micropaleont.* **2** (1) : 55-84, 9 tfs.
- CARPENTER, W. B. 1881. *The microscope and its revelations.* 6th ed. London, Ballantyne, Henson & Co. 882 pps, 25 pls, 502 tfs.
- CARPENTER, W. B., PARKER, W. K. & JONES, T. R. 1862. *Introduction to the study of the foraminifera.* Ray Soc. Lond. 319 pps, 22 pls, 47 tfs.
- CARTER, H. J. 1870. On two new species of the foraminiferal genus *Squamulina*, and on a new species of *Diffugia*. *Ann. Mag. nat. Hist. ser.* **4**, 5 : 309-326, pls 4, 5.
- CHAFFER, W. 1894. 'Foraminifera' in the 7th Ann. Rep. Lpool. Mar. Comm. and their biol. Stat. at Port Erin. *Trans. Lpool. biol. Soc.* **8** : 3-49.
- CHAMNEY, T. P. 1969. Barremian Textulariina, Foraminiferida from Lower Cretaceous Beds, Mount Goodenough Section, Aklavik Range, District of MacKenzie. *Bull. geol. Surv. Can.* **185** : 1-41, pls 1-6.
- CHAPMAN, F. 1899. On the foraminifera collected around the Funafuti Atoll from shallow and moderately deep water. *J. Linn. Soc.* **28** : 379-415, 2 pls, 8 tbs.
- 1941. Report on Foraminiferal Soundings and Dredgings of the F.I.S. 'Endeavour' along the Continental Shelf of the S.E. Coast of Australia. *Trans. R. Soc. S. Aust.* **65** (2) : 145-211, pls 7-9.
- CHAPMAN, F. & PARR, W. J. in PARR, W. J. 1932. Victorian and South Australian shallow water foraminifera. Pt. 2. *Proc. R. Soc. Vict.*, n.s. **44** : 218-234, pls 21-22.
- CHAPMAN, F. & PARR, W. J. 1937. Foraminifera. Aust. Antarctic Exped. 1911-1914. *Sci. Rep. ser. C* **1** (2) : 1-190, 4 pls.
- CHASTER, G. W. 1892. Report on the foraminifera of the Southport District. *Rep. Southport Soc. nat. Sci.* **4** : 54-72, pl. 1. (*Abstr. Jl. Roy. microsc. Soc.* 1892, p. 379.)
- CHIERICI, M. A., BUSI, M. T. & CITA, M. B. 1962. Contribution a une étude écologique des foraminifères dans la mer Adriatique. *Revue Micropaléont.* **5** (2) : 123-142, pls 1, 2, 7 tfs.
- CITA, M. B. & CHIERICI, M. A. 1962. Crociera Talassographica Adriatico 1955 v. Richerche Sui Foraminiferi Contenuti in 18 Carote Prelevata sul Fondo del Mare Adriatico. *Archiv Oceanogr. Limnol.* **12** (3) : 297-359, 8 pls, 9 tabs, 27 tfs.

- CLARKE, J. 1906. Marine Zoology (Foram. list pp. 115-119). In: *A history of Cornwall*. 1. *Victoria History of the Counties of England*. Ed. W. Page.
- CLOSS, D. & BARBARENA, M. C. 1962. Faunal studies of Recent Foraminifera from the shore sands of the State of Rio Grande de Sul in Southern Brazil. *Contr. Cushman Fdn. Foramin. Res.* **13** (3) : 74-78, 1 tf., 1 tab.
- COCKBAIN, A. E. 1963. Distribution of foraminifera in Juan de Fuca and George Straits, British Columbia, Canada. *Contr. Cushman Fdn. Foramin. Res.* **14** (2) : 37-57, 13 tfs, 2 tabs.
- COLLINS, A. C. 1958. Foraminifera: in *Scient. Rep. Gt. Barrier Reef Exped. 1928-1929. Br. Mus. nat. Hist.* **6** (6) : 335-437, pls 1-5 (issued 1960).
- COLOM, G. 1942. Una contribución al conocimiento de los foraminíferos de la bahía de Palma de Mallorca. *Notas. Resúm. Inst. esp. Oceanogr. ser. 2* **108** : 1-53, pls 1-11, tf. 1.
- 1952. Foraminíferos de las costas de Galicia (Campanas del Xauen en 1949 y 1950). *Bull. Inst. esp. Oceanogr.* **51** : 1-58, pls 1-8, tfs 5.
- COOPER, S. C. 1964. Benthonic Foraminifera of the Chukchi Sea. *Contr. Cushman Fdn. Foramin. Res.* **15** (3) : 79-104, pls 5, 6, 17 tfs.
- COSTA, O. G. 1856. Paleontologia del regno di Napoli. Pt. 2. *Accad. Pontaniana Napoli* **7** (2) : 113-378, pls 9-27.
- CUSHMAN, J. A. 1910. A monograph of the foraminifera of the North Pacific Ocean: Pt. 1—Astrorhizidae and Lituolidae. *Bull. U.S. natn. Mus.* **71** : 1-134, 203 tfs.
- 1911. A monograph of the foraminifera of the North Pacific Ocean: Pt. 2—Textulariidae. *Bull. U.S. natn. Mus.* **71** : 1-108, 1 tf.
- 1913. A monograph of the foraminifera of the North Pacific Ocean; Pt. 3—Lagenidae. *Bull. U.S. natn. Mus.* **71** : 1-119, pls 1-47.
- 1915. A monograph of the foraminifera of the North Pacific Ocean; Pt. 5—Rotalidae. *Bull. U.S. natn. Mus.* **71** : 1-83, pls 1-31.
- 1917. A monograph of the foraminifera of the North Pacific Ocean; Pt. 6—Miliolidae. *Bull. U.S. natn. Mus.* **71** (6) : 1-108, pls 1-39, 52 tfs.
- 1918. The Foraminifera of the Atlantic Ocean; Pt. 1—Astrorhizidae. *Bull. U.S. natn. Mus.* **104** (1) : 1-111, pls 1-39.
- 1920. The Foraminifera of the Atlantic Ocean; Pt. 2—Lituolidae. *Bull. U.S. natn. Mus.* **104** (2) : 1-111, p.s 1-18.
- 1921. Foraminifera of the Philippine and adjacent seas. *Bull. U.S. natn. Mus.* **100** (4) : 1-608, pls 1-99, tfs 1-52.
- 1922. The Foraminifera of the Atlantic Ocean; Pt. 3—Textularidae. *Bull. U.S. natn. Mus.* **104** : 1-149, pls 1-26.
- 1923. The foraminifera of the Atlantic Ocean: Pt. 4—Lagenidae. *Bull. U.S. natn. Mus.* **104** : 1-228, pls 1-42.
- 1924. The foraminifera of the Atlantic Ocean; Pt. 5—Chilostomellidae and Globigerinidae. *Bull. U.S. natn. Mus.* **104** : 1-55, pls 1-8.
- 1926. Recent foraminifera from Porto Rico. *Carnegie Inst.* **344** (Dept. mar. Biol., Pap. 23) : 73-84, pl. 1.
- 1927a. An outline of a reclassification of the foraminifera. *Contr. Cushman Lab. Foramin. Res.* **3** (1) : 1-105, pls 1-21.
- 1927b. Recent foraminifera from off the west coast of America. *Bull. Scripps. Instn. Oceanogr. tech. Ser.* **1** (10) : 119-188, pls 1-6.
- 1929. Some species of Fossil and Recent Polymorphinidae found in Japan. *Jap. J. Geol. Geogr.* **6** (3-4).
- 1930. The foraminifera of the Atlantic Ocean; Pt. 7—Nonionidae, Camerinidae, Peneroplidae and Alveolinellidae. *Bull. U.S. natn. Mus.* **104** : 1-79, pls 1-18.
- 1931. The foraminifera of the Atlantic Ocean; Pt. 8—Rotalidae, Amphisteginidae, Calcarinidae, Cymbaloporettidae, Globorotaliidae, Anomalinidae, Planorbulinidae, Rupertiidae and Homotremidae. *Bull. U.S. natn. Mus.* **104** : 1-179, pls 1-26.

- CUSHMAN, J. A. 1933. New Arctic foraminifera collected by Capt. R. A. Bartlett from Fox basin and off the northeast coast of Greenland. *Smithson. misc. Collns.* 89 (9) publ. 3221 : 1-8, pls 1-2.
- 1937a. A monograph of the foraminiferal family Verneuilinidae. *Spec. Publs. Cushman Lab.* 7 : 1-157, pls 1-20.
- 1937b. A monograph of the foraminiferal subfamily Virgulininae. *Spec. Publs. Cushman Lab.* 9 : 1-228, pls 1-24.
- 1939. A monograph of the foraminiferal family Nonionidae. *Prof. Pap. U.S. geol. Surv.* 191 : 1-100, pls 1-20.
- 1941. A study of the foraminifera contained in the cores from Bartlett Deep. *Am. J. Sci.* 259 : 128-147, pls 1-6, 10 tfs.
- 1944. Foraminifera from the shallow waters of the New England Coast. *Spec. Publs. Cushman Lab.* 12 : 1-37, pls 1-4.
- 1948. Arctic Foraminifera. *Spec. Publs. Cushman Lab.* 23 : 1-79, pls 1-8.
- 1949. Recent Belgian Foraminifera. *Inst. R. Sci. Nat. Belg.* 111 : 3-59, pls 1-10.
- CUSHMAN, J. A. & COLE, W. STORRS. 1930. Pleistocene foraminifera from Maryland. *Contr. Cushman Lab. Foramin. Res.* 6 (4) : 94-100 pl. 13.
- CUSHMAN J. A. & LEAVITT, D. H. 1929. On *Elphidium macellum* (Fichtel & Moll), *E. striatopunctatum* (Fichtel & Moll) and *E. crispum* (Linné). *Contr. Cushman Lab. Foramin. Res.* 5 (1) : 18-22, pl. 4.
- CUSHMAN, J. A. & MARTIN, L. T. 1935. A new genus of foraminifera, *Discorbinella* from Monterey Bay, California. *Contr. Cushman Lab. Foramin. Res.* 11 (4) : 89-90, pl. 14.
- CUSHMAN, J. A. & McCULLOCH, I. 1939. A report on some arenaceous foraminifera. *Allan Hancock Pacif. Exped.* 6 (1) : 1-113, pls 1-12.
- 1948a. Three new names for Recent Pacific Foraminifera. *Contr. Cushman Lab. Foramin. Res.* 24 (3) : 76.
- 1948b. The species of *Bulimina* and related genera in the collections of the Allan Hancock Foundation. *Allan Hancock Pacif. Exped.* 6 (5) : 231-257, pls 29-32, tab. 7.
- 1950. Some Lagenidae in the collections of the Allan Hancock Foundation. *Allan Hancock Pacif. Exped.* 6 (6) : 295-364, pls 37-48.
- CUSHMAN, J. A. & OZAWA, Y. 1928. An outline of a revision of the Polymorphinidae. *Contr. Cushman Lab. Foramin. Res.* 4 (1) : 13-20, pls 1-2.
- 1930. A monograph of the foraminiferal family, Polymorphinidae, Recent and fossil. *Proc. U.S. natn. Mus.* 77 (2829) : 1-185, pls 1-40.
- CUSHMAN, J. A. & PARKER, F. L. 1937. Notes on some European Eocene species of *Bulimina*. *Contr. Cushman Lab. Foramin. Res.* 13 (2) : 46-54, pls 5-7.
- 1940. The species of the genus *Bulimina* having Recent types. *Contr. Cushman Lab. Foramin. Res.* 16 (1) : 7-23, pls 2, 3.
- 1947. *Bulimina* and related foraminiferal genera. *Prof. Pap. U.S. geol. Surv.* 210D : 55-176, pls 15-30.
- CUSHMAN, J. A. & TODD, R. 1942. The foraminifera of the type locality of the Naheola Formation. *Contr. Cushman Lab. Foramin. Res.* 18 (2) : 23-46, pls 5-8.
- 1947a. Foraminifera from the coast of Washington. *Cushman Lab. Foramin. Res., Spec. Pub.* 21 : 1-23, pls 1-4.
- 1947b. A foraminiferal fauna from Amchitka Island, Alaska. *Contr. Cushman Lab. Foramin. Res.* 23 (3) : 60-72, pls 14-16.
- CUSHMAN, J. A. & VALENTINE, W. W. 1930. Shallow water foraminifera from the Channel Islands of S. California. *Contr. Dep. Geol. Stanford Univ.* 1 (1) : 1-51, 10 pls.
- DAWSON, G. M. 1870. On Foraminifera from the Gulf and River St. Lawrence. *Can. Naturalist n.s.* 5 : 172-180, 12 tfs.
- DEFRANCE, M. J. L. in BLAINVILLE, H. M. DUCROTAY DE. 1824. *Mollusques, vers et zoophytes. Dictionnaire des Sciences Naturelles* 32 : 1-567. F. G. Levrault, Paris.
- DETLING, M. R. 1958. Some littoral foraminifera from Sunset Bay, Coos County, Oregon. *Contr. Cushman Fdn. Foramin. Res.* 9 (2) : 25-31, 2 pls.

- DROOGER, C. W. & KAASSCHIETER, J. P. H. 1958. Foraminifera of the Orinoco—Trinidad—Paria Shelf. *Rep. Orinoco Shelf Exped. Verh. K. ned. Akad. Wet.* **22**, 4 : 1-108, 4 tfs, 5 pls, 41 maps.
- DUPEUBLE, P. A. 1963. Apercu sur la répartition des principales familles de Foraminifères dans trois facies de la région de Roscoff (Finistère). *Revue Micropaléont.* **5** (4) : 277-279, tfs 1-3.
- EARLAND, A. 1902. A plea for a new 'Williamson'. *J. Quekett microsc. Club ser.* **2**, 8 : 268-270.
- 1905. The foraminifera of the Shoresand of Bognor, Sussex. *J. Quekett. microsc. Club* **9** : 187-232, pls 11-14.
- 1933. Foraminifera; Pt. 2—South Georgia. *'Discovery' Rep.* **7** : 27-138, pls 1-7.
- 1934. Foraminifera; Pt. 3—The Falklands sector of the Antarctic (excluding South Georgia). *'Discovery' Rep.* **10** : 1-208, pls 1-10, tfs 1, 2.
- 1936. Foraminifera; Pt. 4—Additional records from the Weddell Sea sector from material obtained by the S.Y. 'Scotia'. *'Discovery' Rep.* **13** : 1-76, pls 1-2A.
- EHRENCBERG, C. G. 1838. Über dem blossen Auge unsichtbare Kalkthierchen und Kieselthierchen als Hauptbestandtheile der Kreidegebirge. *K. preuss. Akad. Wiss.* 1838, **3** : 192-200.
- 1839. Über die Bildung der Kreidefelsen und des Kreidemergels durch unsichtbare Organismen. *K. preuss. Akad. Wiss.* 1838 : 59-147, pls 1-4, 2 tabs.
- 1843. Verbreitung und Einfluss des mikroskopischen Lebens in Süd- und Nord-Amerika. *K. akad. Wiss. Berlin. Physik.* **1841** : 291-445, pls 1-4.
- ELLISON, R. & NICHOLS, M. M. 1970. Estuarine foraminifera from the Rappahannock River, Virginia. *Contr. Cushman Fdn. Foramin. Res.* **21** (1) : 1-15, pls 1, 2, 9 tfs.
- EMILIANI, C. 1949. Studio micropaleontologico di una serie calabriana. *Riv. ital. Paleont. Stratigr.* **55** (1) : 1-17, pls 1, 2, tabs.
- FAYOSE, E. A. 1965. *The distribution of Recent foraminifera from Aberystwyth Harbour and environs.* Unpublished M.Sc. thesis, Univ. Coll. of Wales.
- FEYLING-HANSSEN, R. W. 1954. Late-Pleistocene foraminifera from the Oslo Fjord Area, South east Norway. *Norsk. geol. Tidsskr.* **33** (1-2) : 109-150, 2 pls.
- 1964. Foraminifera in late Quaternary deposits from the Oslo fjord area. *Norg. geol. Unders.* **235** : 7-385, 21 pls, 41 tfs.
- FICHTEL, L. & MOLL, J. P. C. 1798. *Testacea microscopica aliae minuta ex generibus Argonauta et Nautilus ad naturam delineata et descripta.* (Mikroskopische und andere kleine Schalthiere aus den Geshlechtern Argonaute und Schiffer, nach der Natur gezeichnet und beschrieben.) Wien. Comesina (1803 reprint), 124 pps, 24 pls.
- FINLAY, H. J. 1947. New Zealand foraminifera. Key species in stratigraphy—No. 5. *N.Z. Jl. Sci. Technol. sec. B*, **28** (5) : 259-292, pls 1-9.
- FISCHER, P. 1870. Foraminifères marins du Département de la Gironde et des côtes du Sud-ouest de la France. *Act. Soc. Linn. de Bordeaux* **27** : 377-397.
- FLEMING, J. 1828. *A history of British animals, exhibiting the descriptive characters and systematic arrangements of the genera and species of quadrupeds, birds, fishes, mollusca and Radiata of the United Kingdom.* Edinburgh.
- FLINT, J. M. 1899. Recent foraminifera. A descriptive catalogue of specimens dredged by the U.S. Fish Commission Steamer Albatross. *Rep. U.S. natn. Mus.* **1** : 249-349, pls 1-80.
- FORNASINI, C. 1902. Contributo a la conoscenza delle Bulimine adriatiche. *Memorie R. Accad. Sci. ist. Bologna, ser.* **5**, 9 (1901-1902) 2 : 371-381, pl. o, tfs.
- 1904. Illustrazione di specie orbignyanee di foraminiferi istituite nel 1826. *Memorie R. Accad. Sci. ist. Bologna, ser.* **6**, 1 : 3-17, pls 1-4.
- 1905. Illustrazione di specie orbignyanee di 'Miliolidi' istituite nel 1826. *Memorie R. Accad. Sci. ist. Bologna, ser.* **6**, 2 : 59-70, pls 1-4.
- 1906. Illustrazione di specie orbignyanee di 'Rotalidi' istituite nel 1826. *Memorie R. Accad. Sci. ist. Bologna, ser.* **6**, 3 : 61-70, pls 1-4.

- GALLOWAY, J. J. & WISSLER, S. G. 1927. Pleistocene Foraminifera from the Lomita Quarry, Palos Verdes Hills, California. *J. Paleont.* **1** : 35-87, pls 7-12.
- GOËS, A. 1894. A synopsis of the Arctic and Scandinavian recent marine foraminifera hitherto discovered. *K. Svensk. Vetensk. Akad. Nandl. Natn. For.* **25** (9) : 1-127, 25 pls.
- GONZALEZ-DONOSO, J. M. 1969. Données nouvelles sur la texture et la structure du test de quelques foraminifères du Bassin de Grenade (Espagne). *Revue Micropaléont.* **12** (1) : 3-8, pls 1, 2.
- GOUGH, G. C. 1904. A short note on the foraminifera of the Larne District. *Iv. Nat.* **13** : 37-38.
- 1906. The foraminifera of Larne Lough and District. *Invest. Dublin Fish. Ir.* **3** : 55-62.
- GREEN, K. E. 1960. Ecology of some Arctic foraminifera. *Micropaleontology* **6** (1) : 57-78, pl. 1, 9 tfs, 6 tabs.
- HAAKE, F. W. 1962. Untersuchungen an der Foraminiferen—Fauna im Wattgebiet zwischen Langeoog und dem Festland. *Meyniana* **12** : 25-64, pls 1-12, 5 tabs, 9 tfs.
- HADDON, A. C. 1886. Preliminary report on the fauna of Dublin Bay. *Proc. R. Ir. Acad.* (2), **4** : 523.
- HAECKEL, E. 1894. *Systematische Phylogenie. Entwurf eines natürlichen Systems der Organismen auf Grund ihrer Stammesgeschichte. Theil 1, Systematische Phylogenie der Protisten und Pflanzen 1-XV; 1-400.* Georg Reimer, Berlin.
- HALKYARD, E. 1889. Recent foraminifera of Jersey. *Trans. a. Rep. Manchr. microsc. Soc.* 55-72, pls 1, 2.
- HAMAN, D. 1966a. *A taxonomic and ecologic study of the foraminifera of Tremadoc Bay, North Wales.* Unpublished Ph.D. thesis, Univ. Coll. of Wales.
- 1966b. On some Recent foraminifera from the Faeroe Islands, Denmark. *Contr. Cushman Fdn. Foramin. Res.* **17** (2) : 67-70, pl. 7.
- 1967. A taxonomic re-interpretation and emendation of the genus *Technitella* Norman, 1878. *Contr. Cushman Fdn. Foramin. Res.* **18** (1) : 27-29, pl. 6.
- 1969. Seasonal occurrence of *Elphidium excavatum* (Terquem) in Llandanwg Lagoon (North Wales, U.K.). *Contr. Cushman Fdn. Foramin. Res.* **20** (4) : 139-142, 1 tf.
- HAMILTON, E. L. 1953. Upper Cretaceous, Tertiary and Recent Planktonic Foraminifera from Mid-Pacific Flat-topped Seamounts. *J. Paleont.* **27** (2) : 204-237, pls 29-32, 4 tfs.
- HANNA, G. D. & CHURCH, C. C. 1927. A collection of recent foraminifera taken off San Francisco Bay, California. *J. Paleont.* **1** (3) : 195-202.
- HANSEN, H. J. 1965. On the sedimentology and the quantitative distribution of living foraminifera in the northern part of the Oresund. *Ophelia* **2** (2) : 323-331.
- HANSEN, H. J., REISS, Z. & SCHNEIDERMAN, N. 1969. Ultramicrostructure of bilamellar walls in Foraminiferida. *Revta esp. Micropaleont.* **1** (3) : 293-316, pls 1-8.
- HARMAN, R. A. 1964. Distribution of foraminifera in the Santa Barbara Basin, California. *Micropalaeontology* **10** (1) : 81-96, 12 tfs, 4 tabs.
- HARRINGTON, G. L. 1955. A recent Foraminiferal faunule from the Bay of Fundy. *Contr. Cushman Lab. Foramin. Res.* **6** (4) : 131-132.
- HARRIS, T. J. 1958. *A study of some Recent British Foraminifera.* Unpublished Ph.D. thesis, Univ. Coll. of Wales.
- HAYNES, J. R. 1954. Note on *Bulimina elongata* d'Orbigny. *Micropalaeontologist* **8** (3) : 57.
- 1956. Certain smaller British Palaeocene foraminifera. Pt. 1. *Contr. Cushman Fdn. Foramin. Res.* **7** : 79-101, pls 16-18, 2 tfs.
- 1964. Live and dead foraminifera between the Sarns, Cardigan Bay. *Nature Lond.* **204** (4960) : 774.
- 1965. Symbiosis, wall structure and habitat in foraminifera. *Contr. Cushman Fdn. Foramin. Res.* **16** : 40-43.
- HAYNES, J. R. & DOBSON, M. 1969. Physiography, foraminifera and sedimentation in the Dovey Estuary (Wales). *Lpool. Manchr. geol. J.* **6** (2) : 217-256, pls 17-20, tfs 1-17.
- HEDLEY, R. H., HURDLE, C. M. & BURDETT, I. D. J. 1964. *Trochammina squamata* Jones & Parker (Foraminifera) with observations on some closely related species. *N.Z. Jl. Sci.* **7** : 417-426, tfs 1-3.

- HEDLEY et al. 1965. A Foraminiferal fauna from the western continental shelf off North Island, New Zealand. *Bull. N.Z. Dep. Scient. ind. Res.* **163** : 1-46, pls 1-7, tfs 1-6.
- 1967. The marine fauna of New Zealand: Intertidal Foraminifera of the *Corallina officinalis* Zone. *Bull. N.Z. Dep. scient. ind. Res.* **180** : 9-56, pls 1-12 and frontis., tfs 1-60.
- HEDLEY, R. H. & UNDERWOOD, C. M. 1957. Living foraminifera and empty shells from the North Kent coast. *Ann. Mag. nat. Hist. ser.* **12**, 10 : 721-733, pl. 26.
- HEDLEY, R. H. & WAKEFIELD, J. ST. J. 1967. A collagen-like sheath in the arenaceous foraminifer *Haliphysema* (Protozoa). *Jl. R. microsc. Soc.* **87** : 475-481, tfs 1-7.
- HERON-ALLEN, E. & EARLAND, A. 1908-1911. On the recent and fossil foraminifera of the shore sands at Selsey Bill, Sussex. *Jl. R. microsc. Soc. pt.* **1** : 529-543, pl. 12 (1908); *pt. 2* : 306-336, pls 15, 16 (1909); *pt. 3* : 422-446, pls 17, 18 (1909); *pt. 4* : 677-698, pls 20, 21 (1909); *pt. 5* : 401-426 (1910); *pt. 6* : 693-695 (1910); *pt. 7* : 298-343 (1911); *pt. 8* : 436-448 (1911).
- 1913a. On some foraminifera from the North Sea, etc. dredged by the Fisheries Cruiser 'Goldseeker' (International North Sea Investigations—Scotland); Pt. 2—On the distribution of *Saccammina sphaerica* (M. Sars) and *Psammosphaera fusca* (Schulze) in the North Sea; particularly with reference to the suggested identity of the two species. *Jl. R. microsc. Soc.* **1**-26, pls 1-4.
- 1913b. The foraminifera of the Clare Island District, County Mayo, Ireland. Clare Island Survey, part 64. *Proc. R. Ir. Acad.* **31** : 1-188, pls 1-13.
- 1913c. On some foraminifera from the North Sea dredged by the Fisheries cruiser 'Huxley' (International North Sea Investigations—England). *J. Quekett microsc. Club* **12** : 121-138, pls 10, 11.
- 1914a. Foraminifera. In: Herdman, W. A., 'Cruise of the "Runa" in 1913'. 27th A. Rep. Lpool. biol. Comm. *Proc. Trans. Lpool. biol. Soc.* **28** : 46-52.
- 1914b. The foraminifera of the Kerimba Archipelago (Portuguese East Africa) Pt. 1. *Trans. zool. Soc. Lond.* **20** (1912-1915) (12) : 363-383, pls 35-37.
- 1915. List of species of foraminifera dredged off Bradda Head, 20 fathoms (Isle of Man). In Herdman, W. A., 'S.Y. "Runa", 1913—Foraminifera', 28th A. Rep. Lpool. biol. Comm. *Proc. Trans. Lpool. biol. Soc.* **29** : 39-41.
- 1916a. The foraminifera of the West of Scotland. Collected by W. A. Herdman on the cruise of the S.Y. 'Runa' July to September 1913. Being a contribution to the 'Spolia Runiana'. *Trans. Linn. Soc. Lond.* **11** : 197-300, pls 39-43 and map.
- 1916b. The foraminifera of the shore sands and shallow water zone of the south coast of Cornwall. *Jl. R. microsc. Soc. pt.* **1** : 29-55, pls 5-9.
- 1930. The foraminifera of the Plymouth District. *Jl. R. microsc. Soc. pt.* **1** : 46-84, pls 1-3; *pt. 2* : 161-199, pls 4, 5.
- 1932. Foraminifera Pt. I. The ice free area of the Falkland Islands and adjacent seas. 'Discovery' Rep. **4** : 291-460, pls 6-17.
- HOFKER, J. 1922. Protozoen. In: *Flora en Fauna der Zuiderzee*. Pp. 127-183, 91 tfs.
- 1930. The foraminifera of the Siboga Exped. Pt. 2. *Uitkomsten op Zool. Bot. Oceanograph. en Geologisch Gebied*. Monogr. **IVa** : 79-170, pls 1-26, 22 tfs.
- 1932. Notizenueber die Foraminiferen des Golfs von Neapel; 3—Die Foraminiferen fauna der Ammontatatura. *Pubbl. Staz. zool. Napoli* **12** : 61-145.
- 1951a. The foraminifera of the Siboga Exped. Pt. 3. *Uitkomsten op Zool. Bot. Oceanograph. en Geol. Gebied. Monogr.* **IVa** : 1-513, 348 tfs.
- 1951b. The toothplate foraminifera. *Archs. neerl. Zool.* **8** (4) : 353-372, 30 tfs.
- 1956. Tertiary Foraminifera of coastal Ecuador, Pt. 2. Additional notes on the Eocene species. *J. Paleont.* **30** : 891-958, 101 tfs.
- 1960. Foraminiferen aus dem Golf von Neapel. *Z. Palaont.* **34** (3/4) : 233-262, 6 pls.
- 1967. Hat die feinere Wandstruktur der Foraminiferen supra generische Bedeutung? *Z. Paläont.* **41** : 194-198, pls 19-21.
- 1969. Recent foraminifera from Barbados. In: *Studies on the fauna of Curaçao and other Caribbean Islands* **31** (115) : 1-158, tfs 484.

- HÖGLUND, H. 1947. Foraminifera in the Gullmar Fjord and Skagerak. *Zool. Bidr. Upps.* **26** : 1-328, pls 1-32, tfs 308, 2 maps, 7 tabs.
- HOLTERDAHL, H. 1965. Recent Turbidites in the Hardangerfjord, Norway. Galley Proof. Read at Bristol Conf.
- HULME, S. G. 1964. Recent Foraminifera from Manukau Harbour, Auckland, New Zealand. *N.Z. J. Sci.* **7** : (3) 305-340, 6 tfs, 2 tabs.
- HUSEZIMA, R. & MARUHASI, M. 1944. A new genus and thirteen new species of foraminifera from the core sample of Kasiwazaki oil field, Niigata-Ken. *Sigenkagaku Kenkyusyo. J. Res. Inst. nat. Resour.*, Tokyo **1** (3) : 391-400, pl. 34, 13 tabs.
- JAMES, K. H. 1965. *Sarn Cynfelyn—Recent Foraminifera, a study of ecology, including laboratory experiments.* Unpublished thesis, Dip. Micro-palaeont., Univ. Coll. of Wales.
- JOHNSON, J. A. (Miss). 1965. *The foraminifera of the latest marsh cycle in the Dovey Estuary.* Unpublished M.Sc. thesis, Univ. Coll. of Wales.
- JONES, T. R. In: GRIFFITH, J. W. & HENFREY, A. 1875. *The micrographic dictionary.* Edit. **3**, 1 : 316-320. van Voorst, Lond.
- JONES, T. R. 1896. A monograph of the foraminifera of the Crag. Pt. 3. *Palaeontogr. Soc. (Monogr.)* **211-314**, tf. 23.
- JONES, T. R. & PARKER, W. K. 1860. On the Rhizopodal fauna of the Mediterranean compared with that of the Italian and other Tertiary deposits. *Q.Jl. geol. Soc. Lond.* **16** : 292-307.
- 1876. On some recent and fossil foraminifera dredged up in the English Channel. *Ann. Mag. nat. Hist. Ser.* **4**, 17 : 283-287.
- JONES, T. R., PARKER, W. K. & BRADY, H. B. 1866. A monograph of the Foraminifera of the Crag. Pt. 1. *Palaeontogr. Soc. (Monogr.)*, 1-72, pls 1-4.
- KENT, W. S. 1878. On the foraminiferal nature of *Haliphysema tumanowiczii* (*Squamulina scopula*) Carter. *Ann. Mag. nat. Hist. ser* **5**, 2 : 68-78, pl. 4, figs 1-11; pl. 5, figs a, b.
- KIAER, H. 1900. Synopsis of the Norwegian marine Thalamophora Norway, Fiskeridirektoren. *Rep. Norw. Fishery mar. Invest.* **1** (7) : 1-59, pl. 1.
- KINDLE, E. M. 1931. Sea bottom samples from Cabot Strait, Earthquake Zone. *Bull. geol. Soc. Aust.* **42** : 557-574, 2 tfs.
- KRUIT, C. 1955. Sediments of the Rhone Delta 1: Grain size and Microfauna. *Verh. K. ned. geol.—mijnb. Genoot.* **15** : 357-499, 6 pls, 37 tfs.
- KUWANO, Y. 1950. New species of foraminifera from the Pliocene formations of Tama Hills in the vicinity of Tokyo. *J. geol. Soc. Japan* **56** (657) : 311-321, tfs 1-13.
- LACROIX, E. 1929. *Textularia sagittula* ou *Spiroplecta wrightii*. *Bull. Inst. océanogr., Monaco* **532** : 1-12, tfs 1-12.
- 1931. Les Lituolidés du plateau continental Méditerranéen entre Saint-Raphaël et Monaco. *Bull. Inst. océanogr., Monaco* **549** : 1-16, tfs 1-21.
- 1932. Textularidae du plateau continental méditerranéen entre Saint-Raphaël et Monaco. *Bull. Inst. océanogr., Monaco* **591** : 1-28, tfs 1-33.
- LAMARCK, J. B. 1804. Suite des mémoires sur les fossiles des environs de Paris. *Annls. hist.—nat. Mus. natn. Paris* **5** : 179-188, 237-245, 349-357, pls 17, 62.
- LANKESTER, E. R. 1879. The structure of *Haliphysema tumanowiczii*. *Q. Jl. microsc. Sci., n.s.* **19** : 476-483, pl. 22, tfs 1-11.
- LANKFORD, R. R. 1959. Distribution and Ecology of Foraminifera from East Mississippi Delta Margin. *Bull. Am. Ass. Petrol. Geol.* **43** (9) : 2068-2099, 11 tfs, 3 pls.
- LE CALVEZ, J. & LE CALVEZ, Y. 1958. Repartition des Foraminifères dans la Baie de Villefranche. 1—Miliolidae. *Annls. Inst. océanogr., Monaco* **35** (3) : 159-234, pls 3-16.
- LE CALVEZ, Y. 1958. Les foraminifères de la Mer Celtique. *Revue Trav. Inst. Pêches marit.* **22** (2) : 147-208, 3 pls, 3 tabs, 1 map.
- 1963. Contribution à l'étude des foraminifères de la région d'Abidjan (Côte d'Ivoire). *Revue Micropaléont.* **6** (1) : 41-50, 2 pls, 1 tf.
- LE CALVEZ, Y. & BOILLOT, G. 1967. Étude des Foraminifères contenus dans les sédiments Actuels de la Manche Occidentale. *Rev. Géog. phys. Géol. dynam.* **9** (5) : 394-408, pls 1-3, 3 tfs.

- LEES, A., BULLER, A. T. & SCOTT, J. 1969. Marine carbonate sedimentation processes, Connemara, Ireland. *Geol. Rep. Univ. Reading* **3** : 1-64, pl. 1, tabs.
- LEHMAN, E. P. 1957. Statistical study of Texas Gulf coast. Recent Foraminiferal Facies. *Micropaleontology* **3** (4) : 326-356, 3 pls, 10 tfs, 5 tabs.
- LESLIE, R. J. 1963. Foraminiferal study of a cross section of Hudson Bay, Canada. *Geol. Surv. Pap. Can.*, **63-16** : 1-27, tfs 5.
- LÉVY, A. 1966. Contribution à l'étude écologique et micropaléontologique de quelques *Elphidium* (Foraminifères) du Roussillon. Description d'une nouvelle espèce. *Elphidium cavillieri* n. sp. *Vie milieu* **17** (1A) : 1-8.
- LÉVY, A. et al. 1969. Les représentants de la famille des Elphidiidae (foraminifères) dans les sables des plages des environs de Dunkerque. Remarques sur les espèces de *Polystomella* signalées par O. Terquem. *Revue Micropaléont.* **12** (2) : 92-98, 2 pls.
- LINNAEUS, C. 1767. *Systema naturae*. Ed. 12. Holmiae, Stockholm, impensis L. Salvii **1** : 1-1327.
- LOEBLICH, A. R. & TAPPAN, H. 1953. Studies of Arctic foraminifera. *Smithson misc. Collns. Pub. 4105*, **121** (7) : 1-150, pls 1-24, 1 tab., 2 tfs.
- 1954. New names for two foraminiferal homonyms. *J. Wash. Acad. Sci.* **44** (12) : 384.
- 1955. Revision of some Recent Foraminiferal Genera. *Smithson misc. Collns.* **128** (5) : 1-37, pls 1-4.
- 1957. Eleven new genera of foraminifera. *Bull. U.S. natn. Mus.* **215** : 223-232, pls 72, 73.
- 1958. The foraminiferal genus *Haliphysema* and two new tropical Pacific species. *Proc. U.S. natn. Mus.* **107** : 123-126, pl. 1.
- 1961. Remarks on the systematics of the Sarkodina (Protozoa), renamed homonyms and new and validated genera. *Proc. biol. Soc. Wash.* **74** : 213-234.
- 1962. The status and type species of *Calcarina*, *Tinoporous* and *Eponides* (Foraminiferida). *Contr. Cushman Fdn. Foramin. Res.* **13** (2) : 33-38, tfs a-c.
- 1964a. In: Treatise on Invertebrate Paleontology, edited by R. C. Moore. Part C, *Protista* 2, *Sarcodina chiefly 'Thecamoebians' and Foraminiferida*. Geol. Soc. Amer. & Univ. Kansas Press. 2 vols, 900 pps.
- 1964b. Foraminiferal Classification and Evolution. *J. geol. Soc. India* **5** : 5-40.
- LUTZE, G. F. 1965. Zur Foraminiferen—Fauna der Ostsee. *Meyniana* **15** : 75-142, pls 1-15.
- LYNTS, G. W. 1962. Distribution of Recent Foraminifera in upper Florida Bay and associated sands. *Contr. Cushman Fdn. Foramin. Res.* **13** (4) : 127-145, 10 tfs.
- MACFADYEN, W. A. 1930. Miocene foraminifera from the Clysmic area of Egypt and Sinai. *Egypt. geol. Surv., Cairo* **1-149**, pls 1-4, map.
- 1939. On *Ophthalmidium* and two new names for recent foraminifera of the family Ophthalmidiidae. *Jl. R. microsc. Soc.* **59** : 162-169.
- 1942. A post glacial microfauna from Swansea Docks. *Geol. Mag.* **79** : 133-146.
- MARKS, P. 1951. A revision of the smaller foraminifera from the Miocene of the Vienna Basin. *Contr. Cushman Fdn. Foramin. Res.* **2** (2) : 33-73, pls 5-8.
- MATEU, G. 1968. Contribución al conocimiento de los Foraminíferos que sirven de alimento a las Holoturias. *Boln. Soc. Hist. Nat. Baleares* **14** : 5-17, pls 1-3.
- MATOBIA, Y. 1970. Distribution of Recent shallow water Foraminifera of Matsushima Bay, Miyagi Prefecture, Northeast Japan. *Scient. Rep. Tohoku Univ. ser. 2 (Geol.)*, **42** (1) : 1-85, pls 1-8, 3 tabs, 64 tfs.
- McKENZIE, K. G. 1962. A record of foraminifera from Oyster Harbour, near Albany, western Australia. *J. Proc. R. Soc. West. Aust.* **45** (4) : 117-132, pls 1-3.
- McKNIGHT, W. M. 1962. The distribution of foraminifera off parts of the Antarctic Coast. *Bull. Am. Paleont.* **44** (201) : 61-158, pls 9-23.
- MCLEAN, J. D. 1956. The Foraminifera of the Yorktown formation in the York-James Peninsula of Virginia, with notes on the associated molluscs. *Bull. Am. Paleont.* **36** (160) : 261-394, pls 35-53, 7 tfs, 3 tabs.
- ILLER, D. N. 1953. Ecological study of the foraminifera of Mason Inlet, North Carolina. *Contr. Cushman Fdn. Foramin. Res.* **4** (2) : 41-63, pls 7-10, 4 tfs, 3 tabs.

- MILLETT, F. W. 1898. Report on the Recent Foraminifera of the Malay Archipelago collected by Mr A. Durrand, F.R.M.S. Pts 1-3. *Jl. R. microsc. Soc.* pt. **1** : 258-269, pls 5, 6; pt. **2** : 499-513, pls 11, 12; pt. **3** : 607-614, pl. 13.
- 1899. Report on the Recent Foraminifera of the Malay Archipelago collected by Mr A. Durrand, F.R.M.S. Pts 4-6. *Jl. R. microsc. Soc.* pt. **4** : 249-255, pl. 4; pt. **5** : 357-365, pl. 5; pt. **6** : 557-564, pl. 7.
- 1900. Report on the Recent Foraminifera of the Malay Archipelago collected by Mr A. Durrand, F.R.M.S. Pts 7-9. *Jl. R. microsc. Soc.* pt. **7** : 6-13, pl. 1; pt. **8** : 273-281, pl. 2; pt. **9** : 539-549, pl. 4.
- MILLS, F. W. 1900. The Recent foraminifera of the river Humber. *Trans. Hull. Scient. Fld. Nat. Club* **1** : 142-151, pls 10-11.
- MONTAGU, G. 1803. *Testacea Britannica or Natural History of British Shells, marine, land and freshwater.* 3 vols, 606 pps, 16 pls. J. S. Hollis, Romsey.
- 1808. *A Supplement to the Testacea Britannica.* 183 pps, 30 pls. S. Woolmer, Exeter.
- MONTFORT, D. 1808. *Conchyliologie systématique et classification méthodique des Coquilles.* 1 Paris, Schoell, 409 pps.
- MOORE, J. R. 1968. Recent sedimentation in Northern Cardigan Bay, Wales. *Bull. Br. Mus. nat. Hist. (Miner.)* **2** (2) : 19-131, pls 2-6, 47 tfs.
- MOORE, J. R. & GARRAWAY, S. H. 1963. Use of polymethyl methacrylate in preparing thin sections of recent sediments. *Nature, Lond.* **200** : 62-63.
- MURRAY, J. W. 1965a. On the Foraminiferida of the Plymouth Region. *J. mar. biol. Ass. U.K.* **45** : 481-505, pl. 1.
- 1965b. Two species of British Recent Foraminiferida. *Contr. Cushman Fdn. Foramin. Res.* **16** (4) : 148-150, pls 25, 26.
- 1968. The living Foraminiferida of Christchurch Harbour, England. *Micropaleontology* **14** (1) : 83-96, pl. 1, 9 tfs.
- 1970. Foraminifers of the Western Approaches to the English Channel. *Micropaleontology* **16** (4) : 471-485, pls 1, 2, 8 tfs.
- NAGAHAMA, M. 1951. Studies on the foraminiferal faunas of small or almost enclosed bays in Japan. *Misc. Rep. Res. Inst. nat. Resour., Tokyo* **19-21** : 142-148, 2 tfs.
- NATLAND, M. L. 1933. Temperature and depth distribution of some Recent and fossil foraminifera in the southern California region. *Bull. Scripps Instn. Oceanogr. tech. Ser.* **3** (10) : 225-330, 1 tab., 1 map.
- 1938. New species of foraminifera from off the west coast of N. America and from the later Tertiary of the Los Angeles Basin. *Cal. Univ. Bull. Scripps Instn. Oceanogr. tech. Ser.* **4** (5) : 137-164, pls 3-7.
- NORIN, E. 1958. The sediments of the Central Tyrrhenian Sea. *Rep. Swed. deep Sea Exped.* Vol. 8. Sediment cores from the Mediterranean Sea and the Red Sea **1** : 3-136, pls 1-19.
- NORMAN, A. M. 1878. On the genus *Halyphysema* with a description of several forms apparently allied to it. *Ann. Mag. nat. Hist. ser.* **5**, 1 : 265-284, pl. 16.
- NORVANG, A. 1941. Notes on some Foraminifera from off Bergen. *Naturvitenskapelig rekke* **11** : 3-19, 3 tfs.
- 1945. *The zoology of Iceland* pt. 2, **2** : 1-79, 13 tfs, 2 tabs. Copenhagen and Reykjavik.
- 1966. *Textilina* nov. gen., *Textularia* Defrance and *Spiroplectammina* Cushman (Foraminifera). *Biol. Skr.* **15** (3) : 1-16, pls 1, 2.
- NYHOLM, K.-G. 1961. Morphogenesis and biology of the foraminifer *Cibicides lobatulus*. *Zool. Bidr. Upps.* **33** : 157-196, pls 1-5.
- D'ORBIGNY, A. D. 1826. Tableau méthodique de la classe des Céphalopodes. *Ann. Sci. Nat. Paris.* ser. 1, **7** : 96-132.
- 1839a. Foraminifères. In: Sagra, R. de la, *Histoire physique, politique et naturelle de l'île de Cuba.* Paris, A. Bertrand, 224 pps (plates pub. separately).
- 1839b. Foraminifères des îles Canaries. In: Barker-Webb, P. & Berthelot, S., *Histoire Naturelle des îles Canaries.* Paris, Béthune. **2** (2) Zool. : 119-146, pls 1-3.

- D'ORBIGNY, A. D. 1839c. *Voyage dans l'Amérique Méridionale: Foraminifères*. Strasbourg, P. Bertrand. 5 (5) : 1-86, pls 1-9.
- 1846. Foraminifères fossiles du bassin Tertiaire de Vienne. *Gide et Comp. Paris*. 1-303 pls 1-21.
- OVEY, C. D. 1948 (reprint 1950). Some ecological aspects of the foraminifera and their application to stratigraphy. *S. East Nat.* 53 : 39-47, 1 pl.
- PARFITT, E. 1878. On the structure of *Haliphysema tumanowiczii*. *Ann. Mag. nat. Hist. ser.* 5, 2 : 88-90.
- PARKER, F. L. 1948. Foraminifera of the Continental Shelf from the Gulf of Maine to Maryland. *Bull. Mus. comp. Zool. Harv.* 100 (2) : 213-241, 7 pls.
- 1952a. Foraminifera species off Portsmouth, New Hampshire. *Bull. Mus. comp. Zool. Harv.* 106 (9) : 391-423, 6 pls.
- 1952b. Foraminiferal distribution in the Long Island Sound—Buzzards Bay area. *Bull. Mus. comp. Zool. Harv.* 106 (10) : 428-473, 5 pls.
- 1954. Distribution of the foraminifera in the north eastern Gulf of Mexico. *Bull. Mus. comp. Zool. Harv.* 111 (10) : 453-588, pls 1-13.
- 1958. Eastern Mediterranean foraminifera. *Rep. Swed. deep Sea Exped.* 8 (Sediment cores from the Mediterranean Sea and the Red Sea 4) : 219-283, tabs.
- 1960. Living planktonic foraminifera from the equatorial and southeast Pacific. *Scient. Rep. Tohoku Univ. ser. 2, Spec. vol.* 4 : 71-82.
- 1962. Planktonic foraminiferal species in Pacific Sediments. *Microfaunaontology* 8 (2) : 219-254, pls 1-10.
- 1967. Late Tertiary Biostratigraphy (Planktonic Foraminifera) of Tropical Indo-Pacific Deep Sea Cores. *Bull. Am. Paleont.* 52 (235) : 115-208, pls 17-32.
- PARKER, F. L. & ATHEARN, W. D. 1959. Ecology of marsh foraminifera in Poponesset Bay, Massachusetts. *J. Paleont.* 33 (2) : 333-343, 5 tfs, 1 pl.
- PARKER, F. L., PHLEGER, F. B. & PEIRSON, J. F. 1953. Ecology of foraminifera from San Antonio Bay and environs, Southwest Texas. *Cushman Fdn. Foramin. Res., Spec. Pub* 2 : 1-75, pls 1-4, tfs 1-48, tabs 1-7.
- PARKER, W. K. (in DAWSON, G. M.). 1870. On Foraminifera from the Gulf and River St Lawrence. *Can. Naturalist n.s.* 5 : 172-180.
- PARKER, W. K. & JONES, T. R. 1857. Descriptions of some Foraminifera from the Coast of Norway. *Ann. Mag. nat. Hist. ser.* 2, 19 : 273-303, pls 10, 11.
- 1859. On the nomenclature of the Foraminifera. Pt. 2. On the species enumerated by Walker and Montagu. *Ann. Mag. nat. Hist. ser.* 3, 4 : 333-351.
- 1863. On the nomenclature of the foraminifera. Pt. 10. The species enumerated by d'Orbigny in the 'Annales des Sciences Naturelles', vol. 7, 1826. *Ann. Mag. nat. Hist. ser.* 3, 12 : 429-441.
- 1865. On some foraminifera from the North Atlantic and Arctic oceans including the Davis Straits and Baffin Bay. *Phil. Trans. R. Soc.* 155 : 325-441, pls 13-19, 12 tabs, map.
- PARKER, W. K., JONES, T. R. & BRADY, H. B. 1865. On the nomenclature of the foraminifera. Pt. 12 (misprinted as pt. X continued). The species enumerated by d'Orbigny in the 'Annales des Sciences Naturelles', vol. 7, 1826. *Ann. Mag. nat. Hist. ser.* 3, 16 : 15-41, pls 1-3.
- 1871. On the nomenclature of the foraminifera. Pt. 14. The species enumerated by d'Orbigny in the 'Annales des Sciences Naturelles', 1826, vol. 7 (continued from *Ann. Mag. nat. Hist. ser.* 3, 16 : 41). *Ann. Mag. nat. Hist. ser.* 4, 8 : 145-179; 238-266, pls 8-12.
- ARR, W. J. 1950. Foraminifera. *Rep. B.A.N.Z. Antarctic Res. Exped.* 1929-31 ser. B. (*Zool. & Bot.*), 5 (6) : 236-392, 13 pls, 8 tfs.
- EARCEY, F. G. 1881. Foraminifera. In: Herdman, W.A., Additional notes on the invertebrate fauna of Lamlash Bay, Isle of Arran. *Proc. R. phys. Soc., Edinb.* 6 : 17-30.

- PEARCEY, F. G. 1890. Notes on the foraminifera of the Faroe Channel and Wyville Thompson Ridge with a description of a new species of *Hyperammina*. *Proc. Trans. nat. Hist. Soc. Glasg.* n.s. **2** (1886-1888) : 163-179, pl. 3.
- 1891. Notes on the foraminifera dredged by the L.M.B.C. in Liverpool Bay during 1890. In: Herdman, W. A., 4th A. Rep. Puffin Isl. biol. Stat. and the L.M.B.C.; Append. *Proc. Trans. Lpool. biol. Soc.* **5** : 58-61.
- 1902. Notes on the marine deposits of the Firth of Forth and their relation to its animal life. *Proc. Trans. nat. Hist. Soc. Glasg.* n.s. **6** : 217-251, 1 map.
- 1914. Foraminifera of the Scottish National Antarctic Expedition. *Trans. R. Soc. Edinb.* **49**, pt. 4, (19) : 991-1044, 2 pls.
- PHLEGER, F. B. 1952a. Foraminifera ecology off Portsmouth, New Hampshire. *Bull. Mus. comp. Zool., Harv.* **106** (8) : 315-390, 26 tfs, 18 tabs.
- 1952b. Foraminifera distribution in some sediment samples from the Canadian and Greenland Arctic. *Contr. Cushman Fdn. Foramin. Res.* **3** (2) : 80-89, pls 13, 14, tab. and map.
- 1954. Ecology of Foraminifera and associated micro-organisms from Mississippi Sound and environs. *Bull. Am. Ass. Petrol. Geol.* **38** (4) : 584-647, pls 1-3, 28 tfs.
- 1955. Ecology of foraminifera in S.E. Mississippi Delta Area. *Bull. Am. Ass. Petrol. Geol.* **39** (5) : 712-752, 40 tfs.
- 1956. Significance of living foraminiferal populations along the Central Texas Coast. *Contr. Cushman Fdn. Foramin. Res.* **7** (4) : 106-151, 20 tfs, 11 tabs.
- 1960a. Sedimentary patterns of microfaunas in Northern Gulf of Mexico. In: *Recent Sediments, N.W. Gulf of Mexico 1951-1958*, pp. 267-381, pls 1-6, 16 tfs. Am. Ass. Petrol. Geol. Tulsa, Okla.
- 1960b. *Ecology and distribution of Recent foraminifera*. 297 pps, 11 pls, tfs 83. John Hopkins Press, Baltimore.
- 1965. Patterns of marsh foraminifera, Galveston Bay, Texas. *Limnol. Oceanogr.* **10** : R169-R184.
- 1966. Patterns of living marsh foraminifera in South Texas coastal lagoons. *Boln. Soc. Geol. mex.* **28** (1) : 1-44, tfs 1-22, 10 tabs.
- 1967. Marsh foraminiferal patterns, Pacific Coast of North America. *An. Inst. Biol. Univ. Mex.* 38. Ser. Cienc. Del. Mar Y Limnol. (1) : 11-38, tfs 1-19, 5 tabs.
- PHLEGER, F. B. & BRADSHAW, J. S. 1966. Sedimentary environments in a marine marsh. *Science N.Y.* **154** (3756) : 1551-1553.
- PHLEGER, F. B. & LANKFORD, R. L. 1957. Seasonal occurrences of living benthonic Foraminifera in some Texas Bays. *Contr. Cushman Fdn. Foramin. Res.* **8** (3) : 93-105, 6 tfs.
- PHLEGER, F. B. & PARKER, F. L. 1951. Ecology of foraminifera, northwest Gulf of Mexico. Pt. 2. Foraminifera Species. *Mem. geol. Soc. Am.* **46** : 1-64, pls 1-20.
- 1952. New names for North Western Gulf of Mexico, Foraminifera. *Contr. Cushman Fdn. Foramin. Res.* **3** (1) : 14.
- PHLEGER, F. B., PARKER, F. L. & PEIRSON, J. F. 1953. North Atlantic foraminifera. *Rep. Swed. deep Sea Exped.* **7** (1) : 3-122, pls 1-12, tfs 1-26.
- PHLEGER, F. B. & WALTON, W. R. 1950. Ecology of marsh and bay foraminifera, Barnstable, Mass. *Am. J. Sci.* **248** : 274-294.
- POLSKI, W. 1959. Foraminiferal biofacies of the North Asiatic coast. *J. Palaeont.* **33** (4) : 569-587, pl. 78, 8 tfs.
- READE, T. M. 1900. A contribution to post-glacial geology, Foraminifera of the Formby and Leasowe Marine Beds. *Geol. Mag.* **7** : 97-105, 1 pl.
- REISS, Z. 1959. The wall structure of *Cibicides*, *Planulina*, *Gyroidinoides* and *Globorotalites*. *Micropalaeontology* **5** (3) : 355-356, 1 pl.
- 1963. Reclassification of perforate Foraminifera. *Bull. geol. Surv. Israel* **35** : 1-111, pls 1-8.
- REISS, Z., KLUG, K. & MERLING, P. 1961. Recent Foraminifera from the Mediterranean and Red Sea coasts of Israel. *Bull. geol. Surv. Israel* **32** : 27-28.

- REUSS, A. E. 1844. *Geognostische Skizzen Bohem.* Prag, C. W. Medau, 2, 304 pps, 3 pls.  
 —— 1850. Neues Foraminiferen aus den Schichten des 'osterreichischen Tertiärbeckens. *K. Akad. Wiss. Wien. Math.-Naturw. Cl. 1* : 365-390, pls 46-51.  
 —— 1862. Entwurf einer systematischen Zusammenstellung der Foraminiferen. *K. Akad. Wiss. Wien. Math.-Naturw. Cl. 44* (1861) 1 : 395-396.  
 —— 1863. Die Foraminiferen-Familie der Lagenideen. *Sber. Akad. Wiss. Wien. math.-nat. Kl. 46* (1) : 308-342, pls 1-7.
- RHUMBLER, L. 1906. Foraminiferen von Laysan und den Chatham-Inseln. *Zool. Jb. 24* : 21-80, pls 2-5.  
 —— 1911. Die Foraminiferen (Thalamophoren) der Plankton—Expedition; Erster Teil: Die allgemeinen Organizationsverhältnisse der Foraminiferen. *Plankton—Exped. Humboldt-Stiftung. Ergeb., Kiel u. Leipzig* 3 (Lc) : 1-331, pls 1-39, tfs 1-110.  
 —— 1913. Die Foraminiferen (Thalamophoren) der Plankton—Expedition; Zweiter Teil; Systematik. *Plankton—Exped. Humboldt-Stiftung, Ergeb., Kiel u. Leipzig* 3 (Lc) : 333-476, tfs 111-175.  
 —— 1938. Foraminiferen aus dem Meeressand von Helgoland. *Kieler Meeresforsch.* 2 : 157-222, tfs 1-64.
- RISDAL, DAG. 1963. The foraminiferal fauna in some cores from inner Oslo Fjord. *Norg. geol. Unders.* 224 : 1-90, tfs 1-7.
- RISSE, A. 1826. *Histoire naturelle des principales productions de l'Europe Méridionale.* Paris. F. G. Levrault. 4 : 1-439, pls 1-12.
- ROBERTSON, D. 1870. 'Foraminifera' in Report of the Committee appointed to explore the marine fauna and flora of the South coast of Devon and Cornwall. No. 3. *Rep. Br. Ass. Advmt. Sci., (Exeter)* 1869, p. 91.  
 —— 1877. Notes on the Recent Ostracoda and foraminifera of the Firth of Clyde with some remarks on the distribution of the Mollusca. *Trans. geol. Soc. Glasg.* 5 : 112-153, tab.  
 —— 1883. Report on the sands and gravels and boulder clays in the top silt at Dock F of the Atlantic Docks, Liverpool. Appendix to T. M. Reade: The Drift Beds of the Northwest of England and North Wales. *Q. J. geol. Soc. Lond.* 39 : 129-132.  
 —— 1892. List of foraminifera dredged in Portree Bay, Island of Skye. *Proc. Trans. nat. Hist. Soc. Glasg. n.s.* 3 : 239-242.  
 —— 1901. Foraminifera. In: *Fauna, flora and geology of the Clyde area.* British Assoc. Handb., pp. 376-383.
- ROBERTSON, D. & BRADY, G. S. 1876. Report on the dredging off the coast of Durham and North Yorkshire in 1874. *Rep. Br. Ass. Advmt. Sci., (Bristol)* 1875, pp. 185-199.
- RONAI, P. H. 1955. Brackish water foraminifera of the New York Bight. *Contr. Cushman Fdn. Foramin. Res.* 6 (4) : 140-149, pls 20, 21, 1 tab.
- RUSCELLI, M. 1949. Foraminiferi di Due saggi di Fondo del Mar Ligure. *Inst. Geol. Pal. Geog. Fis. Univ. Studi Milano Ser. P.* 62 : 1-31, 2 pls.
- RUTTEN, L. & HOTZ, W. 1946. Geological, Petrographical and Palaeontological Results of exploration carried out from September 1917 until June 1919 on the Island of Ceram. *J. de Bussy*, ser. 3 (Geol.) 2 (*J. H. Germeraad Geology of Central Ceram.*) : 42-79, 4 tabs, 6 pls.
- RZEHAK, A. 1888. Die Foraminiferen der Nummulitenschichten des Waschberges und Michelsberges bei Stockerau in Nieder-Oesterreich. *Verh. geol. Reichsanst. (St Anst./ Landesanst.), Wien*, pp. 226-229.
- AID, R. 1949. Foraminifera of the Northern Red Sea. *Spec. Publs. Cushman Lab.* 26 : 1-44, 4 pls.  
 —— 1951. Foraminifera of Narragansett Bay. *Contr. Cushman Fdn. Foramin. Res.* 2 (3) : 75-86, 4 tfs.  
 —— 1953. Foraminifera of Great Pond, East Falmouth, Massachusetts. *Contr. Cushman Fdn. Foramin. Res.* 4 (1) : 7-14, 3 tfs.
- AID, R. & KAMEL, T. 1957. The distribution of foraminifera in the Egyptian Mediterranean Coast. *Egypt. J. Geol.* 1 (2) : 132-155, 2 tfs, 2 tabs.

- SARS, M. 1865. Om de i Norge forekommende Fossile Dyrelevninger fra Quataerperioden. Et Bidrag til vor Faunas Historie. *Universitets program, for første halvaar*, 1864.
- SAUNDERS, J. B. 1958. Recent Foraminifera of Mangrove Swamps and river estuaries and their fossil counterparts in Trinidad. *Micropaleontology* 4 (1) : 79-92, pls 1, 2, 3 tfs.
- SCHLUMBERGER, C. 1886. Note sur le genre *Adelosina*. *Bull. Soc. zool. Fr.* 11 : 544-557, pl. 16.
- 1887. Note sur les *Biloculina bulloides* d'Orbigny et *Biloculina ringens* Lamarck. *Bull. Soc. géol. Fr. ser. 3*, 15 (1887-1888) (7) : 573-584, pl. 15.
- 1893. Monographie des Miliolidées du Golfe de Marseille. *Mém. Soc. zool. Fr.* 6 : 57-80, pls 1-4, tfs 1-37.
- SCHNITKER, D. 1969. *Cibicides, Caribeanella* and the polyphyletic origin of *Planorbulina*. *Contr. Cushman Fdn. Foramin. Res.* 20 (2) : 67-69, pls 14, 15, tfs 1-4.
- SCHULTZE, M. S. 1854. Über den Organismen der Polythalamien (Foraminiferen) nebst Bemerkungen über die Rhizopoden im allgemeinen. Leipzig, Engelmann, 68 pps, 7 pls.
- SCHWAGER, C. 1877. Quadro del proposto sistema di classificazione dei foraminifericon guscio Italy. *Boll. R. Com. geol. Ital.* 8 : 18-27, pl. 1.
- SCOTT, J. 1966. The foraminifera of a core from Tremadoc Bay, North Wales. Unpublished M.Sc. thesis, Univ. Coll. of Wales.
- SEGURA, L. R. 1963. Sistematica y distribucion de los Foraminiferos litorales de la 'Playa Washington al sureste de Matamaros, Tamaulipas, Mexico. *Boln. Inst. Geol. Mex.* 68 (1963) : 1-92, tfs 1-42.
- SHIFFLET, E. 1961. Living, dead and total foraminiferal faunas Heald Bank, Gulf of Mexico. *Micropalaontology* 7 (1) : 45-54, 3 tfs.
- SIDDALL, J. D. 1876. On the foraminifera of the River Dee. *Ann. Mag. nat. Hist. ser. 4*, 17 : 37-47.
- 1878. On the foraminifera of the River Dee. *Rep. Chester Soc. nat. Sci.* 2 : 42-56.
- 1886. Report on the foraminifera of the Liverpool Bay District in Herdman, Fauna of Liverpool Bay. *Proc. Lit. phil. Soc. Lpool.* 40 : 42-71.
- SIDDALL, J. D. assisted by BRADY, H. B. 1879. *Catalogue of Recent British Foraminifera for the use of collectors*. G. R. Griffith, Chester, 10 pages.
- SIDEBOTTOM, H. 1904. Report on the Recent foraminifera from the coast of the Island of Delos. Pt. I. *Mem. Proc. Manchr. lit. phil. Soc.* 48 (5) : 1-26, pls 2-5.
- 1912. Lagenae of the south west Pacific Ocean. *J. Quekett microsc. Soc.* 2 : 375-434, pls 14-21.
- 1918. Report on the Recent foraminifera dredged off the east coast of Australia, H.M.S. 'Dart', Station 19 (May 14, 1895); Lat. 29°22'S., Long. 153°51'E., 465 fathoms. Pteropod Ooze. *Jl. R. microsc. Soc.* 1-25, pls 1, 2; 121-152, pls 3-5; 249-264, pls 5, 6.
- SILVESTRI, A. 1901. Appunti sui rizopodi reticolari della Sicilia; Ser. 1. *Atti Rc. Accad. dafnica Acireale* n.s. 10 (1898-1900) 7 : 1-50, pl. 1.
- 1903. Dimorfismo e nomenclatura d'una *Spiroplecta*. Altre notizie sulla struttura della *Siphogenerina columellaris*. *Atti Accad. pontif. Nuovi Lincei* 56 (1902-1903) : 59-66, tfs 1-9.
- 1923. Micro-fauna pliocenica a Rizopoda reticolari di Capocolle presso Forli. *Atti Accad. pontif. Nuovi Lincei* 76 : 70-71.
- SKINNER, H. C. 1961. Revision of *Proteonina diffugiformis*. *J. Paleont.* 35 (6) : 1239.
- SLITER, W. V. 1970. Inner-neritic Bolivinitidae from the eastern Pacific margin. *Micropaleontology* 16 (2) : 155-174, pls 1-8.
- SOLDANI, A. 1795. *Testaceographiae ac Zoophytopgraphiae parvae et microscopicae* 1 (3) : 201-289, pls 143-179, Senis.
- STOLL, N. R. et al. 1961. *International Code of Zoological Nomenclature adopted by the XV International Congress of Zoology, London, 1958*. Int. Trust for Zool. Nomen., Lond., I-XVIII, 1-176 pp.
- STUBBINGS, H. G. 1939. The marine deposits of the Arabian Sea. An investigation into their distribution and biology. *Rep. John Murray Exped. (Br. Mus. nat. Hist.)* 3 (2) : 31-158, 4 pls, 4 chts, 5 tfs, 17 tabs.

- TERQUEM, O. 1875. *Essai sur le classement des animaux qui vivent sur la plage et dans les environs de Dunkerque*. Pt. 1, pp. 1-54, pls 1-6.
- 1876. *Essai sur le classement des animaux qui vivent sur la plage et dans les environs de Dunkerque*. Pt. 2, pp. 55-100, pls 7-12.
- 1877. Essai sur le classement des animaux qui vivent sur la plage et dans les environs de Dunkerque; Deuxième fascicule. *Mém. Soc. dunkerq. Encour. Sci.* **20** (1875-1876) : 146-191, pls 7-12.
- 1878. Les foraminifères et les entomostracés ostracodes du Pliocène supérieur de l'Île de Rhodes. *Mém. géol. Soc. Fr. Ser. 3*, 1 (3) : 1-135, pls 1-14.
- 1880. Essai sur le classement des animaux qui vivent sur la plage et dans les environs de Dunkerque; Troisième fascicule. *Mém. Soc. dunkerq. Encour. Sci.* **21** : 25-77, pls 13-17.
- THALMANN, H. E. 1932. Nomenclator (Um—and Neubenennungen) zu den Tafeln 1 bis 115 in H. B. Brady's Werk über die Foraminiferen der Challenger—Expedition, London, 1884. *Ectog. geol. Helv.* **25** : 293-312.
- TODD, R. 1958. Foraminifera from the Western Mediterranean deep sea cores. *Rept. Swed. deep sea Exped.* **8** (Sediment cores from the Mediterranean Sea and the Red Sea. 3) : 169-215, tabs.
- 1965. The foraminifera of the Tropical Pacific collections of the 'Albatross', 1899-1900, Pt. 4. Rotaliform Families and Planktonic Families. *Bull. U.S. natn. Mus.* **161** : 1-127, pls 1-28, 5 tabs.
- TODD, R. & BRONNIMAN, P. 1957. Recent Foraminifera and Thecamoebina from the Eastern Gulf of Paria. *Spec. Publs. Cushman Fd.* **3** : 1-43, 12 pls, 5 tabs, 7 tfs.
- TODD, R. & LOW, D. 1961. Nearshore Foraminifera of Martha's Vineyard, Mass. *Contr. Cushman Fdn. Foramin. Res.* **12** (1) : 5-21, pls 1, 2, tab.
- TOWE, K. M. & CIFELLI, R. 1967. Wall ultrastructure in the calcareous foraminifera: crystallographic aspects and a model for calcification. *J. Paleont.* **41** (3) : 742-762, pls 87-99.
- TROELSEN, J. C. 1954. Studies on Ceratobuliminidae (Foraminifera). *Meddr. dansk. geol. Foren.* **12** : 448-478.
- UCHIO, T. 1959. Ecology of shallow water foraminifera off the coast of Noboribetsu, southwestern Hokkaido, Japan. *Publs. Seto. mar. biol. Lab.* **7** : 295-302.
- 1960. Ecology of living benthonic foraminifera from San Diego, California. *Spec. Publs. Cushman Fdn.* **5** : 5-72, pls 1-10, tabs 1-9, tfs 1-18.
- 1962. Influence of the River Shinano on foraminifera and sediment grain size distributions. *Publs. Seto mar. biol. Lab.* **10** (2) : 363-392, pl. 18, tfs 1-14, tabs.
- VASILENKO, V. P. 1954. Anomalinidye. Iskopаемые foraminifery SSSR. *VNIGRI, Trudy n.s.* **80** : 1-282, pls 1-36, tfs 1-42.
- VELLA, P. 1957. Studies in New Zealand Foraminifera. Pt. 1. Foraminifera from Cook Strait. Pt. 2. Upper Miocene to Recent species of the genus *Notorotalia*. *Paleont. Bull., Wellington* **28** : 5-64, pls 1-9, tfs 1-3, tabs 1-7.
- VILKS, G. 1969. Recent foraminifera in the Canadian Arctic. *Micropaleontology* **15** (1) : 35-60, pls 1-3.
- VOORTHUYSEN, J. H. VAN. 1950. The quantitative distribution of the Pleistocene, Pliocene and Miocene Foraminifera of a boring at Zaandam (Netherlands). *Meded. geol. Sticht. n.s.* **4** : 51-72, pls 1-4, tfs 1-6, tabs.
- 1951. Recent (and derived Upper Cretaceous) foraminifera of the Netherlands Wadden Sea (tidal flats). *Meded. geol. Sticht. n.s.* **5** : 23-32, 2 pls, 1 map.
- 1957. Foraminiferen aus dem Eemien (Riss-Wurm interglazial) in der Bohrung Amersfoort 1 (*Locus typicus*). *Meded. geol. Sticht. n.s.* **11** : 27-39, pls 23-26.
- 1960. Die foraminiferen des Dollart-Ems Estuarium. *Verh. K. ned. geol.—mijnb. Genoot.* **19** : 237-269, pls 10, 11.
- WADE, M. 1957. Morphology and taxonomy of the foraminiferal family Elphidiidae. *J. Wash. Acad. Sci.* **47** (10) : 330-339, 4 tfs.
- WAGNER, F. J. E. 1962. Faunal report, a submarine geology program, Polar Continental Shelf Project, Isachsen, District of Franklin. *Geol. Surv. Pap. Can.* **61-27** : 1-10, 2 tfs, 2 tabs.

- WALKER, G. & BOYS, W. 1784. *Testacea minuta rariova nuperrime detecta in arena littoris Sandvicensis (A collection of the minute and rare shells lately discovered in the sand of the sea shore near Sandwich).* - G. Walker, Lond., printed by J. March, 25 pps, 3 pls.
- WALKER, G. & JACOB, E. 1798. In Adams, G., *Essays on the microscope, containing a practical description of the most improved microscopes; a general history of Insects. A description of 383 animalcula etc.* 2nd Edition with considerable additions and improvements by F. Kanmacher, Dillon and Keating, Lond., 712 pps, 32 pls.
- WALLER, E. 1868. Report on the foraminifera obtained in the Shetland Seas. In: Preliminary report on the Crustacea, Molluscoidea, Echinodermata and Coelenterata by the Shetland Dredging Committee in 1867. Rev. A. M. Norman. *Rep. Br. Ass. Advmt. Sci.* (Dundee 1867) **37** : 441-446.
- WALLER, H. O. 1960. Foraminiferal Biofacies off the South China Coast. *J. Paleont.* **34** (6) : 1164-1182, 15 tfs.
- WALTON, W. R. 1955. Ecology of living benthonic Foraminifera, Todos Santos Bay, Baja, California. *J. Paleont.* **29** (6) : 952-1018, 6 pls, 24 tfs.
- WARREN, A. D. 1957. Foraminifera of the Buras—Scofield Bayou Region, S.E. Louisiana. *Contr. Cushman Fdn. Foramin. Res.* **8** (1) : 29-40, 4 pls, 1 tf.
- WATKINS, J. G. 1961. Foraminiferal ecology around the Orange County, California, ocean sewer outfall. *Micropalaeontology* **7** (2) : 199-206, 15 tfs.
- WHATLEY, R. C. & WALL, D. R. 1969. A preliminary account of the ecology and distribution of Recent Ostracoda in the Southern Irish Sea. In: *The Taxonomy, Morphology and Ecology of Recent Ostracoda*. Ed. J. W. Neale. Oliver & Boyd, Edinburgh, pp. 268-298.
- WHITE, W. R. 1956. Pliocene and Miocene Foraminifera from the Capistrano Formation, Orange County, California. *J. Paleont.* **30** (2) : 237-260, 6 pls, 2 tfs, 2 tabs.
- WIESNER, H. 1912. Zur Systematik adriatischer Nubecularien, Spiroloculinen, Miliolinien und Biloculinen. *Arch. Protistenk.* **25** : 201-239.
- 1923. *Die Milioliden der östlichen Adria.* 113 pp., 20 pls. The Author, Prag-Bubenc.
- 1931. Die Foraminiferen der deutschen Südpolar-Expedition 1901-1903. In: *Drygalski, E. von, Deutsche Südpolar-Expedition 1901-1903.* Berlin u. Leipzig, Deutschland, de Gruyter, 1931, **20** (Zool. 12) : 53-169.
- WILLIAMSON, W. C. 1848. On the Recent British species of the genus *Lagena*. *Ann. Mag. nat. Hist.* ser. **2**, 1 : 1-20, pls 1, 2.
- 1858. On the Recent Foraminifera of Great Britain. Ray Soc. Lond., xx + 107 pps, 7 pls.
- WISEMAN, J. D. H. & OVEY, C. D. 1950. Recent investigations on the deep-sea floor. *Proc. Geol. Ass.* **61** (1) : 28-84, 2 pls.
- WOOD, A. 1949. The structure of the wall of the test in the Foraminifera; its value in classification. *Q. Jl. geol. Soc. Lond.* **104** : 229-255, pls 13-15.
- WOOD, A., ADAMS, T. D. & HAYNES, J. 1963. The structure of *Ammonia beccarii* (Linné). *Contr. Cushman Fdn. Foramin. Res.* **14** (4) : 156-157, pl. 15.
- WOOD, A. & BARNARD, T. 1946. *Ophthalmidium*—a study of nomenclature, variation and evolution in the Foraminifera. *Q. Jl. geol. Soc.* **102** (2) : 77-113, pls 1-10.
- WOOD, A. & HAYNES, J. 1957. Certain smaller British Palaeocene foraminifera. Pt. 2. *Cibicides* and its allies. *Contr. Cushman Fdn. Foramin. Res.* **8** : 45-53, pls 5, 6.
- WOOD, S. V. 1842. A catalogue of shells from the Crag. *Ann. Mag. nat. Hist.* **9** : 455-462.
- WORTH, R. H. 1900. The commoner foraminifera of the English Channel from the Hand Deep to Start Point at or near the 30 fathom line. *Rep. Trans. Devon. Ass. Advmt. Sci.* **32** : 491-502.
- 1902. The foraminifera of the Exe Estuary. *J. mar. biol. Ass. U.K. n.s.* **6** : 336-343.
- 1904. Foraminifera in Plymouth Marine Investigation of fauna, pp. 155-298. *J. mar. biol. Ass. U.K. n.s.* **7** : 174-185.
- WRIGHT, J. 1877. Recent foraminifera of Down and Antrim. *Proc. Belf. Nat. Fl. Club* (1876-77) **4** : 101-105, pl. 4, tab.
- 1889. Report of a deep sea trawling cruise off the south west coast of Ireland. *Ann. Mag. nat. Hist.* ser. **6**, 4 : 447-449.

- WRIGHT, J. 1890. Deep sea trawling off the south west coast of Ireland. Additional Foraminifera. *Ann. Mag. nat. Hist. ser.* **6**, 5 : 24.
- 1891. Report on the foraminifera obtained off the south west of Ireland during the cruise of the 'Flying Falcon', 1888. *Proc. R. Ir. Acad. ser.* **3**, 1 : 460–502 pl. 1.
- 1895. Foraminifera of Dogs Bay. Preliminary list in: Report of the Conference and Excursions held at Galway. July 11th–17th, 1895. *Ir. Nat.* **4** : 252–253.
- 1900. The foraminifera of Dogs Bay, Connemara. *Ir. Nat.* **9** : 51–55, pl. 2.
- 1901. The foraminifera of the Pleistocene Clay of Boveagh, County Derry. *Proc. Belf. Nat. Fld. Club* (1900–1901) **4** : 603–605.
- 1902a. Some foraminifera from Rathlin Island. *Ir. Nat.* **11** : 211–213, pl. 3.
- 1902b. Foraminifera of the Pleistocene Clay, Shellag. *Lioar Manninagh.* **3** : 627–629.
- 1907. 'Foraminifera' in: Contributions to the Natural History of Lambay, Co. Dublin. *Ir. Nat.* **16** : 88–89.
- 1911. Foraminifera from the estuarine clays of Maghera-morne, County Antrim and Limavady Station, County Derry. *Proc. Belf. Nat. Fld Club* (1910–1911) : 11–20, pl. 2.
- ZALESNEY, E. R. 1959. Foraminiferal ecology of Santa Monica Bay, California. *Micro-palaeontology* **5** (1) : 101–126, 1 pl., 21 tfs, 1 tab.

#### IX. INDEX TO FAMILIES, GENERA, SPECIES AND VARIETIES DESCRIBED

*New Taxonomic names in bold type*

- aberdoveyensis*, *Ammonia*, 184; Pl. 18, fig. 15
- acutimargo* var. *emaciatum*, *Spiropthalmidium*, 50; Pl. 9, fig. 16
- Ammobaculites*, 25
- balkwilli*, 25; Pl. 2, figs 2, 3, Pl. 29, figs 5, 6
- Ammonia*, 184
- aberdoveyensis*, 184; Pl. 18, fig. 15
- batavus*, 187; Pl. 18, figs 5, 6, 14, 16
- limnetes*, 189; Pl. 18, figs 7–9, pl. 19, fig. 8, pl. 30, fig. 8
- tepidia*, 191; Pl. 18, fig. 17, pl. 30, fig. 7
- anglicum*, *Protelphidium*, 216; Pl. 22, figs 15, 16, pl. 23, figs 1, 2, pl. 27, figs 6–9
- angulosa*, *Trifarina*, 126; Pl. 10, figs 12, 13, 16, 17, pl. 11, fig. 11
- anomala*, *Rosalina*, 151; Pl. 17, figs 1–3, pl. 19, fig. 2, pl. 30, figs 1, 2
- aspera*, *Quinqueloculina*, 63; Pl. 7, figs 1–3, pl. 8, fig. 2, pl. 31, figs 1–5
- ASTERIGERINIDAE, 164
- Asterigerinata*, 164
- mamilla*, 164; Pl. 18, figs 1–4, pl. 19, figs 7, 9
- asterotuberculatum*, *Elphidium*, 197; Pl. 22, fig. 7
- astrifica*, *Trochammina*, 34; Pl. 4, figs 18–20
- ASTRORHIZIDAE, 14
- ATAXOPHRAGMIIDAE, 44
- arctica*, *Reophax*, 22; Pl. 3, figs 8–12, pl. 6, figs 4, 5, 7
- arenulata*, *Lagenammina*, 19; Pl. 2, fig. 17, pl. 8, fig. 12
- auberiana* var. A, *Quinqueloculina*, 65; Pl. 7, fig. 15
- auberiana* var. B, *Quinqueloculina*, 66; Pl. 7, figs 6, 7
- auricula*, *Nonionella*, 211
- balkwilli*, *Ammobaculites*, 25; Pl. 2, figs 2, 3, pl. 29, figs 5, 6
- batavus*, *Ammonia*, 187; Pl. 18, figs 5, 6, 14, 16
- bicornis*, *Quinqueloculina*, 67; Pl. 7, fig. 18
- bilobata*, *Biorbulina*, 180; Pl. 20, fig. 5
- Biorbulina*, 180
- bilobata*, 180; Pl. 20, fig. 5
- bocki*, *Textilina*, 47; Pl. 3, figs 6, 7, pl. 8, fig. 8
- Bolivina*, 128
- britannica*, 128
- inflata*, 130
- minima*, 130
- cf. *minima*, 131
- ordinaria*, 131
- pseudoplicata*, 132; Pl. 10, fig. 3, pl. 11, fig. 7
- pseudopunctata*, 134; Pl. 10, fig. 4, pl. 11, figs 4–6
- spathulata*, 135
- striatula*, 137; Pl. 10, fig. 1, pl. 11, fig. 1
- superba*, 138; Pl. 10, fig. 5, pl. 11, figs 2, 3
- cf. *vadescens*, 139; Pl. 10, fig. 7, pl. 11, fig. 9
- variabilis*, 141; Pl. 10, fig. 8, pl. 11, fig. 8
- BOLIVINITIDAE, 128

- borealis**, *Buliminella*, 114  
*borealis*, *Oolina*, 105; Pl. 14, fig. 6  
*bradyi*, *Hemisphaerammina*, 21; Pl. 6, figs 1, 2  
*bradyi*, *Rosalina* cf., 153; Pl. 17, figs 4, 5,  
 pl. 19, figs 1, 3, 6  
*britannica*, *Bolivina*, 128  
*Buccella*, 193  
*frigida*, 193; Pl. 18, fig. 13  
*Bulimina*, 116  
*elongata*, 116; Pl. 10, fig. 9, pl. 11, fig. 10  
*elongata lesleyae*, 119; Pl. 10, fig. 6  
*elongata subulata*, 120; Pl. 10, figs 10, 15  
*gibba*, 121; Pl. 10, fig. 14  
*marginata*, 122; Pl. 10, fig. 18  
*Buliminella*, 114  
**borealis**, 114  
**BULIMINIDAE**, 116
- Cancris*, 145  
*oblongus*, 145; Pl. 20, fig. 13, pl. 23, figs 5, 6  
*carinata*, *Massilina*, 52; Pl. 5, figs 1, 2  
*carinata*, *Pygro*, 59; Pl. 9, fig. 17  
*Cassidulina*, 194  
 cf. *reniforme*, 194  
**CASSIDULINIDAE**, 194  
*Cibicides*, 171  
*fletcheri*, 171  
*fletcheri sachalinica*, 172; Pl. 21, figs 1, 2  
*lobatulus*, 173; Pl. 20, figs 1, 2, pl. 21, figs 3,  
 5, 6, pl. 33, figs 1-7  
**CIBICIDIDAE**, 171  
*clavata*, *Lagena*, 81; Pl. 12, fig. 1, pl. 13, fig. 1  
*cliarensis*, *Quinqueloculina* cf., 68; Pl. 7,  
 figs 8, 9  
*cliarensis* var. A, *Quinqueloculina* cf., 70;  
 Pl. 9, fig. 5  
*concameratus*, *Eponides repandus*, 168; Pl. 18,  
 figs 10-12  
*concava*, *Laryngosigma lactea*, 104  
*constricta*, *Pyrgo* cf., 60; Pl. 9, figs 11, 12  
*corrugata*, *Patellina*, 142; Pl. 15, fig. 12,  
 pl. 16, figs 7-9  
*Cribrostomoides*, 29  
*jeffreysii*, 29; Pl. 2, figs 5, 6, pl. 8, fig. 9,  
 pl. 29, fig. 10  
*cuvillieri*, *Elphidium*, 197; Pl. 24, figs 17, 18  
*Cyclogyra*, 48  
*selseyensis*, 48; Pl. 9, fig. 15, pl. 29, fig. 4  
  
*Dentalina*, 80  
 cf. *trondheimensis*, 80; Pl. 16, fig. 11  
*depressa*, *Spiroloculina*, 78; Pl. 9, figs 6, 7  
*depressulus*, *Nonion*, 209; Pl. 22, figs 8, 11,  
 pl. 29, fig. 9
- DISCORBIDAE**, 145  
*Discorbinella*, 149  
 species A, 149  
*Discorbis*, 147  
*wrightii*, 147; Pl. 16, figs 12-16, pl. 19, fig. 5,  
 pl. 30, figs 4, 5  
*distoma*, *Planorbulina*, 177; Pl. 20, figs 10-12,  
 pl. 21, figs 4, 7, 8  
*doveyensis*, *Lagena*, 82; Pl. 12, figs 7, 8  
*duthiersi*, *Quinqueloculina*, cf. 70; Pl. 7,  
 figs 22, 23  
*earlandi*, *Spiroplectammina*, 31; Pl. 3, fig. 5,  
 pl. 8, fig. 11  
*Eggerelloides scabrum*, 44; Pl. 2, figs 7, 8,  
 pl. 19, figs 10, 11  
*Elliptica*, *Fissurina*, 94; Pl. 14, fig. 5  
*Elphidium*, 197  
*asterotuberculatum*, 197; Pl. 22, fig. 7  
*cuvillieri*, 197; Pl. 24, figs 17, 18  
**exoticum**, 198; Pl. 24, figs 8, 9, pl. 26,  
 figs 2, 3, 6, 8, pl. 28, figs 1-4  
*incertum*, 199; Pl. 22, fig. 6, pl. 24, figs 14-  
 16, pl. 28, figs 8, 9  
*macellum*, 201; Pl. 24, figs 1-3, pl. 25,  
 figs 1-5, 7, 8, pl. 27, figs 4, 5  
*magellanicum*, 202; Pl. 22, fig. 5, pl. 24,  
 figs 5, 6, pl. 26, fig. 11, pl. 28, figs 5-7  
*margaritaceum*, 203; Pl. 24, figs 12, 13,  
 pl. 29, fig. 8  
*selseyense*, 204; Pl. 22, figs 3, 4, pl. 24,  
 fig. 11, pl. 26, figs 4, 5, 7, 9, 10, pl. 29,  
 figs 1-3  
*waddensis*, 206; Pl. 24, figs 4, 10, pl. 26,  
 fig. 1, pl. 28, figs 10, 11  
**williamsoni**, 207; Pl. 24, fig. 7, pl. 25, figs  
 6, 9, pl. 27 figs 1-3  
*elongata*, *Bulimina*, 116; Pl. 10, fig. 9, pl. 11,  
 fig. 10  
*elongata lesleyae*, *Bulimina*, 119; Pl. 10, fig. 6  
*elongata subulata*, *Bulimina*, 120; Pl. 10,  
 figs 10, 15  
*elongata*, *Marsipella*, 16; Pl. 3, fig. 14  
**emaciatum**, *Spirophthalmidium acutimargo*  
 50; Pl. 9, fig. 16  
*Epistominella*, 217  
*naraensis*, 217; Pl. 20, fig. 14, pl. 23, figs 7, 8  
*Eponides*, 168  
*repandus concameratus*, 168; Pl. 18, figs 10-  
 12  
**EPONIDIDAE**, 168  
**exoticum**, *Elphidium*, 198; Pl. 24, figs 8, 9,  
 pl. 26, figs 2, 3, 6, 8, pl. 28, figs 1-4
- FISCHERINIDAE**, 48

- Fissurina*, 94  
*elliptica*, 94; Pl. 14, fig. 5  
*lucida*, 95; Pl. 14, figs 1, 2  
*marginata*, 97  
 species A, 98; Pl. 14, figs 3, 4  
 species B, 99  
*fletcheri*, *Cibicides*, 171  
*fletcheri sachalinica*, *Cibicides*, 172; Pl. 21,  
 figs 1, 2  
*frigida*, *Buccella*, 193; Pl. 18, fig. 13  
*fusca*, *Miliammina*, 54; Pl. 2, figs 9, 10,  
 pl. 31, figs 6, 7  
*fusiformis*, *Reophax*, 23; Pl. 3, figs 3, 4  
*fusiformis*, "Stainforthia", 124; Pl. 5, figs 7, 8
- georgiana*, *Siphonina*, 167; Pl. 20, figs 15,  
 16, pl. 23, fig. 9, pl. 33, fig. 10  
*gibba*, *Bulimina*, 121; Pl. 10, fig. 14  
**GLOBIGERINIDAE**, 180  
*globigeriniformis* var. *pygmaea*, *Trochammina*,  
 36; Pl. 4, fig. 14  
*Globoquadrina*, 181  
*hexagona*, 181; Pl. 20, figs 7–9, pl. 21, fig. 12  
*Globorotalia*, 182  
*inflata*, 182; Pl. 20, figs 3, 4, pl. 21, figs 10, 11  
*Globulina*, 99  
 cf. *inaequalis*, 99; Pl. 15, fig. 11  
*Guttulina*, 100  
*harrisi*, 100
- Halyphysema*, 14  
*tumanowiczii*, 14; Pl. 1, fig. 6, pl. 3, fig. 13  
*hancocki*, *Lagenammina* cf., 20; Pl. 2, figs 11,  
 12, pl. 8, fig. 10  
*Haplophragmoides*, 27  
*wilberti*, 27; Pl. 2, fig. 1, pl. 29, fig. 7  
 species A, 28  
*harrisi*, *Guttulina*, 100  
*haynesi*, *Trochammina*, 35  
*helgolandica*, *Remaneica*, 43; Pl. 5, fig. 19,  
 pl. 6, fig. 6  
*Hemisphaerammina*, 21  
*bradyi*, 21; Pl. 6, figs 1, 2  
*heronalleeni*, *Oolina*, 106; Pl. 14, fig. 7  
*hexagona*, *Globoquadrina*, 181; Pl. 20, figs 7–9,  
 pl. 21, fig. 12  
*hexagona*, *Oolina*, 107; Pl. 14, figs 12, 13,  
 pl. 15, figs 3, 6  
*hibernica*, *Lagena*, 83; Pl. 12, figs 16, 17  
*Hippocrepina*, 15  
 species A, 15; Pl. 2, fig. 4
- HORMOSINIDAE**, 22  
*hyalascidia*, *Laryngosigma*, 102  
*inaequalis*, *Globulina* cf., 99; Pl. 15, fig. 11
- incertum*, *Elphidium*, 199; Pl. 22, fig. 6,  
 pl. 24, figs 14–16, pl. 28, figs 8, 9  
*inflata*, *Bolivina*, 37  
*inflata*, *Globorotalia*, 182; Pl. 20, figs 3, 4,  
 pl. 21, figs 10, 11  
*inflata*, *Trochammina*, 37; Pl. 4, figs 15–17,  
 pl. 6, fig. 3  
*intermedia*, *Trochammina*, 39; Pl. 4, figs 9–13,  
 pl. 6, fig. 9  
*interrupta*, *Lagena sulcata*, 92; Pl. 12, fig. 10  
*intricata*, *Quinqueloculina*, 71; Pl. 7, figs 16,  
 17  
*irregularis*, *Rosalina*, 154
- Jadammina*, 41  
*macrescens*, 41; Pl. 1, fig. 5, pl. 2, figs 14–16  
*jeffreysii*, *Cribrostomoides*, 29; Pl. 2, figs 5, 6,  
 pl. 8, fig. 9, pl. 29, fig. 10
- lactea*, *Laryngosigma*, 103  
*lactea concava*, *Laryngosigma*, 104  
*laevigata*, *Oolina*, 108; Pl. 14, fig. 11  
*laevis*, *Lagena*, 84; Pl. 12, fig. 2  
*Lagena*, 81  
*clavata*, 81; Pl. 12, fig. 1, pl. 13, fig. 1  
*doveyensis*, 82; Pl. 12, figs 7, 8  
*hibernica*, 83; Pl. 12, figs 16, 17  
*laevis*, 84; Pl. 12, fig. 2  
*pacifica*, 85; Pl. 12, fig. 15, pl. 13, figs 2, 3  
*perlucida*, 86; Pl. 12, fig. 5, pl. 13, fig. 5  
*semistriata*, 87; Pl. 12, fig. 6, pl. 13, fig. 4  
*spicata*, 88; Pl. 12, fig. 13  
 cf. *striata*, 89; Pl. 12, fig. 12, pl. 13, figs 7, 8  
*substriata*, 89; Pl. 12, fig. 11, pl. 13, figs 6, 11  
*sulcata*, 90; Pl. 12, fig. 9, pl. 13, fig. 10  
*sulcata interrupta*, 92; Pl. 12, fig. 10  
*sulcata torquiformis*, 93; Pl. 12, fig. 14,  
 pl. 13, figs 9, 12  
 species A, 94; Pl. 12, figs 3, 4
- Lagenammina*, 19  
*arenulata*, 19; Pl. 2, fig. 17, pl. 8, fig. 12  
 cf. *hancocki*, 20; Pl. 2, figs 11, 12, pl. 8,  
 fig. 10
- Laryngosigma*, 102  
*hyalascidia*, 102  
*lactea*, 103  
*lactea concava*, 104  
*lata*, *Quinqueloculina*, 72; Pl. 7, figs 10–13  
*lesleyae*, *Bulimina elongata*, 119; Pl. 10, fig. 6  
*limnetes*, *Ammonia*, 189; Pl. 18, figs 7–9,  
 pl. 19, fig. 8, pl. 30, fig. 8  
*lineata*, *Oolina*, 109; Pl. 14, figs 8–10
- LITUOLIDAE**, 25

- lobatulus*, *Cibicides*, 173; Pl. 20, figs 1, 2, pl. 21, figs 3, 5, 6, pl. 33, figs 1-7  
*loeblichi*, *Stainforthia concava* var., 123; Pl. 5, fig. 10  
*lucida*, *Fissurina*, 95; Pl. 14, figs 1, 2
- macellum*, *Elphidium*, 201; Pl. 24, figs 1-3, pl. 25, figs 1-5, 7, 8, pl. 27, figs 4, 5  
*macrescens*, *Jadammina*, 41; Pl. 1, fig. 5, pl. 2, figs 14-16  
*magellanicum*, *Elphidium*, 202; Pl. 22, fig. 5, pl. 24, figs 5, 6, pl. 26, fig. 11, pl. 28, figs 5-7  
*mamilla*, *Asterigerinata*, 164; Pl. 18, figs 1-4, pl. 19, figs 7, 9  
*margaritaceum*, *Elphidium*, 203; Pl. 24, figs 12, 13, pl. 29, fig. 8  
*marginata*, *Bulimina*, 122; Pl. 10, fig. 18  
*marginata*, *Fissurina*, 97  
*Marsipella*, 16  
*elongata*, 16; Pl. 3, fig. 14  
*Massilina*, 52  
*carinata*, 52; Pl. 5, figs 1, 2  
*secans*, 53; Pl. 5, figs 3, 4, pl. 8, fig. 6, pl. 32, fig. 4  
*mediterranensis*, *Quinqueloculina*, 73; Pl. 7, figs 4, 5, pl. 8, fig. 1  
*Miliammina*, 54  
*fusca*, 54; Pl. 2, figs 9, 10, pl. 31, figs 6, 7  
**MILIOLOIDAE**, 52  
*Miliolinella*, 56  
*subrotunda*, 56; Pl. 5, figs 5, 6, pl. 31, figs 8, 9  
*subrotunda pateorid* var., 57; Pl. 5, figs 12, 13  
*millettii*, *Rosalina*, 155; Pl. 17, figs 11, 12, pl. 30, fig. 6  
*minima*, *Bolivina*, 130  
*minima*, *Bolivina* cf., 131  
*moniliforme*, *Reophax*, 24; Pl. 3, fig. 17, pl. 6, fig. 8  
*moyi*, *Sigmoiopsis*, 77; Pl. 4, figs 1-8, pl. 8, figs 5, 7
- naraensis*, *Epistominella*, 217; Pl. 20, fig. 14, pl. 23, figs 7, 8  
*neopolitana*, *Rosalina*, 158; Pl. 17, figs 16-18  
**NODOSARIIDAE**, 80  
*Nonion*, 209  
*depressulus*, 209; Pl. 22, figs 8-11, pl. 29, fig. 9  
*pauperatum*, 210; Pl. 22, figs 13, 14; pl. 23, fig. 4  
*Nonionella*, 211  
*auricula*, 211  
*turgida*, 213; Pl. 22, fig. 12
- turgida* var. *digitata*, 214  
 species A, 215; Pl. 22, figs 17, 18, pl. 23, fig. 3  
**NONIONIDAE**, 196  
*novangliae*, *Pseudopolymorphina* cf., 112; Pl. 15, fig. 8, pl. 16, figs 10, 17  
**NUBECULARIDAE**, 50
- oblongus*, *Cancris*, 145; Pl. 20, fig. 13, pl. 23, figs 5, 6  
*ochracea*, *Trochammina*, 40; Pl. 5, figs 15-18  
*Oolina*, 105  
*borealis*, 105; Pl. 14, fig. 6  
**heronalleeni**, 106; Pl. 14, fig. 7  
*hexagona*, 107; Pl. 14, figs 12, 13, pl. 15, figs 3, 6  
*laevigata*, 108; Pl. 14, fig. 11  
*lineata*, 109; Pl. 14, figs 8-10  
*squamosa*, 110; Pl. 14, fig. 14, pl. 15, figs 4, 5  
*williamsoni*, 111; Pl. 14, figs 15-17, pl. 15, figs 1, 2, 7
- Orbulina*, 184;  
*universa*, 184 Pl. 20, fig. 6  
*ordinaria*, *Bolivina*, 134
- pacifica*, *Lagena*, 85; Pl. 12, fig. 15, pl. 13, figs 2, 3  
*parva*, *Psammosphaera*, 18; Pl. 2, fig. 13  
*Patellina*, 142  
*corrugata*, 142; Pl. 15, fig. 12, pl. 16, figs 7-9  
*pauperatum*, *Nonion*, 210; Pl. 22, figs 13, 14, pl. 23, fig. 4  
*perforata*, *Spirillina*, 144; Pl. 15, fig. 9, pl. 16, figs 1, 2  
*perlucida*, *Lagena*, 86; Pl. 12, fig. 5, pl. 13, fig. 5  
*Planorbolina*, 177  
*distoma*, 177; Pl. 20, figs 10-12, pl. 21, figs 4, 7, 8  
 species A, 180; Pl. 5, fig. 14, pl. 21, fig. 9  
**PLANORBULINIDAE**, 177  
**POLYMORPHINIDAE**, 94  
*praegeri*, *Rosalina*, 159; Pl. 17, figs 6-9, pl. 19, fig. 4, pl. 30, fig. 3  
*Protelphidium*, 216  
*anglicum*, 216; Pl. 22, figs 15, 16, pl. 23, figs 1, 2, pl. 27, figs 6-9  
*Psammosphaera*, 18  
*parva*, 18; Pl. 2, fig. 13  
*pseudoplicata*, *Bolivina*, 132; Pl. 10, fig. 3, pl. 11, fig. 7  
*Pseudopolymorphina*, 112  
 cf. *novangliae*, 112; Pl. 15, fig. 8, pl. 16, figs 10, 17

- suboblonga*, 113  
*pseudopunctata*, *Bolivina*, 134; Pl. 10, fig. 4,  
 pl. 11, figs 4-6  
*pygmaea*, *Trochammina globigeriniformis* var.,  
 36; Pl. 4, fig. 14  
*Pyrgo*, 59  
*carinata*, 59; Pl. 9, fig. 17  
*cf. constricta*, 60; Pl. 9, figs 11, 12  
*williamsoni*, 61  
 species A, 62; Pl. 9, figs 10, 13  
 species B, 63; Pl. 9, figs 8, 9
- Quinqueloculina*, 63  
*aspera*, 63; Pl. 7, figs 1-3, pl. 8, fig. 2, pl. 31,  
 figs 1-5  
*auberiana* var. A, 65; Pl. 7, fig. 15  
*auberiana* var. B, 66; Pl. 7, figs 6, 7  
*bicornis*, 67; Pl. 7, fig. 18  
*cf. clairensis*, 68; Pl. 7, figs 8, 9  
*cf. clairensis* var. A, 70; Pl. 9, fig. 5  
*cf. duthiersi*, 70; Pl. 7, figs 22, 23  
*intricata*, 71; Pl. 7, figs 16, 17  
*lata*, 72; Pl. 7, figs 10-13  
*mediterranensis*, 73; Pl. 7, figs 4, 5, pl. 8,  
 fig. 1  
*cf. rugosa*, 74; Pl. 7, figs 20, 21  
*seminulum*, 74; Pl. 7, figs 14, 19, pl. 8,  
 fig. 3, pl. 32, figs 1-3
- Remaneica*, 43  
*helgolandica*, 43; Pl. 5, fig. 19, pl. 6, fig. 6  
*reniforme*, *Cassidulina* cf., 194  
*Reophax*, 22  
*arctica*, 22; Pl. 3, figs 8-12, pl. 6, figs 4, 5, 7  
*fusiformis*, 23; Pl. 3, figs 3, 4  
*moniliforme*, 24; Pl. 3, fig. 17, pl. 6, fig. 8  
*repandus concameratus*, *Eponides*, 168; Pl. 18,  
 figs 10-12  
*Rosalina*, 150  
*anomala*, 151; Pl. 17, figs 1-3, pl. 19, fig. 2,  
 pl. 30, figs 1, 2  
*cf. bradyi*, 153; Pl. 17, figs 4, 5, pl. 19,  
 figs 1, 3, 6  
*irregularis*, 154; Pl. 30, figs 9, 10  
*milletti*, 155; Pl. 17, figs 11, 12, pl. 30, fig. 6  
*neopolitana*, 158; Pl. 17, figs 16-18  
*praegeri*, 159; Pl. 17, figs 6-9, pl. 19, fig. 4,  
 pl. 30, fig. 3  
*williamsoni*, 162; Pl. 17, figs 13-15  
 species A, 163; Pl. 17, fig. 10  
*ROTALIIDAE*, 184  
*rugosa*, *Quinqueloculina* cf., 74; Pl. 7, figs 20,  
 21
- SACCAMMINIDAE*, 18  
*sachalinica*, *Cibicides fletcheri*, 172; Pl. 21,  
 figs 1, 2  
*scabrum*, *Eggerelloides*, 44; Pl. 2, figs 7, 8,  
 pl. 19, figs 10, 11  
*Scutularis*, 76  
 species A, 76; Pl. 9, fig. 14  
*secans*, *Massilina*, 53; Pl. 5, figs 3, 4, pl. 8,  
 fig. 6, pl. 32, fig. 4  
*selseyensis*, *Cyclogyra*, 48; Pl. 9, fig. 15, pl. 29,  
 fig. 4  
*selseyense*, *Elphidium*, 204; Pl. 22, figs 3, 4,  
 pl. 24, fig. 11, pl. 26, figs 4, 5, 7, 9, 10, pl.  
 29, figs 1-3  
*seminulum*, *Quinqueloculina*, 74; Pl. 7;  
 figs 14, 19, pl. 8, fig. 3, pl. 32, figs 1-3  
*semistriata*, *Lagena*, 87; Pl. 12, fig. 6, pl. 13,  
 fig. 4  
*Sigmoilopsis*, 77  
*moyi*, 77; Pl. 4, figs 1-8, pl. 8, figs 5, 7  
*Siphonina*, 167  
*georgiana*, 167; Pl. 20, figs 15, 16, pl. 23,  
 fig. 9, pl. 33, fig. 10  
*SIPHONINIDAE*, 167  
*spathulata*, *Bolivina*, 135  
*spicata*, *Lagena*, 88; Pl. 12, fig. 13  
*Spirillina*, 144  
*perforata*, 144; Pl. 15, fig. 9, pl. 16, figs 1, 2  
 species A, 144; Pl. 15, fig. 10, pl. 16, figs 5, 6  
*SPIRILLINIDAE*, 142  
*Spiroloculina*, 78  
*depressa*, 78; Pl. 9, figs 6, 7  
*Spiroplectammina*, 31  
*earlandi*, 31; Pl. 3, fig. 5, pl. 8, fig. 11  
*wrightii*, 32; Pl. 3, figs 1, 2  
*Spiroptthalmidium*, 50  
*acutimargo* var. *emaciatum*, 50; Pl. 5,  
 fig. 11, pl. 9, fig. 16  
*squamosa*, *Oolina*, 110; Pl. 14, fig. 14, pl. 15,  
 figs 4, 5  
*Stainforthia*, 123  
*concava* var. *loeblichii*, 123; Pl. 5, fig. 10  
*fusiformis*, 124; Pl. 5, figs 7, 8  
 species A, 126; Pl. 5, fig. 9, pl. 8, fig. 4  
*striata*, *Lagena* cf., 89; Pl. 12, fig. 12, pl. 13,  
 figs 7, 8  
*striatula*, *Bolivina*, 137; Pl. 10, fig. 1, pl. 11,  
 fig. 1  
*suboblonga*, *Pseudopolymorpha*, 113  
*subrotunda*, *Miliolinella*, 56; Pl. 5, figs 5, 6,  
 pl. 31, figs 8, 9  
*subrotunda pateorid* var., *Miliolinella*, 57;  
 Pl. 5, figs 12, 13

- substriata*, *Lagena*, 89; Pl. 12, fig. 11, pl. 13, figs 6, 11  
*sulcata*, *Lagena*, 90; Pl. 12, fig. 9, pl. 13, fig. 10  
*sulcata interrupta*, *Lagena*, 92; Pl. 12, fig. 10  
*sulcata* var. *torquiformis*, *Lagena*, 93; Pl. 12, fig. 14, pl. 13, figs 9, 12  
*superba*, *Bolivina*, 138; Pl. 10, fig. 5, pl. 11, figs 2, 3
- Technitella*, 17  
*teivyense*, 17; Pl. 1, figs 1-4  
*teivyense*, *Technitella*, 17; Pl. 1, figs 1-4  
*tepida*, *Ammonia*, 191; Pl. 18, fig. 17, pl. 30, fig. 8
- Textilina*, 47  
*bocki*, 47; Pl. 3, figs 6, 7, pl. 8, fig. 8
- Textulariidae*, 31
- torquiformis*, *Lagena sulcata*, 93; Pl. 12, fig. 14, pl. 13, figs 9, 12
- Trifarina angulosa*, 126; Pl. 10, figs 12, 13, 16, 17, pl. 11, fig. 11
- trigonula*, *Triloculina*, 79; Pl. 9, figs 1, 2, pl. 32, fig. 5
- trihedra*, *Triloculina*, 80; Pl. 9, figs 3, 4
- Triloculina*, 79  
*trigonula*, 79; Pl. 9, figs 1, 2, pl. 32, fig. 5  
*trihedra*, 80; Pl. 9, figs 3, 4
- Trochammina*, 34  
*astrifica*, 34; Pl. 4, figs 18-20  
*haynesi*, 35  
*globigeriniformis* var. *pygmaea*, 36; Pl. 4, fig. 14  
*infata*, 37; Pl. 4, figs 15-17, pl. 6, fig. 3  
*intermedia*, 39; Pl. 4, figs 9-13, pl. 6, fig. 9
- ochracea*, 40; Pl. 5, figs 15-18
- TROCHAMMINIDAE**, 34
- trondheimensis*, *Dentalina* cf., 80; Pl. 16, fig. 11
- tumanowiczii*, *Halyphysema*, 14; Pl. 1, fig. 6, pl. 3, fig. 13
- turgida*, *Nonionella*, 213; Pl. 22, fig. 12
- turgida* var. *digitata*, *Nonionella*, 214
- TURRILINIDAE**, 114
- Turrispirillina*, 145  
 species A, 145; Pl. 16, figs 3, 4
- universa*, *Orbulina*, 184; Pl. 20, fig. 6
- UVIGERINIDAE**, 126
- vadescens*, *Bolivina* cf., 139; Pl. 10, fig. 7, pl. 11, fig. 9
- variabilis*, *Bolivina*, 141; Pl. 10, fig. 8, pl. 11, fig. 8
- waddensis*, *Elphidium*, 206; Pl. 24, figs 4, 10, pl. 26, fig. 1, pl. 28, figs 10, 11
- wilberti*, *Haplophragmoides*, 27; Pl. 2, fig. 1, pl. 29, fig. 7
- williamsoni*, *Elphidium*, 207; Pl. 24, fig. 7, pl. 25, figs 6, 9, pl. 27, figs 1-3
- williamsoni*, *Oolina*, 111; Pl. 14, figs 15-17, pl. 15, figs 1, 2, 7
- williamsoni*, *Rosalina*, 162; Pl. 17, figs 13-15
- williamsoni*, *Pyrgo*, 61
- wrightii*, *Discorbis*, 147; Pl. 16, figs 12-16, pl. 19, fig. 5, pl. 30, figs 4, 5
- wrightii*, *Spiroplectammina*, 32; Pl. 3, figs 1, 2

## X. ADDENDUM

References cited but inadvertently left out of Part VIII include:

Atkinson, K. 1968. A taxonomic note on *Massilina carinata* (Fornasini 1905) *Contr. Cushman Fdn. Foramin. Res.* **19** : 165-167, tfs 1-3.

Dupeuble, P. A. 1962. Polymorphisme chez les Cibicidinae Actuels de la Région de Roscoff (Finistère). *Revue Micropaléont.* **4** (4) : 197-202, pls 1, 2.

Two important works on British Recent Foraminifera which came to hand after going to press include:

Atkinson, K. 1971. The relationship of Recent Foraminifera to the sedimentary facies in the turbulent zone, Cardigan Bay. *J. nat. Hist.* **5** : 385-439, tfs 1-14.

Murray, J. W. 1971. *An Atlas of British Recent Foraminiferida*. Heinemann, 244 pp., 96 pls.

Atkinson's paper went to press before we had finished our revision of nomenclature so his names require correction as indicated in Part VII. The same applies to the names in the 'Atlas' where 'accepted British usage' has been followed. However,

Murray has made certain innovations, and two in particular are unacceptable in our opinion. These are the attempt to subsume *Elphidium selseyense* under *E. excavatum* and to place the species called *E. excavatum* by British workers under *E. articulatum* (d'Orbigny). As we have shown (pages 206 and 208) *E. selseyense* can be distinguished from *E. excavatum* as redefined by Lévy *et al.* (1969). Further, as it has proved impossible to find an unambiguous early name for *E. excavatum* of authors' = *Polystomella umbilicatula* of Williamson, this species is renamed by us *E. williamsoni*. To place this form under *E. articulatum* would only make the confusion worse. D'Orbigny's species was described from the coast of Patagonia and the Falklands. The type specimen is lost as was discovered by Heron, Allen and Earland (1932) when they examined d'Orbigny's tube in the Musée d'Histoire Naturelle, Paris. However, the type figure shows a lobate species with inflated chambers, small septal pits and areal apertures in a concave apertural face; clearly different from *E. excavatum* of authors' which is entire, flat-sided and characterized by oblong fossettes.

Specimens figured by Cushman as *E. articulatum* in the Atlantic Monograph (1930) are similar to d'Orbigny's figure although they do not show the areal apertures. It is significant that Cushman distinguished between this species and *E. excavatum* in the same Monograph and maintained this distinction later. *E. excavatum* is well figured from the Belgian coast (1949) whereas the only reference to d'Orbigny's species in the North Atlantic is of doubtful material from off New England, as *E. cf. articulatum* (1944).

In the circumstances the best course seems to be to apply a new name to the brackish water, N. European species. At least there is little doubt that this is the form figured by Williamson.

JOHN ROLAND HAYNES, Ph.D., F.G.S.  
*Department of Geology*  
 UNIVERSITY COLLEGE OF WALES  
 PENGLAIS  
 ABERYSTWYTH, CARDIGANSHIRE

KEITH ATKINSON, Ph.D., C.Eng.,  
 A.M.I.M.M., F.G.S.  
 CAMBORNE SCHOOL OF MINES  
 CAMBORNE  
 CORNWALL

EMMANUEL ABIODUN FAYOSE, M.Sc., Ph.D.  
*Department of Geology*  
 UNIVERSITY OF IBADAN  
 IBADAN  
 NIGERIA

JOAN ANNE JOHNSON, M.Sc.  
*The Library*  
 UNIVERSITY OF LANCASTER  
 BAILRIGG  
 LANCASTER

TERENCE DAVID ADAMS, Ph.D., F.G.S.  
 BRITISH PETROLEUM COMPANY LTD.  
 B.P. HOUSE  
 ROPEMAKER STREET  
 LONDON, E.C.2

DREW HAMAN, Ph.D., F.G.S.  
 STANDARD OIL OF CALIFORNIA  
 P.O. Box 7-839  
 ANCHORAGE  
 ALASKA 99501

KEITH HAVARD JAMES, D.U.C.W., M.Sc.  
*Department of Geology*  
 UNIVERSITY COLLEGE OF WALES  
 PENGLAIS  
 ABERYSTWYTH, CARDIGANSHIRE

JOHN SCOTT, M.Sc., Ph.D.  
*Department of Geology*  
 UNIVERSITY COLLEGE  
 GOWER STREET  
 LONDON, W.1

PLATE I

FIGS 1-4. *Technitella teivyense* Haynes n. sp. 1, holotype, stereopair showing aperture and open spicular structure  $\times 65$ ; 2, side view  $\times 60$ ; 3, paratype showing brushed forward spicules  $\times 45$ ; 4, detail of wall of holotype  $\times 550$ .

FIG. 5. *Jadammina macrescens* (Brady), apertural face showing basal slit and areal aperture with neatly cemented small grains in the lip  $\times 560$ .

FIG. 6. *Halyphysema tumanowiczii* Bowerbank, detailed structure of wall  $\times 265$ .

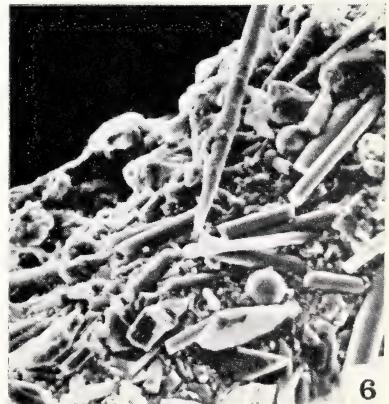
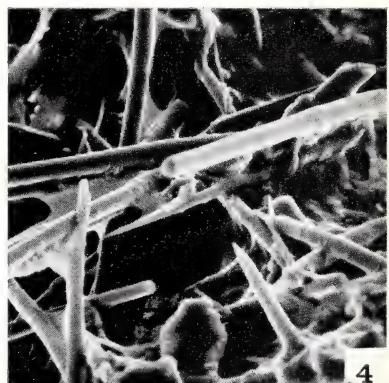
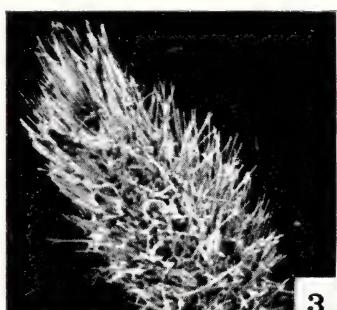
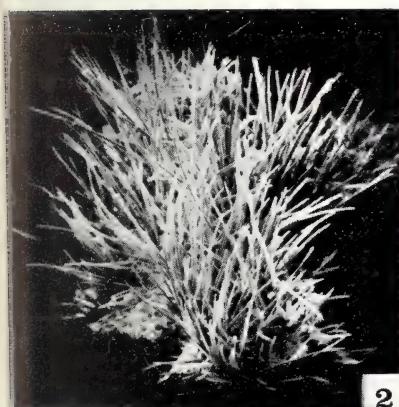
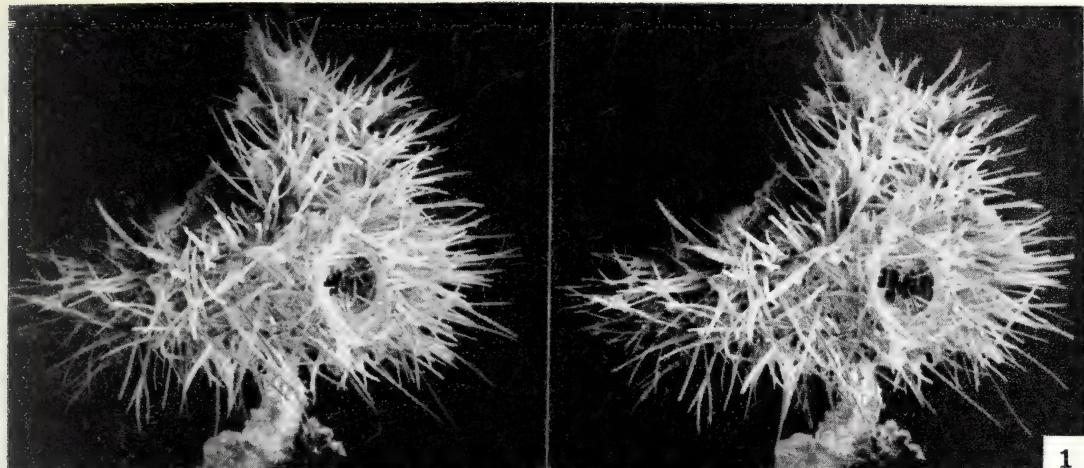


PLATE 2

- FIG. 1. *Haplophragmoides wilberti* Anderson, side view  $\times 105$ .
- FIGS 2, 3. *Ammobaculites balkwilli* Haynes n. sp., paratypes, side views  $\times 65$ .
- FIG. 4. *Hippocrepina* species A, side view  $\times 65$ .
- FIGS 5, 6. *Cribrostomoides jeffreysii* (Williamson), side view  $\times 130$ , and apertural view  $\times 135$ .
- FIGS 7, 8. *Eggerelloides scabrum* (Williamson). 7, side view of microspheric form; 8, side view, megalospheric form  $\times 65$ .
- FIGS 9, 10. *Miliammina fusca* (Brady), apertural view and side view  $\times 110$ .
- FIGS 11, 12. *Lagenammina* cf. *hancocki* (Cushman & McCulloch), side view and oblique apertural view  $\times 210$ .
- FIG. 13. *Psammosphaera parva* Flint, side view  $\times 65$ .
- FIGS 14-16. *Jadammina macrescens* (Brady). 14, ventral view; 15, oblique apertural view; 16, dorsal view  $\times 105$  (different specimens).
- FIG. 17. *Lagenammina arenulata* (Skinner), side view  $\times 120$ .

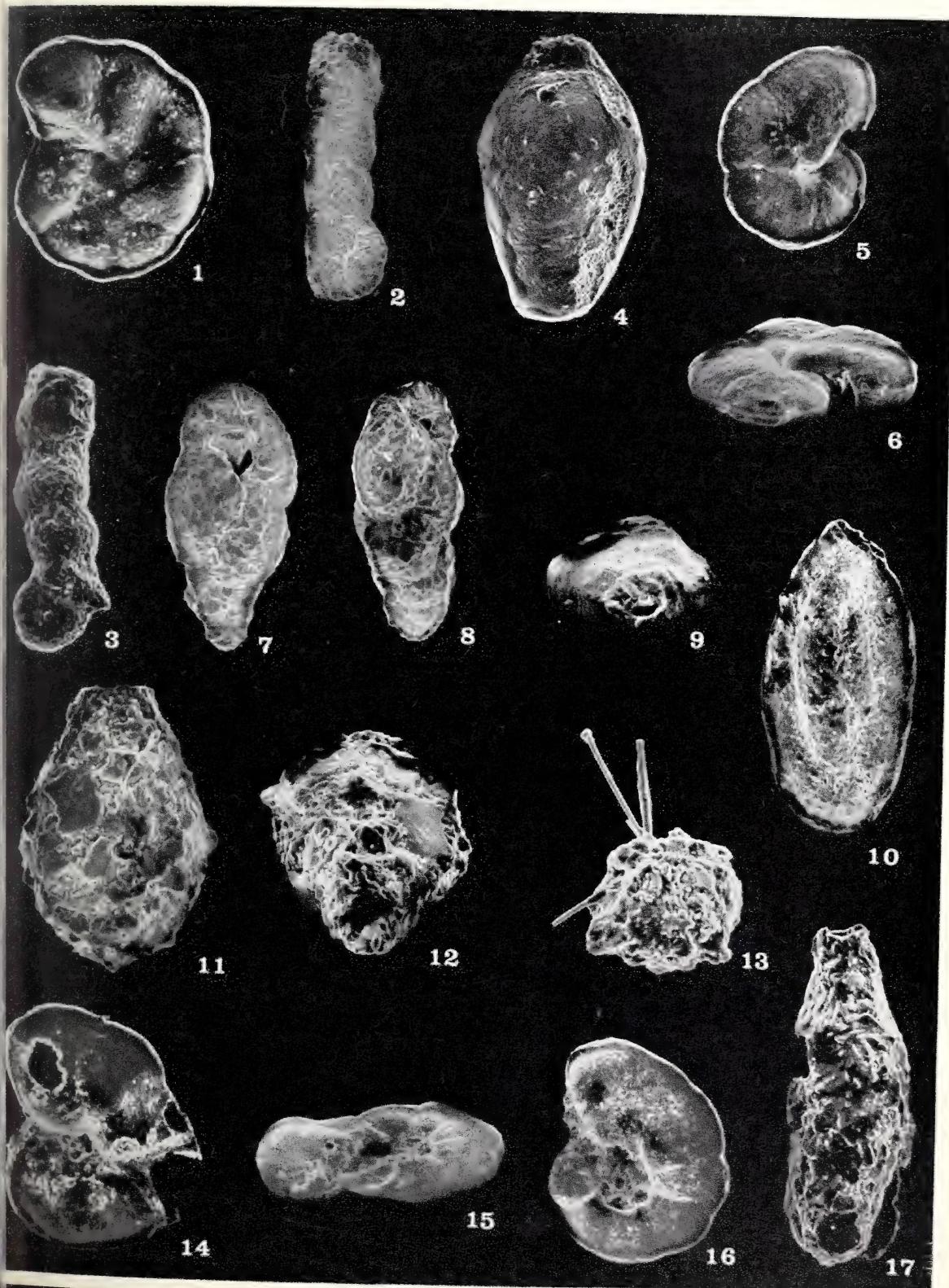


PLATE 3

- FIGS 1, 2. *Spiroplectammina wrightii* (Silvestri), side view and oblique apertural view  $\times 70$ .
- FIGS 3, 4. *Reophax fusiformis* (Williamson), apertural view  $\times 65$ , and side view  $\times 65$ .
- FIG. 5. *Spiroplectammina earlandi* (Parker), side view  $\times 85$ .
- FIGS 6, 7. *Textilina bocki* (Hoglund), side view  $\times 42$ , and apertural view  $\times 46$ .
- FIGS 8-12. *Reophax arctica* Brady. 8 and 9, side view  $\times 130$  and apertural view  $\times 165$ ; 10 and 11, side view  $\times 125$  and apertural view  $\times 165$  of specimen described; 12, side view of more irregular specimen  $\times 170$ .
- FIG. 13. *Haliphysema tumanowiczii* Bowerbank, side view  $\times 100$ .
- FIG. 14. *Marsipella elongata* Norman, side view  $\times 25$ .
- FIG. 15. ? *Marsipella* species A, side view  $\times 55$ .
- FIG. 16. ? *Marsipella* species B, side view  $\times 45$ .
- FIG. 17. *Reophax moniliforme* Siddall, side view  $\times 85$ .

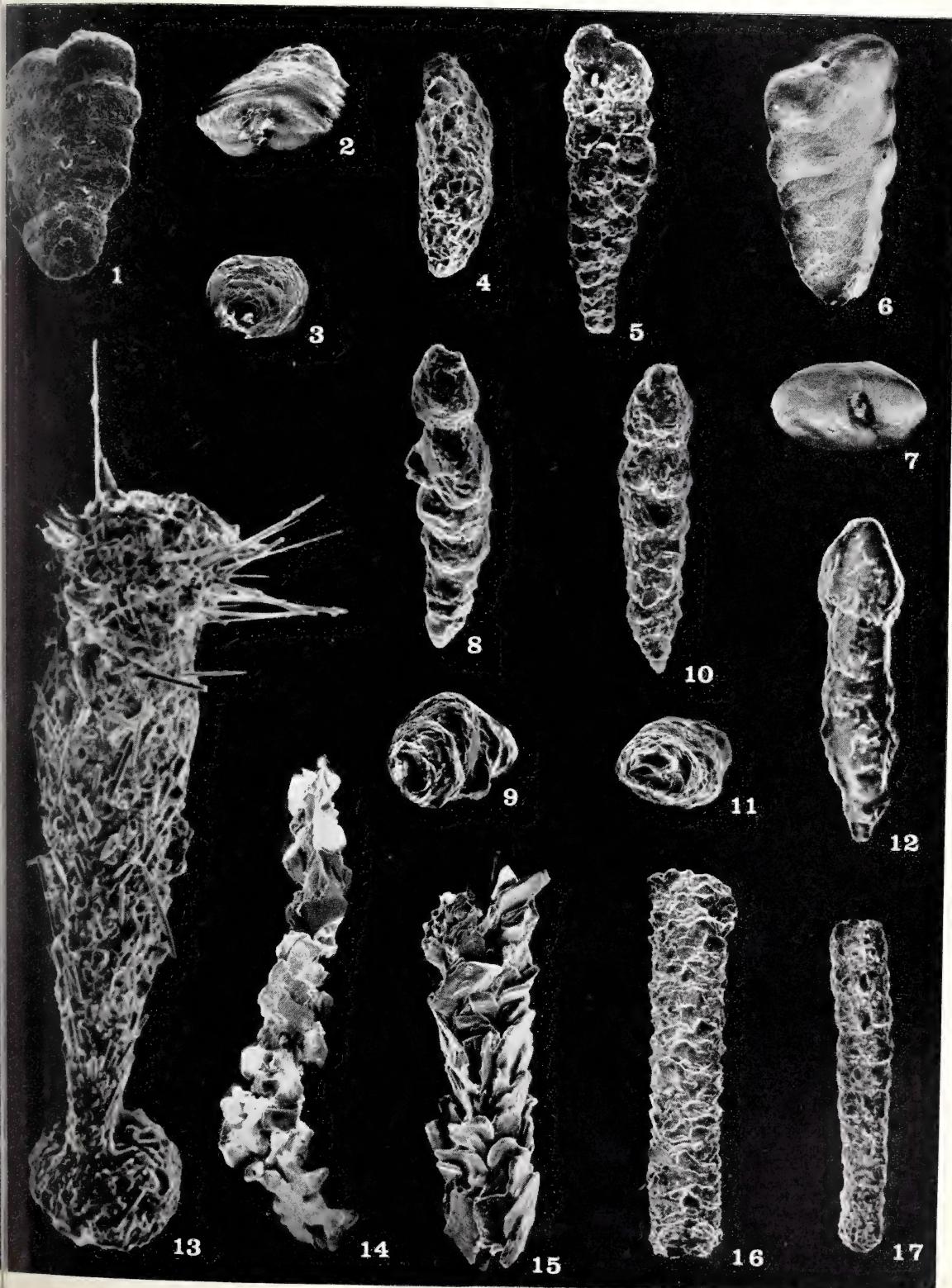


PLATE 4

FIGS 1-8. *Sigmoilopsis moyi* Atkinson. 1, 2, *S. moyi*, side view and apertural view  $\times 65$ ; 3, 4, '*S. schlumbergeri*', side view and apertural view  $\times 85$ ; 5, 6, '*S. woodi*', side view and apertural view  $\times 65$ ; 7, 8, '*S. wanganuiensis*', side view and apertural view  $\times 85$ .

FIGS 9-13. *Trochammina intermedia* Rhumbler? 9, ventral view  $\times 180$ ; 12, 13, dorsal views  $\times 220$  of specimens described; 10, ventral view of specimen with abnormal final chamber  $\times 130$ ; 11, dorsal view of small specimen  $\times 210$ .

FIG. 14. *Trochammina globigeriniformis* var. *pygmaea* Hoglund, ventral view  $\times 200$ .

FIGS 15-17. *Trochammina inflata* (Montagu). 15, ventral view  $\times 65$ ; 16, 17, side view and dorsal view of additional specimen  $\times 85$ .

FIGS 18-20. *Trochammina astrifica* (Rhumbler). 18, ventral view  $\times 175$ ; 19, 20, dorsal view and oblique side view of additional specimen  $\times 210$ .

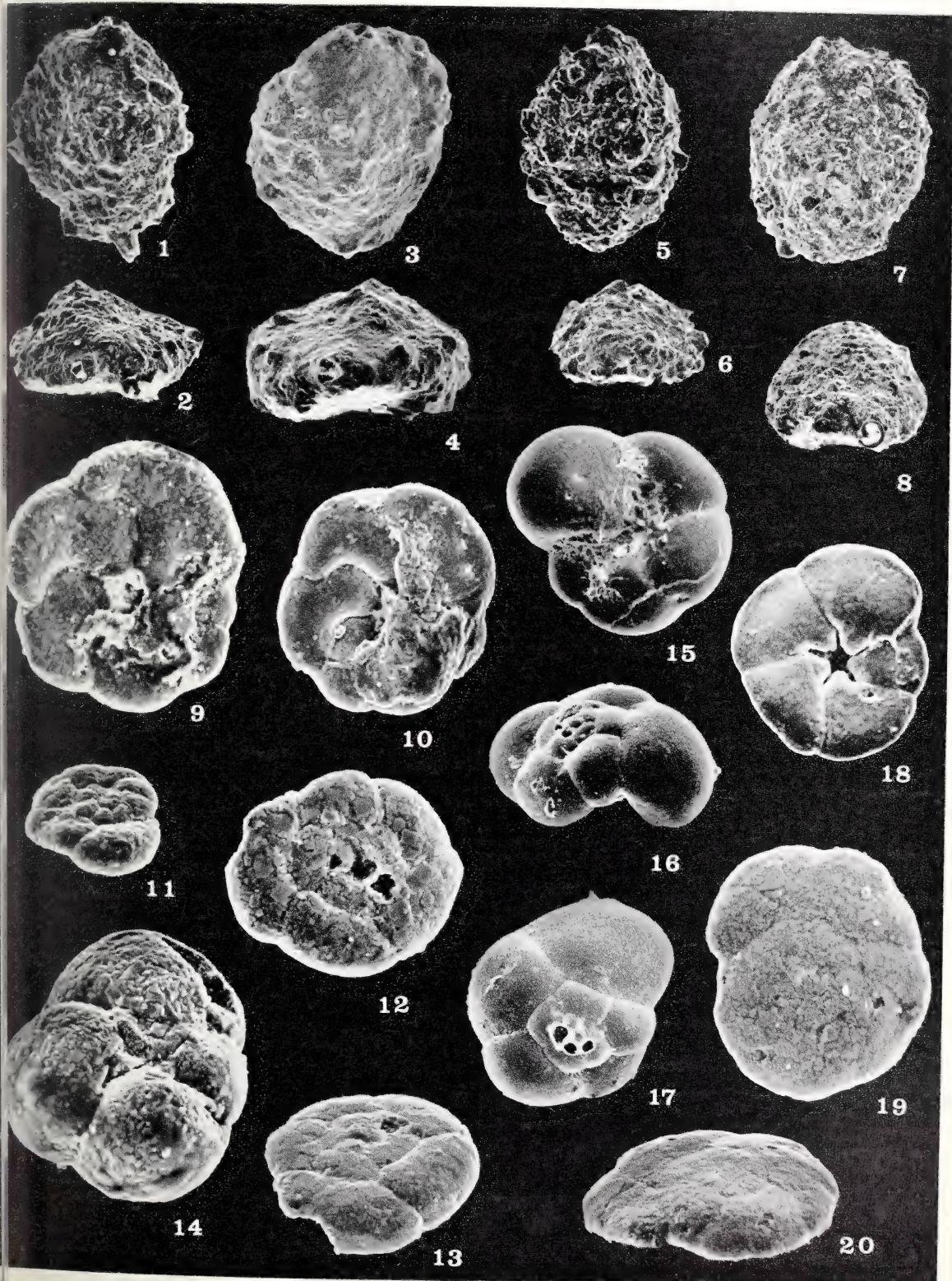


PLATE 5

- FIGS 1, 2. *Massilina carinata* (Fornasini), side view and apertural view  $\times 50$ .
- FIGS 3, 4. *Massilina secans* (d'Orbigny), side view and apertural view  $\times 45$ .
- FIGS 5, 6, 12, 13. *Miliolinella subrotunda* (Montagu). 5, 6, side view and apertural view of large, broken specimen  $\times 105$ ; 12, 13, side view (aperture downwards) and apertural view of pateorid variety  $\times 65$ .
- FIGS 7, 8. 'Stainforthia' *fusiformis* (Williamson), side view and apertural view  $\times 170$ .
- FIG. 9. *Stainforthia* species A, side view  $\times 80$ .
- FIG. 10. *Stainforthia concava* var. *loeblichi* (Feyling-Hanssen), side view  $\times 110$ .
- FIG. 11. *Spirophthalmidium acutimargo* var. *emaciatum* Haynes n. var., side view of holotype  $\times 115$ .
- FIG. 14. *Planorbolina* species A,  $\times 140$ .
- FIGS 15-18. *Trochammina ochracea* (Williamson). 15, oblique ventral view  $\times 200$ ; 16, ventral view  $\times 180$ ; 17, 18 dorsal views  $\times 200$ , of specimens described.
- FIG. 19. *Remaneica helgolandica* Rhumbler, ventral view  $\times 310$ .

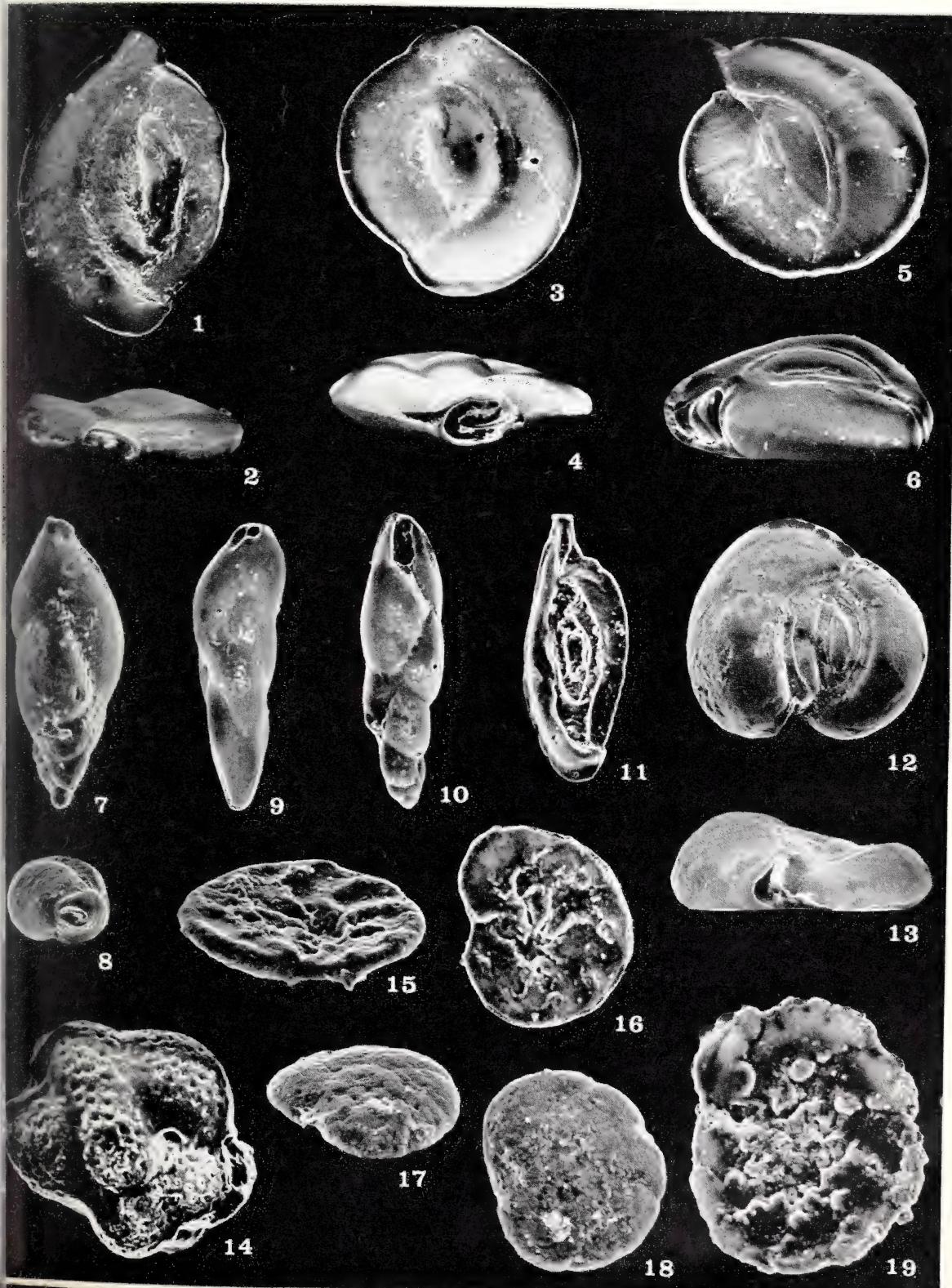


PLATE 6

FIGS 1, 2. *Hemisphaerammina bradyi* Loeblich & Tappan, side view and top view of specimen described  $\times 265$ .

FIG. 3. *Trochammina inflata* (Montagu), detail of breached dorsal side  $\times 525$ . Note tectin lining of proloculus and very fine grains of wall (close up of specimen shown in Pl. 4, fig. 17).

FIGS 4, 5, 7. *Reophax arctica* Brady. 4, detail of chamber wall  $\times 525$ ; 5, small, irregular pores in close up  $\times 5,250$ ; 7, aperture  $\times 1100$ .

FIG. 6. *Remaneica helgolandica* Rhumbler, detail of umbilicus and chamber lobes  $\times 1050$ .

FIG. 8. *Reophax moniliforme* Siddall, detail of aperture  $\times 525$ .

FIG. 9. *Trochammina intermedia* Rhumbler ? detail of wall  $\times 1100$ .

FIG. 10. ? *Marsipella* species A, detail of wall  $\times 265$ .

FIG. 11. ? *Marsipella* species B, detail of wall  $\times 140$ .

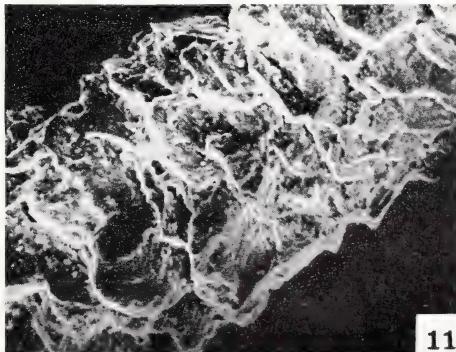
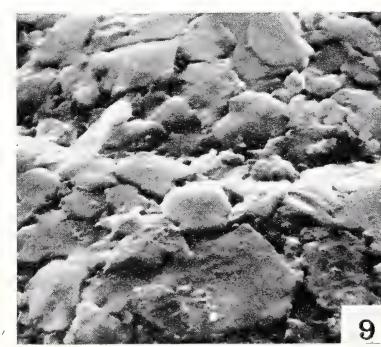
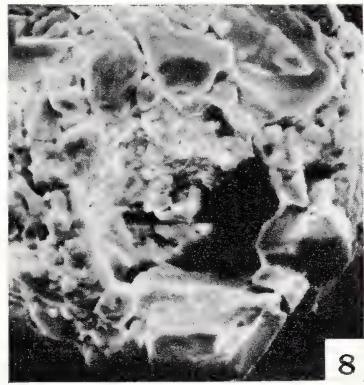
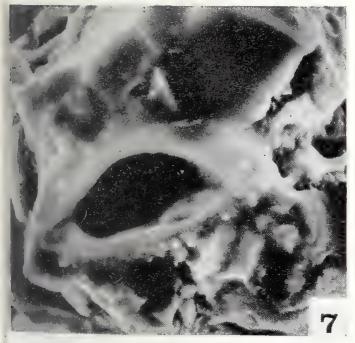
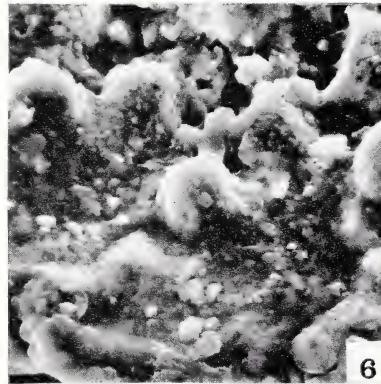
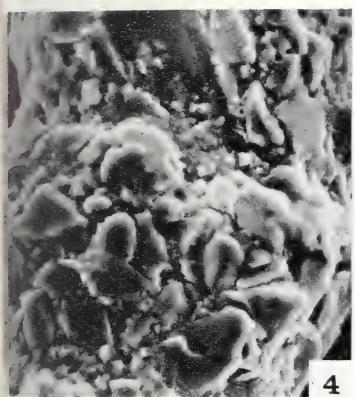
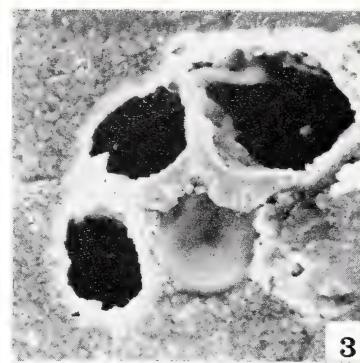
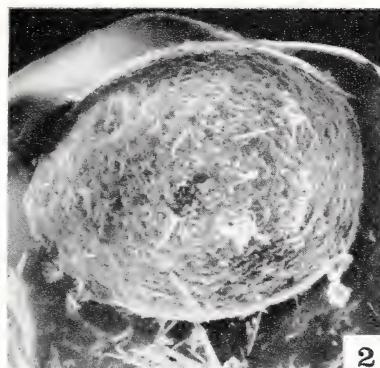
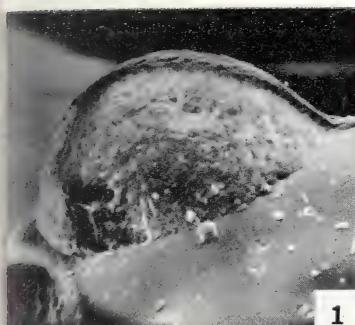


PLATE 7

Figs 1-3. *Quinqueloculina aspera* d'Orbigny. 1, oblique apertural view of slightly irregular specimen  $\times 65$ ; 2, 3, front view and apertural view of more regular form  $\times 55$ .

Figs 4, 5. *Quinqueloculina mediterranensis* Le Calvez & Le Calvez, specimen described. 4, rear view showing periphery  $\times 55$ ; 5, apertural view  $\times 60$ .

Figs 6, 7. *Quinqueloculina auberiana* var. B, specimen described. 6, oblique front view  $\times 65$ ; 7, apertural view  $\times 70$ .

Figs 8, 9. *Quinqueloculina* cf. *clairensis* Heron-Allen & Earland. 8, front view  $\times 55$ ; 9, apertural view  $\times 45$ .

Figs 10-13. *Quinqueloculina lata* Terquem. 10, 11, front view and apertural view of juvenile  $\times 105$  (Q. species 3); 12, 13, front view and apertural view of specimen described  $\times 40$ .

Figs 14, 19. *Quinqueloculina seminulum* (Linnaeus). 14, apertural view  $\times 70$ ; 19, probable juvenile, front view  $\times 130$ .

Fig. 15. *Quinqueloculina auberiana* var. A. Front view of specimen described  $\times 65$ .

Figs 16, 17. *Quinqueloculina intricata* Terquem. 16, front view of specimen described  $\times 45$ ; 17, juvenile with one chamber following the juvenarium  $\times 45$ .

Fig. 18. *Quinqueloculina bicornis* (Walker & Jacob), front view of neotype  $\times 55$ .

Figs 20, 21. *Quinqueloculina* cf. *rugosa* d'Orbigny, front view and apertural view of specimen described  $\times 65$ .

Figs 22, 23. *Quinqueloculina* cf. *duthiersi* (Schlumberger), rear view and apertural view of specimen described  $\times 25$ .

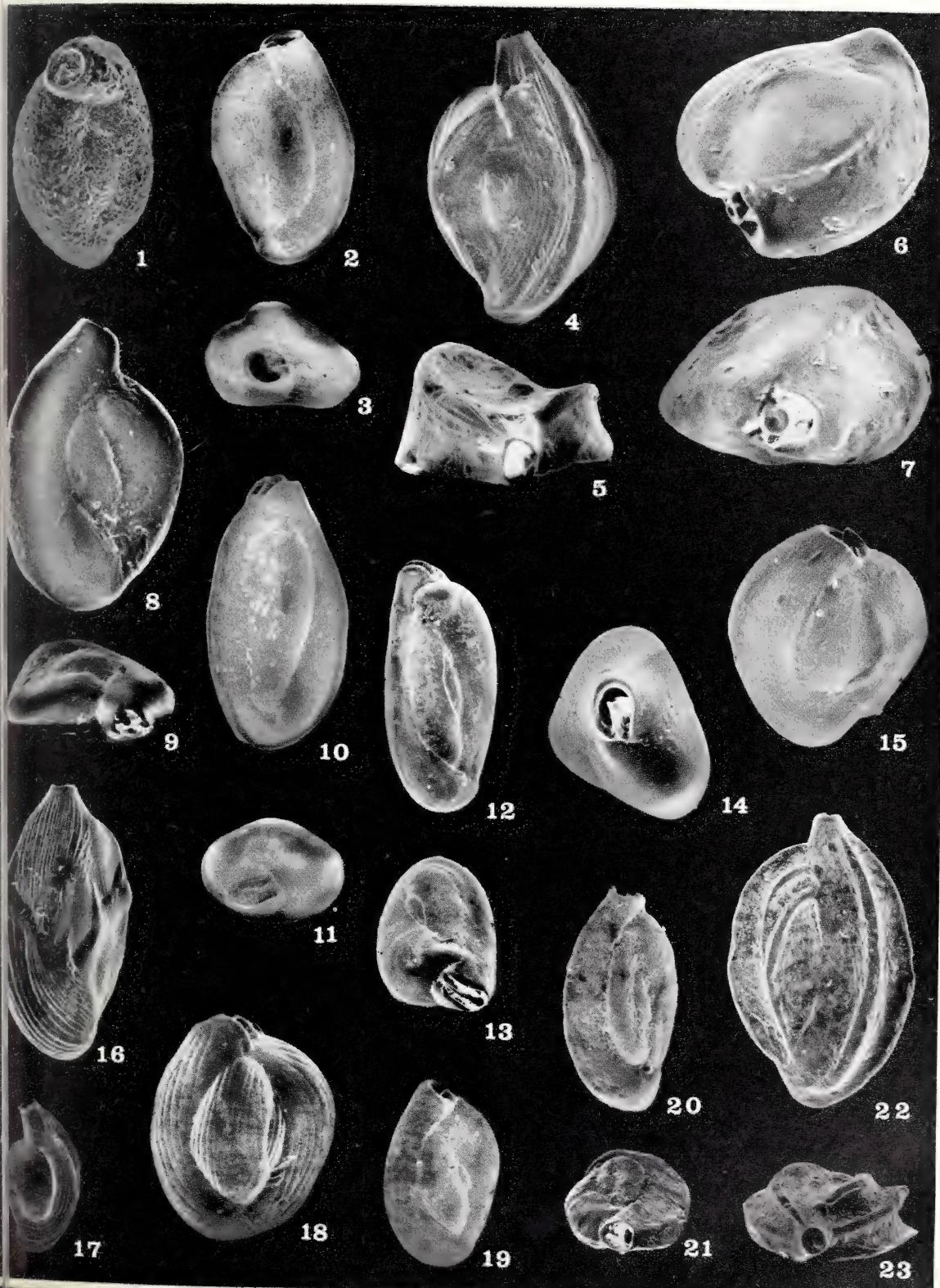


PLATE 8

- FIG. 1. *Quinqueloculina mediterranensis* Le Calvez & Le Calvez, detail of aperture  $\times 300$ .
- FIG. 2. *Quinqueloculina aspera* d'Orbigny, detail of aperture  $\times 275$ .
- FIG. 3. *Quinqueloculina seminulum* (Linneaus), detail of tooth  $\times 575$ .
- FIG. 4. *Stainforthia* species A, detail of aperture  $\times 475$ .
- FIGS 5, 7. *Sigmoilopsis moyi* Atkinson. 5, detail of aperture  $\times 850$ ; 7, detailed wall structure  $\times 525$ .
- FIG. 6. *Massilina secans* (d'Orbigny), detail of aperture  $\times 120$ .
- FIG. 8. *Textilina bocki* (Hoglund), detailed wall structure  $\times 1060$ .
- FIG. 9. *Cribrostomoides jeffreysii* (Williamson), close up showing wall structure in the umbilical area and the projecting apertural lip  $\times 265$ .
- FIG. 10. *Lagenammina* cf. *hancocki* (Cushman & McCulloch), aperture and fine structure of the lip  $\times 525$ .
- FIG. 11. *Spiroplectammina earlandi* (Parker), aperture and wall structure  $\times 500$ .
- FIG. 12. *Lagenammina arenulata* (Skinner), detail of aperture  $\times 500$ .

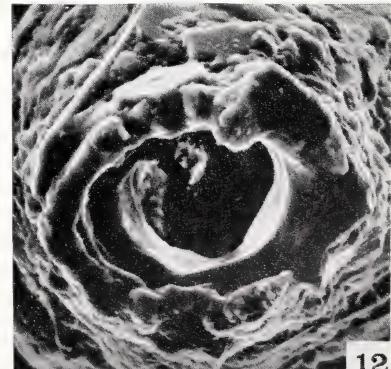
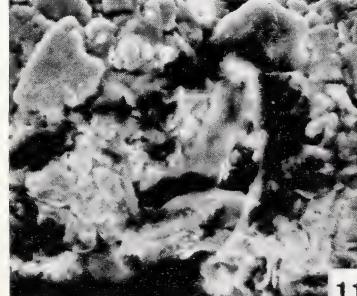
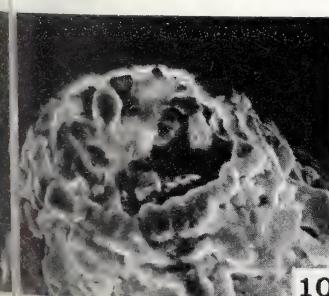
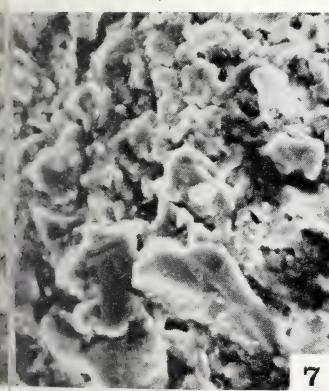
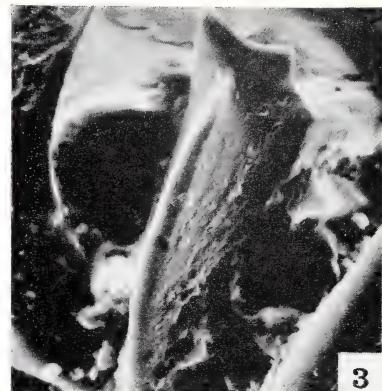
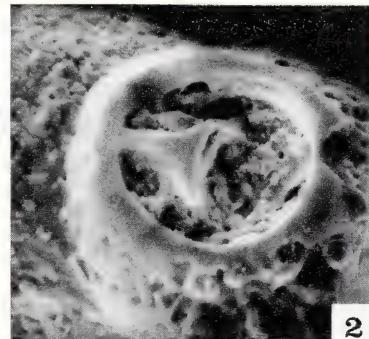
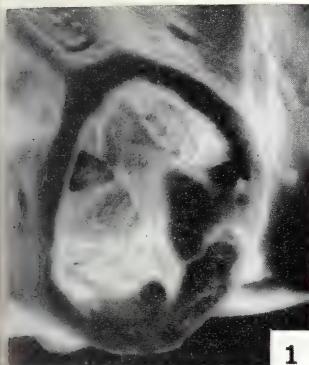


PLATE 9

FIGS 1, 2. *Triloculina trigonula* (Lamarck), front view and apertural view of specimen described  $\times 100$ .

FIGS 3, 4. *Triloculina trihedra* Loeblich & Tappan, front view and oblique apertural view of specimen described  $\times 120$ .

FIG. 5. *Quinqueloculina* cf. *cliarensis* var. A, front view of specimen described  $\times 55$ .

FIGS 6, 7. *Spiroloculina depressa* d'Orbigny, front view and apertural view of specimen described  $\times 65$ .

FIGS 8, 9. *Pyrgo* species B, front view and apertural view of specimen described  $\times 105$ .

FIGS 10, 13. *Pyrgo* species A, front view and apertural view of specimen described  $\times 105$ .

FIGS 11, 12. *Pyrgo* cf. *constricta* Costa, front view and apertural view of specimen described  $\times 60$ . N.B. Specimen mounted aperture downwards in fig. 12.

FIG. 14. *Scutuloritis* sp., front view of specimen described  $\times 85$ .

FIG. 15. *Cyclogyra selseyense* (Heron-Allen & Earland), oblique side view of juvenile  $\times 130$ .

FIG. 16. *Spiropthalmidium acutimargo* var. *emaciatum* Haynes n. var., oblique apertural view of holotype  $\times 145$ .

FIG. 17. *Pyrgo carinata* (d'Orbigny), front view of specimen described  $\times 105$ .

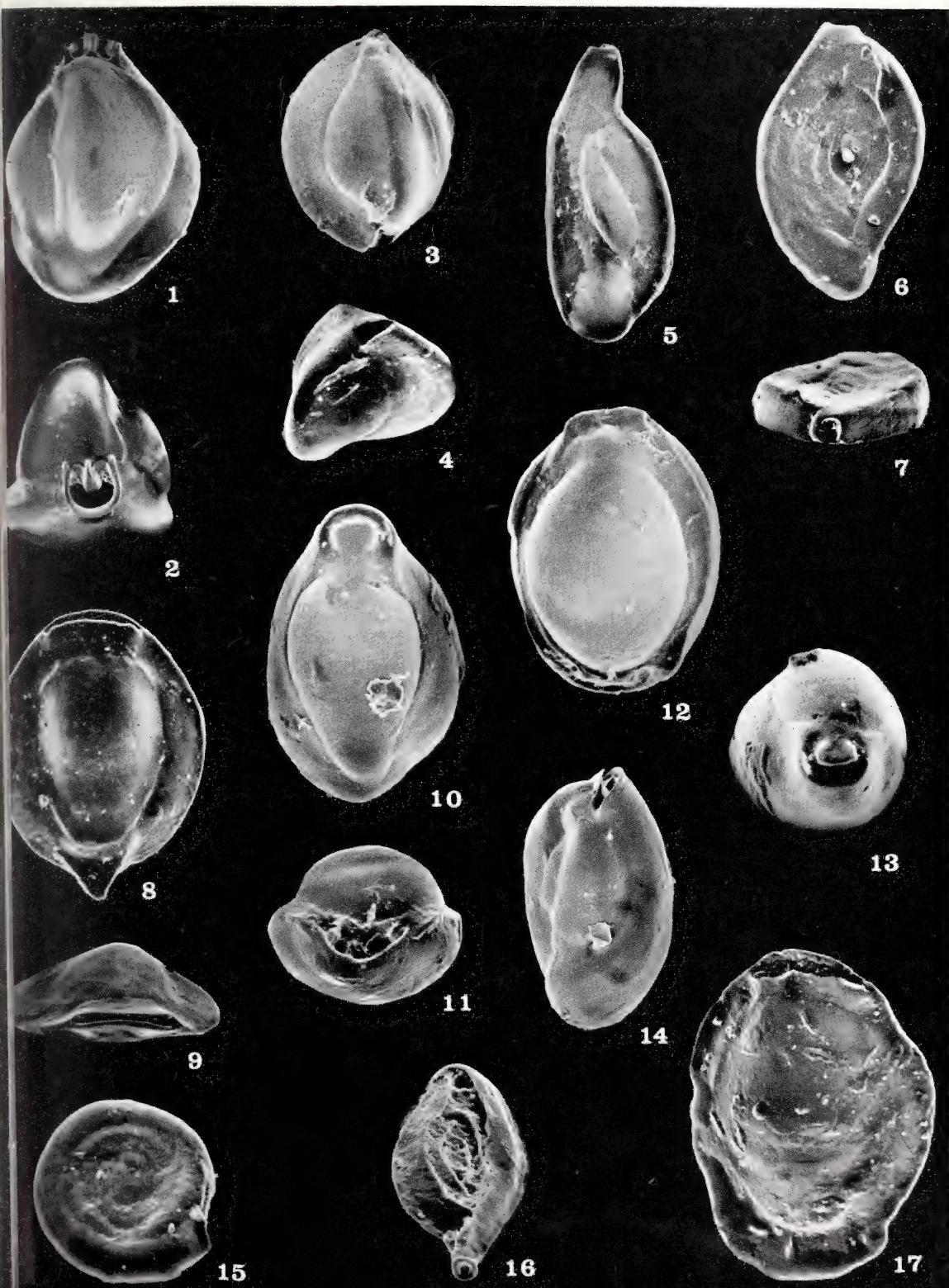


PLATE 10

- FIG. 1. *Bolivina striatula* Cushman, side view (stereopair)  $\times 125$ .  
FIG. 2. *Bolivina* sp., side view  $\times 140$ .  
FIG. 3. *Bolivina pseudoplicata* Heron-Allen & Earland, side view  $\times 135$ .  
FIG. 4. *Bolivina pseudopunctata* Hoglund, side view  $\times 125$ .  
FIG. 5. *Bolivina superba* Emiliani, side view (stereopair)  $\times 110$ .  
FIG. 6. *Bulimina elongata* var. *lesleyae* Atkinson, side view  $\times 105$ .  
FIG. 7. *Bolivina* cf. *vadescens* Cushman sensu Hoglund, side view  $\times 125$ .  
FIG. 8. *Bolivina variabilis* (Williamson), side view, note pits,  $\times 125$ .  
FIG. 9. *Bulimina elongata* d'Orbigny, side view  $\times 105$ .  
FIGS 10, 15. *Bulimina elongata* var. *subulata* Cushman & Parker. 10, side view  $\times 125$ ; 15, apertural view  $\times 110$ .  
FIG. 11. *Bulimina elongata* d'Orbigny, intermediate with *B. gibba*, side view  $\times 125$ .  
FIG. 12. *Trifarina angulosa* (Williamson) variety towards *T. carinata*, side view  $\times 180$ .  
FIG. 13. *Trifarina angulosa* (Williamson) variety towards *T. fluens*, side view  $\times 105$ .  
FIG. 14. *Bulimina gibba* Fornasini, juvenile, side view  $\times 105$ .  
FIGS 16, 17. *Trifarina angulosa* (Williamson), 16, apertural view  $\times 200$ ; 17, side view  $\times 140$ .  
FIG. 18. *Bulimina marginata* d'Orbigny, side view  $\times 125$ .

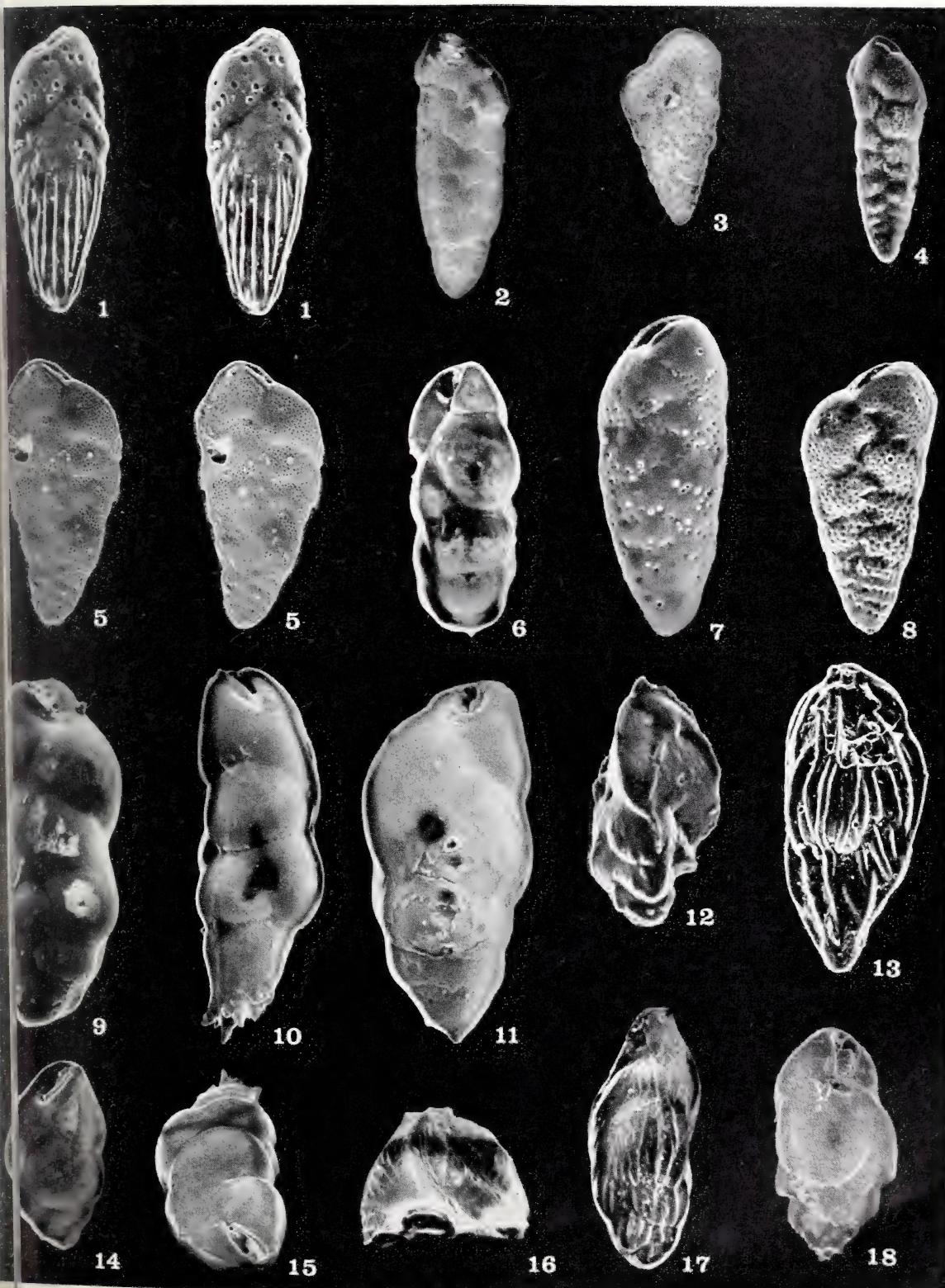


PLATE II

- FIG. 1. *Bolivina striatula* Cushman, detail of pores  $\times 530$ . Note borings.  
FIGS 2, 3. *Bolivina superba* Emiliani. 2, detail of pores and imperforate areas  $\times 530$ ; 3, close up of pores  $\times 5300$ .  
FIGS 4–6. *Bolivina pseudopunctata* Hoglund. 4, side view showing imperforate areas of the chambers and pores  $\times 525$ ; 5, close up of pores  $\times 10,500$ ; 6, close up of aperture  $\times 525$ .  
FIG. 7. *Bolivina pseudoplicata* Heron-Allen & Earland, side view showing ornament  $\times 1075$ .  
FIG. 8. *Bolivina variabilis* (Williamson), side view showing pores  $\times 530$ .  
FIG. 9. *Bolivina* cf. *vadescens* Cushman sensu Hoglund, side view showing pores  $\times 525$ .  
FIG. 10. *Bulimina elongata* d'Orbigny, pores in final chamber  $\times 525$ .  
FIG. 11. *Trifarina angulosa* (Williamson), stereopair showing aperture  $\times 200$ .

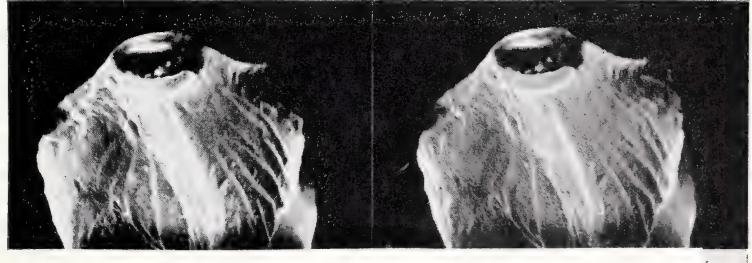
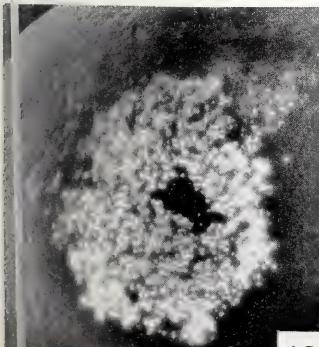
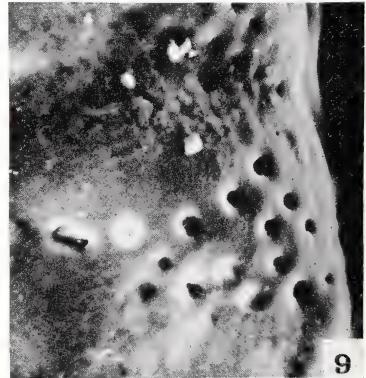
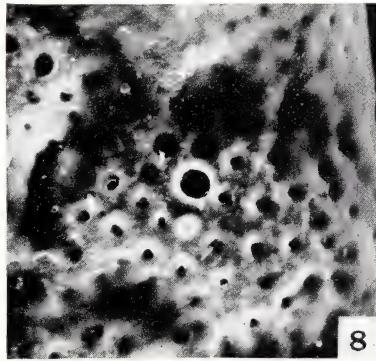
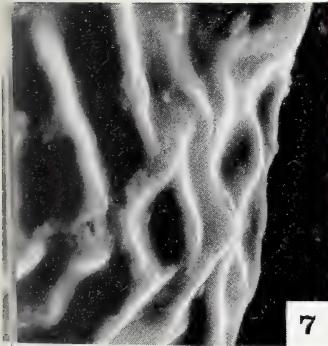
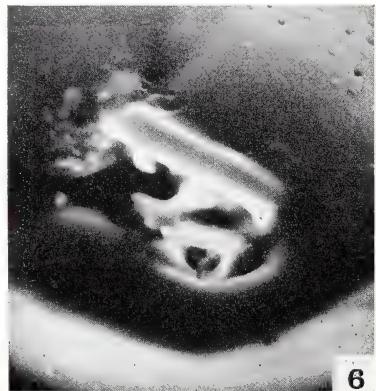
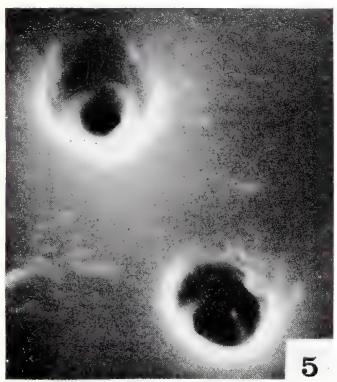
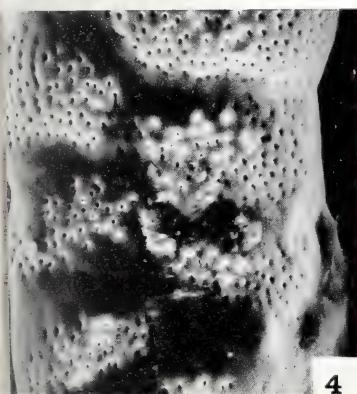
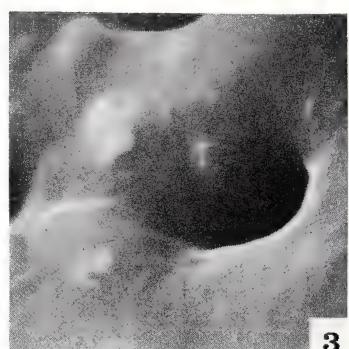
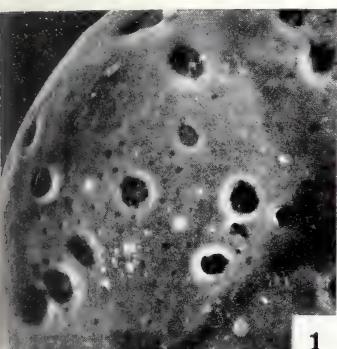


PLATE 12

- FIG. 1. *Lagena clavata* (d'Orbigny), side view,  $\times 135$ .
- FIG. 2. *Lagena laevis* (Montagu), side view,  $\times 130$ .
- FIG. 3. *Lagena* species A, side view,  $\times 125$ .
- FIG. 4. *Lagena* species A, basal view showing striae  $\times 200$ .
- FIG. 5. *Lagena perlucida* (Montagu), side view  $\times 125$ .
- FIG. 6. *Lagena semistriata* (Williamson), side view,  $\times 125$ .
- FIG. 7. *Lagena doveyensis* Haynes n. sp., holotype, side view  $\times 170$ .
- FIG. 8. *Lagena doveyensis* Haynes n. sp., holotype, basal view showing striae,  $\times 400$ .
- FIG. 9. *Lagena sulcata* (Walker & Jacob), side view,  $\times 105$ .
- FIG. 10. *Lagena sulcata* var. *interrupta* (Williamson), side view,  $\times 105$ .
- FIG. 11. *Lagena substriata* Williamson, side view,  $\times 105$ .
- FIG. 12. *Lagena* cf. *striata* (d'Orbigny), side view,  $\times 130$ .
- FIG. 13. *Lagena spicata* (Cushman & McCulloch), side view,  $\times 130$ .
- FIG. 14. *Lagena sulcata* var. *torquiformis* Haynes n. var., side view,  $\times 105$ .
- FIG. 15. *Lagena pacifica* Sidebottom, side view,  $\times 170$ .
- FIG. 16. *Lagena hibernica* Haynes n. sp., holotype, side view,  $\times 330$ .
- FIG. 17. *Lagena hibernica* Haynes n. sp., holotype, apertural view,  $\times 330$ .

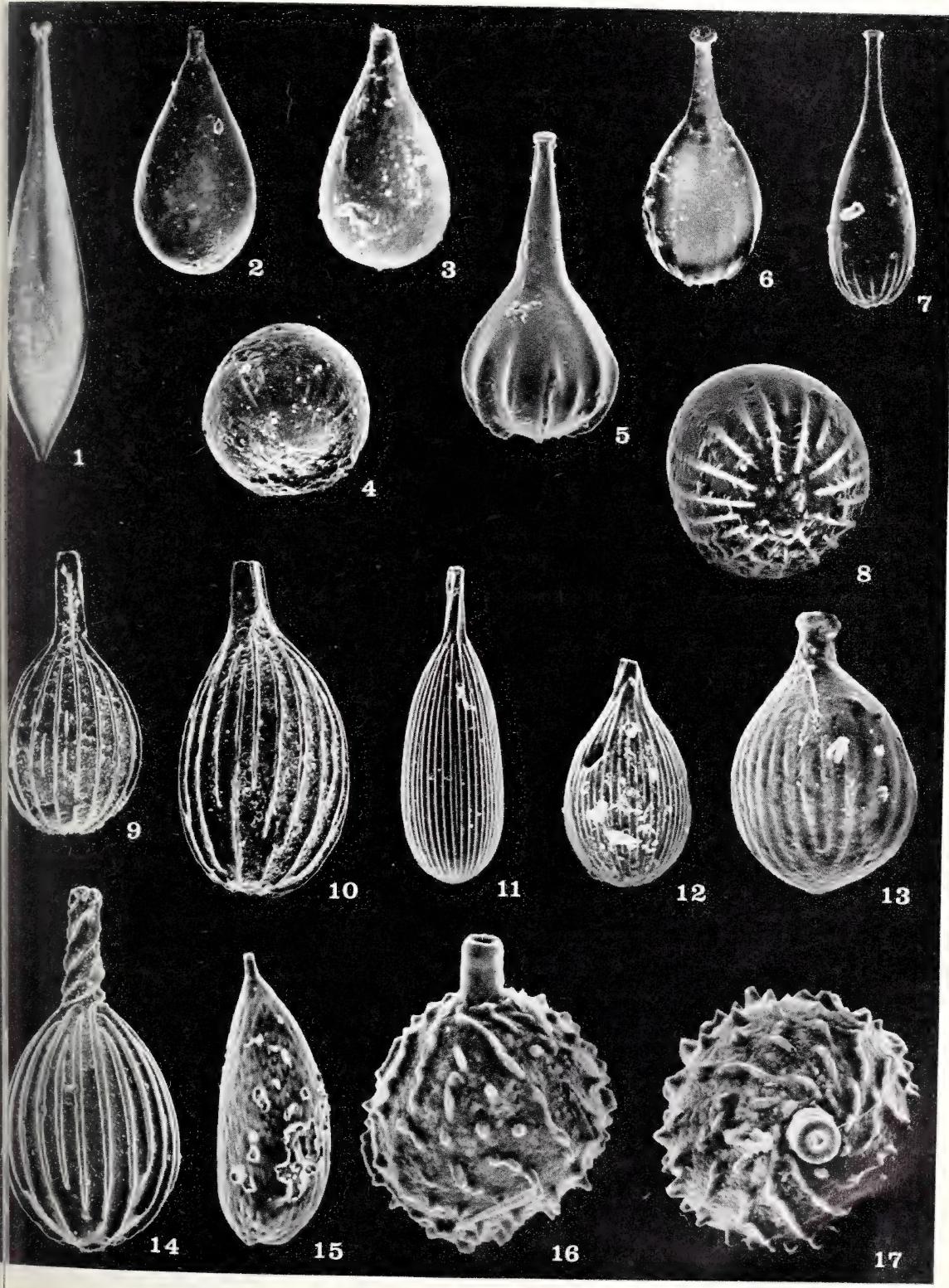


PLATE 13

- FIG. 1. *Lagena clavata* (d'Orbigny), aperture, showing frilled, everted lip,  $\times 1330$ .
- FIG. 2. *Lagena pacifica* Sidebottom, pores of apertural end and breached lamella,  $\times 265$ .
- FIG. 3. *Lagena pacifica* Sidebottom, aperture, showing smooth rim  $\times 2750$ .
- FIG. 4. *Lagena semistriata* (Williamson), aperture with everted lip and internal overhang  $\times 1060$ .
- FIG. 5. *Lagena perlucida* (Montagu), aperture with irregular radial grooves  $\times 1150$ .
- FIG. 6. *Lagena substriata* Williamson, smooth ribs on neck  $\times 1050$ .
- FIG. 7. *Lagena cf. striata* (d'Orbigny), twisted ribs on neck  $\times 540$ .
- FIG. 8. *Lagena cf. striata* (d'Orbigny), close up of ribs, showing double rows of denticles  $\times 2725$ .
- FIG. 9. *Lagena sulcata* var. *torquiformis* Haynes n. var., aperture showing four spiral ribs on the neck, looped back to form aperture rim  $\times 265$ .
- FIG. 10. *Lagena sulcata* (Walker & Jacob), basal view  $\times 265$ .
- FIG. 11. *Lagena substriata* Williamson, aperture with six spiral ribs on neck  $\times 1050$ .
- FIG. 12. *Lagena sulcata* var. *torquiformis* Haynes n. var., apertural neck showing spiral ribs  $\times 265$ .

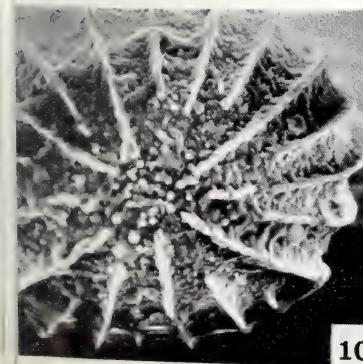
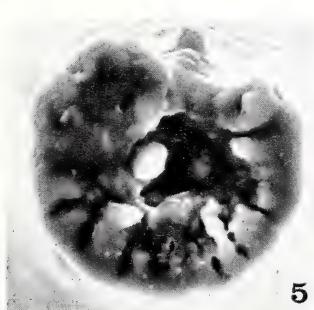
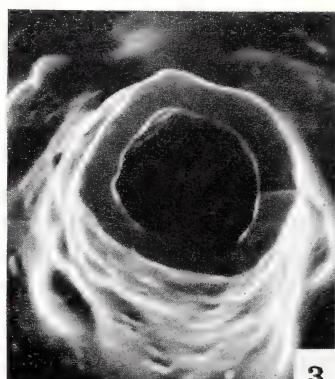
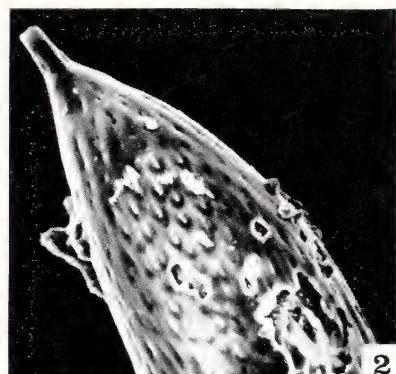


PLATE 14

FIGS 1, 2. *Fissurina lucida* (Williamson). 1, side view  $\times 135$ ; 2, apertural view of additional specimen  $\times 110$ .

FIGS 3, 4. *Fissurina* species A. 1, side view  $\times 175$ ; 2, apertural view  $\times 160$ .

FIG. 5. *Fissurina elliptica* (Cushman), oblique side view  $\times 165$ .

FIG. 6. *Oolina borealis* Loeblich & Tappan, side view of specimen described  $\times 105$ .

FIG. 7. *Oolina heronalleni* Haynes n. sp., side view of holotype  $\times 170$ .

FIGS 8-10. *Oolina lineata* (Williamson). 8, side view of specimen described  $\times 210$ ; 9, 10, basal view  $\times 100$  and side view  $\times 125$  of spinose variety.

FIG. 11. *Oolina laevigata* d'Orbigny side view of specimen described  $\times 170$ .

FIGS 12, 13. *Oolina hexagona* (Williamson), side view of specimen described  $\times 170$ ; apertural view of additional specimen  $\times 160$ .

FIG. 14. *Oolina squamosa* (Montagu), side view of specimen described  $\times 170$ .

FIGS 15-17. *Oolina williamsoni* (Alcock). 15, 16, side and apertural views of specimen described  $\times 125$ ; 17, side view of variety with fewer, broader, flattened ribs  $\times 170$ .

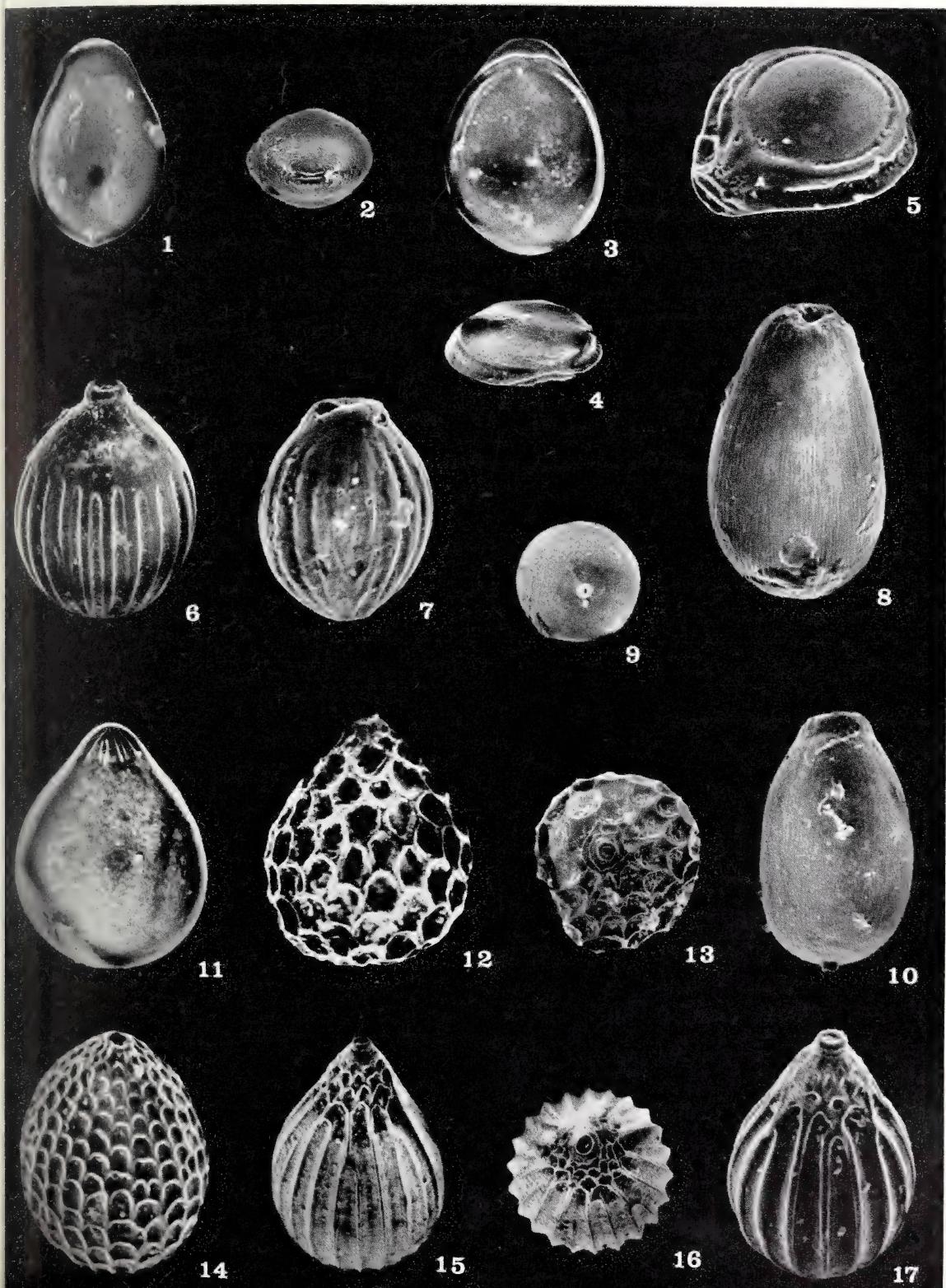


PLATE 15

FIGS 1, 2, 7. *Oolina williamsoni* (Alcock). 1, oblique side view showing the undercut ribs  $\times 265$ ; 2, detail of aperture and neck ornament  $\times 525$ ; 7, detail of pores and ribs  $\times 525$ .

FIGS 3, 6. *Oolina hexagona* (Williamson). 3, side view showing hexagons  $\times 265$ ; 6, close-up of hexagons  $\times 1060$ .

FIGS 4, 5. *Oolina squamosa* (Montagu). 4, side view showing loops  $\times 265$ ; 5, close-up of loops  $\times 530$ .

FIG. 8. *Pseudopolymorphina* cf. *novangliae* (Cushman), detail of aperture  $\times 560$ .

FIG. 9. *Spirillina perforata* (Schultze), detail of pores  $\times 2625$ .

FIG. 10. *Spirillina* species A, detail of pores  $\times 580$ .

FIG. 11. *Globulina* cf. *inaequalis* Reuss, detail of aperture  $\times 575$ .

FIG. 12. *Patellina corrugata* Williamson, side view showing pores and secondary calcite  $\times 700$ .

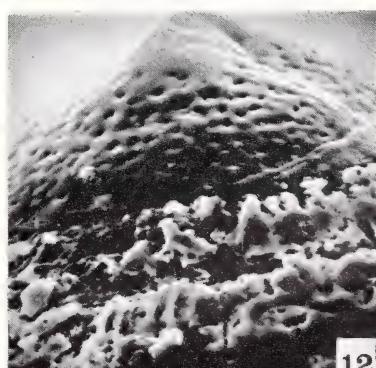
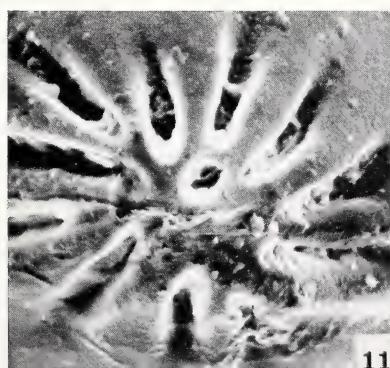
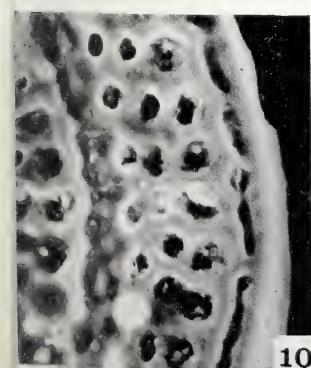
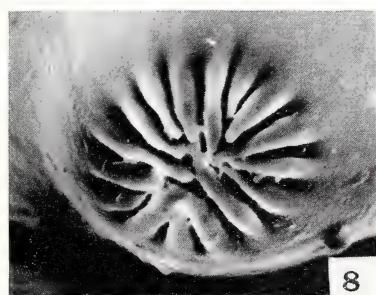
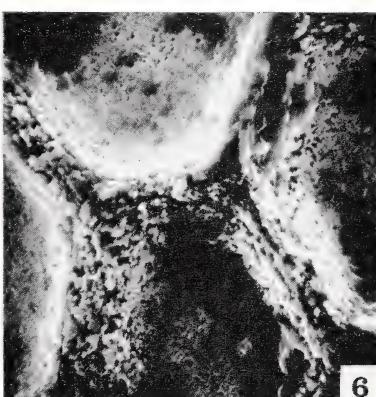
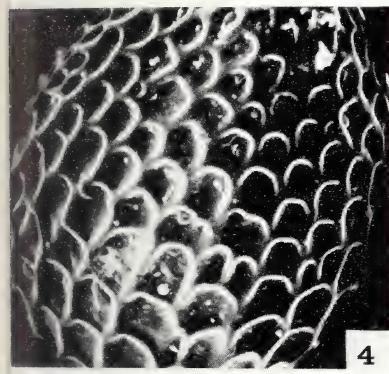
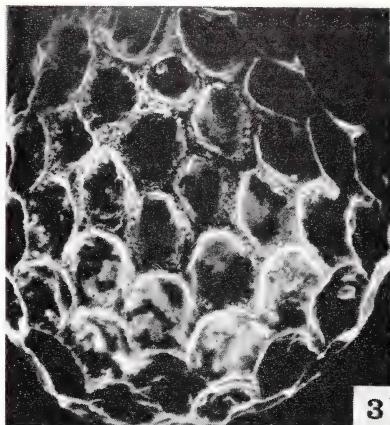
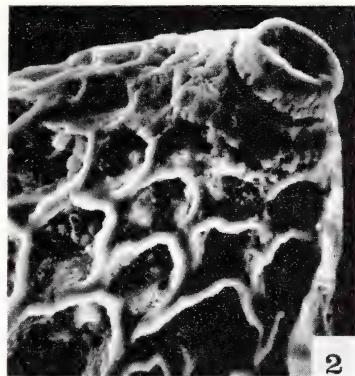
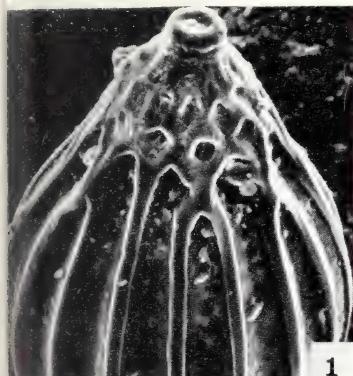


PLATE 16

FIGS 1, 2. *Spirillina perforata* (Schultze), side view and edge view  $\times 85$ .

FIGS 3, 4. *Turrispirillina* species A. 3 : 3, stereopair of side view; 4, edge view  $\times 125$ .

FIGS 5, 6. *Spirillina* species A, side view and edge view  $\times 105$ .

FIGS 7-9. *Patellina corrugata* Williamson, specimens described. 7, 8, dorsal view and edge view of same specimen  $\times 145$ ; 9, ventral view of additional small specimen  $\times 215$ .

FIGS 10, 17. *Pseudopolymorpha* cf. *novangliae* (Cushman), side view and apertural view of specimen described  $\times 125$ .

FIG. 11. *Dentalina* cf. *trondheimensis* Feyling-Hanssen, side view of specimen described  $\times 55$ .

FIGS 12-16. *Discorbis wrightii* (Brady). 12, dorsal view of large, angular specimen  $\times 140$ ; 13, 14, edge and dorsal views of small specimen + 125; 15, 16, oblique ventral views of further specimens showing plugs  $\times 125$  and  $\times 140$ .

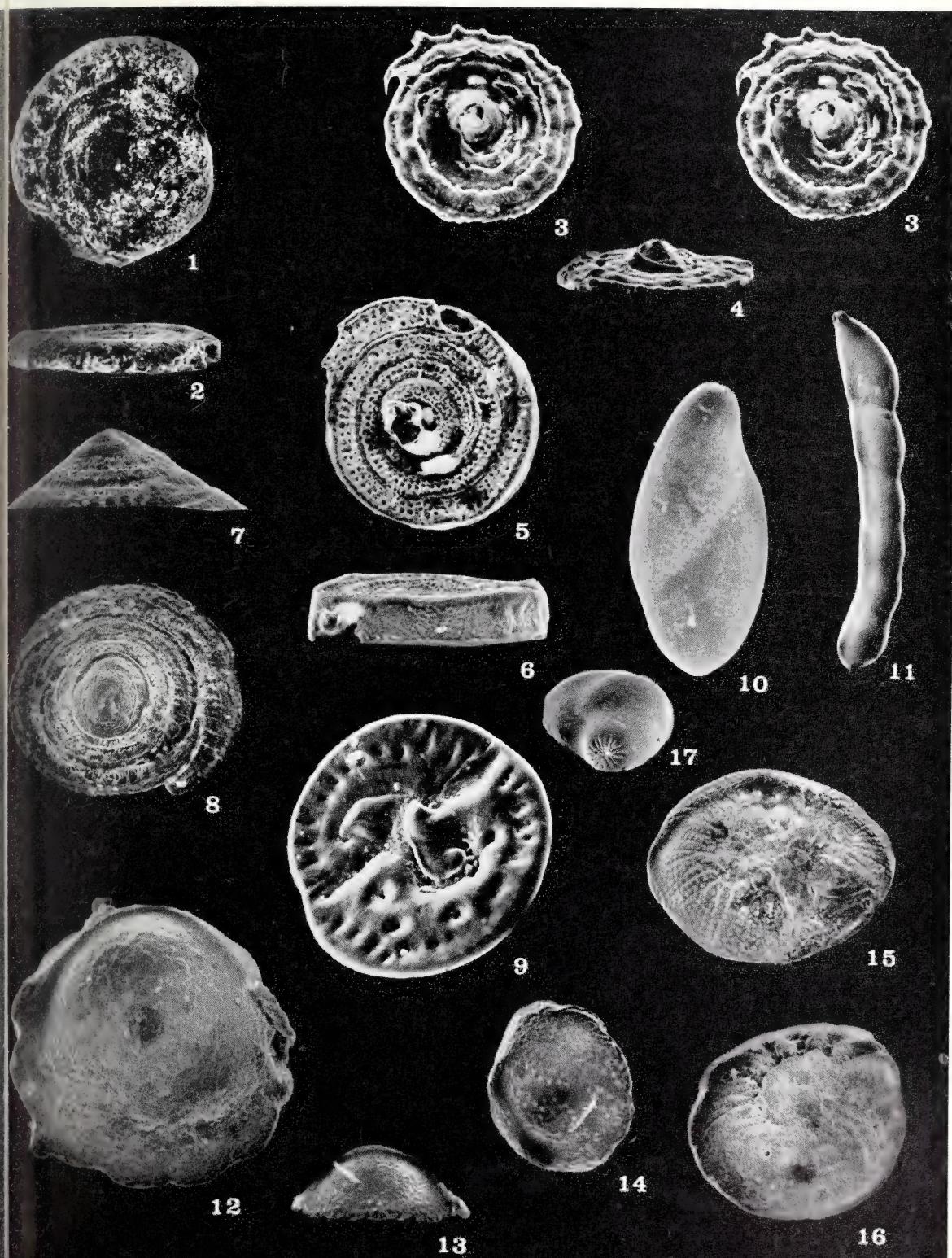


PLATE 17

FIGS 1-3. *Rosalina anomala* Terquem. 1, 2, ventral view and oblique ventral view of same specimen  $\times 65$ ; 3, dorsal view of further specimen  $\times 65$ .

FIGS 4, 5. *Rosalina* cf. *bradyi* (Cushman). 4, ventral view of small specimen  $\times 105$ ; 5, dorsal view of larger form  $\times 65$ .

FIGS 6-9. *Rosalina praegeri* (Heron-Allen & Earland). 7, 9, ventral and oblique ventral views of same specimen  $\times 125$ ; 6, 8, dorsal and side view of slightly smaller specimen  $\times 125$ .

FIG. 10. *Rosalina* species A, ventral view of specimen described  $\times 180$ .

FIGS 11, 12. *Rosalina millettii* (Wright). 11, oblique ventral view of broken specimen  $\times 130$ ; 12, dorsal view of additional specimen  $\times 210$ .

FIGS 13-15. *Rosalina williamsoni* (Chapman & Parr). 13, ventral view  $\times 85$ ; 14, 15, dorsal and side views of a smaller form  $\times 90$ .

FIGS 16-18. *Rosalina neapolitana* (Hofker). 16, oblique ventral view  $\times 85$ ; 17, 18, dorsal view and oblique side view of smaller form  $\times 125$ .

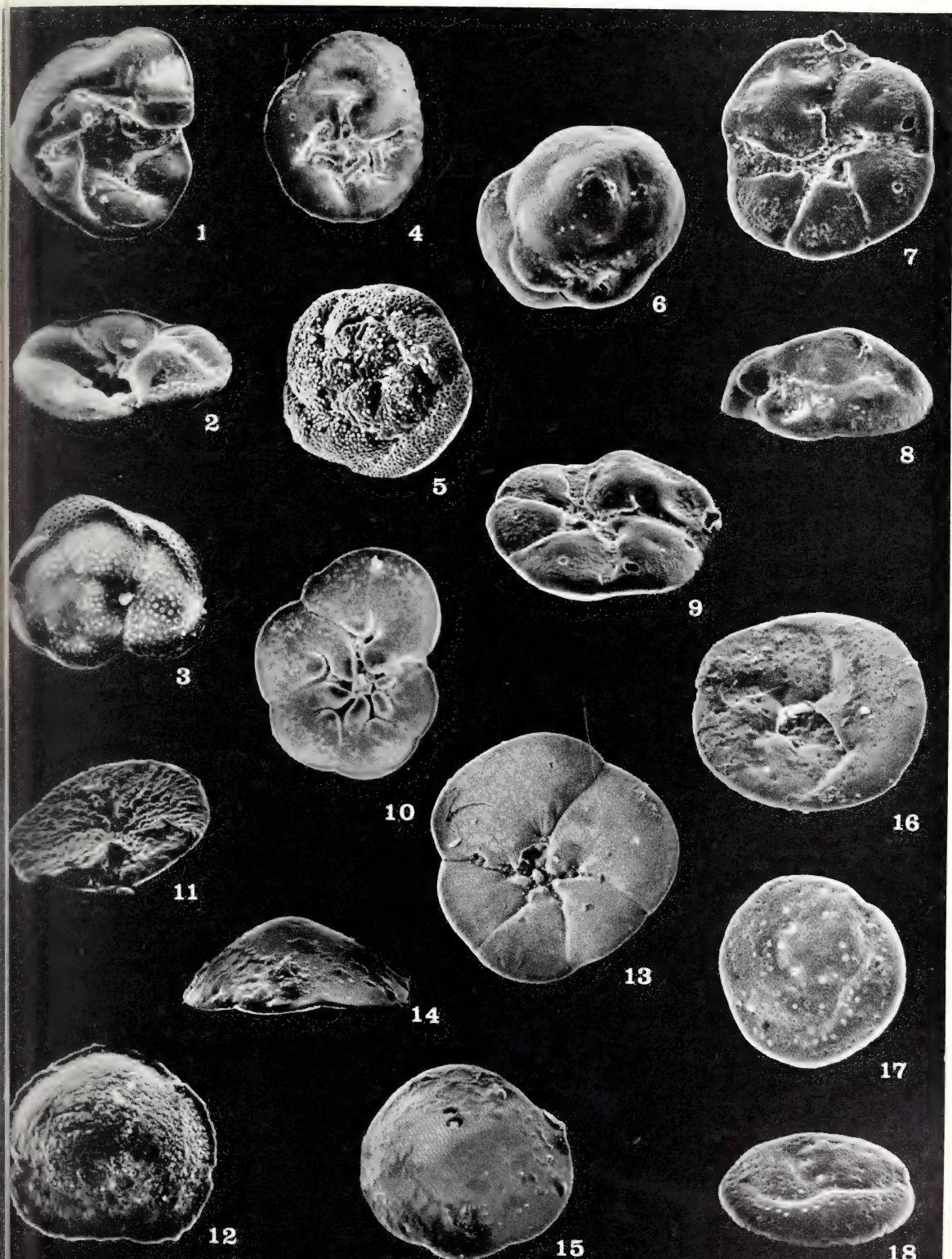


PLATE 18

Figs 1-4. *Asterigerinata mamilla* (Williamson). 1, oblique umbilical view showing foramen and supplementary chamberlets  $\times 125$ ; 2, dorsal view  $\times 130$ ; 3, side view of carinate form  $\times 110$ ; 4, oblique ventral view of juvenile with rounded periphery  $\times 170$  (four different specimens).

Figs 5, 6. *Ammonia batavus* (Hofker), side view and ventral view  $\times 65$ .

Figs 7-9. *Ammonia limnetes* (Todd & Bronnimann). 7, 8, ventral view and side view  $\times 110$ ; 9, dorsal view of larger form  $\times 105$ .

Figs 10-12. *Eponides repandus concameratus* (Montagu). 10, 11, ventral view and side view  $\times 35$ ; 12, dorsal view of additional specimen  $\times 35$ .

Fig. 13. *Buccella frigida* (Cushman), ventral view  $\times 265$ .

Figs 14, 16. *Ammonia batavus* (Hofker), dorsal views  $\times 65$ .

Fig. 15. *Ammonia aberdoveyensis* Haynes n. sp., ventral view of paratype  $\times 65$ .

Fig. 17. *Ammonia tepida* (Cushman), oblique ventral view  $\times 65$ .

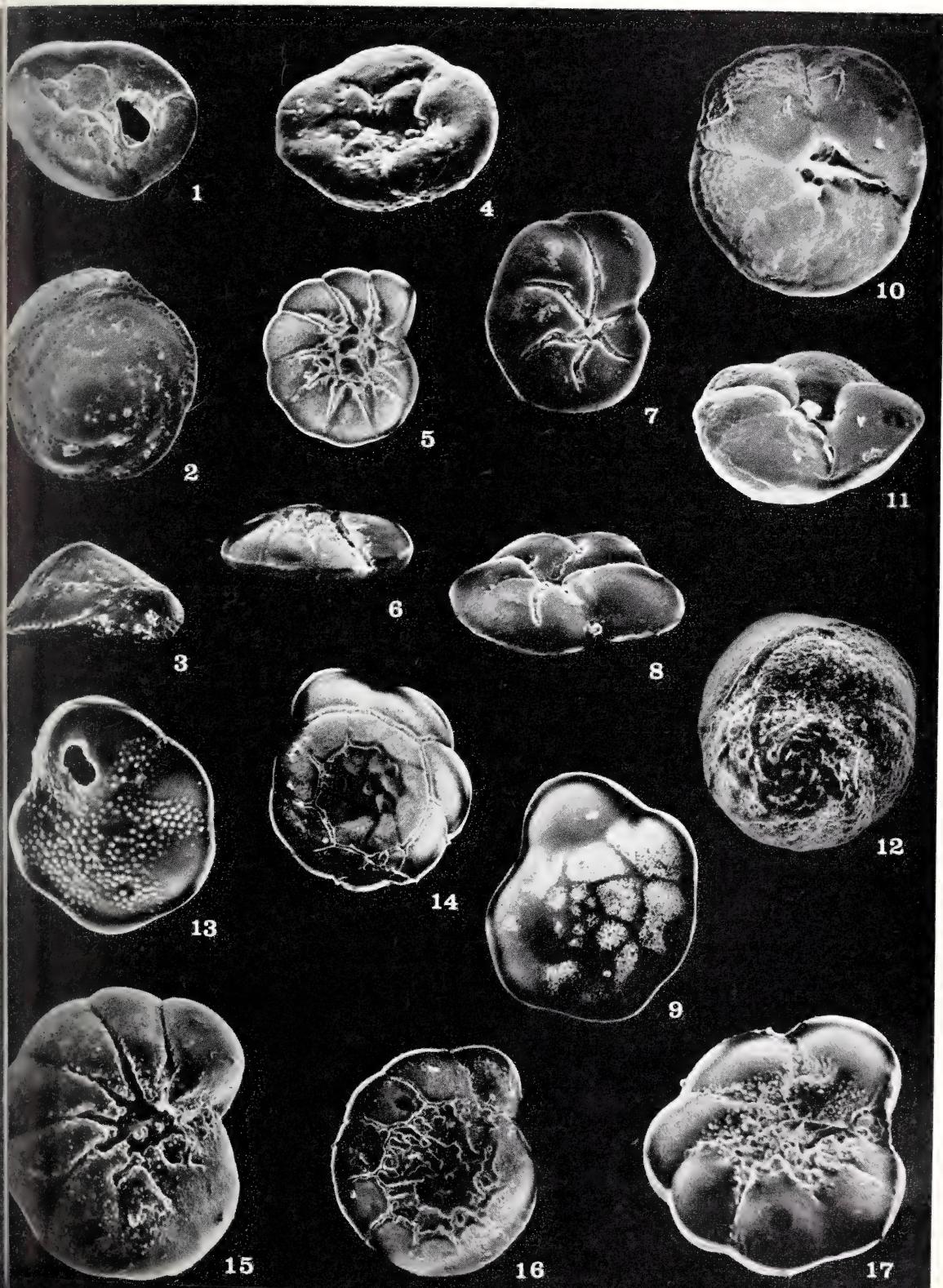


PLATE 19

FIGS 1, 3, 6. *Rosalina* cf. *bradyi* (Cushman). 1, pores on dorsal side  $\times 1060$ ; 3, close-up of pores  $\times 2800$ ; 6, umbilical area  $\times 280$ .

FIG. 2. *Rosalina anomala* Terquem, pores on dorsal side  $\times 525$ , last chamber of specimen shown in Pl. 17, fig. 3.

FIG. 4. *Rosalina praegeri* (Heron-Allen & Earland), detail of umbilicus and lobes  $\times 250$ . Note poreless area.

FIG. 5. *Discorbis wrightii* (Brady), detail of umbilicus and chamber ornament  $\times 265$ .

FIGS 7, 9. *Asterigerinata mamilla* (Williamson). 7, umbilical area  $\times 265$ ; 9, large, dorsal pores  $\times 270$ .

FIG. 8. *Ammonia limnetes* (Todd & Bronnimann), detail of umbilical area showing lobes  $\times 555$ . Note finger nail shape of final lobe.

FIGS 10, 11. *Eggerelloides scabrum* (Williamson). 10, detail of aperture showing tooth plate  $\times 265$ ; 11, last whorl showing aperture and wall structure  $\times 105$ .

N.B. The figures are close-ups of specimens shown in Plates 2, 17 and 18.

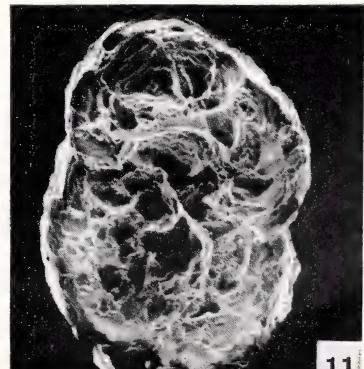
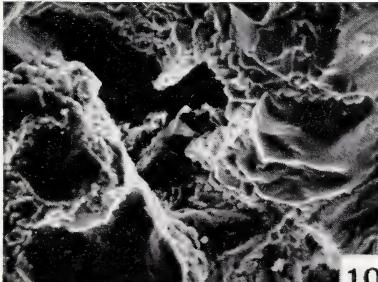
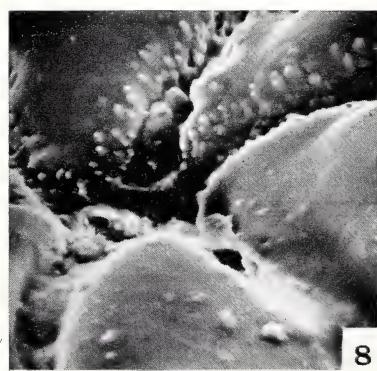
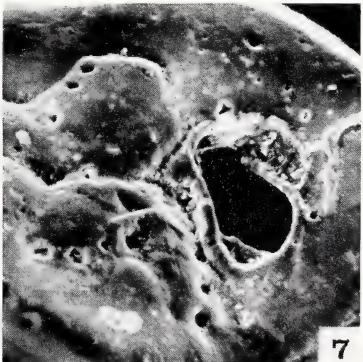
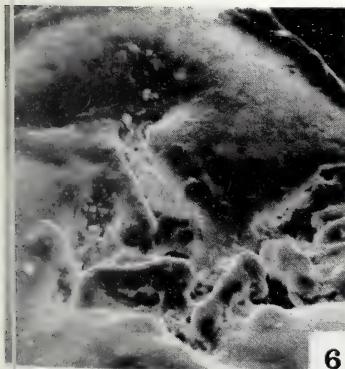
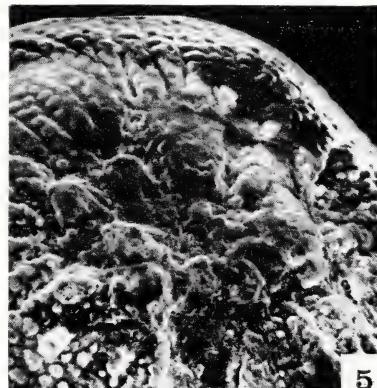
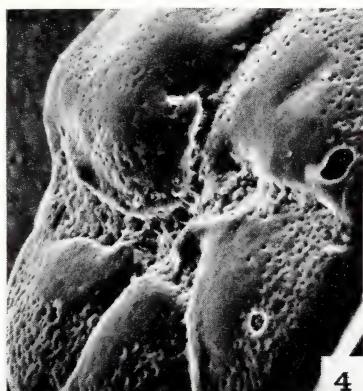
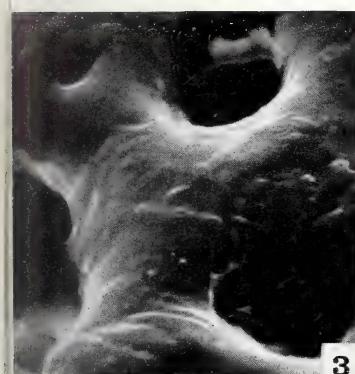
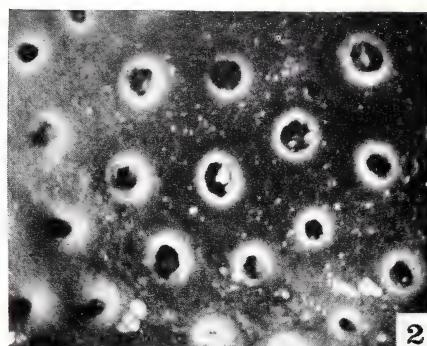
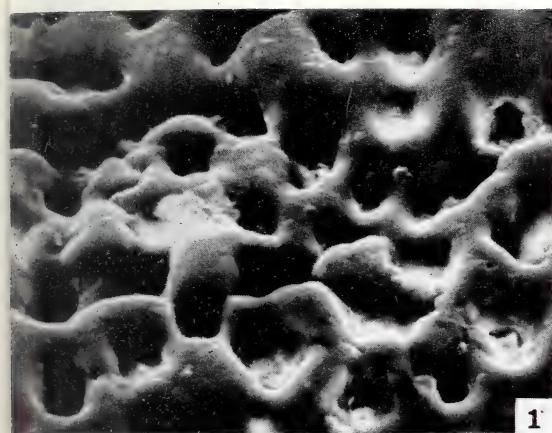


PLATE 20

FIGS 1, 2. *Cibicides lobatulus* (Walker & Jacob). 1, dorsal view  $\times 65$ ; 2, ventral view  $\times 85$ .

FIGS 3, 4. *Globorotalia inflata* (d'Orbigny). 3, dorsal view  $\times 85$ ; 4, ventral view  $\times 95$ .

FIG. 5. *Biorbulina bilobata* (d'Orbigny), specimen described  $\times 105$ .

FIG. 6. *Orbulina universa* d'Orbigny, specimen described  $\times 105$ .

FIGS 7-9. *Globoquadrina hexagona* (Natland). 7, 8, ventral view and side view  $\times 145$ ; 9, dorsal view of slightly larger specimen  $\times 140$ .

FIGS 10-12. *Planorbulina distoma* Terquem, specimens described. 10, 11, side view and ventral view  $\times 65$ ; 12, dorsal view of slightly smaller specimen  $\times 65$ .

FIG. 13. *Cancris oblongus* (Williamson), ventral view  $\times 105$ .

FIG. 14. *Epistominella naraensis* (Kuwano) ventral view  $\times 360$ .

FIGS 15, 16. *Siphonina georgiana* Haynes n. sp. 15, dorsal view  $\times 125$ ; 16, ventral view of larger specimen  $\times 110$ .

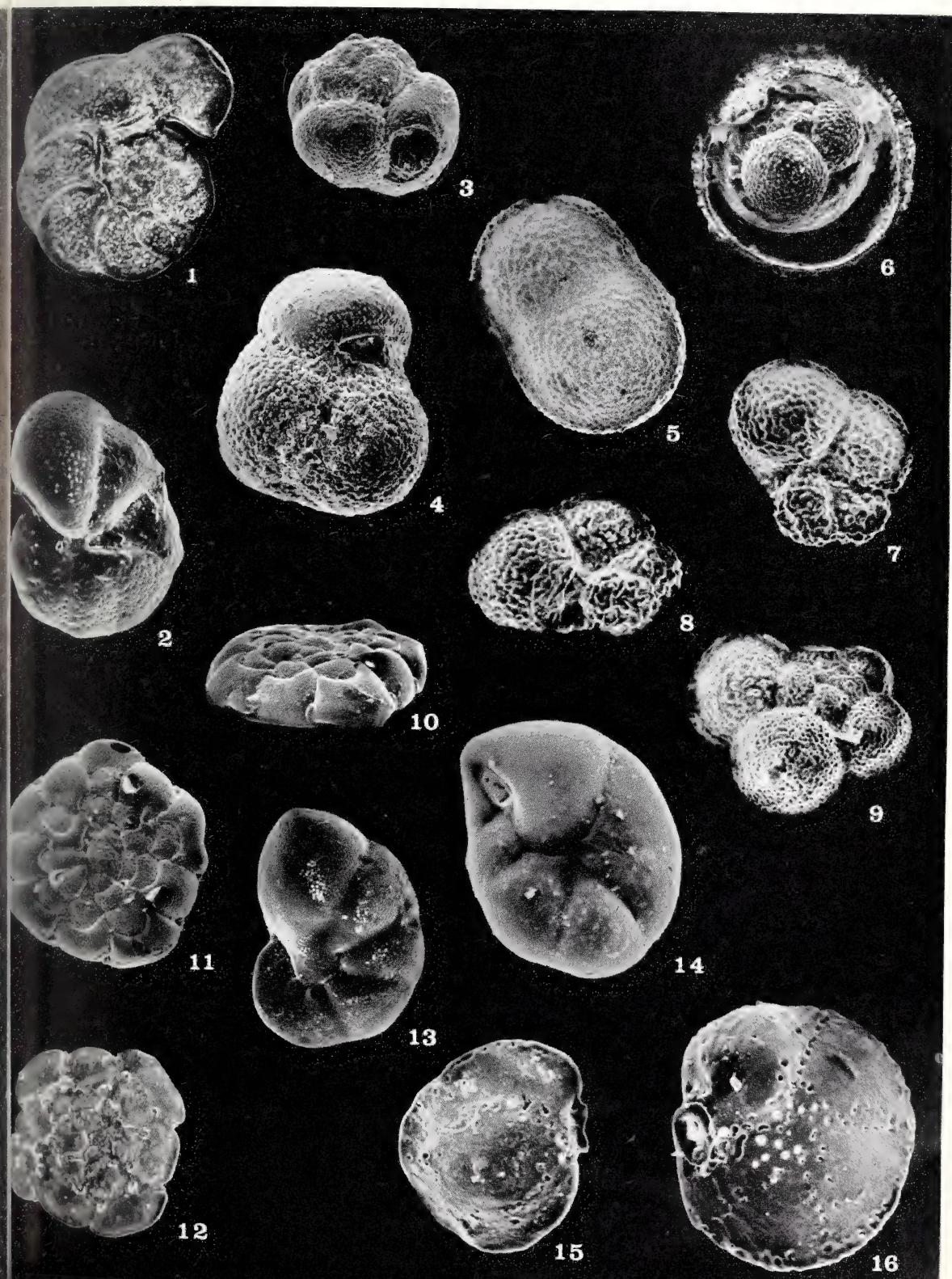


PLATE 21

FIGS 1, 2. *Cibicides fletcheri* var. *sachalinica* Vasilenko. 1, dorsal view showing chamber lobes and umbilical boss (note random boreholes)  $\times 265$ ; 2, detail of umbilicus  $\times 525$ .

FIGS 3, 5, 6. *Cibicides lobatulus* (Walker & Jacob). 3, final chamber showing pores  $\times 265$ ; 5, peripheral view of aperture  $\times 265$ ; 6, dorsal view of aperture  $\times 265$ . (Close-ups of specimens shown in Pl. 20.)

FIGS 4, 7, 8. *Planorbolina distoma* Terquem. 4, oblique ventral view showing peripheral and ventral apertures and pores  $\times 280$ ; 7, pores on dorsal side  $\times 525$ ; 8, detail of pore showing interlocking plates and smaller, subsidiary pores  $\times 10,000$ . (Close-ups of specimens shown in Pl. 20.)

FIG. 9. *Planorbolina* species A showing pores and pitted surface  $\times 1150$ .

FIGS 10, 11. *Globorotalia inflata* (d'Orbigny). 10, dorsal surface showing pores  $\times 265$ ; 11, close-up of pores showing slight pits  $\times 1050$ . (Details of specimens shown in Pl. 20.)

FIG. 12. *Globoquadrina hexagona* (Natland) showing hexagonal pits  $\times 2875$ . (Detail of specimen shown in Pl. 20.)

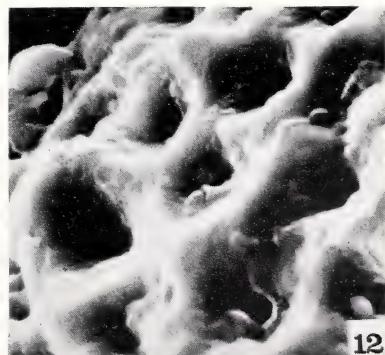
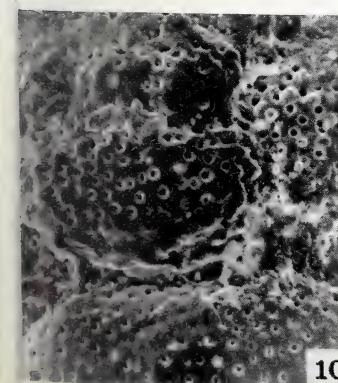
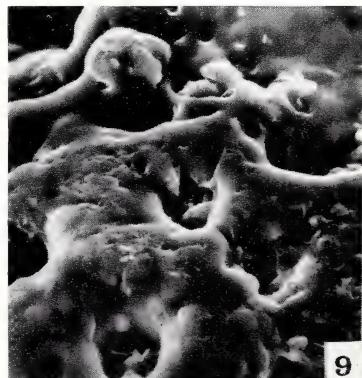
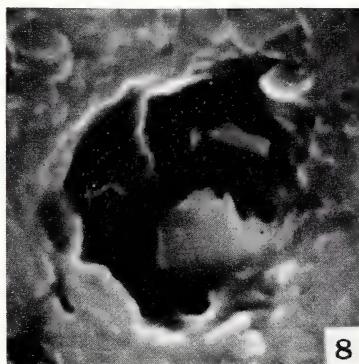
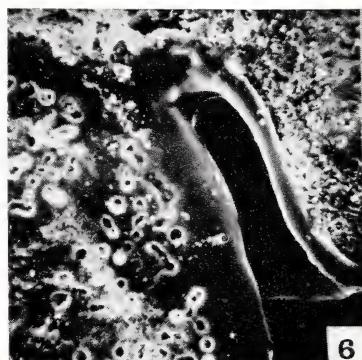
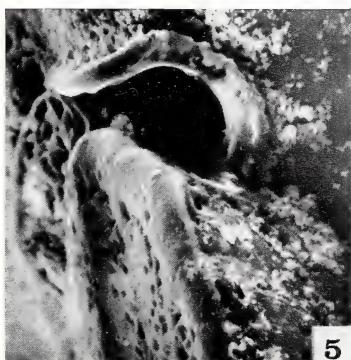
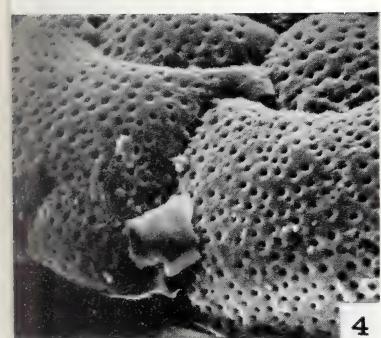
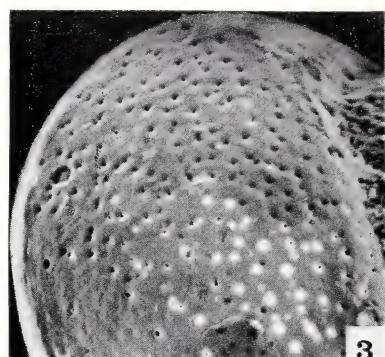
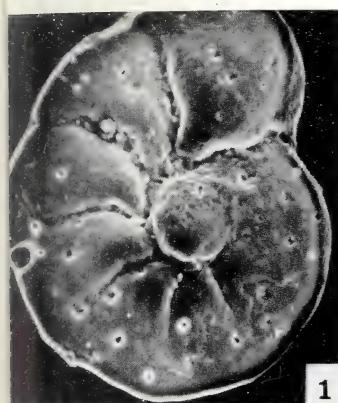


PLATE 22

Figs 1, 2. *Elphidium* sp., ? lobate variety *E. selseyense* gr. (Heron-Allen & Earland). 1, side view showing excavated sutures  $\times 105$ ; 2, apertural view  $\times 110$ .

Figs 3, 4. *Elphidium selseyense* gr. (Heron-Allen & Earland). 3, specimen with bulla-like final chamber and areal apertures  $\times 105$ ; 4, side view of specimen described  $\times 105$ .

FIG. 5. *Elphidium magellanicum* (Heron-Allen & Earland), apertural view  $\times 125$ .

FIG. 6. *Elphidium incertum* (Williamson), apertural view  $\times 200$  (also Pl. 24, fig. 14).

FIG. 7. *Elphidium asterotuberculatum* (Voorthuysen), apertural view  $\times 305$ .

Figs 8-11. *Nonion depressulus* (Walker & Jacob). 8, side view of specimen with markedly hooked back sutures  $\times 125$ ; 9, side view of specimen with irregular thickening in umbilicus  $\times 125$ ; 10, 11, side view and apertural view of specimen described  $\times 125$ .

FIG. 12. *Nonionella turgida* (Williamson), side view  $\times 170$ .

Figs 13, 14. *Nonion pauperatum* (Balkwill & Wright), side view and apertural view  $\times 125$ .

Figs 15, 16. *Protelphidium anglicum* Murray, side view and edge view of specimen described  $\times 105$ .

Figs 17, 18. *Nonionella* sp. A, side view and apertural view  $\times 85$ .

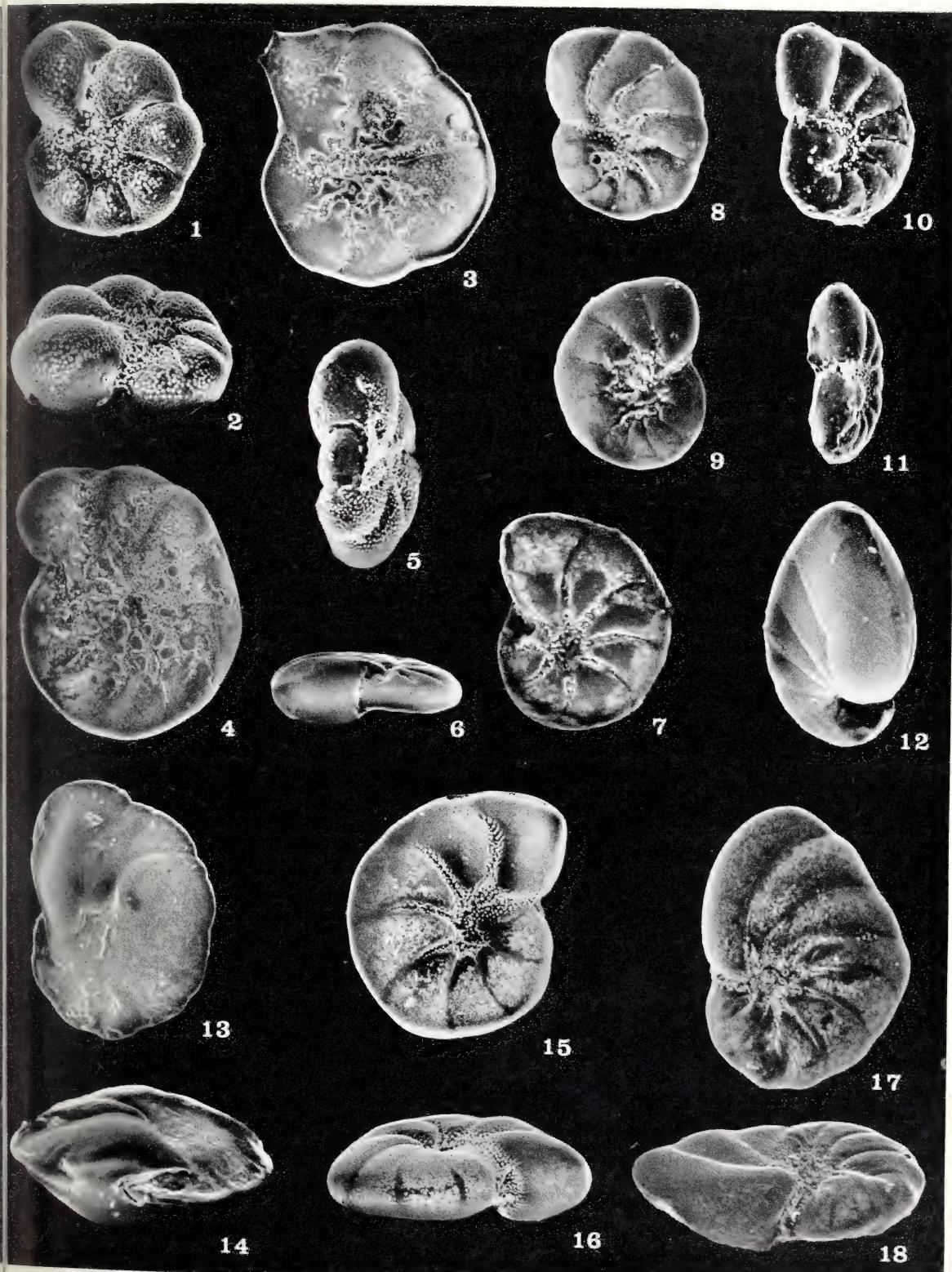


PLATE 23

FIGS 1, 2. *Protelphidium anglicum* Murray. 1, umbilical area  $\times 265$ ; 2, detail of umbilicus and basal suture of last chamber  $\times 1100$ .

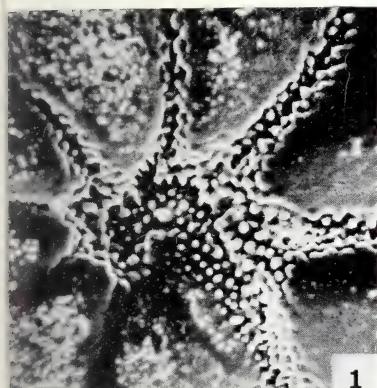
FIG. 3. *Nonionella* species A, oblique apertural view  $\times 110$ .

FIG. 4. *Nonion pauperatum* (Balkwill & Wright), apertural view  $\times 550$ .

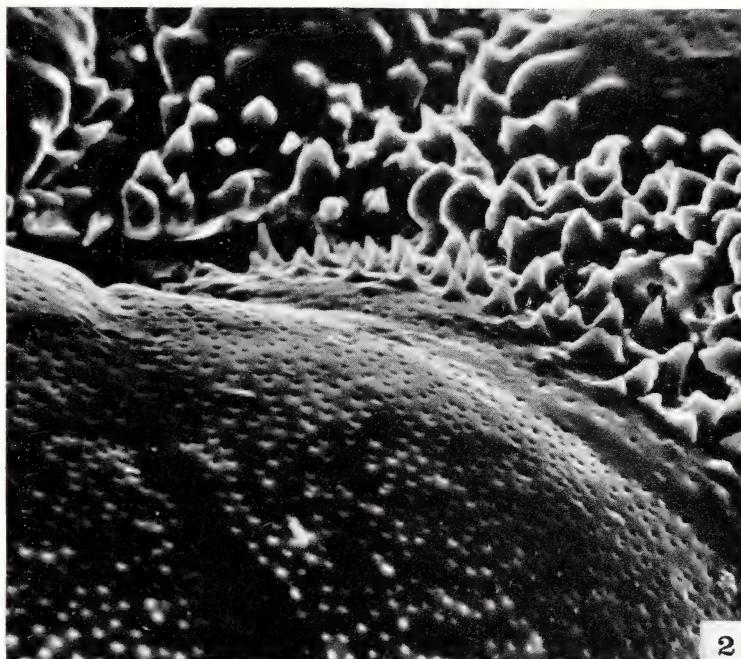
FIGS 5, 6. *Cancris oblongus* (Williamson). 5, final chamber showing pores and imperforate area  $\times 265$ ; 6, close-up of pores  $\times 525$ .

FIGS 7, 8. *Epistominella naraensis* (Kuwano). 7, aperture  $\times 1000$ ; 8, detail of umbilicus showing imperforate area  $\times 1000$ .

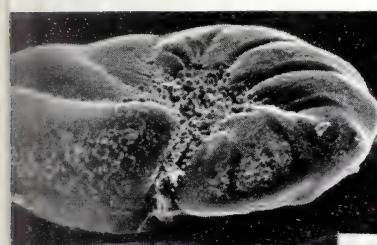
FIG. 9. *Siphonina georgiana* Haynes n. sp., aperture  $\times 500$ .



1



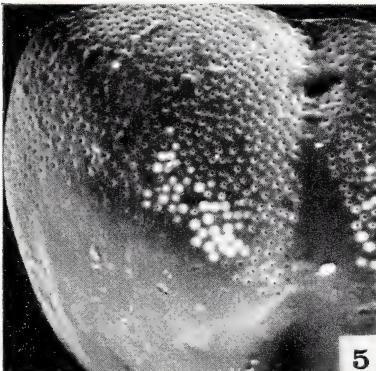
2



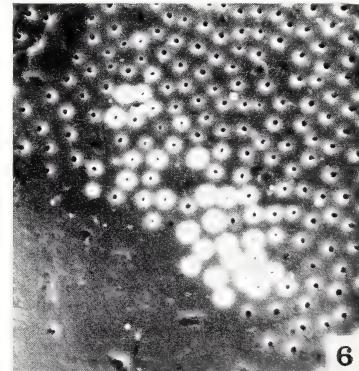
3



4



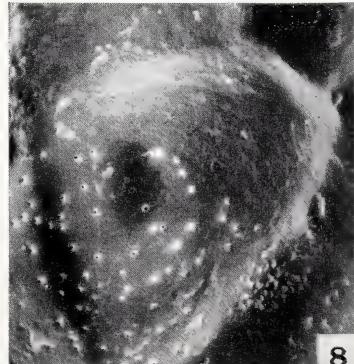
5



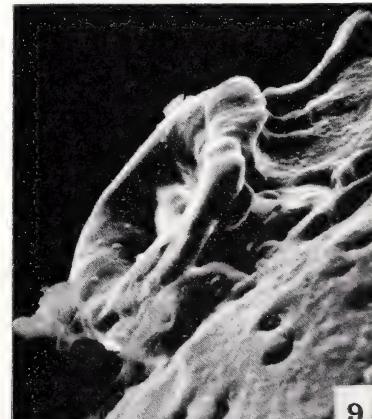
6



7



8



9

PLATE 24

FIGS 1-3. *E. macellum* (Fichtel & Moll). 1, side view of described specimen  $\times 60$ ; 2, side view of spinose juvenile  $\times 110$ ; 3, apertural view  $\times 110$ .

FIGS 4, 10. *E. waddensis* (Voorthuysen), side view and apertural view of specimen described  $\times 110$ .

FIGS 5, 6. *E. magellanicum* (Heron-Allen & Earland), side view  $\times 125$ , and apertural view  $\times 130$  of specimen described.

FIG. 7. *E. williamsoni* Haynes n. sp., holotype, side view  $\times 100$ .

FIGS 8, 9. *E. exoticum* Haynes n. sp., holotype, side view and apertural view  $\times 105$ .

FIG. 11. *E. selseyense* gr. (Heron-Allen & Earland), side view of entire variety with excavated sutures  $\times 110$ .

FIGS 12, 13. *E. margaritaceum* (Cushman), side view  $\times 110$ , and apertural view  $\times 120$ , of specimen described.

FIGS 14-16. *E. incertum* (Williamson). 14, side view of juvenile  $\times 210$ ; 15, 16, side view  $\times 175$  and apertural view of specimen described  $\times 180$ .

FIGS 17, 18. *E. cuvillieri* Lévy, side view  $\times 120$ , and apertural view  $\times 125$ , of specimen described.

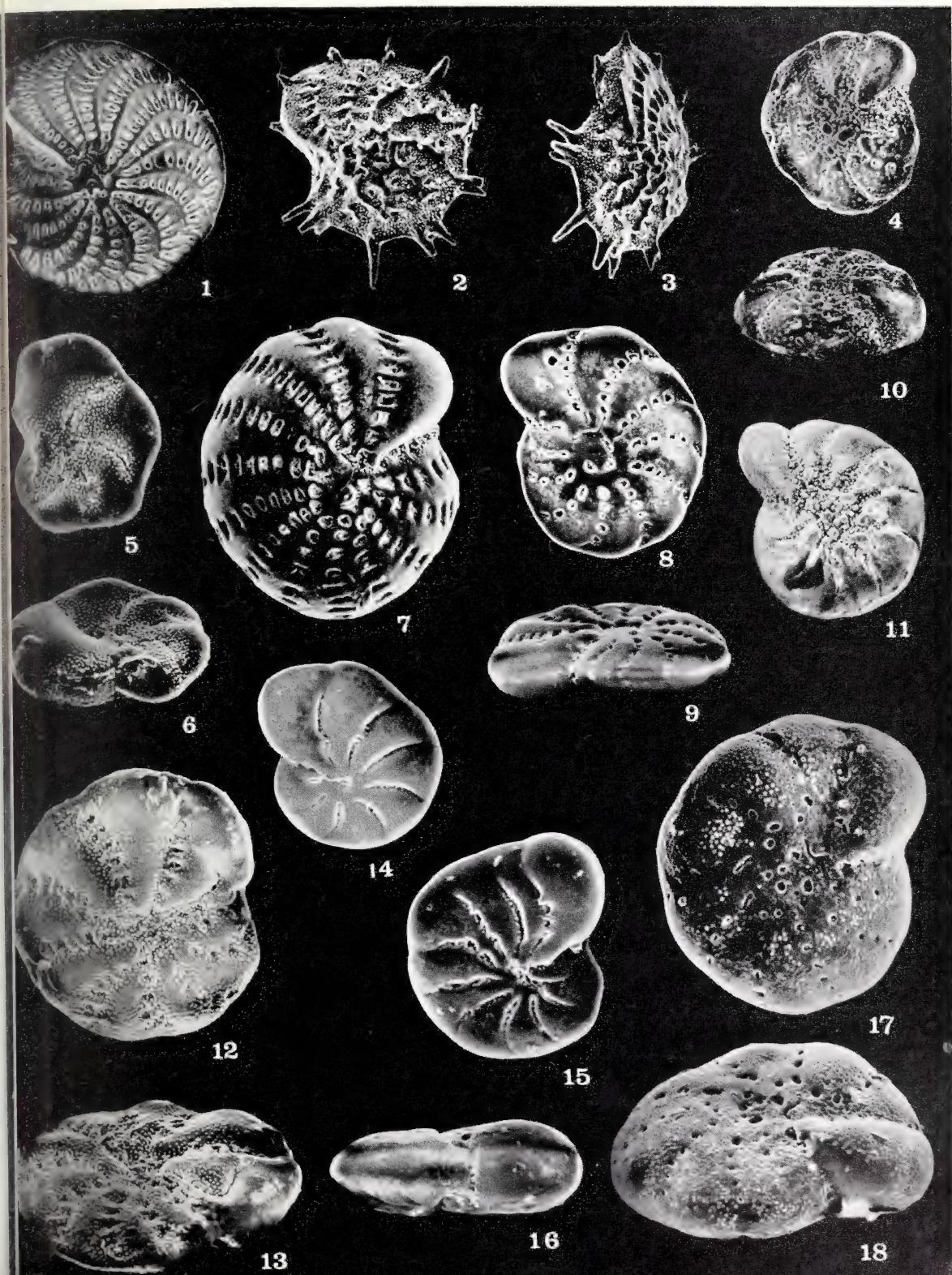


PLATE 25

FIGS 1-5, 7, 8. *E. macellum* (Fichtel & Moll). 1, breached specimen showing retral processes and septal canals between infolded septal flaps and previous chamber walls  $\times 210$ ; 2, umbilical area of specimen described showing irregular lobes formed by the ends of the chambers  $\times 105$ ; 3, apertural face of specimen described showing keel  $\times 115$ ; 4, detail of apertural face with part of ultimate row of septal pits and septal bars  $\times 580$ ; 7, irregular apertures connecting with pits in first visible chamber  $\times 580$ ; 5, 8, detail of spines in apertures  $\times 2900$ .

FIGS 6, 9. *E. williamsoni* Haynes n. sp. holotype. 6, detail of apertural face showing irregular basal apertures obscured by tubercles, oblong septal pits and almost flush septal bars,  $\times 250$ ; 9, detail of septal pits showing sparse internal tubercles  $\times 525$ .

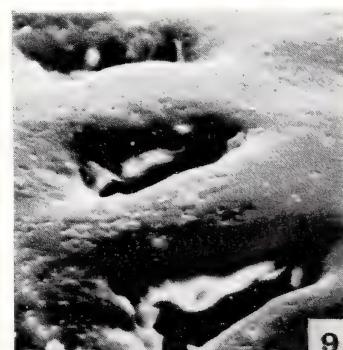
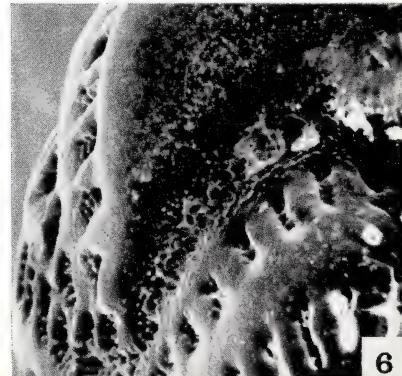
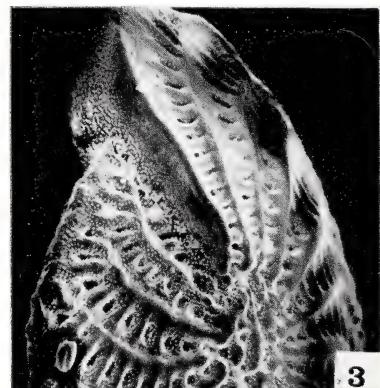
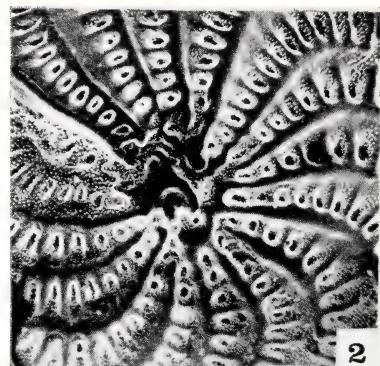
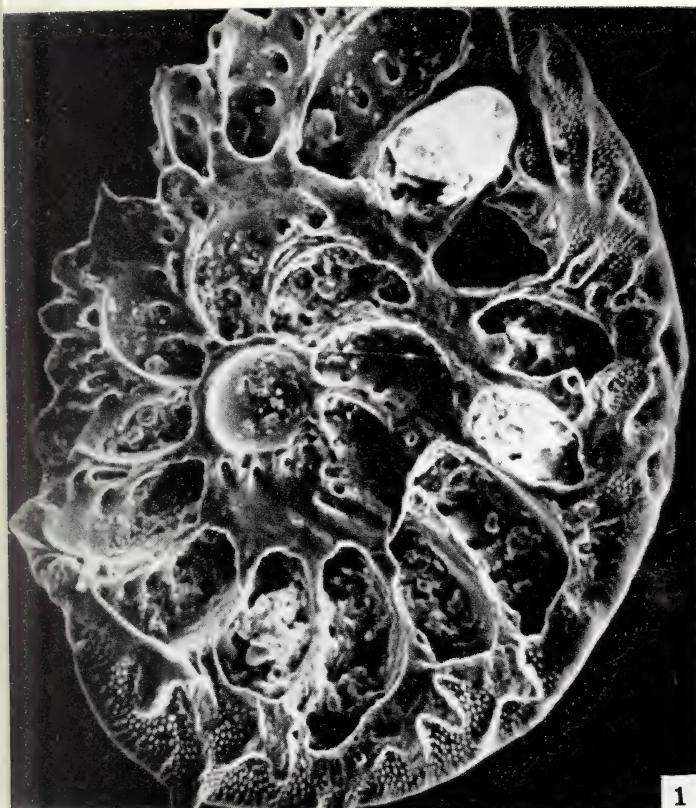


PLATE 26

FIG. 1. *E. waddensis* (Voorthuysen), apertural view showing distribution of large pores and tubercles  $\times 275$ .

FIGS 2, 3, 6, 8. *E. exoticum* Haynes n.sp. holotype. 2, apertural face in oblique view showing ultimate row of fossettes and septal bars and some apertures  $\times 260$ ; 3, umbilical area showing chamber lobes and proximally open retral processes of ultimate chamber  $\times 260$ ; 6, detail of hooded apertures  $\times 525$ ; 8, detail of fingernail-shaped fossettes (septal pits) showing spines and distribution of pores  $\times 1150$ .

FIGS 4, 7, 9. *E. selseyense* gr. (Heron-Allen & Earland). 4, oblique view of specimen showing umbilical ornament varying towards that of *E. clavatum* (Cushman)  $\times 240$ ; 7, detail of the two final chambers of specimen described showing pores and irregular septal pits  $\times 260$ ; 9, detail showing areal apertures of specimen with irregular final chamber  $\times 275$ .

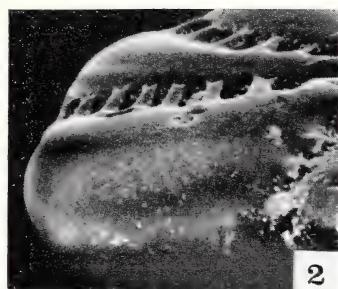
FIGS 5, 10. *E. selseyense* gr. lobate variety. 5, detail of apertural face showing protuberant areal apertures and irregular basal apertures surrounded by tubercles  $\times 590$ ; 10, umbilical area showing fissures and irregular granules  $\times 260$ .

FIG. 11. *E. magellanicum* (Heron-Allen & Earland), showing the depressed, granulate umbilical area  $\times 260$ .

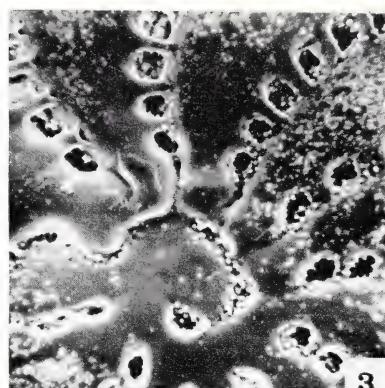
FIG. 12. *E. cuvillieri* Lévy, detail of final chamber and umbilical area showing apertures, pores, final row of septal pits and large pits in the umbilicus,  $\times 280$ .



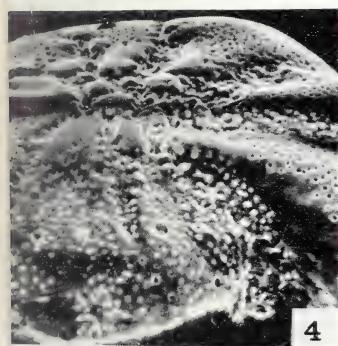
1



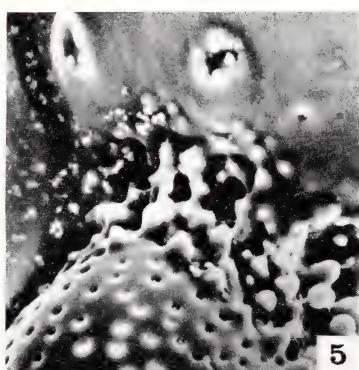
2



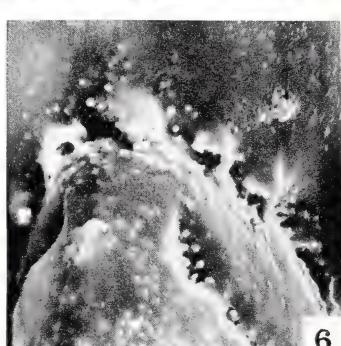
3



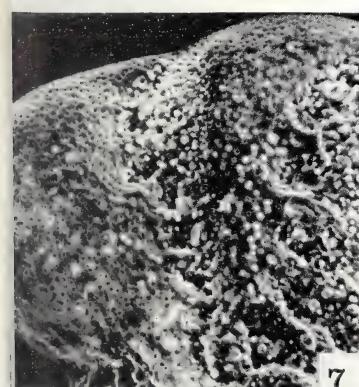
4



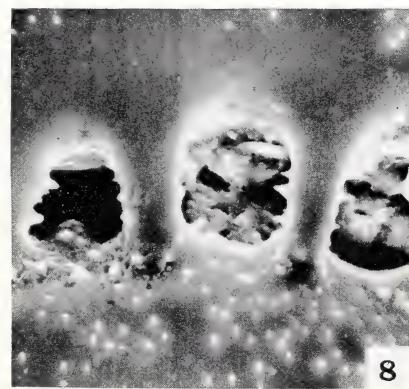
5



6



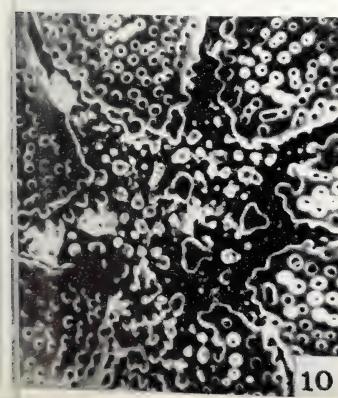
7



8



9



10



11



12

PLATE 27

FIGS 1-3. *Elphidium williamsoni* Haynes n. sp. 1, equatorial section of megalospheric specimen showing lamellar structure, ord. light  $\times 160$ ; 2, axial section, ord. light  $\times 160$ ; 3, equatorial section showing radial structure, crossed nicols  $\times 120$ .

FIGS 4, 5. *Elphidium macellum* (Fichtel & Moll). 4, axial section, ord. light  $\times 80$ ; 5, equatorial section, ord. light  $\times 80$ .

FIGS 6-9. *Protelphidium anglicum* Murray. 6, equatorial section of megalospheric specimen, ord. light  $\times 120$ ; 7, equatorial section of megalospheric specimen showing radial structure, crossed nicols  $\times 160$ ; 8, axial section, ord. light  $\times 120$ ; 9, equatorial section of microspheric specimen, ord. light  $\times 120$ .

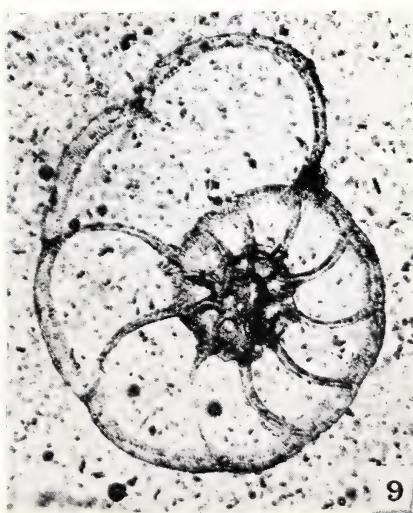
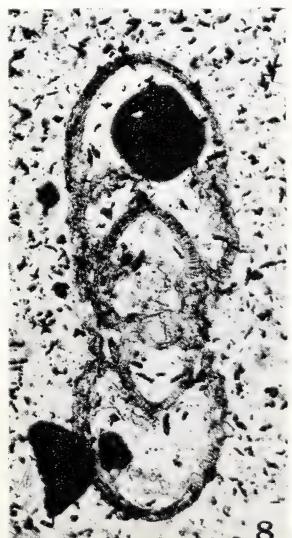
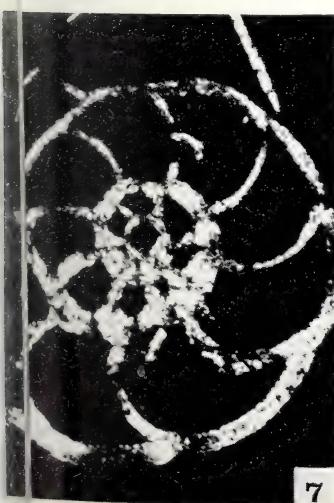
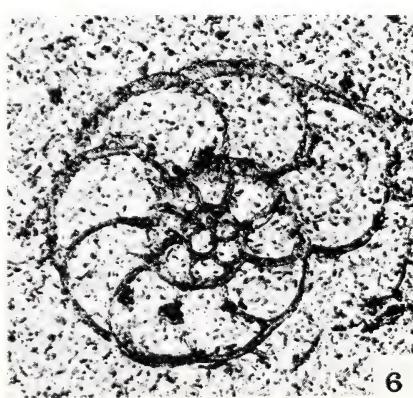
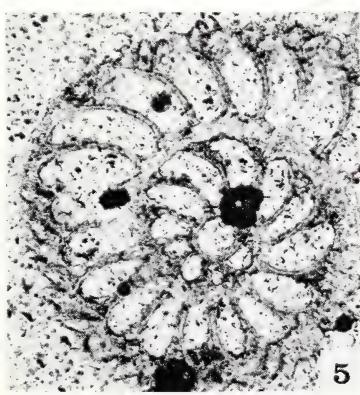
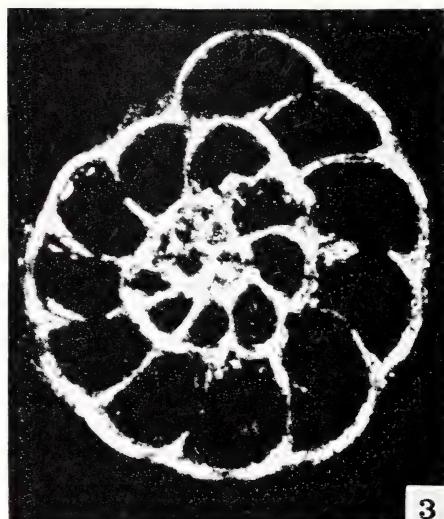


PLATE 28

FIGS 1-4. *Elphidium exoticum* Haynes n. sp. 1, equatorial section of megalospheric specimen, ord. light  $\times 160$ ; 2, equatorial section showing optically granular wall structure, crossed nicols  $\times 160$ ; 3, equatorial section of additional megalospheric specimen, ord. light  $\times 160$ ; 4, axial section, ord. light  $\times 160$ .

FIGS 5-7. *Elphidium magellanicum* (Heron-Allen & Earland). 5, equatorial section of megalospheric specimen showing thin, radial wall, ord. light  $\times 160$ ; 6 and 7, axial section, ord. light and crossed nicols  $\times 160$ .

FIGS 8, 9. *Elphidium incertum* (Williamson). 8, equatorial section of megalospheric specimen showing optically granular wall, crossed nicols  $\times 160$ ; 9, equatorial section of 'paralectotype' showing granular wall, crossed nicols  $\times 160$ .

FIGS 10, 11. *Elphidium waddensis* (Voorthuysen). 10, equatorial section of megalospheric specimen, ord. light  $\times 120$ ; 11, detail of equatorial section showing thick, radial, lamellar wall and coarse pores  $\times 250$ .

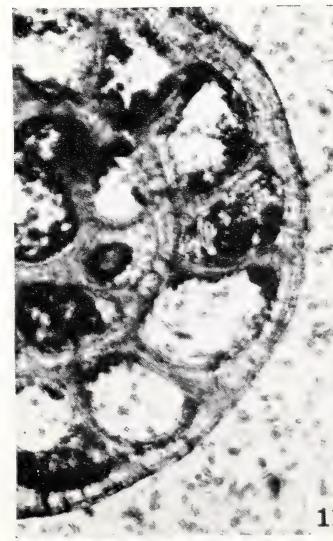
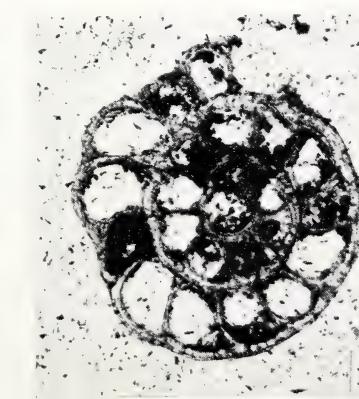
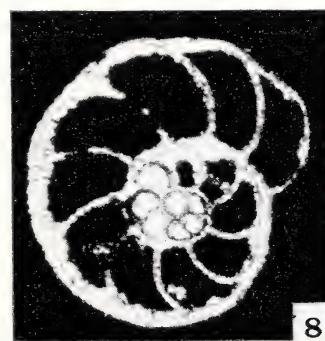
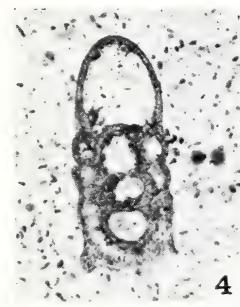
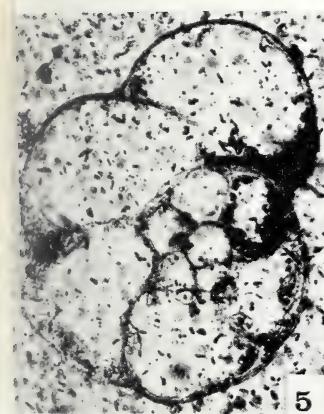
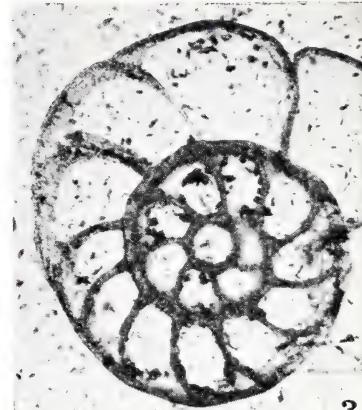
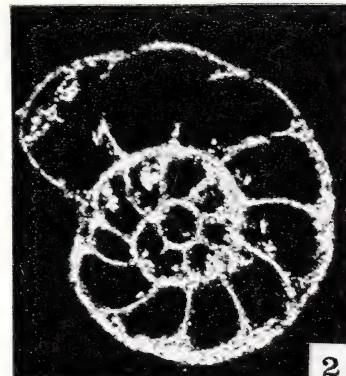
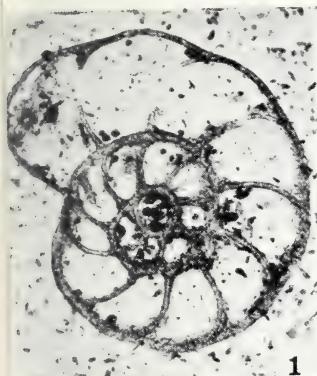


PLATE 29

FIGS 1-3. *Elphidium selseyense* (Heron-Allen & Earland). 1, equatorial section of lobate megalospheric specimen, ord. light  $\times 120$ ; 2, equatorial section of more entire megalospheric specimen, ord. light  $\times 120$ ; 3, lobate specimen showing radial, lamellar walls, crossed nicols  $\times 120$ . Note pseudo extinction cross in proloculus.

FIG. 4. *Cyclogyra selseyense* (Heron-Allen & Earland) showing proloculus and thin porcelainous wall (brown in transmitted light)  $\times 120$ .

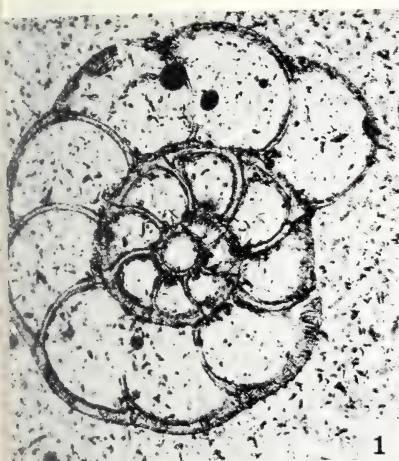
FIGS 5, 6. *Ammobaculites balkwilli* Haynes n. sp. equatorial section by ord. light and crossed nicols showing agglutinated grains and their vertical arrangement around the aperture and foramen  $\times 80$ .

FIG. 7. *Haplophragmoides wilberti* Anderson, equatorial section showing tectinous early chambers, ord. light  $\times 80$ .

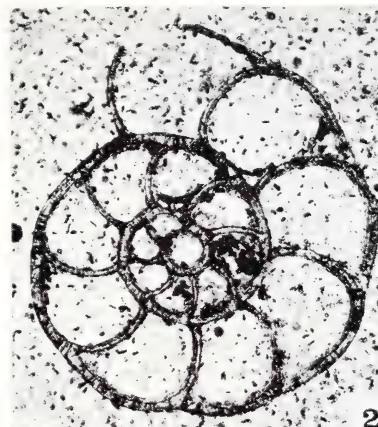
FIG. 8. *Elphidium margaritaceum* (Cushman), equatorial section showing weakly radial wall, crossed nicols  $\times 120$ .

FIG. 9. *Nonion depressulus* (Walker & Jacob), equatorial section showing optically granular wall  $\times 240$ .

FIG. 10. *Cribostomoides jeffreysii* (Williamson), axial section showing agglutinated grains, crossed nicols  $\times 160$ .



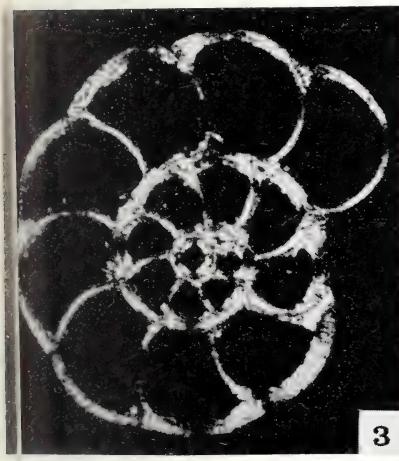
1



2



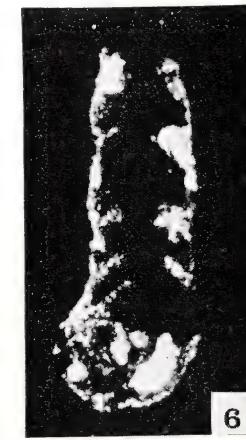
5



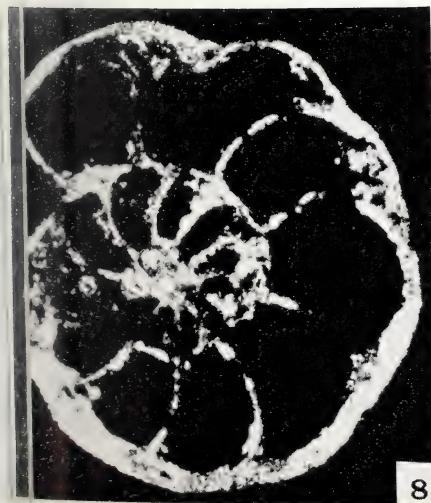
3



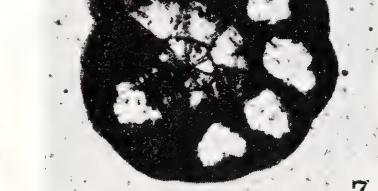
4



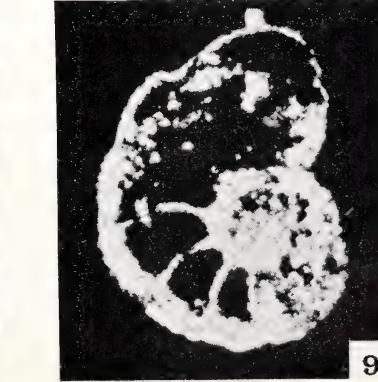
6



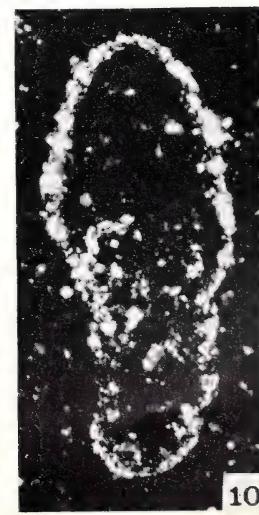
8



7



9



10

PLATE 30

FIGS 1, 2. *Rosalina anomala* Terquem. 1, vertical section showing proloculus and open umbilicus, ord. light  $\times 80$ ; 2, close up showing tectin layer  $\times 250$ .

FIG. 3. *Rosalina praegeri* (Heron-Allen & Earland), vertical section showing weakly radial lamellar structure and closed umbilicus, ord. light  $\times 240$ .

FIGS 4, 5. *Discorbis wrightii* (Brady). 4, vertical section showing thick, lamellar, coarsely punctate wall and umbilical plug, ord. light  $\times 250$ ; 5, same under crossed nicols  $\times 240$ . Note pseudo extinction cross in proloculus.

FIG. 6. *Rosalina milletii* (Wright), vertical section showing partially open umbilicus and plano-convex form, ord. light  $\times 240$ .

FIG. 7. *Ammonia tepida* (Cushman), horizontal section showing proloculus, ord. light  $\times 120$ .

FIG. 8. *Ammonia limnetes* (Todd & Bronnimann), close-up of horizontal section showing extremely thin, radial wall, "double septa" not readily apparent, ord. light  $\times 250$ .

FIGS 9, 10. *Rosalina irregularis* Rhumbler, off centre vertical section by ord. light and crossed nicols, apparently optically granular with inner tectin lining  $\times 80$  (apparently bilamellar).

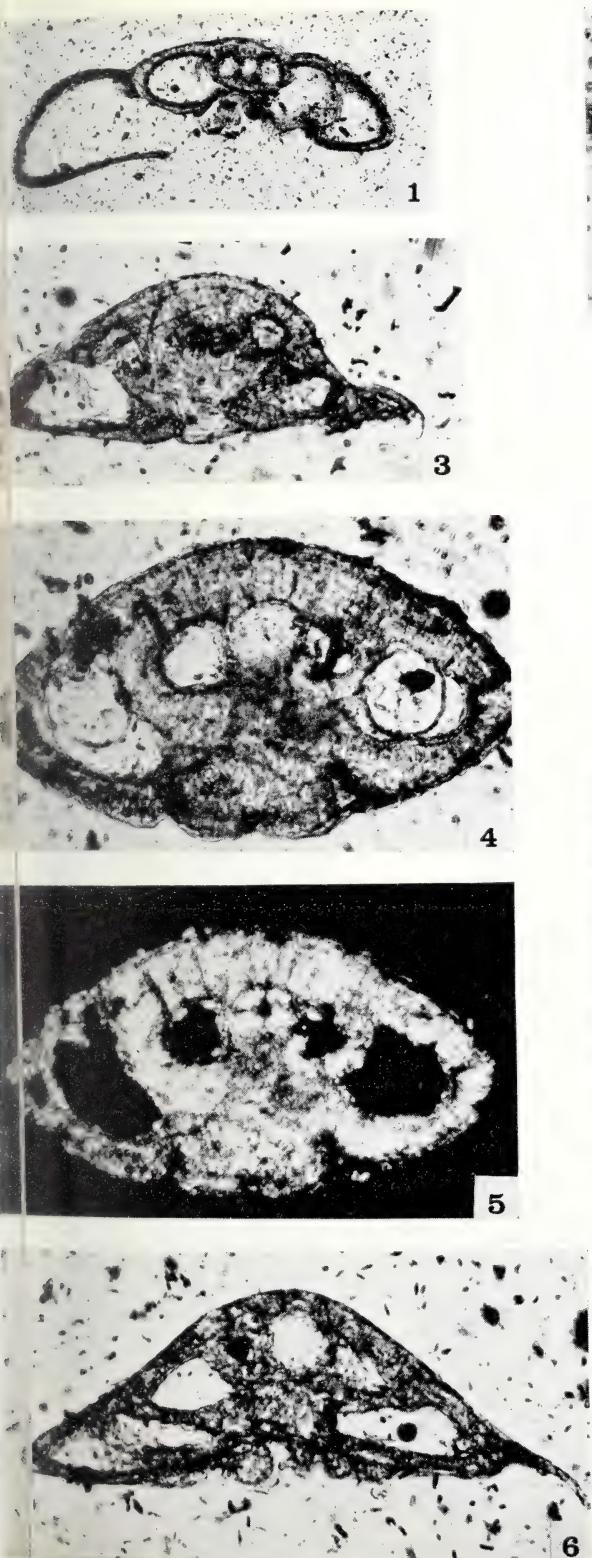


PLATE 31

Figs 1-5. *Quinqueloculina aspera* d'Orbigny. 1, 2, horizontal section of specimen with large first chamber by ord. light and crossed nicols  $\times 120$ ; 3, detail of chamber wall showing quartz silt grains embedded in outer layers of porcelaneous wall  $\times 250$ ; 4, horizontal section of additional specimen with smaller first chamber, ord. light  $\times 120$ ; 5, detail of same showing agglutinated grains in outer wall  $\times 250$ .

Figs 6, 7. *Miliammina fusca* (Brady). 6, horizontal section showing that the wall is entirely made up of agglutinated quartz silt grains, ord. light  $\times 240$ ; 7, same by crossed nicols  $\times 200$ .

Figs 8, 9. *Miliolinella subrotunda* (Montagu). 8, horizontal section showing flattened quinqueloculine chamber arrangement, ord. light  $\times 120$ ; 9, detail of chamber wall showing parallel layers  $\times 250$ .

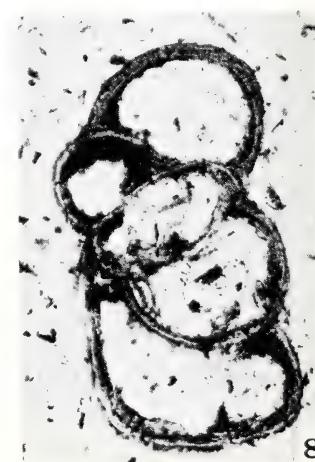
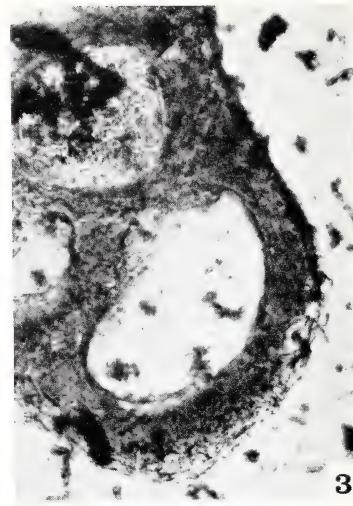
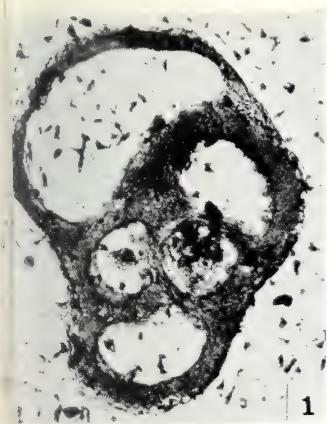


PLATE 32

FIGS 1-3. *Quinqueloculina seminulum* (Linnaeus). 1, horizontal section showing rounded trigonal form, ord. light  $\times 120$ ; 2, detail of wall showing inner and outer layers  $\times 250$ ; 3, horizontal section of additional specimen, ord. light  $\times 160$ .

FIG. 4. *Massilina secans* (d'Orbigny), horizontal section showing keels and inner and outer layers of the wall, ord. light  $\times 80$ .

FIG. 5. *Triloculina trigonula* (Lamarck), horizontal section showing inner and outer layers, ord. light  $\times 120$ .

FIGS 6-9. *Cibicides refulgens* Montfort. 6, horizontal section showing 'bilamellid' wall with dark tectin intervening layer, ord. light  $\times 40$ . Note how the outer lamellae build up a thick crust in the early part of the test; on the other hand the outer layer and tectin lining are difficult to distinguish in the final chamber; 7, close-up of same showing lamellae  $\times 80$ ; 8, detail of septa  $\times 80$ ; 9, vertical section  $\times 40$ . Here again the outer lamella is difficult to distinguish in the final chamber.



1



2



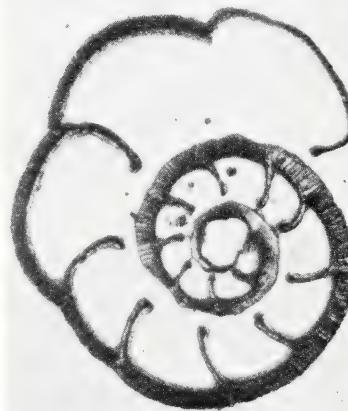
3



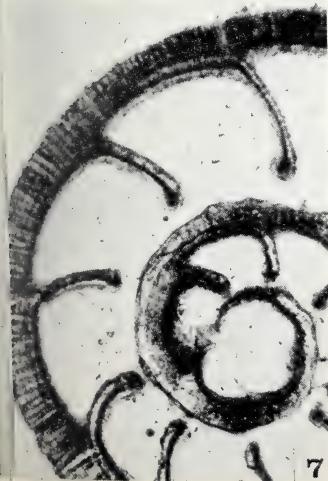
4



5



6



7



8



9

PLATE 33

FIGS 1, 2. *Cibicides lobatulus* (Walker & Jacob) from Moss Head. 1, horizontal section showing proloculus and 'bilamellid' wall structure, ord. light  $\times 60$ ; 2, vertical section, ord. light  $\times 80$ . Note how the outer lamellae build up into a thick crust in the early part of the test while the last chamber merely abutts the previous ones, the outer layer being thin and hard to distinguish from the tectin layer.

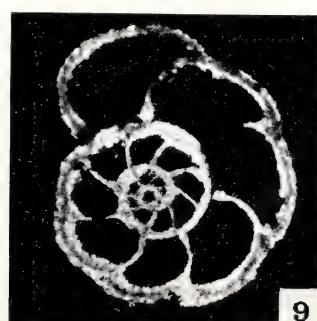
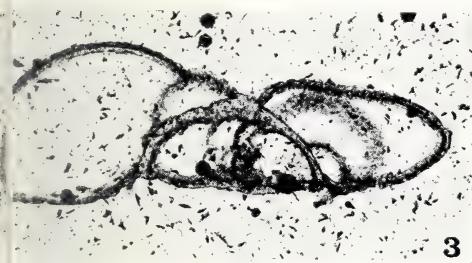
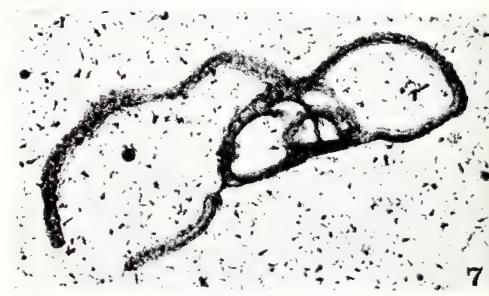
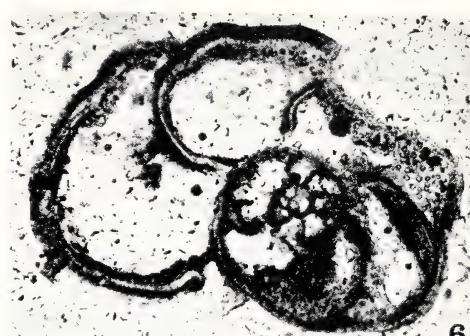
FIGS 3, 4. *Cibicides lobatulus* (Walker & Jacob) from Dogs Bay, vertical sections showing 'bilamellid' wall structure, ord. light  $\times 80$ . Note pores.

FIGS 5-7. *Cibicides lobatulus* (Walker & Jacob) from Cardigan Bay. 5 and 7, vertical sections, ord. light  $\times 80$ ; 6, horizontal section showing proloculus and pores on dorsal side, ord. light  $\times 80$ . Dried protoplasm, showing black, as at the aperture, obscures the details but essentially the wall structure is the same as in the other specimens illustrated.

FIG. 8. *Cibicides pseudoungerianus* (Cushman), horizontal section showing radial lamellar wall, by crossed nicols  $\times 40$ .

FIG. 9. *Cibicides cassivellauni* Haynes, horizontal section showing optically granular wall, by crossed nicols  $\times 80$ .

FIG. 10. *Siphonina georgiana* Haynes n. sp. holotype, side and apertural view showing keel and lines of pores  $\times 120$ .







A LIST OF SUPPLEMENTS  
TO THE ZOOLOGICAL SERIES  
OF THE BULLETIN OF  
THE BRITISH MUSEUM (NATURAL HISTORY)

---

1. KAY, E. ALISON. Marine Molluscs in the Cuming Collection British Museum (Natural History) described by William Harper Pease. Pp. 96; 14 Plates. 1965. (Out of Print.) £3.75.
2. WHITEHEAD, P. J. P. The Clupeoid Fishes described by Lacepede, Cuvier and Valenciennes. Pp. 180; 11 Plates, 15 Text-figures. 1967. £4.
3. TAYLOR, J. D., KENNEDY, W. J. & HALL, A. The Shell Structure and Mineralogy of the Bivalvia. Introduction. Nuculacea-Trigonacea. Pp. 125; 29 Plates, 77 Text-figures. 1969. £4.50.



